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CAMBRIDGE UNIT
DEVELOPMENTS PTY LTD

Geotechnical Investigation

143A Stoney Creek Road, Beverly Hills, NSW

E23967.G03_Rev4
19 May 2020

Document Control

Report Title: Geotechnical Investigation

Report No: E23967.G03_Rev4

Copies	Recipient
1 Soft Copy (PDF – Secured, issued by email)	Cambridge Unit Developments Pty Ltd C/- Mr Chris Ryan PO Box 165, Cronulla Cronulla NSW 2230
2 Original (Saved to Digital Archives) (Z:\07 - Projects\E23967_Sutherland & Associates_Beverly Hills_DSI\05_Deliverables\Work in Progress\E23967.G03_Rev4 - Report.docx)	EI Australia Suite 6.01, 55 Miller Street, PYRMONT NSW 2009

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Revision	Details	Date	Amended By
	Original	19 March 2020	
Rev1	Revised based on updated drawings and client comments	27 March 2020	DS
Rev2	Revised based on updated drawings and client comments	12 May 2020	DS
Rev3	Revised based on updated drawings	18 May 2020	DS
Rev3	Updated with final drawing references	19 May 2020	DS

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1. Introduction

1.1 Background

At the request of Chris Ryan on behalf of Cambridge Unit Developments Pty Ltd (the Client), EI Australia (EI) has carried out a Geotechnical Investigation (GI) for the proposed development at 143A Stoney Creek Road, Beverly Hills, NSW (the Site).

This GI report has been prepared to provide advice and recommendations to assist in the preparation of designs for the proposed development. The investigation has been carried out in accordance with the agreed scope of works outlined in EI's proposal referenced P15449.5, dated 25 February 2020.

EI has completed a Detailed Site Investigation (DSI) Report, referenced E23967.E02_Rev1, dated 7 February 2020. This GI report should be read in conjunction with the DSI report.

1.2 Proposed Development

The following documents, supplied by the Client, were used to assist with the preparation of this GI report:

- Architectural drawings prepared by Rothe Lowman Property – Dated 18 May 2020, Drawing Nos. TP00.00 (Rev P5), TP00.01 (Rev P3), TP01.01 (Rev P6), TP01.02 (Rev P6), TP01.03 (Rev P6), TP01.04 (Rev P6), TP01.05 (Rev P5), TP01.06 (Rev P5), TP01.07 (Rev P4), TP03.01 (Rev P5), TP03.02 (Rev P4), TP03.03 (Rev P4), TP03.04 (Rev P3), TP10.00 (Rev P5), TP10.01 (Rev P5); and
- Site survey plan prepared by LTS Lockley – Referenced 50474001DT, dated 20 September 2018. The datum in the survey plan is in Australian Height Datum (AHD), hence all Reduced Levels (RL) mentioned in this report are henceforth in AHD.

Based on the provided documents, EI understands that the proposed development involves the demolition of the existing site structures and the construction of a three-storey medical centre overlying a three-level basement. The lowest basement is proposed to have a finished floor level (FFL) of RL 19.5m Australian Height Datum (AHD). A Bulk Excavation Level (BEL) of RL 19.2m AHD is assumed for the construction which includes allowance for a concrete basement slab. To achieve the BEL, an excavation depth of about 10.8m Below Existing Ground Level (BEGL) is expected. Locally deeper excavations may be required for footings, service trenches, crane pads, and lift overrun pits.

1.3 Objectives

The objective of the GI was to assess site surface and subsurface conditions at four borehole locations, and to provide geotechnical advice and recommendations addressing the following:

- Dilapidation Surveys;
- Excavation methodologies and monitoring requirements;
- Groundwater considerations;
- Vibration considerations;
- Excavation support requirements, including geotechnical design parameters for retaining walls and shoring systems;

- Building foundation options, including;
    - Design parameters.
    - Earthquake loading factor in accordance with AS1170.4:2007.
- The requirement for additional geotechnical works.

1.4 Scope of Works

The scope of works for the GI included:

- Preparation of a Work Health and Safety Plan;
- Review of relevant geological maps for the project area;
- Site walkover inspection by a Geotechnical Engineer to assess topographical features and site conditions;
- Scanning of proposed borehole locations for buried conductive services using a licensed service locator with reference to Dial Before You Dig (DBYD) plans;
- Auger drilling of four boreholes (BH101M, BH102, BH103 and BH104) by a track-mounted drill rig using solid flight augers equipped with a ‘Tungsten-Carbide’ (T-C) bit. BH101M, BH102, BH103 and BH104 were auger drilled to depths of about 6.2m BEGL (RL 23.7m), 6.5m BEGL (RL 23.6m), 6.5m BEGL (RL 23.5m) and 7.6m BEGL (RL 22.4m), respectively.
    - Standard Penetration Testing (SPT) was carried out (as per AS 1289.6.3.1-2004), where possible, during auger drilling of the boreholes to assess soil strength/relative densities.
    - Measurements of groundwater seepage/levels, where possible, in the augered sections of the boreholes during and shortly after completion of auger drilling;
    - The strength of the bedrock in the augered sections of the boreholes was assessed by observation of the auger penetration resistance using a T-C drill bit and examination of the recovered rock cuttings. It should be noted that rock strengths assessed from augered boreholes are approximate and strength variances can be expected.
    - The approximate surface levels shown on the borehole logs were interpolated from spot levels shown on the supplied survey plan. Approximate borehole locations are shown on **Figure 2**;
- Continuation of BH101M, BH102, BH103 and BH104 using NMLC diamond coring techniques to a termination depth of about 13.4m BEGL (RL 16.5m), 13.1m BEGL (RL 17m), 13.4m BEGL (RL 16.6m) and 9.4m BEGL (RL 20.6m), respectively. The rock core photographs are presented in **Appendix A**;
- Borehole BH101M was converted into a groundwater monitoring well with a depth of 11.0m BEGL (RL 18.9m) to allow for long-term groundwater monitoring.
- Boreholes BH102, BH103 and BH104 were backfilled with drilling spoils upon completion;
- Soil and rock samples were sent to Macquarie Geotechnical Pty Ltd (Macquarie) and SGS Australia (SGS), which are National Australian Testing Authority (NATA) accredited laboratories, for testing and storage.
- Preparation of this GI report.

An EI Geotechnical Engineer was present full-time onsite to set out the borehole locations, direct the testing and sampling, log the subsurface conditions and record groundwater levels.

1.5 Constraints

The GI was limited by the intent of the investigation and the presence of existing site structures. The discussions and advice presented in this report are intended to assist in the preparation of final designs for the proposed development. Further geotechnical inspections should be carried out during construction to confirm the geotechnical and groundwater models, and the design parameters provided in this report.

2. Site Description

2.1 Site Description and Identification

The site identification details and associated information are presented in **Table 2-1** below while the site locality is shown on **Figure 1.** An aerial photograph of the site is presented in **Plate 1** below.

Table 2-1 Summary of Site Information

Information	Detail
Street Address	143A Stoney Creek Road, Beverly Hills, NSW
Lot and Deposited Plan (DP) Identification	Lot 2 & 3 in DP 1205598
Brief Site Description	At the time of our investigation, the site was occupied by an untenanted, single storey rendered building in the northern corner of the site with the majority of the site occupied by concrete-paved parking areas and laneways. Based on a Dial Before You Dig search for Sydney Water assets (Ref. 19025301, dated 12 February 2020), a 1981x1219 reinforced concrete stormwater line runs beneath the eastern half of the site in a roughly north-south orientation at an unknown depth. We understand that the existing easement is proposed to be removed and made good for new easement diverting back into existing line.
Site Area	The site area is approximately 2460m^2 (based on the provided survey plan referenced above).

Plate 1: Aerial photograph of the site (source: Nearmap, accessed 21/1/18)

2.2 Local Land Use

The site is situated within an area of residential use. Current uses on surrounding land at the time of our presence on site are described in **Table 2-2** below. For the sake of this report, the site boundary adjacent to Stoney Creek Road shall be adopted as the northern site boundary.

Table 2-2 Summary of Local Land Use

Direction Relative to Site	Land Use Description
North	Stoney Creek Road, a four lane, asphalt-paved road. Beyond this are three to four-storey brick residential dwellings with no basements observed onsite. Stoney Creek Road is a Roads and Maritimes Services (RMS) asset.
East	Cambridge Street, a two lane asphalt paved road. Beyond this are single storey brick residential buildings.
South	Property ay 147 Cambridge Street, which consists of three single storey brick townhouse buildings, concrete driveway and landscaped areas. The buildings are set back approximately 2.0m to 2.5m from the southern site boundary.
West	Properties at 108 Arcadia Street and 141a Stoney Creek Road, both of which are two storey residential properties. The properties are at a similar elevation in relation to the Site. An in-ground swimming pool, which is set back approximately 1m from the western site boundary, was observed within 141a Stoney Creek Road.

2.3 Regional Setting

The site topography and geological information for the locality is summarised in **Table 2-3** below**.**

Table 2-3 Topographic and Geological Information

Attribute	Description
Topography	The site is flat and raised up in relation to the surrounding topography. The site levels are at RL 29.9 to 30.1m whereas the surrounding topography dips gently (<10°) towards the north with site levels varying from RL 30.1 at the southern corner to RL 29.4 at the northern corner.
Regional Geology	Information on regional sub-surface conditions, referenced from the Department of Mineral Resources Geological Map Sydney 1:100,000 Geological Series Sheet 9130 (DMR 1983) indicates the site to be underlain by Ashfield Shale, which consists of black to dark grey shale and laminite.

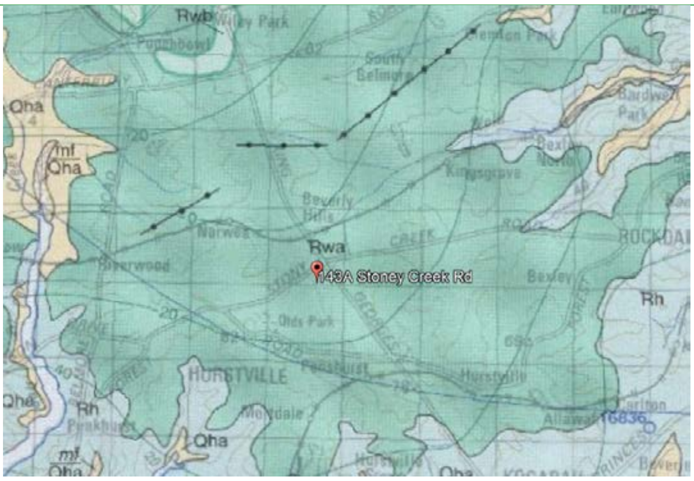


Plate 2: Excerpt of geological map showing location of site.

3. Assessment Results

3.1 Stratigraphy

For the development of a site-specific geotechnical model, the stratigraphy observed in the GI has been grouped into four geotechnical units. A summary of the subsurface conditions across the site, interpreted from the assessment results, is presented in **Table 3-1** below. More detailed descriptions of subsurface conditions at each borehole location are available on the borehole logs presented in **Appendix A**. The details of the methods of soil and rock classifications, explanatory notes and abbreviations adopted on the borehole logs are also presented in **Appendix A.**

Table 3-1 Summary of Subsurface Conditions

Unit	Material[2]	Depth to Top of Unit (m BEGL)[1]	RL of Top of Unit (m AHD)[1]	Observed Thickness (m)	Comments
1	**Fill**	0.00 (Surface)	29.9 to 30.1	0.9 to 1.5	Concrete pavements of 140mm to 160mm thickness, underlain by gravelly sand / silty clay fill. Fill was assessed, based on our observations during drilling and SPT N Values to be poorly compacted;
2	**Residual Soil**	0.9 to 1.5	28.5 to 29.1	4.6 to 6.1	High plasticity, stiff to hard silty clay with ironstone gravels. SPT N values ranged from 7 to 37.
3	**Very Low to Low Strength Shale**	5.5 to 7.6	22.4 to 24.5	5.5 to 7.6	Distinctly weathered, very low to low strength shale, with occasional medium strength bands. The shale/siltstone in BH102 was visibly heat-affected by a possible nearby igneous intrusion, and was highly fractured. BH104 terminated in Unit 3.
4	**Medium Strength Shale**	9.9 to 12.1	18.0 to 20.0	-[3]	Slightly weathered to fresh, medium strength shale.

Note 1 Approximate depth and level at the time of our assessment. Depths and levels may vary across the site.
Note 2 For more detailed descriptions of the subsurface conditions, reference should be made to the borehole logs attached to **Appendix A.**
Note 3 Observed up to termination depth in BH101M, BH102 and BH103 only.

A summary of the depth/RL of the shale units in each borehole is summarised in **Table 3-2 below.**

Table 3-2 Summary of Depth and RL of Shale Units in Each Borehole

	Depth to Unit in Borehole (m BEGL) [RL of top of Unit in Borehole (m AHD)]			
Unit	BH101M	BH102	BH103	BH104
3 – Very Low to Low Strength Shale	6.2 [23.7]	6.5 [23.6]	5.5 [24.5]	7.6 [22.4]
4 – Medium Strength Shale	9.9 [20.0]	12.1 [18.0]	11.1 [18.9]	**-**

- = Not Encountered in Borehole BH104

3.2 Groundwater Observations

Groundwater seepage was observed during auger drilling of BH104 only. Following completion, a groundwater monitoring well were installed in BH101M and bailed dry. The groundwater levels were then measured within BH101M and existing monitoring wells onsite as per **Table 3-3** below:

Table 3-3 Groundwater Levels

Borehole ID	Measurement Date	Depth to Groundwater (m BEGL)	Groundwater RL (m AHD)
BH1M	18/02/2020	0.7	29.3
BH5M	18/02/2020	1.0	29.1
BH6M	18/02/2020	1.7	28.3
BH101M	19/02/2020	3.5	26.4

We note that the groundwater levels in BH101M may not have become evident or stabilised in within the limited observation period.

