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15 JUBILEE PTY LTD

Geotechnical Investigation

15 Jubilee Avenue, Warriewood

E24716.G03_Rev3
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Revision	Details	Date	Amended By
	Original	22 July 2020	
Rev1	Updated Drawings	17 August 2020	IW
Rev2	Updated Drawings	6 May 2021	DS
Rev3	Updated Drawings	7 May 2021	DS

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1. Introduction

1.1 Background

At the request of 15 Jubilee Pty Ltd (the Client), EI Australia (EI) has carried out a Geotechnical Investigation (GI) for the proposed development at 15 Jubilee Avenue, Warriewood (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 P17823.4, dated 10 June 2020, and with the Client's signed authorisation to proceed, dated 10 June 2020.

1.2 Proposed Development

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

- Architectural plans prepared by SBA Architects, Job No. 20259:
  - Drawing No. DA 101 and DA 700, Issue A, dated 6 May 2021;
  - Drawing No. DA 100, DA 200, DA 201, DA 300, DA 301, DA 500, DA 501 and DA 600, Issue B, dated 6 May 2021;
- Site survey plan prepared by Usher & Company – Referenced 5814-DET, Initial Issue, dated 21 November 2016. 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; and

Based on the provided documents, EI understands that the proposed development involves the removal of the existing site structures and the construction of a three-level storage facility with storage units, warehouses and offices. The lowest ground floor level is to have a finished floor level (FFL) of RL 18.4m. A bulk excavation level (BEL) of RL 18.2m is assumed to allow for the construction of a concrete floor slab. To achieve the BEL, excavation of up to 3.0m BEGL within the eastern portion of the site and filling up to 0.8m within the western portion of the site is expected. Locally deeper excavations may be required for footings, and service trenches.

1.3 Objectives

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

- Excavation methodologies and monitoring requirements;
- Groundwater considerations;
- Excavation support requirements, including preliminary geotechnical design parameters for retaining walls and shoring systems;
- Building foundation options, including;
  - Preliminary 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 six boreholes (BH1, BH2, BH3M, BH4M, BH5M, and BH6) by a track-mounted drill rig using solid flight augers equipped with a 'Tungsten-Carbide' (T-C) bit. BH1, BH2, BH3M, BH4M, BH5M, and BH6 were auger drilled to depths of about 3.50m BEGL (RL of about 18.20m), 4.00m BEGL (RL of about 16.70m), 6.00m BEGL (RL of about 12.80m), 6.00m BEGL (RL of about 14.20m), 6.08m BEGL (RL of about 11.22m), and 7.10m BEGL (RL of about 11.10m) 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**;
- Excavation of six test pits (TP1, TP2, TP3, TP4, TP5 and TP6) by an excavator. TP1, TP2, TP3, TP4, TP5 and TP6 were excavated to depths of about 2.30m BEGL (RL of about 18.70m), 2.00m BEGL (RL of about 18.70m), 1.50m BEGL (RL of about 18.40m), 1.50m BEGL (RL of about 16.40m), 1.50m BEGL (RL of about 16.40m), and 2.50m BEGL (RL of about 15.30m) respectively;
- Boreholes BH3M, BH4M and BH5M were converted into groundwater monitoring wells with depths of about 6.00m BEGL (RL of about 12.80m), 6.00m BEGL (RL of about 14.20m) and 6.10m BEGL (RL of about 11.20m), respectively to allow for long-term groundwater monitoring;
- Boreholes BH1, BH2 and BH6, and all test pits were backfilled with drilling and excavated spoils upon completion;
- Soil 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; and
- 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 preliminary and intended to assist in the preparation of initial designs for the proposed development. Further geotechnical inspections should be carried out during construction to confirm the geotechnical and groundwater models, and the preliminary 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	15 Jubilee Avenue, Warriewood
Lot and Deposited Plan (DP) Identification	Lot 202 in DP 1019363
Brief Site Description	At the time of our investigation, the site comprised of a grassy field with a number of mature trees present in the western portion of the site, and a storage container located within the north-eastern portion of the site. The site was gently sloping towards the west, and an easement runs in a roughly north-south direction through the western half of the site.
Site Area	The site area is approximately 4554m^2 (based on the provided survey plan referenced above).

Plate 1: Aerial photograph of the site (source: Six Maps, accessed 30 June 2020)

2.2 Local Land Use

The site is situated within an area of mixed commercial and 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 Jubilee Avenue shall be adopted as the northern site boundary.

Table 2-2 Summary of Local Land Use

Direction Relative to Site	Land Use Description
North	Jubilee Avenue, a two lane, asphalt-paved road. Beyond this are two to three-storey commercial buildings. The buildings are slightly higher than the site with no basement levels observed.
East	Property at 19 Jubilee Avenue, a single-storey fibre cement residential dwelling with an attached carport, and paved driveway and grassed front and rear yard. The main house has an offset of about 5m from the eastern boundary and it appeared to be in fair condition based on a cursory inspection of the external walls. The dwelling is on a similar elevation to the site, with no basement levels observed.
South	Two to three storey commercial buildings which abuts the southern site boundary. The buildings are slightly lower than the site with basement levels observed.
West	A small creek runs along the western site boundary followed by a three storey commercial building. The building has an offset of about 5m from the western site boundary. The building is on a similar level to the site, with basement levels observed.

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 located on the south side of the road within gently west dipping topography with site levels varying from R.L. 22.4m at the north-eastern site corner to R.L. 15.5 at the south-western site 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 is underlain by the Newport formation, which typically comprises interbedded laminite, shale, and quartz, to lithic-quartz sandstone, and minor red claystone north of the Hawkesbury River; clay pellet sandstone south of Hawkesbury River.

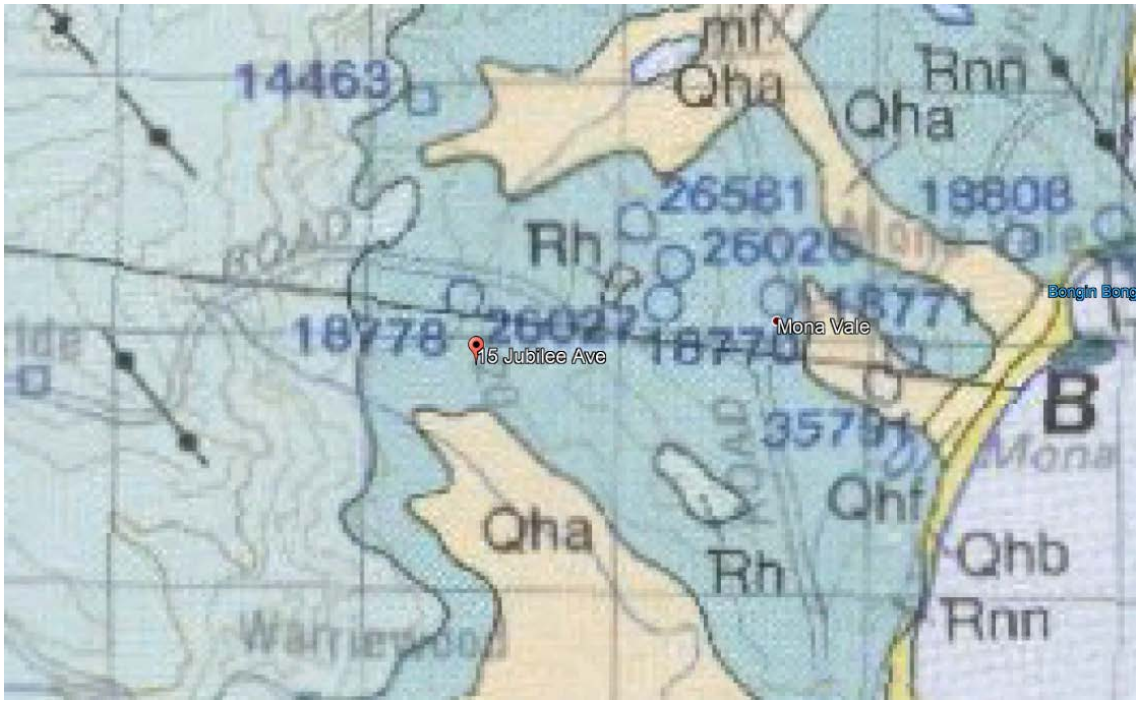


Plate 2: **Excerpt of geological map showing location of site.**

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 three 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	**Topsoil/Fill**	Surface	17.30 to 21.70	0.10 to 2.20	Topsoil and fill comprising fine to medium grained, brown, silty sand with rootlets, followed by fine to medium grained, pale brown to brown silty to clayey sand;
2	**Alluvial Soil**	0.10 to 2.20	16.00 to 21.20	1.27 to 4.90[2]	Firm to very stiff, low plasticity sandy to silty clay, or clayey sand, with fine to medium ironstone gravels. SPT N-values range from 7 to 19;
3[3]	**Very Low to Low Strength Clay Pellet Sandstone**	1.77 to 7.10	11.10 to 19.93	-[4]	Very low to low strength, distinctly weathered, fine to medium grained sandstone with clay and claystone bands. Not encountered in BH5, TP3, TP4, TP5, or TP6. The depth to bedrock varies across the site, being most shallow at the eastern end (BH1), becoming deeper at the western end (BH6).