3.3 Test Results

Four soil samples were selected for laboratory testing to assess the following:

- Atterberg Limits and Linear Shrinkage
- Soil aggressivity (pH, chloride and sulfate content and electrical conductivity).

A summary of the soil test results is provided in **Table 3-4** below. Laboratory test certificates are presented in **Appendix B**.

Table 3-4 Summary of Soil Laboratory Test Results

Test/ Sample ID		BH102_2.0-2.45	BH101M_1.5-1.95	BH103_3.0-3.45	BH104_4.5-4.95
Unit		2	2	2	2
Material Description [1]		Silty CLAY	Silty CLAY	Silty CLAY	Silty CLAY
Aggressivity	Chloride Cl (ppm)	-	30	550	360
	Sulfate SO_4 (ppm)	-	280	190	140
	pH	-	5.4	4.5	5.2
	Electrical Conductivity (µS/cm)	-	190	520	360
	Moisture Content (%)	22.7	23.2	15.6	8.5
Attergerg Limits	Liquid Limit (%)	69	-	-	-
	Plastic Limit (%)	21	-	-	-
	Plasticity Index (%)	48	-	-	-
	Linear Shrinkage (%)	15	-	-	-

Note 1 More detailed descriptions of the subsurface conditions at each borehole location are available on the borehole logs presented in **Appendix A**.

The Atterberg Limits result on the selected clay sample indicated clays to be of high plasticity and of high shrink-swell potential.

The assessment indicated low permeability soil was present above the groundwater table. In accordance with Tables 6.4.2(C) and 6.5.2(C) of AS 2159:2009 'Piling – Design and Installation', the results of the pH, chloride and sulfate content and electrical conductivity of the soil provided the following exposure classifications:

- 'Mild' for buried concrete structural elements; and
- 'Mild' to 'Non-Aggressive' for buried steel structural elements.

In accordance with Table 4.8.1 of AS3600-2009 'Concrete Structures' these soils would be classified as exposure classification 'A2' for concrete in sulfate soils.

22 selected rock core samples were tested by Macquarie to estimate the Point Load Strength Index (Is_{50}) values to assist with rock strength assessment. The results of the testing are summarised on the attached borehole logs.

The point load strength index tests generally correlated reasonably well with our field assessments of rock strength, with the exception of a few tests from BH101M and BH102 which suggested that there were medium to high strength bands within Unit 3. The approximate Unconfined Compressive Strength (UCS) of the rock core, estimated from correlations with the point load strength index test results, varied from <1 MPa to 41 MPa.

4. Recommendations

4.1 Geotechnical Issues

Based on the results of the assessment, we consider the following to be the main geotechnical issues for the proposed development:

- Basement excavation and retention to limit lateral deflections and ground loss as a result of excavations, resulting in damage to nearby structures;
- Rock excavation;
- Groundwater within the depth of the excavation;
- Possible volcanic intrusion within the site with an unknown extent;
- Presence of nearby Sydney Water and RMS assets; and
- Foundation design for building loads.

4.2 Dilapidation Surveys

Prior to excavation and construction, we recommend that detailed dilapidation surveys be carried out on all structures and infrastructures surrounding the site that falls within the zone of influence of the excavation to allow assessment of the recommended vibration limits and protect the client against spurious claims of damage. The zone of influence of the excavation is defined by a distance back from the excavation perimeter of twice the total depth of the excavation. The reports would provide a record of existing conditions prior to commencement of the work. A copy of each report should be provided to the adjoining property owner who should be asked to confirm that it represents a fair assessment of existing conditions. The reports should be carefully reviewed prior to demolition and construction.

4.3 Excavation Methodology

4.3.1 Excavation Assessment

Prior to any excavation commencing, we recommend that reference be made to the Safe Work Australia Excavation Work Code of Practice, dated August 2019.

EI assumes that the proposed development will require a BEL of RL 19.2m for the basement, or an excavation depth of about 10.8m BEGL. Locally deeper excavations for footings, service trenches, crane pads and lifts overrun pits may be required.

Based on the borehole logs, the proposed basement excavations will therefore extend through Units 1 to 3 and possibly Unit 4 in some areas of the site as outlined in **Table 3-1** above. As such, an engineered retention system must be installed prior to excavation commencing.

Units 1, 2 and 3 could be excavated using buckets of large earthmoving Hydraulic Excavators, particularly if fitted with ‘Tiger Teeth’. Excavation of harder bands in Unit 3 and Units 4 (if encountered) may present hard or heavy ripping, or “hard rock” excavation conditions. Ripping would require a high capacity and heavy bulldozer for effective production. Wear and tear should also be allowed for. The use of a smaller size bulldozer will result in lower productivity and higher wear and tear, and this should be allowed for. Alternatively, hydraulic rock breakers, rock saws, ripping hooks or rotary grinders could be used, though productivity would be lower and equipment wear increased, and this should be allowed for.

Should rock hammers be required for the excavation of the medium strength bedrock, further advice should be sought from EI regarding vibration mitigation and monitoring.

Groundwater seepage monitoring should be carried out during bulk excavation works and prior to finalising the design of a pump out facility. Outlets into the stormwater system will require Council approval.

Furthermore, any existing buried services, which run below the site, will require diversion prior to the commencement of excavation or alternatively be temporarily supported during excavation, subject to permission or other instructions from the relevant service authorities. Enquiries should also be made for further information and details, such as invert levels, on the buried services. It is our understanding that the easement for Sydney Water is proposed to be diverted during construction.

4.3.2 Excavation Monitoring

Consideration should be made to the impact of the proposed development upon neighbouring structures, roadways and services. Basement excavation retention systems should be designed so as to limit lateral deflections.

Contractors should also consider the following limits associated with carrying out excavation and construction activities:

- Limit lateral deflection of temporary or permanent retaining structures, particularly along Stoney Creek Road, an RMS asset;
- Limit vertical settlements of ground surface at common property boundaries and services easement; and
- Limit Peak Particle Velocities (PPV) from vibrations, caused by construction equipment or excavation, experienced by any nearby structures and services.

Monitoring of deflections of retaining structures and surface settlements should be carried out by inclinometers and/or a registered surveyor at agreed points along the excavation boundaries and along existing building foundations / services / pavements and other structures located within or near the zone of influence of the excavation. Owners of existing services adjacent to the site should be consulted to assess appropriate deflection limits for their infrastructures. Measurements should be taken in the following sequence:

- Before commencing installation of retaining structures where appropriate to determine the baseline readings. Two independent sets of measurements must be taken confirming measurement consistency;
- After installation of the retaining structures, but before commencement of excavation;
- After excavation to the first row of supports or anchors, but prior to installation of these supports or anchors;
- After excavation to any subsequent rows of supports or anchors, but prior to installation of these supports or anchors;
- After excavation to the base of the excavation;
- After de-stressing and removal of any rows of supports or anchors; and
- One month after completion of the permanent retaining structure or after three consecutive measurements not less than a week apart showing no further movements, whichever is the latter.

4.4 Groundwater Considerations

Groundwater was observed in all monitoring wells as detailed in **Table 3-2**, all of which are above the assumed BEL RL of 19.2m.

Due to the low permeability of the soil and bedrock profile, and the stiffness of the residual soil, any groundwater inflows into the excavation should not have an adverse impact on the proposed development or on the neighbouring sites and should be manageable during construction and as a drained basement in the long term. However, we expect that some groundwater inflows into the excavation along the soil/rock interface and through any defects within the shale bedrock (such as jointing, and bedding planes, etc.) particularly following a period of heavy rainfall. The initial flows into the excavation may be locally high, but would be expected to decrease considerably with time as the bedding seams/joints are drained. We recommend that monitoring of seepage be implemented during the excavation works to confirm the capacity of the drainage system.

We expect that any seepage that does occur will be able to be controlled by a conventional sump and pump system. We recommend that a sump-and-pump system be used both during construction and for permanent groundwater control below the basement floor slab.

In the long term, drainage should be provided behind all basement retaining walls, around the perimeter of the basement and below the basement slab. The completed excavation should be inspected by the hydraulic engineer to confirm that adequate drainage has been allowed for. Drainage should be connected to the sump-and-pump system and discharging into the stormwater system. The permanent groundwater control system should take into account any possible soluble substances in the groundwater which may dictate whether or not groundwater can be pumped into the stormwater system.

The design of drainage and pump systems should take the above issues into account along with careful ongoing inspections and maintenance programs.

We recommend that pump-out tests and seepage analysis is undertaken to assess the expected groundwater seepage volumes into the excavation during construction and the structure’s lifetime.

4.5 Excavation Retention

4.5.1 Support Systems

From a geotechnical perspective, it is critical to maintain the stability of all adjacent structures and infrastructures during demolition, excavation and construction works.

Based on the provided architectural plans, the proposed basement outline has a setback between approximately 4.0m to 5.5m from the northern boundary, 4.0m from the western boundary and 3.0m from the eastern boundary, with the basement abutting the southern boundary. Based on the encountered subsurface conditions, proposed basement excavation depth, and the above setbacks, temporary batters are not suitable to support the excavation for this site.

Unsupported vertical cuts of the soil are not recommended for this site as these carry the risk of potential slumping, especially after a period of wet weather. Slumping of the material may result in injury to personnel and/or damage to nearby structures/infrastructures and equipment.

Hence, a suitable retention system will be required for the support of the entire depth of the excavation. For this site, EI recommends an anchored and/or propped soldier pile wall with mass concrete in between the piles be founded into medium strength shale (Unit 4). Anchors/props and mass concrete must be installed progressively as excavation proceeds. Where anchors are not feasible due to unobtainable permission from neighbours, or the presence of underground services (such as the Sydney Water asset), props may be required. Contiguous pile walls may be required where stiffer retaining walls are required.

Bored piles are considered to be the most suitable for this site. Tremie pumps may be required where high groundwater seepage inflows are present during the drilling of the bored piles. Relatively large capacity piling rigs may be required for drilling through the medium strength shale bedrock (Unit 4). The proposed pile locations should take into account the presence of buried services. Further advice should be sought from prospective piling contractors who should be provided with a copy of this report.

4.5.2 Retaining Wall Design Parameters

The following parameters may be used for static design of temporary and permanent retaining walls at the subject site:

- For progressively anchored or propped walls where minor movements can be tolerated (provided there are no buried movement sensitive services), we recommend the use of a trapezoidal earth pressure distribution of 4H kPa for soil, where H is the retained height in meters. These pressures should be assumed to be uniform over the central 50% of the support system, tapering to nil at top and bottom;
- For progressively anchored or propped walls which support areas which are highly sensitive to movement (such as areas where movement sensitive structures or infrastructures or buried services are located in close proximity), we recommend the use of a trapezoidal earth pressure distribution of 8H kPa for soil, where 'H' is the retained height in meters. These pressures should be assumed to be uniform over the central 50% of the support system, tapering to nil at top and bottom;
- All surcharge loading affecting the walls (including from construction equipment, construction loads, adjacent high level footings, etc.) should be adopted in the retaining wall design as an additional surcharge using an 'at rest' earth pressure coefficient, Ko, of 0.58;
- The retaining walls should be designed as drained and measures are to be taken to provide complete and permanent drainage behind the walls. Strip drains protected with a non-woven geotextile fabric should be used behind the shotcrete infill panels for soldier pile walls or inserted between gaps in contiguous piles.;
- For piles embedded into Unit 4 or better, the allowable lateral toe resistance values outlined in **Table 4-1** below may be adopted. These values assume excavation is not carried out within the zone of influence of the wall toe and the rock does not contain adverse defects etc. The upper 0.3m depth of the socket should not be taken into account to allow for tolerance and disturbance effects during excavation.
- If temporary anchors extend beyond the site boundaries, then permission from the neighbouring properties would need to be obtained prior to installation. Also, the presence of neighbouring basements and/or services and their levels must be confirmed prior to finalising anchor design**.**
- Anchors should have their bond length within Unit 3 or better. For the design of anchors bonded into Unit 3 or better, the allowable bond stress value outlined in **Table 4-1** below may be used, subject to the following conditions:
    1. Anchor bond lengths of at least 3m behind the 'active' zone of the excavation (taken as a 45 degree zone above the base of the excavation) is provided;
    2. Overall stability, including anchor group interaction, is satisfied;

3. All anchors should be proof loaded to at least 1.33 times the design working load before locked off at working load. Such proof loading is to be witnessed by and engineer independent of the anchoring contractor. We recommend that only experienced contractors be considered for anchor installation with appropriate insurances;
4. If permanent anchors are to be used, these must have appropriate corrosion provisions for longevity.

Table 4-1 Geotechnical Design Parameters

Material [1]		**Unit 1 Fill**	**Unit 2 Residual Soil**	**Unit 3 Very Low Strength Shale**	**Unit 4 Medium Strength Shale**
RL of Top of Unit (m AHD) [2]		**29.9 to 30.1**	**28.5 to 29.1**	**22.4 to 24.5**	**18.0 to 20.0**
Bulk Unit Weight (kN/m^3)		**18**	**20**	**24**	**24**
Friction Angle, ϕ' (°)		**25**	**28**	**-**	**-**
Earth Pressure Coefficients	At rest, K_o [3]	0.58	0.53	0.43	-
	Active, K_a [3]	0.41	0.36	0.27	-
	Passive, K_p [3]	-	-	3.69	-
Allowable Bearing Pressure (kPa) [5]		-	-	700	3000
Allowable Shaft Adhesion (kPa) [4, 5]	in Compression	-	-	70	300
	in Uplift	-	-	35	150
Allowable Toe Resistance (kPa)		-	-	-	250
Allowable Bond Stress (kPa)		-	-	50	200
Earthquake Site Risk Classification		▪ AS 1170.4:2007 indicates an earthquake subsoil class of Class C_e.(Shallow Soil) ▪ AS 1170.4:2007 indicates that the hazard factor (z) for Sydney is 0.08.			

Notes:

1 More detailed descriptions of subsurface conditions are available on the borehole logs presented in **Appendix A.**
2 Approximate levels of top of unit at the time of our investigation. Levels may vary across the site.
3 Earth pressures are provided on the assumption that the ground behind the retaining walls is horizontal.
4 Side adhesion values given assume there is intimate contact between the pile and foundation material and should achieve a clean socket roughness category R2 or better. Design engineer to check both 'piston pull-out' and 'cone liftout' mechanics in accordance with AS4678-2002 Earth Retaining Structures.
5 To adopt these parameters we have assumed that:
  - Footings have a nominal socket of at least 0.3m, into the relevant founding material;
  - For piles, there is intimate contact between the pile and foundation material (a clean socket roughness category of R2 or better);
  - Potential soil and groundwater aggressivity will be considered in the design of piles and footings;
  - Piles should be drilled in the presence of a Geotechnical Engineer prior to pile construction to verify that ground conditions meet design assumptions. Where groundwater ingress is encountered during pile excavation, concrete is to be placed as soon as possible upon completion of pile excavation. Pile excavations should be pumped dry of water prior to pouring concrete, or alternatively a tremmie system could be used;
  - The bases of all pile, pad and strip footing excavations are cleaned of loose and softened material and water is pumped out prior to placement of concrete;
  - The concrete is poured on the same day as drilling, inspection and cleaning.
  - The allowable bearing pressures given above are based on serviceability criteria of settlements at the footing base/pile toe of less than or equal to 1% of the minimum footing dimension (or pile diameter).

4.6 Foundations

Following bulk excavation, Unit 3 shale bedrock is expected to be exposed at BEL.

It is recommended that all footings for the building be founded within similar material to provide uniform support and reduce the potential for differential settlements.

For piles or pad footings founded into Unit 4 medium strength shale bedrock, these can be designed for a maximum end allowable bearing pressure of 3000kPa. The allowable shaft adhesion for piles in shale bedrock may be designed as 10% of the allowable bearing pressure (or 5% for uplift) for the socket length in excess of 0.5m.

Alternatively, the building may possibly be supported on shallow footings in Unit 3 shale, which is suitable for an allowable bearing pressure of 700kPa.

It is noted that a volcanic intrusion such as a dyke may be present in this site based on the results of BH102. Hence, variation of the ground conditions at bulk is likely and hence, we recommend frequent inspections of footings (shallow and/or piles) by a geotechnical engineer to verify that ground conditions meet design assumptions.

Where groundwater ingress is encountered during pile excavation, concrete is to be placed as soon as possible upon completion of pile excavation. Pile excavations should be pumped dry of water prior to pouring concrete, or alternatively a tremmie system could be used. Concrete must be poured on the same day as drilling, inspection and drilling.

The aggressivity of natural soils and groundwater (if encountered) should be taken into consideration in the design.

4.7 Basement Floor Slab

Following bulk excavations for the proposed basement, very low strength Unit 3 shale bedrock is expected to be exposed at the basement floor BEL.

Following the removal of all loose and softened materials, we recommend that underfloor drainage be provided and should comprise a strong, durable, single sized washed aggregate such as ‘blue metal gravel’. Joints in the concrete floor slab should be designed to accommodate shear forces but not bending moments by using dowelled and keyed joints. The basement floor slab should be isolated from columns. The completed excavation should be inspected by the hydraulic engineer to confirm the extent of the drainage required.

In addition, a system of sub-soil drains comprising a durable single sized aggregate with perforated drains/pipes leading to sumps should be provided. The basement floor slab should be isolated from columns.

Permission may need to be obtained from the NSW Department of Primary Industries (DPI) and possibly Council for any permanent discharge of seepage into the drainage system. Given the subsurface conditions, we expect that seepage volumes would be low and within the DPI limits. However, if permission for discharge is not obtained, the basement may need to be designed as a tanked basement.

4.8 Sydney Water and RMS assets

It is noted that RMS assets are present adjacent to and through the site. With proper engineering design, monitoring and construction, the proposed development can be constructed without adversely affecting these assets. RMS may request that finite element analysis and an accompanying monitoring plan be completed to confirm this, and EI can prepare these if requested.

It is our understanding that the Sydney Water asset is to be diverted.

5. Further Geotechnical Inputs

Below is a summary of the previously recommended additional work that needs to be carried out:

- Long term groundwater monitoring, pump-out tests and seepage modelling;
- Finite Element Analysis for impact assessment for Sydney Water and RMS (if required);
- Dilapidation surveys;
- Design of working platforms (if required) for construction plant by an experienced and qualified geotechnical engineer;
- Witnessing installation of support measures and proof-testing of anchors (if required).
- Geotechnical inspections of all new footings/piles by an experienced geotechnical professional before concrete or steel are placed to verify their bearing capacity and the in-situ nature of the founding strata; and
- Ongoing monitoring of groundwater inflows into the bulk excavation;

We recommend that a meeting be held after initial structural design has been completed to confirm that our recommendations have been correctly interpreted. We also recommend a meeting at the commencement of construction to discuss the primary geotechnical issues and inspection requirements.

6. Statement of Limitations

This report has been prepared for the exclusive use of Cambridge Unit Developments Pty Ltd who is the only intended beneficiary of EI's work. The scope of the assessment carried out for the purpose of this report is limited to those agreed with Cambridge Unit Developments Pty Ltd

No other party should rely on the document without the prior written consent of EI, and EI undertakes no duty, or accepts any responsibility or liability, to any third party who purports to rely upon this document without EI's approval.

EI has used a degree of care and skill ordinarily exercised in similar investigations by reputable members of the geotechnical industry in Australia as at the date of this document. No other warranty, expressed or implied, is made or intended. Each section of this report must be read in conjunction with the whole of this report, including its appendices and attachments.

The conclusions presented in this report are based on a limited investigation of conditions, with specific sampling and test locations chosen to be as representative as possible under the given circumstances.

EI's professional opinions are reasonable and based on its professional judgment, experience, training and results from analytical data. EI may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified by EI.

EI's professional opinions contained in this document are subject to modification if additional information is obtained through further investigation, observations, or validation testing and analysis during construction. In some cases, further testing and analysis may be required, which may result in a further report with different conclusions.

We draw your attention to the document "Important Information", which is included in **Appendix C** of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by EI, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

Should you have any queries regarding this report, please do not hesitate to contact EI.

References

AS1289.6.3.1:2004, *Methods of Testing Soils for Engineering Purposes,* Standards Australia.

AS1726:2017, *Geotechnical Site Investigations*, Standards Australia.

AS2159:2009, *Piling – Design and Installation*, Standards Australia.

AS3600:2009, *Concrete Structures,* Standards Australia

Safe Work Australia Excavation Work Code of Practice, dated August 2019 – WorkCover NSW

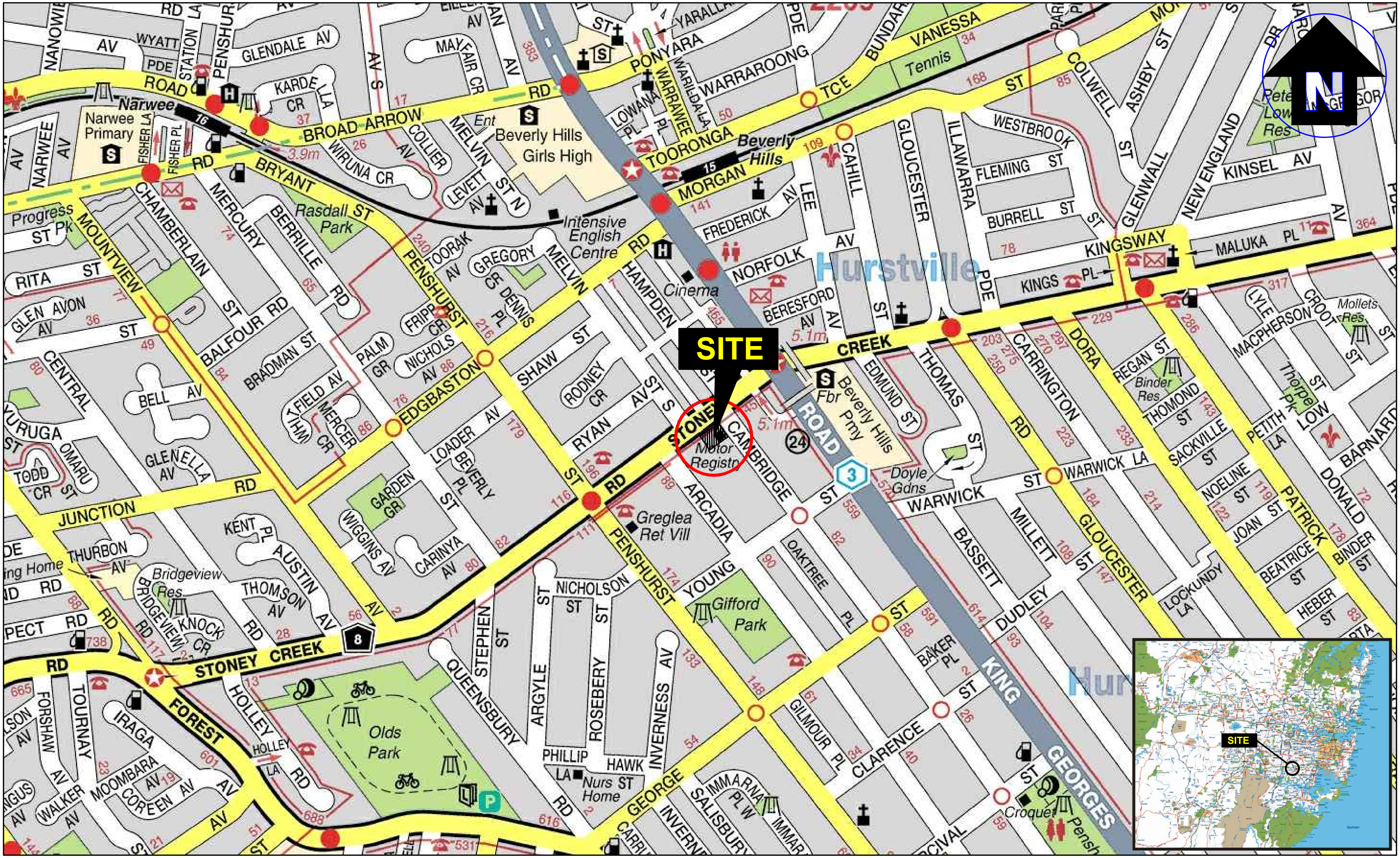
NSW Department of Finance and Service, Spatial Information Viewer, maps.six.nsw.gov.au.

NSW Department of Mineral Resources (1983) Sydney 1:100,000 Geological Series Sheet 9130 (Edition 1). Geological Survey of New South Wales, Department of Mineral Resources.

Abbreviations

AHD	Australian Height Datum
AS	Australian Standard
BEL	Bulk Excavation Level
BEGL	Below Existing Ground Level
BH	Borehole
DBYD	Dial Before You Dig
DP	Deposited Plan
EI	EI Australia
GI	Geotechnical Investigation
NATA	National Association of Testing Authorities, Australia
RL	Reduced Level
SPT	Standard Penetration Test
T-C	Tungsten-Carbide
UCS	Unconfined Compressive Strength

Figures



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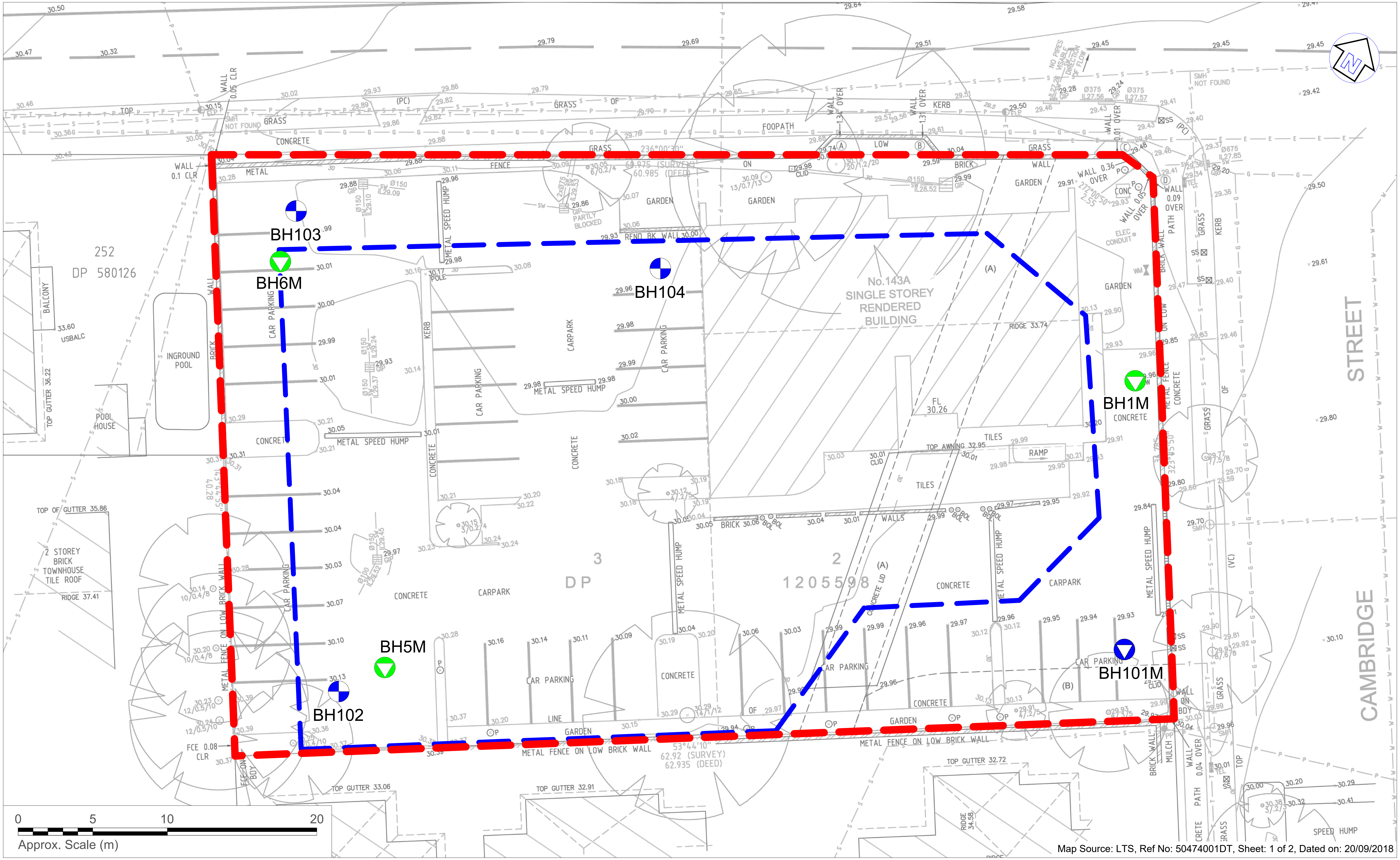
Drawn:	AM.H.
Approved:	D.S.
Date:	19/05/20
Scale:	Not To Scale