Note 1 Approximate depth and level at the time of our assessment. Depths and levels may vary across the site.
Note 2 Observed up to termination in BH5M, TP3, TP4, TP5 and TP6.
Note 3 Observed in BH1, BH2, BH3M, BH4M, BH5M, BH6, TP1 and TP2 only.
Note 4 Observed up to termination in BH1, BH2, BH3M, BH4M, BH5M, BH6, TP1 and TP2.
Note 5 For more detailed descriptions of the subsurface conditions, reference should be made to the borehole logs attached to **Appendix A.**

3.2 Groundwater Observations

Groundwater seepage was observed during auger drilling of BH3M, BH4M, BH5M and BH6 only at depths between 2.5 to 3.9m BEGL. Following their completion, groundwater monitoring wells were installed in BH3M, BH4M, BH5M and bailed dry. The groundwater levels were then measured within the monitoring wells as per **Table 3-2** below:

Table 3-2 Groundwater Levels

Borehole ID	Measurement Date	Depth to Groundwater (m BEGL)	Groundwater RL (m AHD)
BH3M	18/6/20	1.1	17.3
BH4M	18/6/20	1.8	18.4
BH5M	18/6/20	1.5	15.8

3.3 Test Results

Six soil and two bulk 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).
- California Bearing Ratio (CBR).

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

Table 3-3 Summary of Soil Laboratory Test Results

Test/ Sample ID		BH2_3.0-3.45	BH3M_1.5-1.95	BH6_3.0-3.45	BH1_0.5-0.95	BH4M_1.5-1.95	BH5M_1.5-1.95
Unit		3	2	2	2	2	2
Material Description [1]		Clay Pellet Sandstone	Sandy Clay	Sandy Clay	Sandy Clay	Sandy Clay	Sandy Clay
Aggressivity	Chloride Cl (ppm)	5.1	80	12	-	-	-
	Sulfate SO_4 (ppm)	46	84	62	-	-	-
	pH	4.7	4.5	4.8	-	-	-
	Electrical Conductivity (µS/cm)	33	88	43	-	-	-
	Moisture Content (%)	12.4	16.5	16.2	22.3	18.8	17.3
Attergerg Limits	Liquid Limit (%)	-	-	-	31	28	29
	Plastic Limit (%)	-	-	-	19	19	15
	Plasticity Index (%)	-	-	-	12	9	14
	Linear Shrinkage (%)	-	-	-	6.5	6.5	9.0

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 low plasticity and of low shrink-swell potential.

The assessment indicated low to high permeability soil was present above and below 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:

- 'Moderate' for buried concrete structural elements; and
- 'Mild' 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 'B1' to 'A2' for concrete in sulfate soils.

Table 3-4 Summary of CBR Test Results

Test/ Sample ID	TP2_0.5-1.3	TP6_0.8-1.5
Depth (m BEGL)	0.5-1.3	0.8-1.5
Unit	2	2
Material Description [1]	Clayey Sand	Clayey Sand
CBR (4-day Soaked) (%)	14%	20%
Maximum Dry Density (t/m^3)	1.773	1.951
Optimum Moisture Content (%)	15.6	11.3

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

Bulk samples of the Unit 2 material from TP2 and TP6 were tested for compaction and four day soaked CBR, resulted in values of 14% and 20% when compacted to 100% of Standard Maximum Dry Density (SMDD) and surcharged with 9kg.

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;
- Foundation design for building loads;
- Bulk earthworks including subgrade preparation and engineered fill; and
- Pavement design.

4.2 Site Preparation

Following removal of all vegetation and trees (including their root balls), and removal of the existing storage containers, all grass, topsoil, root affected soils and any deleterious fill or contaminated soil should be stripped. Based on the results of the investigation, topsoil/root affected soil should be stripped to a nominal depth. Stripped topsoil and root affected soils should be stockpiled separately as they are considered unsuitable for reuse as engineered fill.

All existing fill will need to be stripped down to the surface of the underlying natural soils and stockpiled for reuse as engineered fill, if it conforms to the fill specification provided in section below.

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 18.2m for the ground floor, or an excavation depth of up to 3.0m 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 excavation will require excavation down to unit 2 alluvial soils within the western and central portions of the site and unit 3 weathered sandstone bedrock within the eastern portion of the site. 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’.

Due to the weathered nature and limited extent of the bedrock expected at BEL, rock hammering is not expected to be required during excavation. However, should rock hammers be required for the excavation of the 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.

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;
- 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 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 base of the excavation; 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 Excavation Retention

4.4.1 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 of 6.0m from the northern site boundary, 3.0m from the western and eastern site boundaries and 1.0m from the southern site boundaries.

Based on the depth of the excavation, the encountered subsurface conditions and given setbacks, temporary batters of no steeper than a safe angle of 1 Vertical (V) to 1 Horizontal (H) may be feasible **where space allows** along the northern, and eastern site boundaries. The above temporary batters should remain stable provided that all surcharge loads, including construction loads, are kept at a distance of at least 2h (where ‘h’ is the height of the batter in metres) from the crest of the batter. If steeper batters are to be used, then these must be supported by shotcrete and soil nail system designed by a suitable structural or geotechnical engineer. The stability of these batters can be assessed using computer slope stability analysis software such as Slope/W. we can complete such analysis, if commissioned to do so.

Where batters are used, the space between the batters and the permanent retaining walls will need to be carefully backfilled to reduce future settlement of the backfill. Only light compaction equipment should be used for compaction behind retaining walls so that excessive lateral pressures are not placed on the walls. This will require the backfill to be placed in thin layers, say 100mm loose thickness, appropriate to the compaction equipment being used. The compaction specification for the backfill will depend on whether paving or structures are to be supported on the fill. If the fill is to support paved areas it should be compacted to a density of at least 98% of Standard Maximum Dry Density (SMDD) for granular fill materials, but if it is only to support landscaped areas of lower compaction specification, say 95% of SMDD, may be appropriate, provided the risk of future settlement and maintenance can be accepted. An alternative for backfill would also be to use a uniform granular material, wrapped in a geofabric.

Unsupported vertical cuts of the soil greater than 0.5m in height are not recommended for this site as these carry the risk of potential slumping / collapse especially after a period of wet weather, which may result in injury to personnel or damage to nearby structures, infrastructures and equipment.

A suitable retention system will be required for the support of units 1, 2 and 3 along the southern site boundary (and possibly the northern and eastern boundaries should temporary batters be not feasible) where space does not allow for temporary batters. For this site, EI recommends a cantilevered soldier pile wall founded below bulk excavation level and into the weathered sandstone (Unit 3). Contiguous pile walls may be used where sensitive assets or properties are adjacent to the excavation. The retention system will need to be installed to depths which satisfy stability and foundation considerations.

Bored piles are considered suitable for this site. The proposed pile locations should take into account the presence of the neighbouring anchors and/or the presence of buried services, notably the sewer easement running through the western portion of the site. Further advice should be sought from prospective piling contractors who should be provided with a copy of this report.

Working platforms may also be required. We can complete the design of the working platform, if commissioned to do so.