Cambridge Unit Developments Pty Ltd
Geotechnical Investigation
143A Stoney Creek Road, Beverly Hills NSW
Site Locality Plan

Figure:
1

Project: E23967.G03_Rev4



Map Source: LTS, Ref No: 50474001DT, Sheet: 1 of 2, Dated on: 20/09/2018

LEGEND

🟥 – –	Approximate site boundary
🟦 – –	Approximate basement boundary
◐	Approximate borehole location
▼	Approximate borehole/monitoring well location (EI, 2020)
▽	Approximate previous borehole/monitoring well locations (EI, 2018)

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Approved:	D.S.
Date:	19/05/20

Cambridge Unit Developments Pty Ltd
Geotechnical Investigation
143A Stoney Creek Road, Beverly Hills NSW
Borehole Location Plan

Figure:
2

Project:
E23967.G03_Rev4

Appendix A – Borehole Logs And Explanatory Notes

BOREHOLE LOG

BH NO. BH101M

Project	Proposed Development	**Sheet**	1 of 3
Location	143A Stoney Creek Road, Beverly Hills NSW	**Date Started**	17/02/2020
Position	Refer to Figure 2	**Date Completed**	17/02/2020
Job No.	E23967.G03	**Logged By** DS	**Date** 17/02/2020
Client	Cambridge Unit Developments Pty Ltd	**Reviewed By** SK	**Date** 19/03/2020

Drilling Contactor	Geosense Drilling	**Surface RL**	≈29.90 m AHD
Drill Rig	Tight Access Rig	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
DT			0	*0.14* 29.76				-	CONCRETE; 140 mm thick.	-	-	CONCRETE
AD/T	-		1	*1.10* 28.80	SPT 0.50-0.95 m 4,6,8 N=14			-	FILL: Silty CLAY; low plasticity, grey mottled orange-brown, trace fine to medium, dark grey gravel and fine to coarse grained sand.	M (<PL)	-	FILL
			2	*2.20* 27.70	SPT 1.50-1.95 m 3,4,5 N=9			CH	Silty CLAY; high plasticity, grey-brown mottled orange-brown, with fine to medium ironstone gravel.	M (<PL)	St	RESIDUAL SOIL
		19/02/20	3 4 5	*5.10* 24.80	SPT 3.00-3.45 m 12,20,17 N=37 SPT 4.50-4.95 m 8,9,10 N=19				From 2.2 m, grey to orange-brown, with fine to coarse ironstone gravel bands, trace rootlets.	M (=PL)	VSt	
			6	*6.20*	SPT 6.00-6.35 m 33,10/50mm HB N>30				From 5.1 m, brown-dark grey grading to extremely weathered shale.	M (<PL)	VSt H	
			7 8 9 10						Continued as Cored Borehole			

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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CORED BOREHOLE LOG

BH NO. BH101M

Project	Proposed Development	**Sheet**	2 OF 3
Location	143A Stoney Creek Road, Beverly Hills NSW	**Date Started**	17/02/2020
Position	Refer to Figure 2	**Date Completed**	17/02/2020
Job No.	E23967.G03	**Logged By** DS	**Date** 17/02/2020
Client	Cambridge Unit Developments Pty Ltd	**Reviewed By** SK	**Date** 19/03/2020

Drilling Contactor	Geosense Drilling	**Surface RL**	≈29.90 m AHD
Drill Rig	Tight Access Rig	**Inclination**	-90°

Drilling						Field Material Description		Defect Information
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	DEFECT DESCRIPTION & Additional Observations
				0–6.20				
NMLC	100% RETURN	100	29	6.20	6.20 23.70	Continuation from non-cored borehole SHALE; dark grey to orange-brown, very thinly bedded, laminated with sub-horizontal grey laminations, with ironstaining.	DW	
				6.75				6.75-6.80: XWS
				6.94				6.94-7.02: XWS
				7.31				7.31-7.38: FS
				7.99				7.99-8.06: JT, 90°, Clay VNR, PR, RF
				8.40	8.40 21.50	From 8.4 m, dark grey, no ironstaining, very thinly bedded.		
	50% RETURN	100	0	9.15			SW - FR	9.15-9.50: JT, 70°, Clay VNR, PR, RF
				9.56				9.56-9.59: JT, 90°, Clay VNR, PR, RF 9.67-9.70: XWS
		100	42	9.84				9.84: JT, 20°, Clay VNR, PR, RF
				10				

INFERRED STRENGTH $Is_{(50)}$ MPa: VL 0.1 L 0.3 M 1 H 3 VH 10 EH

Average Defect Spacing (mm): 30 100 300 1000 3000

GRAPHIC LOG

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORED BOREHOLE LOG

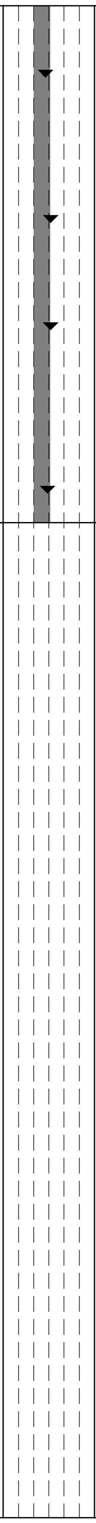
BH NO. BH101M

Project	Proposed Development	**Sheet**	3 OF 3
Location	143A Stoney Creek Road, Beverly Hills NSW	**Date Started**	17/02/2020
Position	Refer to Figure 2	**Date Completed**	17/02/2020
Job No.	E23967.G03	**Logged By** DS	**Date** 17/02/2020
Client	Cambridge Unit Developments Pty Ltd	**Reviewed By** SK	**Date** 19/03/2020

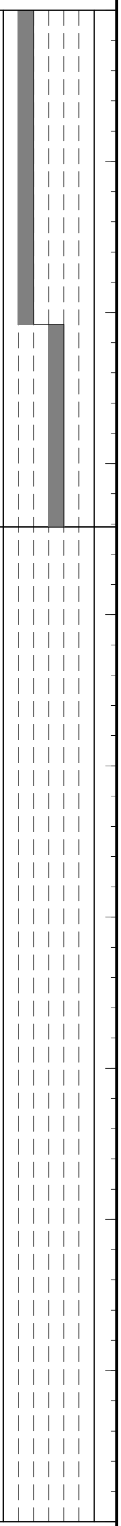
Drilling Contractor	Geosense Drilling	**Surface RL**	≈29.90 m AHD
Drill Rig	Tight Access Rig	**Inclination**	-90°

METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	DEFECT DESCRIPTION & Additional Observations
NMLC	50% RETURN	100	42	10		SHALE; dark grey to orange-brown, very thinly bedded, laminated with sub-horizontal grey laminations, with ironstaining.	SW - FR	9.87: JT, 20°, Clay VNR, PR, RF
		100	33					10.55: JT, 5°, Clay VNR, PR, RF 10.69: JT, 20°, Clay VNR, PR, RF
	25% RETURN	100	26	11	*10.86* 19.04	From 10.86 m, thinly bedded.		11.00-11.31: JT, 60°, CN, PR, SM 11.72-11.80: JT, 70°, CN, PR, RF
		100	94	12 13	*12.08* 17.82	From 12.08 m, thinly to medium bedded.		12.66: JT, 0°, Clay VNR, PR, RF 12.79-12.86: JT, 50°, CN, PR, SM 13.09: JT, 10°, CN, PR, SM 13.23-13.31: JT, 60°, CN, PR, SM
				14 15 16 17 18 19 20	*13.42* 16.48	Hole Terminated at 13.42 m Target Depth Reached.		

INFERRED STRENGTH $Is_{(50)}$ MPa



Average Defect Spacing (mm)



This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORE PHOTOGRAPH OF BOREHOLE: BH101M

Project	Proposed Residential Development			**Depth Range**	6.2m to 13.42m BEGL		
Location	143A Stoney Creek Road, Beverly Hills NSW			**Contractor**	Geosense Drilling Engineers Pty Ltd		
Position	See Figure 2	**Surface RL**	≈ 29.9m	**Drill Rig**	Tight Access Rig		
Job No.	E23967.G03	**Inclination**	-90°	**Logged**	DS	**Date**	17 / 02 / 2020
Client	Cambridge Unit Developments Pty Ltd	**Box**	1-2 of 2	**Checked**	SK	**Date**	19 / 03 / 2020

MONITORING WELL LOG

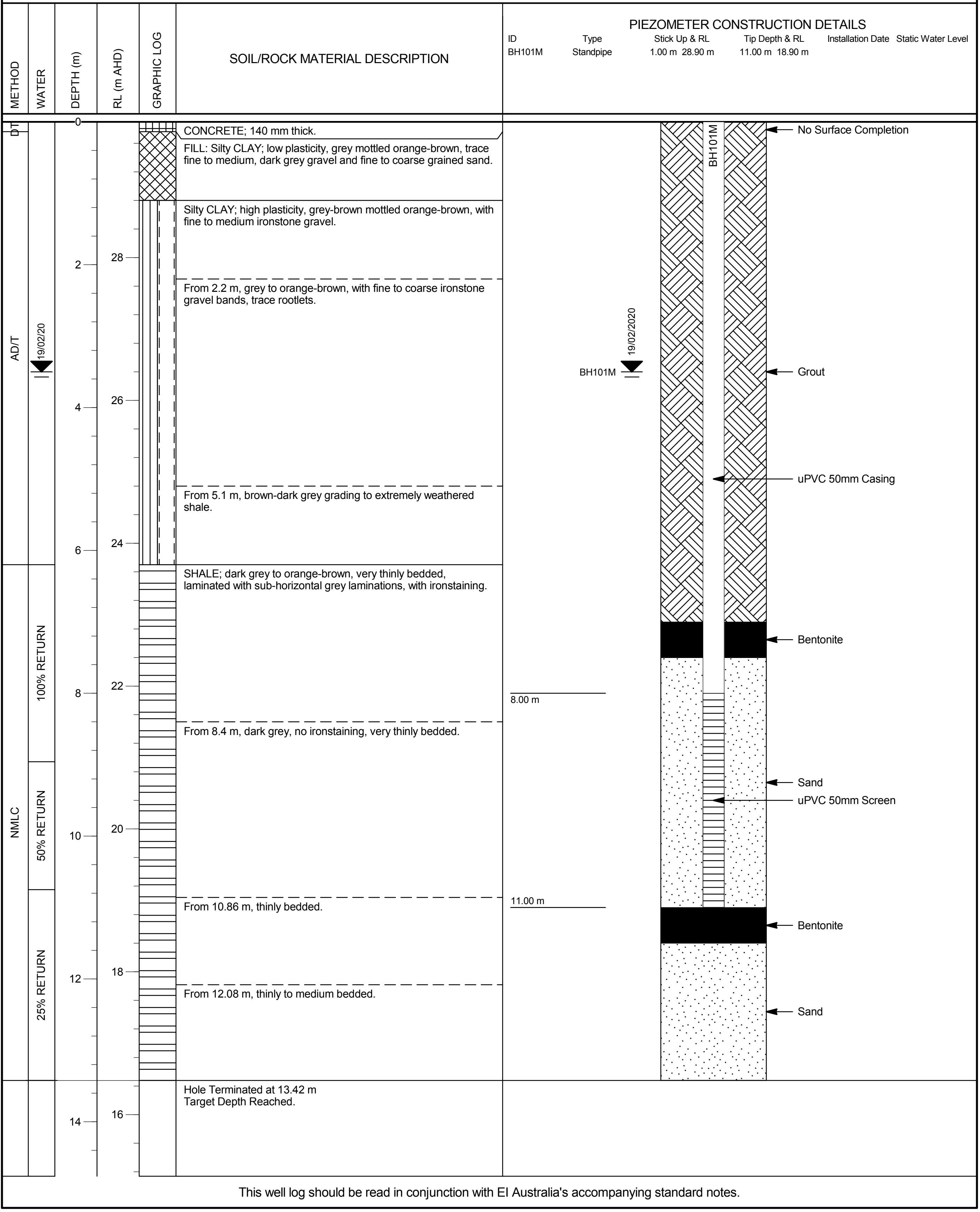
MW NO. BH101M

Project	Proposed Development	**Sheet**	1 of 2
Location	143A Stoney Creek Road, Beverly Hills NSW	**Date Started**	17/02/2020
Position	Refer to Figure 2	**Date Completed**	17/02/2020
Job No.	E23967.G03	**Logged By** DS	**Date** 17/02/2020
Client	Cambridge Unit Developments Pty Ltd	**Reviewed By** SK	**Date** 19/03/2020

Drilling Contactor	Geosense Drilling	**Surface RL**	≈29.90 m AHD
Drill Rig	Tight Access Rig	**Inclination**	-90°

PIEZOMETER CONSTRUCTION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL	Installation Date	Static Water Level
BH101M	Standpipe	1.00 m 28.90 m	11.00 m 18.90 m		



CONCRETE; 140 mm thick.

FILL: Silty CLAY; low plasticity, grey mottled orange-brown, trace fine to medium, dark grey gravel and fine to coarse grained sand.

Silty CLAY; high plasticity, grey-brown mottled orange-brown, with fine to medium ironstone gravel.

From 2.2 m, grey to orange-brown, with fine to coarse ironstone gravel bands, trace rootlets.

From 5.1 m, brown-dark grey grading to extremely weathered shale.

SHALE; dark grey to orange-brown, very thinly bedded, laminated with sub-horizontal grey laminations, with ironstaining.

From 8.4 m, dark grey, no ironstaining, very thinly bedded.

From 10.86 m, thinly bedded.

From 12.08 m, thinly to medium bedded.

Hole Terminated at 13.42 m
Target Depth Reached.

This well log should be read in conjunction with EI Australia's accompanying standard notes.

EIA 2.00.3 LIB.GLB Log EIA PIEZOMETER INSTALLATION LOG E23967.G03 BOREHOLE LOGS.GPJ <<DrawingFile>> 19/03/2020 15:07 10.0.000 Datgel Lab and In Situ Tool - DGD | Lib: EIA 2.00.3 2017-11-21 Prj: EIA 2.00.1 2017-09-26

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BOREHOLE LOG

BH NO. BH102

Project	Proposed Development	**Sheet**	1 of 3
Location	143A Stoney Creek Road, Beverly Hills NSW	**Date Started**	17/02/2020
Position	Refer to Figure 2	**Date Completed**	18/02/2020
Job No.	E23967.G03	**Logged By** DS	**Date** 17/02/2020
Client	Cambridge Unit Developments Pty Ltd	**Reviewed By** SK	**Date** 19/03/2020

Drilling Contactor	Geosense Drilling	**Surface RL**	≈30.10 m AHD
Drill Rig	Tight Access Rig	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
DT			0	*0.15* 29.95				-	CONCRETE; 150 mm thick.	-	-	CONCRETE
AD/T	-			*0.70* 29.40				-	FILL: Gravelly SAND; fine to medium grained, grey, fine to medium gravel.	M	-	FILL
			1	*1.50* 28.60	SPT 1.00-1.75 m 0/450mmHW N=0			-	FILL: Silty CLAY; medium plasticity, grey-brown mottled orange-brown, with fine to medium gravel, dark grey.	M (<PL)	-	
		18/02/20		*1.60* 28.50	BH102_1.5-1.6 DS			CH	Silty CLAY; high plasticity, grey-brown mottled orange-brown, with fine to medium ironstone gravel.	M (<PL)		RESIDUAL SOIL
			2 3 4	*4.30* 25.80	SPT 2.00-2.45 m 4,5,6 N=11 SPT 3.00-3.45 m 6,8,9 N=17				From 1.6 m, high plasticity, grey to orange-brown, with fine to coarse ironstone gravel bands, trace rootlets.		St	
			5 6	*6.40* *6.49*	SPT 4.50-4.95 m 7,8,13 N=21 SPT 6.00-6.45 m 4,8,17 N=25				From 4.3 m, pale grey, no ironstone gravel.	M (=PL)	VSt	
WB									From 6.4 m, dark grey grading to extremely weathered shale.			
			7 8 9 10						Continued as Cored Borehole			

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORED BOREHOLE LOG

BH NO. BH102

Project	Proposed Development	**Sheet**	2 OF 3
Location	143A Stoney Creek Road, Beverly Hills NSW	**Date Started**	17/02/2020
Position	Refer to Figure 2	**Date Completed**	18/02/2020
Job No.	E23967.G03	**Logged By** DS	**Date** 17/02/2020
Client	Cambridge Unit Developments Pty Ltd	**Reviewed By** SK	**Date** 19/03/2020

Drilling Contactor	Geosense Drilling	**Surface RL**	≈30.10 m AHD
Drill Rig	Tight Access Rig	**Inclination**	-90°

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH Is$_{(50)}$ MPa VL 0.1 L 0.3 M 1 H 3 VH 10 EH	DEFECT DESCRIPTION & Additional Observations	Average Defect Spacing (mm) 30 100 300 1000 3000
				0–6.49	*6.49*		Continuation from non-cored borehole				
NMLC	80% RETURN	100	0		*6.49* 23.61		SHALE; dark grey to orange-brown, very thinly to thinly bedded, laminated with sub-horizontal grey laminations, with ironstaining.	DW		6.52: JT, 15°, Fe SN, PR, RF 6.63-6.69: FS 6.69-6.80: JT, 60°, Clay VNR, PR, RF 6.85-6.90: JT, 70°, Clay VNR, PR, RF 6.96-7.03: FS 7.03-7.11: JT, 80°, Fe SN, PR, RF	
					7.30 22.80		SILTSTONE; pale grey-grey, very thinly bedded, with sub-horizontal pale grey laminations. (siltstone is shale bedrock heat-affected by nearby igneous instrusion)			7.32: JT, 20°, Clay VNR, PR, RF 7.43: JT, 20°, Clay VNR, PR, RF 7.43-7.51: JT, 80°, CN, PR, RF 7.61-7.82: XWZ 7.85-7.95: JT, 60°, Clay VNR, PR, RF 8.05: JT, 70°, Clay VNR, PR, SM 8.11-8.14: JT, 30°, Clay VNR, PR, RF 8.14-8.40: FZ	
		100	15							8.52-8.61: JT, 50°, CN, PR, RF	
					8.62 21.48		From 8.62 m, very thinly to thinly bedded.			8.87-9.22: JTx6, 40 - 80°, CN, PR, RF 9.32-9.41: FS 9.49-9.58: JT, 70°, Clay VNR, PR, RF	
		100	0	10						9.73-9.78: XWS 9.78-9.87: JT, 60°, Clay VNR, PR, RF	

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORED BOREHOLE LOG

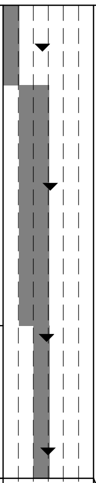
BH NO. BH102

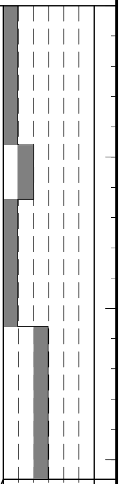
Project Proposed Development
Location 143A Stoney Creek Road, Beverly Hills NSW
Position Refer to Figure 2
Job No. E23967.G03
Client Cambridge Unit Developments Pty Ltd

Sheet 3 OF 3
Date Started 17/02/2020
Date Completed 18/02/2020
Logged By DS **Date** 17/02/2020
Reviewed By SK **Date** 19/03/2020

Drilling Contactor Geosense Drilling
Drill Rig Tight Access Rig
Surface RL ≈30.10 m AHD
Inclination -90°

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa VL 0.1 L 0.3 M 1 H 3 VH 10 EH	DEFECT DESCRIPTION & Additional Observations	Average Defect Spacing (mm) 30 100 300 1000 3000
NMLC	50% RETURN	100	0	10			SILTSTONE; pale grey-grey, very thinly bedded, with sub-horizontal pale grey laminations. (siltstone is shale bedrock heat-affected by nearby igneous instrusion)	DW		9.93-10.14: XWS 10.23-10.28: JT, 50°, Clay VNR, PR, RF 10.33-10.37: JT, 50°, Clay VNR, PR, RF 10.45-10.53: XWS	
		100	31	11 12						11.28-11.55: FZ 11.61-11.79: JTx2, 80°, CN, PR, RF 11.62-11.82: JT, 90°, CN, PR, RF 11.86: JT, 15°, Clay VNR, PR, RF 11.95-12.07: JT, 40°, Clay VNR, PR, RF	
					12.12 17.98		From 12.12 m, thinly to medium bedded.	SW - FR		12.90: JT, 10°, CN, PR, RF 12.97: JT, 10°, CN, PR, RF 12.99-13.13: FZ	
				13	*13.13* 16.97		Hole Terminated at 13.13 m Target Depth Reached.				
				14 15 16 17 18 19 20							





This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORE PHOTOGRAPH OF BOREHOLE: BH102

Project	Proposed Residential Development			**Depth Range**	6.49m to 13.13m BEGL		
Location	143A Stoney Creek Road, Beverly Hills NSW			**Contractor**	Geosense Drilling Engineers Pty Ltd		
Position	See Figure 2	**Surface RL**	≈ 30.1m	**Drill Rig**	Tight Access Rig		
Job No.	E23967.G03	**Inclination**	-90°	**Logged**	DS	**Date**	17 / 02 / 2020
Client	Cambridge Unit Developments Pty Ltd	**Box**	1-2 of 2	**Checked**	SK	**Date**	19 / 03 / 2020

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BOREHOLE LOG

BH NO. BH103

Project	Proposed Development	**Sheet**	1 of 3
Location	143A Stoney Creek Road, Beverly Hills NSW	**Date Started**	18/02/2020
Position	Refer to Figure 2	**Date Completed**	19/02/2020
Job No.	E23967.G03	**Logged By** DS	**Date** 18/02/2020
Client	Cambridge Unit Developments Pty Ltd	**Reviewed By** SK	**Date** 19/03/2020

Drilling Contactor	Geosense Drilling	**Surface RL**	≈30.00 m AHD
Drill Rig	Tight Access Rig	**Inclination**	-90°

Drilling					**Sampling**	**Field Material Description**						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
DT	-	GWNE	0	*0.15* 29.85				-	CONCRETE; 150 mm thick.	-	-	CONCRETE
AD/T				*0.50* 29.50				-	FILL: Gravelly SAND; fine to medium grained, brown-grey, fine to coarse gravel, trace silt.	M	-	FILL
				0.90 29.10	SPT 0.50-0.95 m 3,3,4 N=7			-	FILL: Silty CLAY; medium plasticity, brown, with fine to medium, dark grey gravel.	M (<PL)	-	
			1		SPT 1.50-1.95 m 4,7,6 N=13			CH	Silty CLAY; high plasticity, grey to red-brown mottled orange-brown, with fine to coarse ironstone gravel.	M (<PL)	VSt	RESIDUAL SOIL
			2									
			3		SPT 3.00-3.45 m 4,7,17 N=24							
			4	*4.20* 25.80					From 4.2 m, grey to orange-brown grading to extremely weathered shale.			
				4.80 25.20	SPT 4.50-4.85 m 7,17,9/50mm HB N>30				From 4.8 m, dark grey.		H	
	L-M		5	*5.50* 24.50	BH103_5.6-5.7 DS			-	SHALE; dark grey, very low strength, distinctly weathered.	-	-	BEDROCK
			6	*6.50*								
			7						Continued as Cored Borehole			
			8									
			9									
			10									

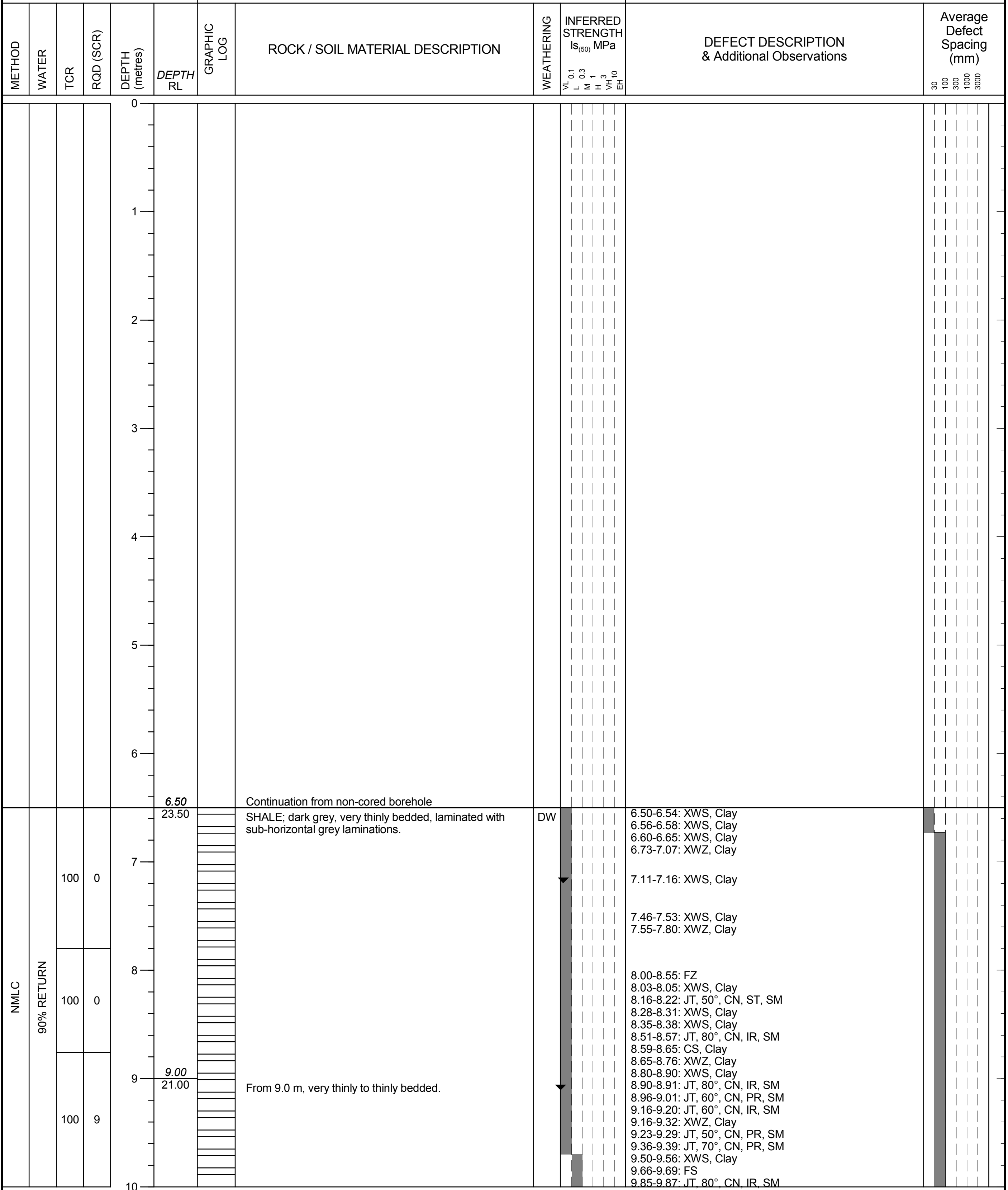
This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORED BOREHOLE LOG