4.4.2 Retaining Wall Design Parameters

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

- Conventional free-standing cantilever walls which support areas where movement is of little concern (i.e. where only gardens or open areas are to be retained), may be designed using a triangular lateral earth pressure distribution and an ‘active’ earth pressure coefficient, K_a, as shown in **Table 4-1;**
- Cantilevered walls, where the tops of which are restrained by the floor slabs of the permanent structure or which support movement sensitive elements, should be designed using a triangular lateral earth pressure distribution and an ‘at rest’ earth pressure coefficient, K_o, as shown in **Table 4-1** below.
- 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.
- The retaining walls should be designed as drained and measures are to be taken to provide complete and permanent drainage behind the walls;

- For piles embedded into Unit 3 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.

Table 4-1 Geotechnical Design Parameters

Material [1]		Unit 1 Topsoil/Fill	Unit 2 Alluvial Soil	Unit 3 Very Low to Low Strength Clay Pellet Sandstone
RL of Top of Unit (m AHD) [2]		17.3 to 21.7	16 to 21.2	11.1 to 19.93
Bulk Unit Weight (kN/m^3)		18	20	23
Friction Angle, ϕ' (°)		25	26	35
Earth Pressure Coefficients	At rest, K_o [3]	0.58	0.56	0.43
	Active, K_a [3]	0.41	0.39	0.27
	Passive, K_p [3]	2.46	2.56	3.69
Allowable Bearing Pressure (kPa) [5]		-	100	700
Allowable Shaft Adhesion (kPa) [4, 5]	in Compression	-	-	70
	in Uplift	-	-	35
Allowable Toe Resistance (kPa)		-	-	70
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).

4.5 Groundwater Considerations

Groundwater was observed in all monitoring wells as detailed in **Table 3-2**, all of which are close to or below the assumed BEL RL of 18.2m. 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. However, we expect that some groundwater inflows into the excavation along the soil/rock interface and through any defects within the sandstone 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.

4.6 Foundations

The most competent foundation stratum at the site is the weathered bedrock (Unit 3) and in view of the variable soil conditions at the proposed BEL and shallow depth to bedrock, we recommend that the development be supported on footings founded into bedrock. Footings founded on different materials (e.g. alluvial soils and sandstone) are not recommended due to the potential for differential settlement.

For piles founded into Unit 3 bedrock, these must be embedded a minimum of 0.5m into the sandstone, and can be designed for a maximum allowable bearing pressure of 700kPa. The allowable shaft adhesion in the bedrock may be designed as 10% of the allowable bearing pressure (or 5% for uplift) for the socket length in excess of 0.5m.

At least the initial drilling of piles should be completed in the presence of a geotechnical engineer to verify that ground conditions meet design assumptions.

Where groundwater ingress is encountered during pile drilling, 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.

Where unit 3 bedrock or better is exposed at the base of the excavation, such as towards the eastern end of the site, shallow footings may be utilised and can be designed for a maximum allowable bearing pressure of 700kPa. For smaller on-ground structures separate from the main development, such as the above ground bioretention basin adjacent to the northern site boundary, these may be supported on shallow footings within the unit 2 alluvial soils designed for an allowable bearing capacity of 100kPa when founded on stiff clays or better. Shallow footing excavations should be cleaned out, inspected by a geotechnical engineer, and poured

without delay. If delays in pouring are envisaged, then we recommend that a concrete blinding layer be provided over the base to reduce deterioration due to weathering.

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

4.7 Existing Fill

Based on the investigation results, the site is covered by a layer of fill between 0.1m and 2.2m deep. Based on SPT tests within the fill, it appears that it has generally been poorly compacted. However, the SPT tests do not give a precise determination of in-situ densities, since they are affected by friction during driving, the presence of gravels, and the changes in moisture content. Based on available information, the fill on site is not considered to be 'controlled fill'. AS2870 defines 'controlled' fill as material that has been placed and compacted in layers by compaction equipment within a defined moisture range, to a defined density requirement, and placed in accordance with AS3798.

4.8 Subgrade Preparation and Engineered Fill

4.8.1 Subgrade Preparation

Earthworks recommendations provided in this report should be complemented by reference to AS3798.

1 Fill should be fully excavated down to surface of the alluvial soils, and stockpiled separately since these materials are not suitable for re-use as engineered fill. Such excavation may need to be carried out with the excavation sides battered at an angle of no steeper than 1 Vertical to 2 Horizontal. The new fill must be 'keyed-in' the sides of these batters.

2 The exposed subgrade at the base of the excavation should be proof rolled with a smooth drum roller (say 12 tonne) used in static or non-vibratory mode of operation. Caution is required when proof rolling near existing infrastructures and utilities (where present). The purpose of the proof rolling is to detect any soft or heaving areas, and to allow for some further improvement in strength or compaction.

3 The final pass should be undertaken in the presence of an experienced geotechnician or geotechnical engineer, to detect any unstable or soft subgrade areas, and to allow for some further improvement in strength/compaction.

4 If dry conditions prevail at the time of construction then any exposed alluvial clay subgrade may become desiccated or have shrinkage cracks prior to pouring any concrete slabs. If this occurs, the subgrade must be watered and rolled until the cracks disappear.

5 Unstable subgrade detected during proof rolling should be locally excavated down to a sound base and replaced with engineered fill or further advice should be sought. Any fill placed to raise site levels should also be engineered fill, as per the specifications below.

If suspended floor slabs or pavement are designed, then it would be unnecessary to complete any particular subgrade preparation other than stripping of root affected soils from the footprint of the proposed building structures and replaced with surface levelling compacted fill for the floor slab formwork.

4.8.2 Engineered Fill Specifications

Any fill used to backfill unstable subgrade areas, raise surface levels or backfill service trenches should be engineered fill. Materials preferred for use as engineered fill are well-graded granular materials, such as ripped or crushed sandstone, free of deleterious substances and having a maximum particle size not exceeding 75 mm. such fill should be compacted in layers not greater than 200 mm loose thickness, to a minimum density of 98% of SMDD.

The existing clayey soils excavated from cut areas may be reused as engineered fill, provided unsuitable ('over wet' and 'oversized') material and any deleterious material is removed.

Density tests should be regularly carried out on the fill to confirm the above specifications are achieved. The frequency of density testing should be at least one test per layer per material type per 2500 m^2 or 1 test per 500m^3 distributed reasonably evenly throughout full depth and area or 3 tests per lot, whichever requires the most tests. We recommend that at least Level 2 control of fill compaction, as defined in AS3798-2007, be adhered to on this Site. Preferably, the geotechnical testing authority (GTA) should be engaged directly on behalf of the client and not by the earthworks subcontractor.

We recommend that the engineered fill layers extend a horizontal distance of at least 1m beyond the design geometry. The roller must extend over the edge of each placed layer in order to seal the batter surface. On completion of filling, the excess under-compacted edge fill should be trimmed back to the design geometry.

The 'tying in' of engineered fill to temporary cut batter slopes can be achieved by locally benching the cut slopes in no greater than 0.4m high steps. This can be carried out progressively as the height of engineered fill increases.

For backfilling confined excavations such as service trenches, a similar compaction to engineered fill should be adhered to, but if light compaction equipment is used then the layer thickness should be limited to 100mm loose thickness.

During construction of the fill, platform runoff should be enhanced by providing suitable falls to reduce ponding of water on the surface of the fill. Ponding of water may lead to softening of the fill and subsequent delays in the earthworks program. A poorly drained subgrade may become un-trafficable when wet. We recommend that if soil softening occurs, the subgrade be over-excavated to below the affected soil, and then replaced with engineered fill as specified above.

4.9 Pavement Design

The design of new pavements will depend on subgrade preparation, subgrade drainage, the nature and composition of fill excavated or imported to the site, as well as vehicle loadings and use. Various alternative types of construction could be used for the pavements. Concrete construction would undoubtedly be the best in areas where heavy vehicles manoeuvre such as trucks turning and manoeuvring. Flexible pavements may have a lower initial cost, but maintenance will be higher. These factors should be considered when making the final choice.

Based on the laboratory test results, the samples collected from the alluvial soil beneath the proposed road alignments registered the CBR value 14% to 20%. We recommend that pavement design may be based on the CBR value of 14.0%.

5. Further Geotechnical Inputs

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

- Classification of all excavated material transported off site;
- Proof rolling and certification of engineered subgrade material;
- 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.

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 Joshua Mete and 15 Jubilee 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 Joshua Mete and 15 Jubilee 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 D** 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

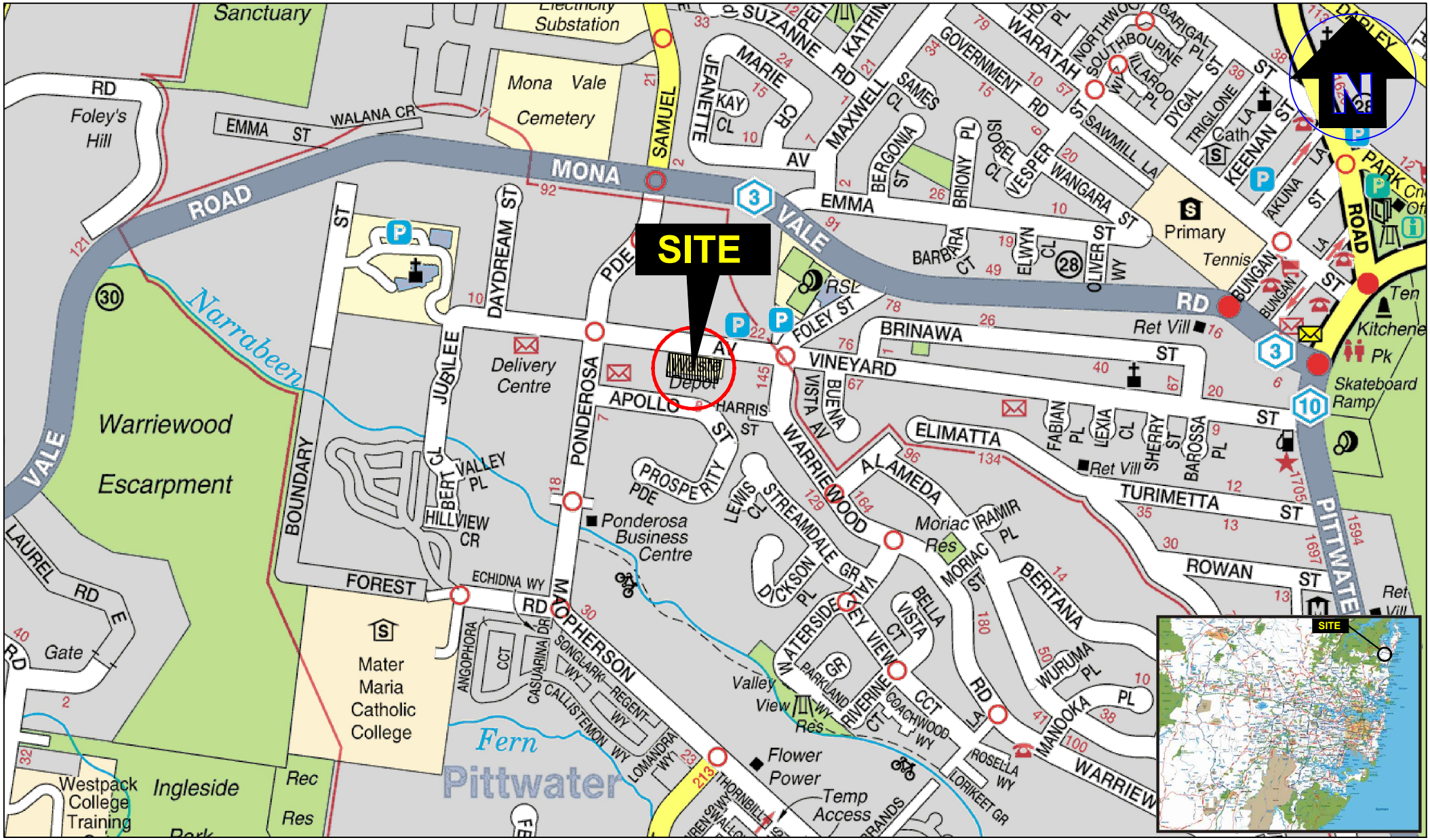
NSW Department of Finance and Service, Spatial Information Viewer, maps.six.nsw.gov.au.

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



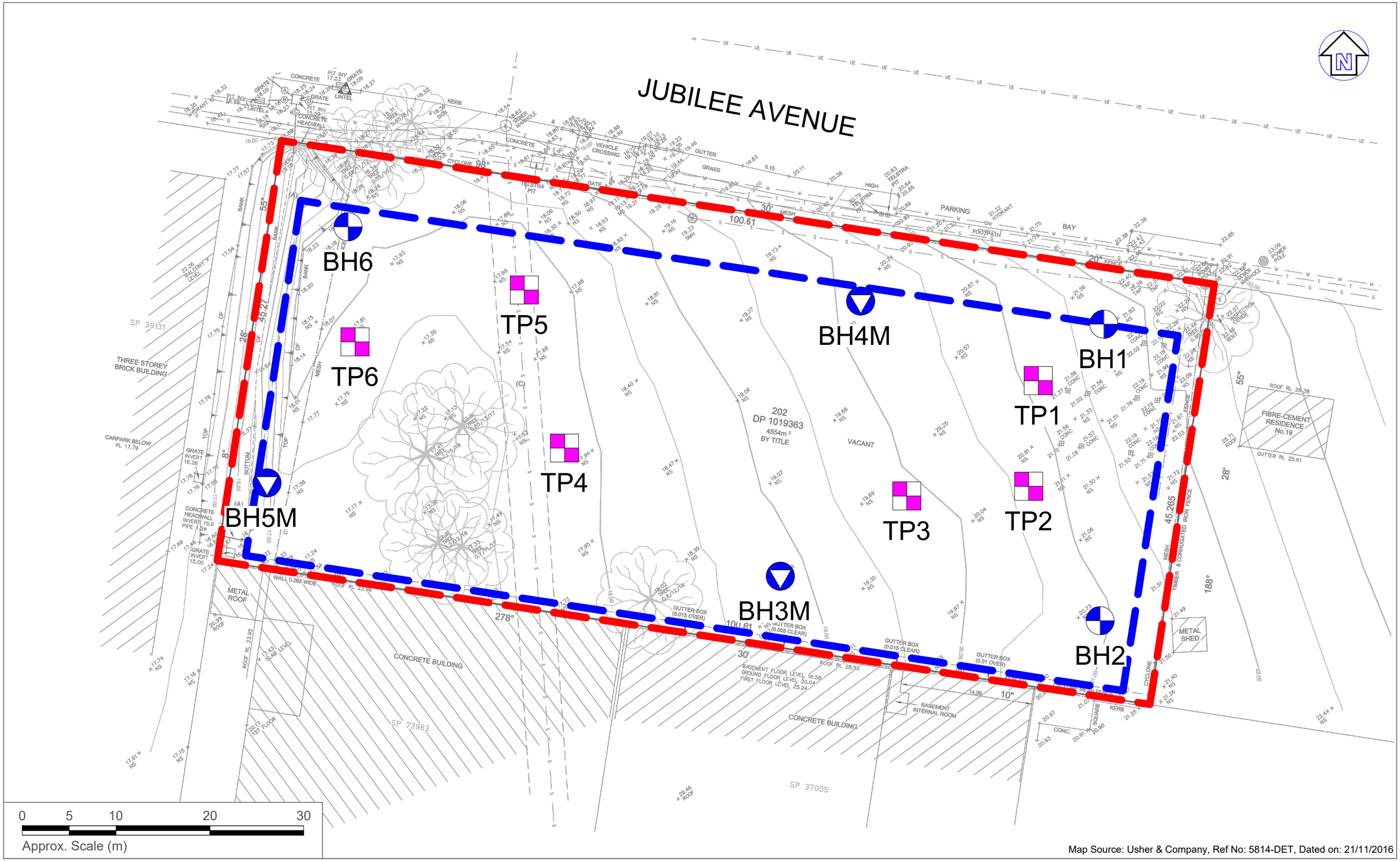
Drawn:	AM.H.	
Approved:	B.L.	
Date:	07-07-20	
Scale:	Not To Scale	

15 Jubilee Pty Ltd
Geotechnical Investigation
15 Jubilee Avenue, Warriewood NSW
Site Locality Plan

Figure:
1

Project: E24716.G03_Rev3

eiaustralia
Contamination | Remediation | Geotechnical
Suite 6.01, 55 Miller Street, PYRMONT 2009
Ph (02) 9516 0722 Fax (02) 9518 5088