BH NO. BH103

Project	Proposed Development	**Sheet**	2 OF 3
Location	143A Stoney Creek Road, Beverly Hills NSW	**Date Started**	18/02/2020
Position	Refer to Figure 2	**Date Completed**	19/02/2020
Job No.	E23967.G03	**Logged By** DS	**Date** 18/02/2020
Client	Cambridge Unit Developments Pty Ltd	**Reviewed By** SK	**Date** 19/03/2020

Drilling Contactor	Geosense Drilling	**Surface RL**	≈30.00 m AHD
Drill Rig	Tight Access Rig	**Inclination**	-90°



Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH Is(50) MPa VL 0.1 L 0.3 M 1 H 3 VH 10 EH	DEFECT DESCRIPTION & Additional Observations	Average Defect Spacing (mm) 30 100 300 1000 3000
				0 – 6.50	*6.50*		Continuation from non-cored borehole				
NMLC	90% RETURN	100	0	6.50 – 7.80	23.50		SHALE; dark grey, very thinly bedded, laminated with sub-horizontal grey laminations.	DW		6.50-6.54: XWS, Clay 6.56-6.58: XWS, Clay 6.60-6.65: XWS, Clay 6.73-7.07: XWZ, Clay 7.11-7.16: XWS, Clay 7.46-7.53: XWS, Clay 7.55-7.80: XWZ, Clay	
		100	0	7.80 – 9.00						8.00-8.55: FZ 8.03-8.05: XWS, Clay 8.16-8.22: JT, 50°, CN, ST, SM 8.28-8.31: XWS, Clay 8.35-8.38: XWS, Clay 8.51-8.57: JT, 80°, CN, IR, SM 8.59-8.65: CS, Clay 8.65-8.76: XWZ, Clay 8.80-8.90: XWS, Clay 8.90-8.91: JT, 80°, CN, IR, SM 8.96-9.01: JT, 60°, CN, PR, SM	
		100	9	9.00 – 10	*9.00* 21.00		From 9.0 m, very thinly to thinly bedded.			9.16-9.20: JT, 60°, CN, IR, SM 9.16-9.32: XWZ, Clay 9.23-9.29: JT, 50°, CN, PR, SM 9.36-9.39: JT, 70°, CN, PR, SM 9.50-9.56: XWS, Clay 9.66-9.69: FS 9.85-9.87: JT, 80°, CN, IR, SM	

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORED BOREHOLE LOG

BH NO. BH103

Project	Proposed Development	**Sheet**	3 OF 3
Location	143A Stoney Creek Road, Beverly Hills NSW	**Date Started**	18/02/2020
Position	Refer to Figure 2	**Date Completed**	19/02/2020
Job No.	E23967.G03	**Logged By** DS	**Date** 18/02/2020
Client	Cambridge Unit Developments Pty Ltd	**Reviewed By** SK	**Date** 19/03/2020

Drilling Contactor	Geosense Drilling	**Surface RL**	≈30.00 m AHD
Drill Rig	Tight Access Rig	**Inclination**	-90°

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH Is(50) MPa VL 0.1 L 0.3 M 1 H 3 VH 10 EH	DEFECT DESCRIPTION & Additional Observations	Average Defect Spacing (mm) 30 100 300 1000 3000
NMLC	90% RETURN	100	9	10			SHALE; dark grey, very thinly bedded, laminated with sub-horizontal grey laminations.	DW		9.95-10.00: XWS, Clay 10.00-10.07: JT, 90°, CN, IR, SM 10.26-10.55: FZ	
		100	35	11				FR		10.58-10.60: JT, 90°, CN, PR, SM 10.66-10.71: JT, 90°, CN, IR, SM 10.92-10.95: JT, 70°, CN, IR, SM 10.97-11.03: JT, 60°, CN, PR, SM 11.06-11.08: CS 11.20-11.21: JT, 90°, CN, IR, SM 11.46-11.48: JT, 80°, CN, IR, SM	
		100	47	12 13	*13.41*					12.08-12.10: JT, 60°, CN, PR, SM 12.43-12.48: JT, 80°, CN, IR, SM 12.82-12.84: JT, 90°, CN, IR, SM 13.19-13.30: JT, 90°, CN, IR, SM	
				14 15 16 17 18 19 20	16.59		Hole Terminated at 13.41 m Target Depth Reached.				

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORE PHOTOGRAPH OF BOREHOLE: BH103

Project	Proposed Residential Development			**Depth Range**	6.5m to 13.41m BEGL		
Location	143A Stoney Creek Road, Beverly Hills NSW			**Contractor**	Geosense Drilling Engineers Pty Ltd		
Position	See Figure 2	**Surface RL**	≈ 30.0m	**Drill Rig**	Tight Access Rig		
Job No.	E23967.G03	**Inclination**	-90°	**Logged**	DS	**Date**	18 / 02 / 2020
Client	Cambridge Unit Developments Pty Ltd	**Box**	1-2 of 2	**Checked**	SK	**Date**	19 / 03 / 2020

BOREHOLE LOG

BH NO. BH104

Project	Proposed Development	**Sheet**	1 of 2
Location	143A Stoney Creek Road, Beverly Hills NSW	**Date Started**	19/02/2020
Position	Refer to Figure 2	**Date Completed**	19/02/2020
Job No.	E23967.G03	**Logged By** BK	**Date** 19/02/2020
Client	Cambridge Unit Developments Pty Ltd	**Reviewed By** SK	**Date** 19/03/2020

Drilling Contactor	Geosense Drilling	**Surface RL**	≈30.00 m AHD
Drill Rig	Tight Access Rig	**Inclination**	-90°

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY REL. DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
DT			0	0.16 29.84			▦	-	CONCRETE; 160 mm thick.	-	-	CONCRETE
AD/T	-			0.50 29.50			▨	-	FILL: Gravelly SAND; fine to medium grained, grey-brown, with fine to coarse, angular to sub-angular gravel.	M	-	FILL
			1	1.50 28.50	SPT 0.50-0.95 m 2,3,2 N=5	■	▨	-	FILL: Silty CLAY; medium plasticity, brown mottled pale grey, with fine to medium, rounded to sub-rounded gravel.	M (<PL)	-	
			2	2.50 27.50	SPT 1.50-1.95 m 3,3,6 N=9	■		CH	Silty CLAY; high plasticity, red-brown mottled pale grey, with fine to medium, rounded to sub-rounded ironstone gravel.		St	RESIDUAL SOIL
									From 2.5 m, red-brown mottled pale grey to orange-brown, fine to coarse ironstone gravel.			
		▷	3 4		SPT 3.00-3.45 m 4,8,13 N=21	■						
			5	4.70 25.30	SPT 4.50-4.95 m 10,13,10 N=23	■			From 4.7 m, medium to high plasticity, grey to orange-brown, with fine to coarse ironstone gravel.	M (<PL)	VSt	
			6 7	6.10 23.90	SPT 6.00-6.45 m 8,13,20 N=33	■			From 6.1 m, no ironstone gravel.		H	
			8 9 10	7.60	SPT 7.50-7.95 m 28, 150 mmHB N>30	■			Continued as Cored Borehole			

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

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CORED BOREHOLE LOG

BH NO. BH104

Project	Proposed Development	**Sheet**	2 OF 2
Location	143A Stoney Creek Road, Beverly Hills NSW	**Date Started**	19/02/2020
Position	Refer to Figure 2	**Date Completed**	19/02/2020
Job No.	E23967.G03	**Logged By** BK	**Date** 19/02/2020
Client	Cambridge Unit Developments Pty Ltd	**Reviewed By** SK	**Date** 19/03/2020

Drilling Contactor	Geosense Drilling	**Surface RL**	≈30.00 m AHD
Drill Rig	Tight Access Rig	**Inclination**	-90°

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH Is$_{(50)}$ MPa VL 0.1 L 0.3 M 1 H 3 VH 10 EH	DEFECT DESCRIPTION & Additional Observations	Average Defect Spacing (mm) 30 100 300 1000 3000
				0–7.60	*7.60*		Continuation from non-cored borehole				
NMLC	90% RETURN	100	16	7.60–9.44	22.40 *9.44*		SHALE; dark grey to orange-brown, very thinly bedded, with grey claystone laminations, with ironstaining.	DW		7.60-7.61: XWS, Clay 7.65-7.71: XWS, Clay 7.73-7.76: XWS, Clay 7.78-7.81: XWS, Clay 7.83-7.85: XWS, Clay 7.88-7.92: XWS, Clay 7.94-8.03: XWS, Clay 8.40-8.50: JT, 50°, SN, IR, RF 8.52-8.56: JT, 90°, CN, PR, SM 8.56-8.62: XWS, Clay 8.66-8.71: XWS, Clay 8.71-8.77: JT, 50°, SN, IR, SM 8.91-9.00: JT, 50°, SN, IR, RF 9.06-9.07: XWS, Clay 9.09-9.12: FS 9.25-9.44: FZ	
				9.44–10	20.56		Hole Terminated at 9.44 m Target Depth Reached.				

This borehole log should be read in conjunction with EI Australia's accompanying standard notes.

CORE PHOTOGRAPH OF BOREHOLE: BH104

Project	Proposed Residential Development			**Depth Range**	7.6m to 9.44m BEGL		
Location	143A Stoney Creek Road, Beverly Hills NSW			**Contractor**	Geosense Drilling Engineers Pty Ltd		
Position	See Figure 2	**Surface RL**	≈ 30.0m	**Drill Rig**	Tight Access Rig		
Job No.	E23967.G03	**Inclination**	-90°	**Logged**	BK	**Date**	19 / 02 / 2020
Client	Cambridge Unit Developments Pty Ltd	**Box**	1 of 1	**Checked**	SK	**Date**	19 / 03 / 2020

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EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT LOGS

DRILLING/EXCAVATION METHOD

HA	Hand Auger	**ADH**	Hollow Auger	**NQ**	Diamond Core - 47 mm
DT	Diatube Coring	**RT**	Rotary Tricone bit	**NMLC**	Diamond Core - 52 mm
NDD	Non-destructive digging	**RAB**	Rotary Air Blast	**HQ**	Diamond Core - 63 mm
AD*	Auger Drilling	**RC**	Reverse Circulation	**HMLC**	Diamond Core - 63 mm
***V**	V-Bit	**PT**	Push Tube	**EX**	Tracked Hydraulic Excavator
***T**	TC-Bit, e.g. AD/T	**WB**	Washbore	**HAND**	Excavated by Hand Methods

PENETRATION RESISTANCE

L	**Low Resistance**	Rapid penetration/ excavation possible with little effort from equipment used.
M	**Medium Resistance**	Penetration/ excavation possible at an acceptable rate with moderate effort from equipment used.
H	**High Resistance**	Penetration/ excavation is possible but at a slow rate and requires significant effort from equipment used.
R	**Refusal/Practical Refusal**	No further progress possible without risk of damage or unacceptable wear to equipment used.

These assessments are subjective and are dependent on many factors, including equipment power and weight, condition of excavation or drilling tools and experience of the operator.

WATER

▽ **Standing Water Level**

▷ **Water Seepage**

◁ **Partial water loss**

◀ **Complete Water Loss**

GWNO	GROUNDWATER NOT OBSERVED - Observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave-in of the borehole/ test pit.
GWNE	GROUNDWATER NOT ENCOUNTERED - Borehole/ test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/ test pit been left open for a longer period.