Map Source: Usher & Company, Ref No: 5814-DET, Dated on: 21/11/2016

LEGEND

- Approximate site boundary
- Approximate ground floor boundary
- Approximate borehole location
- Approximate borehole/monitoring well location
- Approximate test pit location

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Drawn:	D.S.
Approved:	S.K.
Date:	07-05-2021

15 Jubilee Pty Ltd
Geotechnical Investigation
15 Jubilee Avenue, Warriewood NSW
Borehole Location Plan

Figure: 2

Project: E24716.G03_Rev3

Appendix A – Borehole Logs And Explanatory Notes

BOREHOLE LOG

BH NO. BH1

Project	Proposed Development	**Sheet**	1 of 1
Location	15 Jubilee Avenue, Warriewood NSW	**Date Started**	11/06/2020
Position	Refer to Figure 2	**Date Completed**	11/06/2020
Job No.	E24716.G03	**Logged By** BY	**Date** 11/06/2020
Client	15 Jubilee Pty Ltd	**Reviewed By** SR	**Date** 20/07/2020

Drilling Contactor	Hagstrom	**Surface RL**	≈21.70 m AHD
Drill Rig	HP Scout	**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
			0	*0.15*				-	TOPSOIL/FILL: Silty SAND; fine to medium grained, brown, with rootlets.	M	-	TOPSOIL/FILL
				21.55				-				FILL
				0.50					FILL: Clayey SAND; fine to medium grained, pale brown-brown.	M	-	
				21.20	BH1_0.5-0.95 SPT 0.50-0.95 m 2,3,3 N=6			CL	Sandy CLAY; low plasticity, red-brown to orange-brown to pale grey, trace fine to medium, sub-rounded to sub-angular ironstone gravels.			ALLUVIAL SOIL
AD/T	-	GWNE	1							M (=PL)	F	
					BH1_1.5-1.77 SPT 1.50-1.92 m 13,9/120mm HB							
				1.77								
				19.93				-	CLAY PELLET SANDSTONE; fine to medium grained, red-brown to pale grey, with clay and claystone bands, very low to low strength, distinctly weathered.			BEDROCK
	M-H		2							-	-	
			3	*3.50*								
									Hole Terminated at 3.50 m T/C Bit Refusal. Backfilled with Drilling Spoil.			
			4									
			5									
			6									
			7									
			8									
			9									
			10									

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

BOREHOLE LOG

BH NO. BH2

Project	Proposed Development	**Sheet**	1 of 1
Location	15 Jubilee Avenue, Warriewood NSW	**Date Started**	11/06/2020
Position	Refer to Figure 2	**Date Completed**	11/06/2020
Job No.	E24716.G03	**Logged By** BY	**Date** 11/06/2020
Client	15 Jubilee Pty Ltd	**Reviewed By** SR	**Date** 20/07/2020

Drilling Contactor	Hagstrom	**Surface RL**	≈20.70 m AHD
Drill Rig	HP Scout	**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
AD/T	-	GWNE	0	*0.15*				-	TOPSOIL/FILL: Silty SAND; fine to medium grained, brown, with rootlets.	M	-	TOPSOIL/FILL
				20.55				-	FILL: Silty SAND; fine to medium grained, pale brown-brown, trace clay.	M	-	FILL
					BH2_0.8-0.95							
				0.80								
			1	19.90	SPT 0.80-1.25 m 2,1,3 N=4			CL	Sandy CLAY; low plasticity, red-brown to orange-brown to pale grey, trace fine to medium, sub-rounded to sub-angular ironstone gravels.		F	ALLUVIAL SOIL
					BH2_1.5-1.95 SPT 1.50-1.95 m 3,4,8 N=12					M (=PL)		
			2								St	
				2.50								
	M-H			18.20				-	CLAY PELLET SANDSTONE; fine to medium grained, red-brown to pale grey, with clay and claystone bands, very low to low strength, distinctly weathered.	-	-	BEDROCK
			3		BH2_3.0-3.45 SPT 3.00-3.45 m 6,15,22 N=37							
				4.00					Hole Terminated at 4.00 m T/C Bit Refusal Backfilled with Drilling Spoil.			
			4									
			5									
			6									
			7									
			8									
			9									
			10									

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

BOREHOLE LOG

BH NO. BH3M

Project	Proposed Development	**Sheet**	1 of 1
Location	15 Jubilee Avenue, Warriewood NSW	**Date Started**	11/06/2020
Position	Refer to Figure 2	**Date Completed**	11/06/2020
Job No.	E24716.G03	**Logged By** BY	**Date** 11/06/2020
Client	15 Jubilee Pty Ltd	**Reviewed By** SR	**Date** 20/07/2020

Drilling Contactor	Hagstrom	**Surface RL**	≈18.80 m AHD
Drill Rig	HP Scout	**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
AD/T	-	17/06/20	0	0.10 18.70				-	TOPSOIL/FILL: Silty SAND; fine to medium grained, brown, with rootlets.	M	-	TOPSOIL/FILL
								SM	Silty SAND; fine to medium grained, pale grey.		-	ALLUVIAL SOIL
			1	1.10 17.70	BH3M_0.5-0.9 SPT 0.50-0.95 m 2,2,3 N=5			CL	Sandy CLAY; low plasticity, pale grey-red mottled brown.	M	L	
					BH3M_1.5-1.95 SPT 1.50-1.95 m 3,5,8 N=13							
			2	2.00 16.80				CI	Silty CLAY; medium plasticity, red-brown to orange-brown to pale grey, trace fine to medium, sub-rounded to sub-angular ironstone and sandstone gravels.	M (<PL)	St	
				2.80 16.00				-	CLAY PELLET SANDSTONE; fine to medium grained, red-brown to pale grey, with clay and claystone bands, very low strength, distinctly weathered.			BEDROCK
	M		3		BH3M_3.0-3.38 SPT 3.00-3.38 m 10,21,10/80mm HB					-	-	
			4									
			5		BH3M_4.5-4.78 SPT 4.50-4.93 m 10,12/130mm HB							
	H		6	6.00					Hole Terminated at 6.00 m Target Depth Reached. T/C Bit near Refusal Based on Drilling Rig Resistance			
			7									
			8									
			9									
			10									

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

MONITORING WELL LOG

MW NO. BH3M

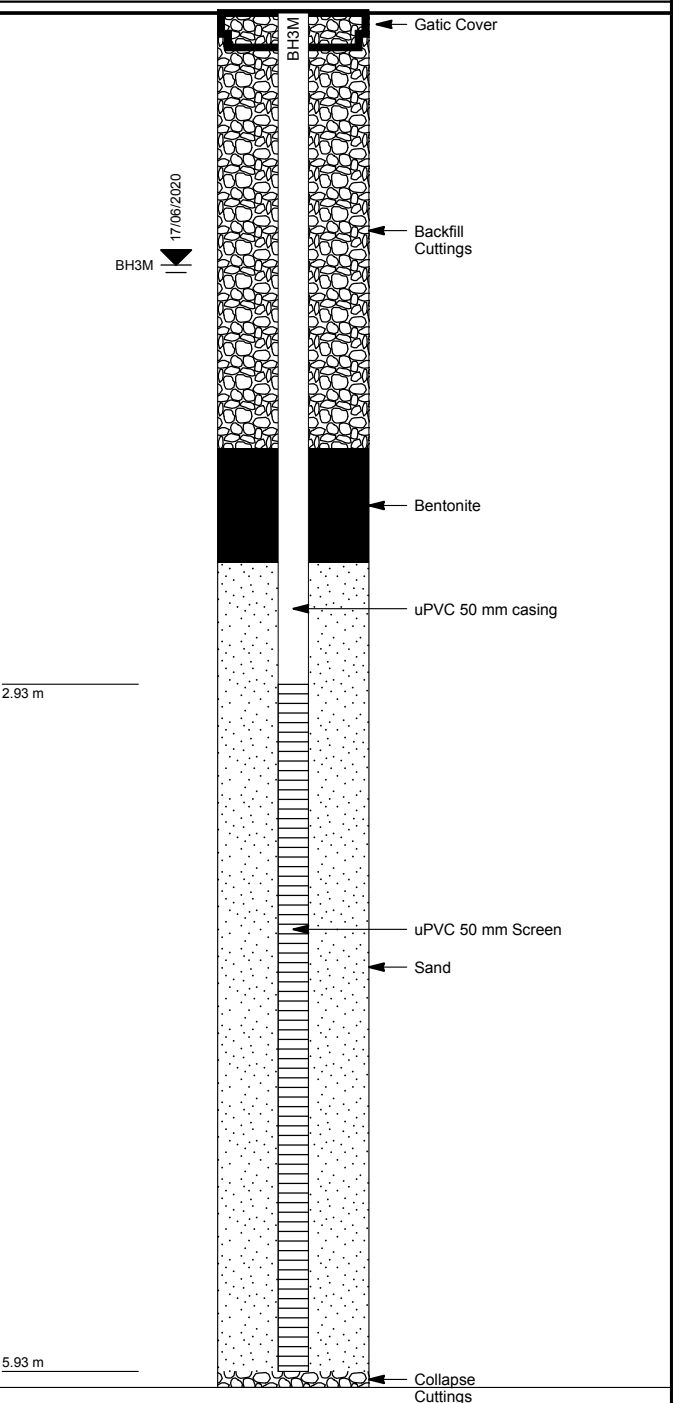
Project	Proposed Development	**Sheet**	1 of 1
Location	15 Jubilee Avenue, Warriewood NSW	**Date Started**	11/06/2020
Position	Refer to Figure 2	**Date Completed**	11/06/2020
Job No.	E24716.G03	**Logged By** BY	**Date** 11/06/2020
Client	15 Jubilee Pty Ltd	**Reviewed By** SR	**Date** 20/07/2020

Drilling Contactor	Hagstrom	**Surface RL**	≈18.80 m AHD
Drill Rig	HP Scout	**Inclination**	-90°

METHOD	WATER	DEPTH (m)	RL (m AHD)	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION
AD/T	17/06/20	0	18		TOPSOIL/FILL: Silty SAND; fine to medium grained, brown, with rootlets.
		1			Silty SAND; fine to medium grained, pale grey.
			17		Sandy CLAY; low plasticity, pale grey-red mottled brown.
		2			Silty CLAY; medium plasticity, red-brown to orange-brown to pale grey, trace fine to medium, sub-rounded to sub-angular ironstone and sandstone gravels.
			16		CLAY PELLET SANDSTONE; fine to medium grained, red-brown to pale grey, with clay and claystone bands, very low strength, distinctly weathered.
		3			
			15		
		4			
			14		
		5			
			13		
		6			Hole Terminated at 6.00 m Target Depth Reached. T/C Bit near Refusal Based on Drilling Rig Resistance

PIEZOMETER CONSTRUCTION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL	Installation Date	Static Water Level
BH3M	Standpipe	0.01 m 18.79 m	5.93 m 12.87 m		



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

BOREHOLE LOG

BH NO. BH4M

Project	Proposed Development	**Sheet**	1 of 1
Location	15 Jubilee Avenue, Warriewood NSW	**Date Started**	11/06/2020
Position	Refer to Figure 2	**Date Completed**	11/06/2020
Job No.	E24716.G03	**Logged By** BY	**Date** 11/06/2020
Client	15 Jubilee Pty Ltd	**Reviewed By** SR	**Date** 20/07/2020

Drilling Contactor	Hagstrom	**Surface RL**	≈20.20 m AHD
Drill Rig	HP Scout	**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
AD/T	-	17/06/20	0	0.10 20.10				-	TOPSOIL/FILL: Silty SAND; fine to medium grained, brown, with rootlets.	-	-	TOPSOIL/FILL
								-	FILL: Silty SAND; fine to medium grained, pale brown-brown.	M	-	FILL
			1	1.10 19.10	BH4M_0.5-0.95 SPT 0.50-0.95 m 2,2,2 N=4			CL	Sandy CLAY; low plasticity, red-brown to orange-brown to pale grey, trace fine to medium, sub-rounded to sub-angular ironstone gravels.	M (=PL)	St	ALLUVIAL SOIL
			2		BH4M_1.5-1.95 SPT 1.50-1.95 m 5,5,6 N=11							
			3		BH4M_3.0-3.45 SPT 3.00-3.45 m 7,13,19 N=32						H	
			4	4.00 16.20				-	CLAY PELLET SANDSTONE; fine to medium grained, red-brown, pale grey, with clay and claystone bands, very low strength, distinctly weathered.	-	-	BEDROCK
	M		5		BH4M_4.5-4.67 SPT 4.50-4.82 m 7,12/20mm HB							
			6	6.00					Hole Terminated at 6.00 m Target Depth Reached.			
			7									
			8									
			9									
			10									

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

MONITORING WELL LOG

MW NO. BH4M

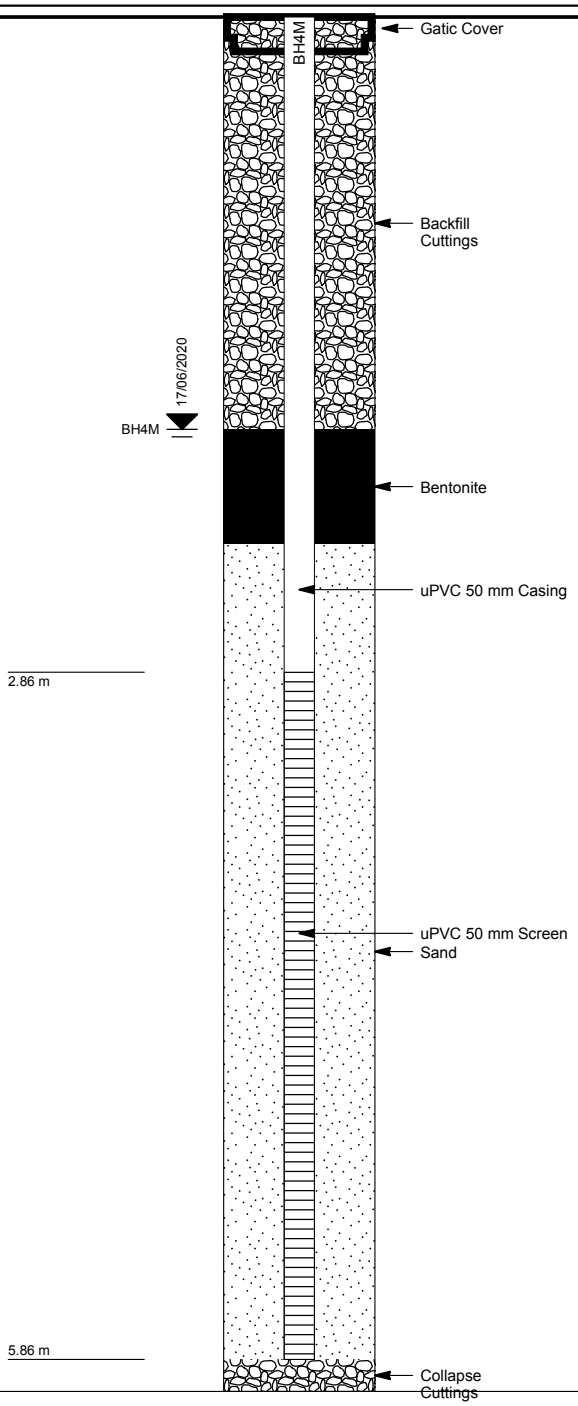
Project	Proposed Development	**Sheet**	1 of 1
Location	15 Jubilee Avenue, Warriewood NSW	**Date Started**	11/06/2020
Position	Refer to Figure 2	**Date Completed**	11/06/2020
Job No.	E24716.G03	**Logged By** BY	**Date** 11/06/2020
Client	15 Jubilee Pty Ltd	**Reviewed By** SR	**Date** 20/07/2020

Drilling Contactor	Hagstrom	**Surface RL**	≈20.20 m AHD
Drill Rig	HP Scout	**Inclination**	-90°

METHOD	WATER	DEPTH (m)	RL (m AHD)	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION
AD/T	17/06/20	0	20		TOPSOIL/FILL: Silty SAND; fine to medium grained, brown, with rootlets.
					FILL: Silty SAND; fine to medium grained, pale brown-brown.
		1	19		Sandy CLAY; low plasticity, red-brown to orange-brown to pale grey, trace fine to medium, sub-rounded to sub-angular ironstone gravels.
		2	18		
		3	17		
		4	16		CLAY PELLET SANDSTONE; fine to medium grained, red-brown, pale grey, with clay and claystone bands, very low strength, distinctly weathered.
		5	15		
		6	14		Hole Terminated at 6.00 m Target Depth Reached.