SAMPLING AND TESTING

SPT	Standard Penetration Test to AS1289.6.3.1-2004
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following a 150mm seating drive
30/80mm	Where practical refusal occurs, the blows and penetration for that interval are reported, N is not reported
RW	Penetration occurred under the rod weight only, N<1
HW	Penetration occurred under the hammer and rod weight only, N<1
HB	Hammer double bouncing on anvil, N is not reported
Sampling	
DS	Disturbed Sample
ES	Sample for environmental testing
BDS	Bulk disturbed Sample
GS	Gas Sample
WS	Water Sample
U50	Thin walled tube sample - number indicates nominal sample diameter in millimetres
Testing	
FP	Field Permeability test over section noted
FVS	Field Vane Shear test expressed as uncorrected shear strength (sv= peak value, sr= residual value)
PID	Photoionisation Detector reading in ppm
PM	Pressuremeter test over section noted
PP	Pocket Penetrometer test expressed as instrument reading in kPa
WPT	Water Pressure tests
DCP	Dynamic Cone Penetrometer test
CPT	Static Cone Penetration test
CPTu	Static Cone Penetration test with pore pressure (u) measurement

GEOLOGICAL BOUNDARIES

——————— = Observed Boundary (position known)

– – – – – – – – – – – – = Observed Boundary (position approximate)

– –?– –?– –?– – = Boundary (interpreted or inferred)

ROCK CORE RECOVERY

TCR=Total Core Recovery (%)

$$= \frac{\boldsymbol{Length\ of\ core\ recovered}}{\boldsymbol{Length\ of\ core\ run}} \times \mathbf{100}$$

RQD = Rock Quality Designation (%)

$$= \frac{\sum \boldsymbol{Axial\ lengths\ of\ core} > \mathbf{100}\boldsymbol{mm}}{\boldsymbol{Length\ of\ core\ run}} \times \mathbf{100}$$

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METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT LOGS

▩	FILL	ψ	ORGANIC SOILS (OL, OH or Pt)	▤	CLAY (CL, CI or CH)
⬠	COUBLES or BOULDERS	×	SILT (ML or MH)	⁖	SAND (SP or SW)
◌	GRAVEL (GP or GW)	Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay			

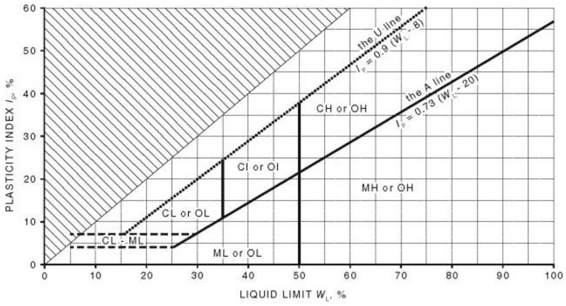
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS 1726:2017, Section 6.1 – Soil description and classification.

PARTICLE SIZE CHARACTERISTICS

Fraction	Components	Sub Division	Size mm
Oversize	BOULDERS		>200
	COBBLES		63 to 200
Coarse grained soil	GRAVEL	Coarse	19 to 63
		Medium	6.7 to 19
		Fine	2.36 to 6.7
	SAND	Coarse	0.6 to 2.36
		Medium	0.21 to 0.6
		Fine	0.075 to 0.21
Fine grained soil	SILT		0.002 to 0.075
	CLAY		<0.002

PLASTICITY PROPERTIES



GROUP SYMBOLS

Major Divisions		Symbol	Description
COARSE GRAINED SOILS More than 65% of soil excluding oversize fraction is greater than 0.075mm	**GRAVEL** More than 50% of coarse fraction is >2.36mm	GW	Well graded gravel and gravel-sand mixtures, little or no fines, no dry strength.
		GP	Poorly graded gravel and gravel-sand mixtures, little or no fines, no dry strength.
		GM	Silty gravel, gravel-sand-silt mixtures, zero to medium dry strength.
		GC	Clayey gravel, gravel-sand-clay mixtures, medium to high dry strength.
	SAND More than 50% of coarse fraction is <2.36 mm	SW	Well graded sand and gravelly sand, little or no fines, no dry strength.
		SP	Poorly graded sand and gravelly sand, little or no fines, no dry strength.
		SM	Silty sand, sand-silt mixtures, zero to medium dry strength.
		SC	Clayey sand, sandy-clay mixtures, medium to high dry strength.
FINE GRAINED SOILS More than 35% of soil excluding oversized fraction is less than 0.075mm	Liquid Limit less < 50%	ML	Inorganic silts of low plasticity, very fine sands, rock flour, silty or clayey fine sands, zero to medium dry strength.
		CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, medium to high dry strength.
		OL	Organic silts and organic silty clays of low plasticity, low to medium dry strength.
	Liquid Limit > than 50%	MH	Inorganic silts of high plasticity, high to very high dry strength.
		CH	Inorganic clays of high plasticity, high to very high dry strength.
		OH	Organic clays of medium to high plasticity, medium to high dry strength.
Highly Organic soil		PT	Peat muck and other highly organic soils.

MOISTURE CONDITION

Symbol	Term	Description
D	Dry	Non- cohesive and free-running.
M	Moist	Soils feel cool, darkened in colour. Soil tends to stick together.
W	Wet	Soils feel cool, darkened in colour. Soil tends to stick together, free water forms when handling.

Moisture content of cohesive soils shall be described in relation to plastic limit (PL) or liquid limit (LL) for soils with higher moisture content as follows: Moist, dry of plastic limit (w < PL); Moist, near plastic limit (w ≈ PL); Moist, wet of plastic limit (w < PL); Wet, near liquid limit (w ≈ LL), Wet, wet of liquid limit (w > LL),

CONSISTENCY

Symbol	Term	Undrained Shear Strength (kPa)	SPT “N” #
VS	Very Soft	≤ 12	≤ 2
S	Soft	>12 to ≤ 25	>2 to ≤ 4
F	Firm	>25 to ≤ 50	>4 to 8
St	Stiff	>50 to ≤ 100	>8 to 15
VSt	Very Stiff	>100 to ≤ 200	>15 to 30
H	Hard	>200	>30
Fr	Friable	-	

DENSITY

Symbol	Term	Density Index %	SPT “N” #
VL	Very Loose	≤ 15	0 to 4
L	Loose	>15 to ≤ 35	4 to 10
MD	Medium Dense	>35 to ≤ 65	10 to 30
D	Dense	>65 to ≤ 85	30 to 50
VD	Very Dense	>85	Above 50

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material.
SPT correlations are not stated in AS1726:2017, and may be subject to corrections for overburden pressure, moisture content of the soil, and equipment type.

MINOR COMPONENTS

Term	Assessment Guide	Proportion by Mass
Add ‘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 soil: ≤ 15%
Add ‘With’	Presence easily detectable by feel or eye but soil properties little or no different to general properties of primary component	Coarse grained soils: 5 - 12% Fine grained soil: 15 - 30%
Prefix soil name	Presence easily detectable by feel or eye in conjunction with the general properties of primary component	Coarse grained soils: >12% Fine grained soil: >30%

TERMS FOR ROCK MATERIAL STRENGTH AND WEATHERING

CLASSIFICATION AND INFERRED STRATIGRAPHY

Rock is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 2017, Section 6.2 – Rock identification, description and classification.

ROCK MATERIAL STRENGTH CLASSIFICATION

Symbol	Term	Point Load Index, $Is_{(50)}$ (MPa) $^{\#}$	Field Guide
VL	Very Low	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm can be broken by finger pressure.
L	Low	0.1 to 0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium	0.3 to 1	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
H	High	1 to 3	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken with pick with a single firm blow; rock rings under hammer.
VH	Very High	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
EH	Extremely High	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

$^{\#}$ **Rock Strength Test Results**

▼	Point Load Strength Index, $Is_{(50)}$, Axial test (MPa)
●	Point Load Strength Index, $Is_{(50)}$, Diametral test (MPa)

Relationship between rock strength test result ($Is_{(50)}$) and unconfined compressive strength (UCS) will vary with rock type and strength, and should be determined on a site-specific basis. However UCS is typically 20 x $Is_{(50)}$.

ROCK MATERIAL WEATHERING CLASSIFICATION

Symbol		Term	Field Guide
RS		Residual Soil	Soil developed on extremely weathered 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.
XW		Extremely Weathered	Rock is weathered to such an extent that it has soil properties - i.e. it either disintegrates or can be remoulded, in water.
DW	HW	Distinctly Weathered	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores. In some environments it is convenient to subdivide into Highly Weathered and Moderately Weathered, with the degree of alteration typically less for MW.
	MW		
SW		Slightly Weathered	Rock slightly discoloured but shows little or no change of strength relative to fresh rock.
FR		Fresh	Rock shows no sign of decomposition or staining.

ABBREVIATIONS AND DESCRIPTIONS FOR ROCK MATERIAL AND DEFECTS

CLASSIFICATION AND INFERRED STRATIGRAPHY

Rock is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 2017, Section 6.2 – Rock identification, description and classification.

DETAILED ROCK DEFECT SPACING

Defect Spacing

Term	Description
Massive	No layering apparent
Indistinct	Layering just visible; little effect on properties
Distinct	Layering (bedding, foliation, cleavage) distinct; rock breaks more easily parallel to layering

Bedding Thickness (Stratification)

Term	Spacing (mm)
Thinly laminated	<6
Laminated	6 – 20
Very thinly bedded	20 – 60
Thinly bedded	60 – 200
Medium bedded	200 – 600
Thickly bedded	600 – 2,000
Very thickly bedded	> 2,000

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT TYPES

Defect Type	Abbr.	Description
Joint	JT	Surface of a fracture or parting, formed without displacement, across which the rock has little or no tensile strength. May be closed or filled by air, water or soil or rock substance, which acts as cement.
Bedding Parting	BP	Surface of fracture or parting, across which the rock has little or no tensile strength, parallel or sub-parallel to layering/ bedding. Bedding refers to the layering or stratification of a rock, indicating orientation during deposition, resulting in planar anisotropy in the rock material.
Contact	CO	The surface between two types or ages of rock.
Sheared Surface	SSU	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.
Sheared Seam/ Zone (Fault)	SS/SZ	Seam or zone with roughly parallel almost planar boundaries of rock substance cut by closely spaced (often <50 mm) parallel and usually smooth or slickensided joints or cleavage planes.
Crushed Seam/ Zone (Fault)	CS/CZ	Seam or zone composed of disoriented usually angular fragments of the host rock substance, with roughly parallel near-planar boundaries. The brecciated fragments may be of clay, silt, sand or gravel sizes or mixtures of these.
Extremely Weathered Seam/ Zone	XWS/XWZ	Seam of soil substance, often with gradational boundaries, formed by weathering of the rock material in places.
Infilled Seam	IS	Seam of soil substance, usually clay or clayey, with very distinct roughly parallel boundaries, formed by soil migrating into joint or open cavity.
Vein	VN	Distinct sheet-like body of minerals crystallised within rock through typically open-space filling or crack-seal growth.

NOTE: Defects size of <100mm SS, CS and XWS. Defects size of >100mm SZ, CZ and XWZ.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT SHAPE AND ROUGHNESS

Shape	Abbr.	Description	Roughness	Abbr.	Description
Planar	PR	Consistent orientation	Polished	POL	Shiny smooth surface
Curved	CU	Gradual change in orientation	Slickensided	SL	Grooved or striated surface, usually polished
Undulating	UN	Wavy surface	Smooth	SM	Smooth to touch. Few or no surface irregularities
Stepped	ST	One or more well defined steps	Rough	RO	Many small surface irregularities (amplitude generally <1mm). Feels like fine to coarse sandpaper
Irregular	IR	Many sharp changes in orientation	Very Rough	VR	Many large surface irregularities, amplitude generally >1mm. Feels like very coarse sandpaper

Orientation:
Vertical Boreholes – The dip (inclination from horizontal) of the defect.
Inclined Boreholes – The inclination is measured as the acute angle to the core axis.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT COATING

Coating	Abbr.	Description
Clean	CN	No visible coating or infilling
Stain	SN	No visible coating but surfaces are discoloured by staining, often limonite (orange-brown)
Veneer	VNR	A visible coating of soil or mineral substance, usually too thin to measure (< 1 mm); may be patchy

DEFECT APERTURE

Aperture	Abbr.	Description
Closed	CL	Closed.
Open	OP	Without any infill material.
Infilled	-	Soil or rock i.e. clay, silt, talc, pyrite, quartz, etc.