PIEZOMETER CONSTRUCTION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL	Installation Date	Static Water Level
BH4M	Standpipe		5.86 m 14.34 m		



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

BOREHOLE LOG

BH NO. BH5M

Project	Proposed Development	**Sheet**	1 of 1
Location	15 Jubilee Avenue, Warriewood NSW	**Date Started**	11/06/2020
Position	Refer to Figure 2	**Date Completed**	11/06/2020
Job No.	E24716.G03	**Logged By** BY	**Date** 11/06/2020
Client	15 Jubilee Pty Ltd	**Reviewed By** SR	**Date** 20/07/2020

Drilling Contactor	Hagstrom	**Surface RL**	≈17.30 m AHD
Drill Rig	HP Scout	**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
AD/T	-	17/06/20	0	17.30				-	TOPSOIL/FILL: Silty SAND; fine to medium grained, brown, with rootlets and roots.			FILL
				0.40								
				16.90	BH5M_0.5-0.95 SPT 0.50-0.95 m 4,6,6 N=12				From 0.4 m, pale brown.	M	-	
			1	1.00 16.30				CL	Sandy CLAY; low plasticity, grey, fine to medium grained sand.			ALLUVIAL SOIL
					BH5M_1.5-1.95 SPT 1.50-1.95 m 3,5,5 N=10							
			2	2.00 15.30					From 2.0 m, pale grey.	M (=PL)	St	
			3		BH5M_3.0-3.45 SPT 3.00-3.45 m 3,6,8 N=14							
			4							M (>PL) - W		
					BH5M_4.5-4.95 SPT 4.50-4.95 m 6,8,11 N=19							
			5	5.00 12.30					From 5.0-5.5 m, red-brown to pale grey.	M (=PL) - M (>PL)	VSt	
			6	6.08					Hole Terminated at 6.08 m Target Depth Reached.			
			7									
			8									
			9									
			10									

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

MONITORING WELL LOG

MW NO. BH5M

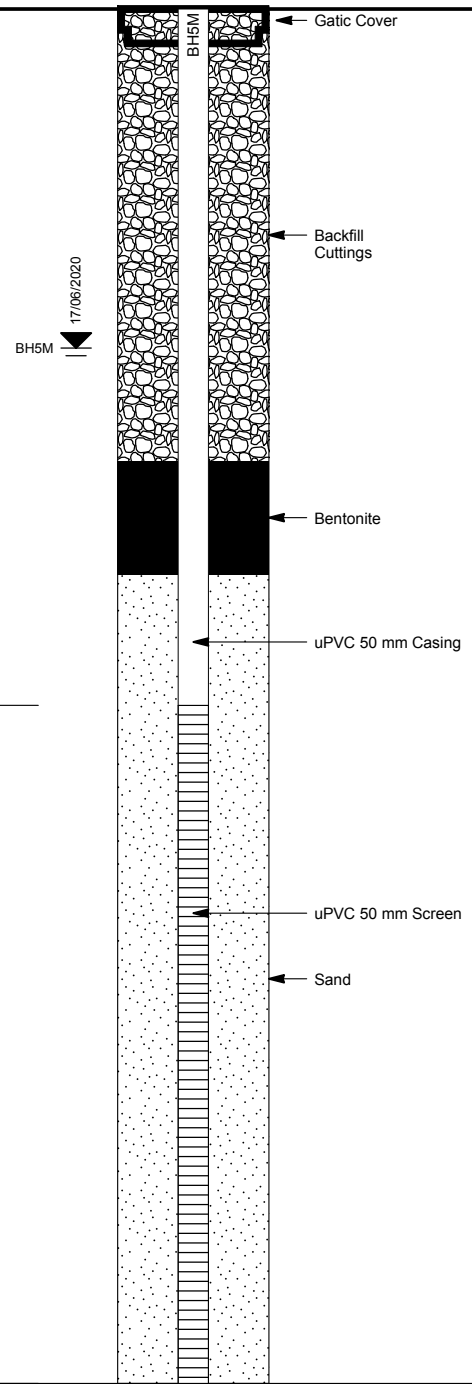
Project	Proposed Development	**Sheet**	1 of 1
Location	15 Jubilee Avenue, Warriewood NSW	**Date Started**	11/06/2020
Position	Refer to Figure 2	**Date Completed**	11/06/2020
Job No.	E24716.G03	**Logged By** BY	**Date** 11/06/2020
Client	15 Jubilee Pty Ltd	**Reviewed By** SR	**Date** 20/07/2020

Drilling Contactor	Hagstrom	**Surface RL**	≈17.30 m AHD
Drill Rig	HP Scout	**Inclination**	-90°

METHOD	WATER	DEPTH (m)	RL (m AHD)	GRAPHIC LOG	SOIL/ROCK MATERIAL DESCRIPTION
AD/T	17/06/20	0	17		TOPSOIL/FILL: Silty SAND; fine to medium grained, brown, with rootlets and roots.
					From 0.4 m, pale brown.
		1	16		Sandy CLAY; low plasticity, grey, fine to medium grained sand.
		2	15		From 2.0 m, pale grey.
		3	14		
		4	13		
		5	12		From 5.0-5.5 m, red-brown to pale grey.
		6	11		Hole Terminated at 6.08 m Target Depth Reached.

PIEZOMETER CONSTRUCTION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL	Installation Date	Static Water Level
BH5M	Standpipe	0.04 m 17.26 m	6.08 m 11.22 m		



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

BOREHOLE LOG

BH NO. BH6

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Project	Proposed Development	**Sheet**	1 of 1
Location	15 Jubilee Avenue, Warriewood NSW	**Date Started**	12/06/2020
Position	Refer to Figure 2	**Date Completed**	12/06/2020
Job No.	E24716.G03	**Logged By** BY	**Date** 12/06/2020
Client	15 Jubilee Pty Ltd	**Reviewed By** SR	**Date** 20/07/2020

Drilling Contactor	Hagstrom	**Surface RL**	≈18.20 m AHD
Drill Rig	HP Scout	**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
AD/T	-	▽	0	18.20	BH6_0.5-0.95 SPT 0.50-0.95 m 4,8,7 N=15			-	TOPSOIL/FILL: Silty SAND; fine to medium grained, brown, with rootlets.	M	-	TOPSOIL/FILL
			1	*1.00* 17.20	BH6_1.5-1.95 SPT 1.50-1.95 m 2,0,1 N=1			-	FILL: Silty SAND; fine to medium grained, pale brown-brown.	M	VL - L	FILL
			2	*2.20* 16.00	BH6_3.0-3.45 SPT 3.00-3.45 m 2,3,4 N=7			CL-CI	Sandy CLAY; low to medium plasticity, pale grey, fine to medium grained sand.	M (<PL) M (<PL)	F	ALLUVIAL SOIL
	M		4	*4.00* 14.20	BH6_4.5-4.95 SPT 4.50-4.95 m 5,12,16 N=28				From 4.0 m, with red-brown ironstone bands.	M (>PL)	VSt	
	H		6		BH6_6.0-6.45 SPT 6.00-6.45 m 9,16,25 HB N=41						H	
			7	*7.10*					Hole Terminated at 7.10 m T/C Bit Refusal on Bedrock. Backfilled with Drilling Spoil.			
			8									
			9									
			10									

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

TEST PIT: TP1

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Project	Proposed Development			Sheet	1 OF 1
Location	15 Jubilee Avenue, Warriewood NSW				
Position	Refer to Figure 2	Surface RL	21.70 m AHD		
Job No.	E24716.G03	Contractor	Ken Coles Excavation Pty Ltd	Date	11/06/2020
Client	15 Jubilee Pty Ltd	Machine	Excavator	Logged	ES
		Bucket Size			