Appendix B - Laboratory Certificates

MOISTURE CONTENT TEST REPORT

Client:	EI Australia Pty Ltd	**Job No:**	S20096-1
Address:	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Report No:**	S58217-MC
Project:	143A Stoney Creek Road Beverly Hills (E23967 G03)		

Test Procedure:

☑ AS 1289 2.1.1 Soil moisture content tests - Determination of the moisture content of a soil - Oven drying method (Standard method).
☐ AS4133 1.1.1 Rock moisture content tests - Determination of the moisture content of rock - Oven drying method (standard method)
☐ RMS T120 Moisture content of road construction materials (Standard method)
☐ RMS T262 Determination of moisture content of aggregates (Standard method)

Sampling: Sampled by Client **Date Sampled:** 18-20/02/2020

Preparation: Prepared in accordance with the test method

Sample No.	Source	Sample Description	Moisture Content %
S58217	BH102 2.0-2.45m	Silty CLAY	**22.7**

Notes:

NATA

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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

5/03/2020

Date:

MACQUARIE GEOTECH

Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

SOIL CLASSIFICATION REPORT

Client	EI Australia Pty Ltd	**Source**	BH102 2.0-2.45m
Address	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Sample Description**	Silty CLAY
Project	143A Stoney Creek Road Beverly Hills (E23967 G03)	**Report No**	S58217-PI
Job No	S20096-1	**Lab No**	S58217

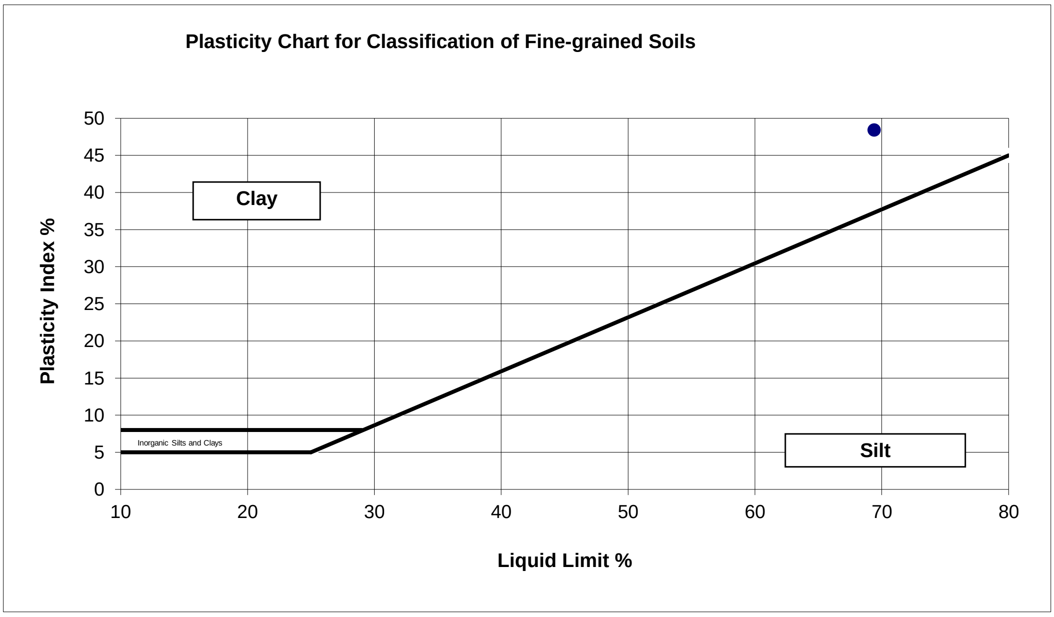
Test Procedure:

☐ AS1289 2.1.1 Soil moisture content tests (Oven drying method)
☑ AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point casagrande method
☐ AS1289 3.1.2 Soil classification tests - Determination of the liquid limit if a soil - One point Casagrande method (subsidiary method)
☑ AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
☑ AS1289 3.3.1 Soil classification tests - Calculation of the plasticity Index of a soil
☑ AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling: Sampled by Client | **Date Sampled:** 18-20/02/2020

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	69	**Linear Shrinkage (%)**	15.0
Plastic Limit (%)	21	**Plasticity Index**	48



Soil Preparation Method: Dry Sieved
Soil History: Oven Dried
Soil Condition: Linear

Notes

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Authorised Signatory:

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5/03/2020

Date:

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Alexandria NSW 2015

POINT LOAD STRENGTH INDEX REPORT

Client:	EI Australia Pty Ltd	**Moisture Content Condition:**	As received
Address:	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Storage History:**	Core boxes
Project:	143A Stoney Creek Road Beverly Hills (E23967 G03)	**Report No:**	S58218-PL
Job No:	S20096-1	**Date Tested:**	4/03/2020

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** 18-20/02/2020

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S58218	BH101M 7.68 - 7.73m	Shale	Axial	51.5	21.0	0.71	0.52	0.45	1
S58219	BH101M 8.61 - 8.70m	Shale	Axial	51.5	11.0	1.15	1.59	1.21	1
S58220	BH101M 9.93 - 10.0m	Shale	Axial	51.7	37.0	1.91	0.78	0.78	1
S58221	BH101M 10.38 - 10.49m	Shale	Axial	51.4	37.0	1.79	0.74	0.73	1
S58222	BH101M 11.37 - 11.47m	Shale	Axial	51.6	42.0	2.91	1.05	1.08	1
S58223	BH101M 12.08 - 12.16m	Shale	Axial	51.8	31.0	2.28	1.12	1.07	1
S58224	BH101M 13.16 - 13.25m	Shale	Axial	51.7	44.0	2.34	0.81	0.84	1
S58225	BH102 8.65 - 8.75m	Shale	Axial	51.7	30.0	1.14	0.58	0.55	1
S58226	BH102 9.61 - 9.69m	Shale	Axial	52.0	36.0	4.92	2.06	2.04	1
S58227	BH102 10.26 - 10.30m	Shale	Axial	51.6	22.0	0.97	0.67	0.59	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

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Street
Alexandria NSW

POINT LOAD STRENGTH INDEX REPORT

Client:	EI Australia Pty Ltd	**Moisture Content Condition:**	As received
Address:	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Storage History:**	Core boxes
Project:	143A Stoney Creek Road Beverly Hills (E23967 G03)	**Report No:**	S58228-PL
Job No:	S20096-1	**Date Tested:**	5/03/2020

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** 18-20/02/2020

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S58228	BH102 11.15 - 11.26m	Shale	Axial	51.7	36.0	2.61	1.10	1.09	1
S58229	BH102 12.16 - 12.25m	Shale	Axial	51.8	19.0	1.18	0.94	0.81	1
S58230	BH102 12.93 - 12.97m	Shale	Axial	51.7	37.0	2.23	0.92	0.91	1
S58231	BH103 7.14 - 7.20m	Shale	Axial	52.0	31.0	0.09	0.04	0.04	1
S58232	BH103 9.02 - 9.12m	Shale	Axial	52.4	35.0	0.05	0.02	0.02	1
S58233	BH103 10.08 - 10.14m	Shale	Axial	51.8	42.0	0.82	0.30	0.30	1
S58234	BH103 10.79 - 10.87m	Shale	Axial	51.8	32.0	1.22	0.58	0.56	1
S58235	BH103 11.08 - 11.18m	Shale	Axial	51.7	38.0	4.06	1.62	1.62	1
S58236	BH103 12.21 - 12.30m	Shale	Axial	51.8	36.0	3.69	1.55	1.54	1
S58237	BH103 13.08 - 13.18m	Shale	Axial	51.8	36.0	3.08	1.30	1.28	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

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Date

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Street
Alexandria NSW

POINT LOAD STRENGTH INDEX REPORT

Client:	EI Australia Pty Ltd	**Moisture Content Condition:**	As received
Address:	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Storage History:**	Core boxes
Project:	143A Stoney Creek Road Beverly Hills (E23967 G03)	**Report No:**	S58238-PL
Job No:	S20096-1	**Date Tested:**	5/03/2020

Test Procedure: ☑ AS4133 4.1 Rock strength tests - Determination of point load strength index

Sampling: Sampled by Client **Date Sampled:** 18-20/02/2020

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Failure Mode
S58238	BH104 7.91 - 7.99m	Shale	Axial	53.8	31.0	0.06	0.03	0.03	1
S58239	BH104 8.07 - 8.13m	Shale	Axial	52.2	28.0	0.08	0.04	0.04	1

Failure Modes

1 - Fracture through fabric of specimen oblique to bedding, not influenced by weak planes.

2 - Fracture along bedding.

3 - Fracture influenced by pre-existing plane, microfracture, vein or chemical alteration.

4 - Chip or partial fracture.

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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

5/03/2020

Date

MACQUARIE GEOTECH

Macquarie Geotechn
U7/8 10 Bradford
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Alexandria NSW

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	David Saw
Client	EI AUSTRALIA
Address	SUITE 6.01 55 MILLER STREET PYRMONT NSW 2009
Telephone	61 2 9516 0722
Facsimile	(Not specified)
Email	david.saw@eiaustralia.com.au
Project	**E23967.G03 143A Stoney Creek Road**
Order Number	**E23967.G03**
Samples	3

LABORATORY DETAILS

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Laboratory	SGS Alexandria Environmental
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SGS Reference	**SE203110 R0**
Date Received	21/2/2020
Date Reported	28/2/2020

COMMENTS

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

SIGNATORIES

Shane MCDERMOTT
Inorganic/Metals Chemist

Soluble Anions (1:5) in Soil by Ion Chromatography [AN245] Tested: 26/2/2020

PARAMETER	UOM	LOR	BH101M_1.5-1.95 SOIL - 17/2/2020 SE203110.001	BH103_3.0-3.45 SOIL - 18/2/2020 SE203110.002	BH104_4.5-4.95 SOIL - 19/2/2020 SE203110.003
Chloride	mg/kg	0.25	30	550	360
Sulfate	mg/kg	5	280	190	140

pH in soil (1:5) [AN101] Tested: 26/2/2020

PARAMETER	UOM	LOR	BH101M_1.5-1.95 SOIL - 17/2/2020 SE203110.001	BH103_3.0-3.45 SOIL - 18/2/2020 SE203110.002	BH104_4.5-4.95 SOIL - 19/2/2020 SE203110.003
pH	pH Units	0.1	5.4	4.5	5.2

Conductivity and TDS by Calculation - Soil [AN106] Tested: 26/2/2020

			BH101M_1.5-1.95 SOIL - 17/2/2020	BH103_3.0-3.45 SOIL - 18/2/2020	BH104_4.5-4.95 SOIL - 19/2/2020
PARAMETER	**UOM**	**LOR**	**SE203110.001**	**SE203110.002**	**SE203110.003**
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	190	520	360

Moisture Content [AN002] Tested: 25/2/2020

PARAMETER	UOM	LOR	BH101M_1.5-1.95 SOIL - 17/2/2020 SE203110.001	BH103_3.0-3.45 SOIL - 18/2/2020 SE203110.002	BH104_4.5-4.95 SOIL - 19/2/2020 SE203110.003
% Moisture	%w/w	1	23.2	15.6	8.5

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN101	pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, sediments and sludges, an extract with water (or 0.01M CaCl2) is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos /cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Salinity can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. Reference APHA 2510 B.
AN245	Anions by Ion Chromatography: A water sample is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
		NVL	Not validated.	LOR	Limit of Reporting.
**	Indicative data, theoretical holding time exceeded.	IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Unless it is reported that sampling has been performed by SGS, the samples have been analysed as received.
Solid samples expressed on a dry weight basis.

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

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

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

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

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

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

The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/en-gb/environment-health-and-safety.

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Appendix C – Vibration Limits

German Standard DIN 4150 – Part 3: 1999 provides guideline levels of vibration velocity for evaluating the effects of vibration in structures. The limits presented in this standard are generally considered to be conservative.

The DIN 4150 values (maximum levels measured in any direction at the foundation, OR, maximum levels measured in (x) or (y) directions, in the plane of the uppermost floor), are summarised in **Table A** below.

It should be noted that peak vibration velocities higher than the minimum figures in **Table A** for low frequencies may be quite 'safe', depending on the frequency content of the vibration and the actual conditions of the structures.

It should also be noted that these levels are 'safe limits', up to which no damage due to vibration effects has been observed for the particular class of building. 'Damage' is defined by DIN 4150 to include even minor non-structural cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls. Should damage be observed at vibration levels lower than the 'safe limits', then it may be attributed to other causes. DIN 4150 also states that when vibration levels higher than the 'safe limits' are present, it does not necessarily follow that damage will occur. Values given are only a broad guide.

Table A DIN 4150 – Structural Damage – Safe Limits for Building Vibration

Group	Type of Structure	Peak Vibration Velocity (mm/s)			
		At Foundation Level at a Frequency of:			Plane of Floor of Uppermost Storey
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All Frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 and 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Note: For frequencies above 100 Hz, the higher values in the 50 Hz to 100 Hz column should be used.

Appendix D – Important Information

Important Information

SCOPE OF SERVICES

The geotechnical report ("the report") has been prepared in accordance with the scope of services as set out in the contract, or as otherwise agreed, between the Client And EI Australia ("EI"). The scope of work may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

RELIANCE ON DATA

EI has relied on data provided by the Client and other individuals and organizations, to prepare the report. Such data may include surveys, analyses, designs, maps and plans. EI has not verified the accuracy or completeness of the data except as stated in the report. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations ("conclusions") are based in whole or part on the data, EI will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to EI.

GEOTECHNICAL ENGINEERING

Geotechnical engineering is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared for a specific client, for a specific project and to meet specific needs, and may not be adequate for other clients or other purposes (e.g. a report prepared for a consulting civil engineer may not be adequate for a construction contractor). The report should not be used for other than its intended purpose without seeking additional geotechnical advice. Also, unless further geotechnical advice is obtained, the report cannot be used where the nature and/or details of the proposed development are changed.

LIMITATIONS OF SITE INVESTIGATION

The investigation programme undertaken is a professional estimate of the scope of investigation required to provide a general profile of subsurface conditions. The data derived from the site investigation programme and subsequent laboratory testing are extrapolated across the site to form an inferred geological model, and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite investigation, the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies. The engineering logs are the subjective interpretation of subsurface conditions at a particular location and time, made by trained personnel. The actual interface between materials may be more gradual or abrupt than a report indicates.

SUBSURFACE CONDITIONS ARE TIME DEPENDENT

Subsurface conditions can be modified by changing natural forces or man-made influences. The report is based on conditions that existed at the time of subsurface exploration. Construction operations adjacent to the site, and natural events such as floods, or ground water fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. EI should be kept appraised of any such events, and should be consulted to determine if any additional tests are necessary.

VERIFICATION OF SITE CONDITIONS

Where ground conditions encountered at the site differ significantly from those anticipated in the report, either due to natural variability of subsurface conditions or construction activities, it is a condition of the report that EI be notified of any variations and be provided with an opportunity to review the recommendations of this report. Recognition of change of soil and rock conditions requires experience and it is recommended that a suitably experienced geotechnical engineer be engaged to visit the site with sufficient frequency to detect if conditions have changed significantly.

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REPORT FOR BENEFIT OF CLIENT

The report has been prepared for the benefit of the Client and no other party. EI assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of EI or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

OTHER LIMITATIONS

EI will not be liable to update or revise the report to take into account any events or emergent circumstances or fact occurring or becoming apparent after the date of the report.