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	-	GWNE	0	21.70				-	TOPSOIL: Silty SAND; fine to medium grained, poorly graded, brown, with trace roots, root fibres.	M	-	TOPSOIL
				0.20	TP1_0.1-0.2 ES 0.10-0.20 m			-	FILL: SAND; fine to coarse grained, poorly graded, pale brown.	M	-	FILL
				21.50								
				0.50	TP1_0.4-0.5 ES 0.40-0.50 m			SC	Clayey SAND;poorly graded, orange-brown, trace ironstone gravels.	M	-	ALLUVIAL SOIL
			1	21.20	TP1_0.7-0.8 ES 0.70-0.80 m							
				1.40				CL-CI	Sandy CLAY; low to medium plasticity, red mottled pale grey.	M	-	
			2	20.30	TP1_1.6-1.7 ES 1.60-1.70 m							
				2.30					Hole Terminated at 2.30 m Refusal on Bedrock			
			3									
			4									

Sketch & Other Observations

Comments
Refusal on Bedrock

Checked SR
Date 20/07/2020

TEST PIT: TP2

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Contamination | Remediation | Geotechnical

Project	Proposed Development			Sheet	1 OF 1
Location	15 Jubilee Avenue, Warriewood NSW				
Position	Refer to Figure 2	Surface RL	20.70 m AHD		
Job No.	E24716.G03	Contractor	Ken Coles Excavation Pty Ltd	Date	11/06/2020
Client	15 Jubilee Pty Ltd	Machine	Excavator	Logged	ES
		Bucket Size			

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	-	GWNE	0	20.70				-	TOPSOIL: Silty SAND; fine to medium grained, poorly graded, brown, with trace roots, root fibres.	M	-	TOPSOIL
				0.20	TP2_0.1-0.2 ES							
				20.50	0.10-0.20 m			-	FILL: SAND; poorly graded, pale brown.	M	-	FILL
				0.50	TP2_0.4-0.5 ES							
				20.20	0.40-0.50 m			SC	Clayey SAND; poorly graded, orange-brown, trace ironstone gravels.			ALLUVIAL SOIL
			1		TP2_0.7-0.8 ES					M	-	
					0.70-0.80 m							
				1.30								
				19.40				CL-CI	Sandy CLAY; low to medium plasticity, red mottled pale grey.			
					TP2_1.5-1.6 ES					M	-	
					1.50-1.60 m							
				2.00								
			2						Hole Terminated at 2.00 m Refusal on Bedrock.			
			3									
			4									

Sketch & Other Observations

Comments
Refusal on Bedrock.

Checked SR
Date 20/07/2020

TEST PIT: TP3

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Contamination | Remediation | Geotechnical

Project	Proposed Development			Sheet	1 OF 1
Location	15 Jubilee Avenue, Warriewood NSW				
Position	Refer to Figure 2	Surface RL	19.90 m AHD		
Job No.	E24716.G03	Contractor	Ken Coles Excavation Pty Ltd	Date	11/06/2020
Client	15 Jubilee Pty Ltd	Machine	Excavator	Logged	ES
		Bucket Size			

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	-	GWNE	0	19.90				-	TOPSOIL: Silty SAND; fine to medium grained, poorly graded, brown, with trace roots, root fibres.	M	-	TOPSOIL
				0.20	TP3_0.1-0.2 ES							
				19.70	0.10-0.20 m			-	FILL: SAND; poorly graded, pale brown.	M	-	FILL
				0.60	TP3_0.4-0.5 ES							
				19.30	0.40-0.50 m			SC	Clayey SAND; poorly graded, orange-brown, trace ironstone gravels.	M	-	ALLUVIAL SOIL
			1	1.00	TP3_0.8-0.9 ES							
				18.90	0.80-0.90 m			CL-CI	Sandy CLAY; low to medium plasticity, red mottled pale grey.	M	-	
				1.50								
									Hole Terminated at 1.50 m Target Depth Reached.			
			2									
			3									
			4									

Sketch & Other Observations

Comments
Target Depth Reached.

Checked SR
Date 20/07/2020

TEST PIT: TP4

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Contamination | Remediation | Geotechnical

Project	Proposed Development			Sheet	1 OF 1
Location	15 Jubilee Avenue, Warriewood NSW				
Position	Refer to Figure 2	Surface RL	17.90 m AHD		
Job No.	E24716.G03	Contractor	Ken Coles Excavation Pty Ltd	Date	11/06/2020
Client	15 Jubilee Pty Ltd	Machine	Excavator	Logged	ES
		Bucket Size			

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	-	GWNE	0	17.90 *0.20* 17.70	TP4_0.1-0.2 ES 0.10-0.20 m			-	TOPSOIL: Silty SAND; fine to medium grained, poorly graded, brown, with trace roots, root fibres.	M	-	TOPSOIL
					TP4_0.4-0.5 ES 0.40-0.50 m			SC	Clayey SAND; poorly graded, pale grey.	M	-	ALLUVIAL SOIL
			1	*1.30* 16.60 *1.50*					From 1.3 m, grey mottled red.			
									Hole Terminated at 1.50 m Target Depth Reached.			
			2									
			3									
			4									

Sketch & Other Observations

Comments
Target Depth Reached.

Checked SR
Date 20/07/2020

TEST PIT: TP5

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Contamination | Remediation | Geotechnical

Project	Proposed Development			Sheet	1 OF 1
Location	15 Jubilee Avenue, Warriewood NSW				
Position	Refer to Figure 2	Surface RL	17.90 m AHD		
Job No.	E24716.G03	Contractor	Ken Coles Excavation Pty Ltd	Date	11/06/2020
Client	15 Jubilee Pty Ltd	Machine	Excavator	Logged	ES
		Bucket Size			

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	-	GWNE	0	17.90				-	TOPSOIL: Silty SAND; fine to medium grained, poorly graded, brown, with trace roots, root fibres.	M	-	TOPSOIL
				0.20	TP5_0.1-0.2 ES							
				17.70	0.10-0.20 m			SC	Clayey SAND; poorly graded, pale grey.			ALLUVIAL SOIL
					TP5_0.4-0.5 ES							
			1		0.40-0.50 m					M	-	
				1.50					Hole Terminated at 1.50 m Target Depth Reached.			
			2									
			3									
			4									

Sketch & Other Observations

Comments
Target Depth Reached.

Checked SR
Date 20/07/2020

TEST PIT: TP6

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Project	Proposed Development			Sheet	1 OF 1
Location	15 Jubilee Avenue, Warriewood NSW				
Position	Refer to Figure 2	Surface RL	17.80 m AHD		
Job No.	E24716.G03	Contractor	Ken Coles Excavation Pty Ltd	Date	11/06/2020
Client	15 Jubilee Pty Ltd	Machine	Excavator	Logged	ES
		Bucket Size			

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	GROUP SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	17.80				-	TOPSOIL: Silty SAND; fine to medium grained, poorly graded, brown, with trace roots, root fibres.			TOPSOIL
					TP6_0.2-0.3 ES 0.20-0.30 m					M	-	
					TP6_0.6-0.7 ES 0.60-0.70 m							
				0.80								
E	-	GWNE	1	17.00	TP6_0.9-1.0 ES 0.90-1.00 m			SC	Clayey SAND; poorly graded, pale grey.			ALLUVIAL SOIL
					TP6_1.5-1.6 ES 1.50-1.60 m					M	-	
			2	*2.50*								
									Hole Terminated at 2.50 m Target Depth Reached.			
			3									
			4									

Sketch & Other Observations

Comments
Target Depth Reached.

Checked SR
Date 20/07/2020

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 **Partial water loss**

Water Seepage **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 (%)

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

RQD = Rock Quality Designation (%)

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

METHOD OF SOIL DESCRIPTION USED ON BOREHOLE AND TEST PIT LOGS

	FILL		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			

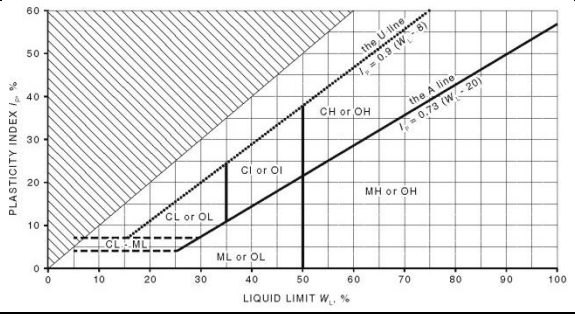
CLASSIFICATION AND INFERRED STRATIGRAPHY

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

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Benjamin Yuan
Client	EI AUSTRALIA
Address	SUITE 6.01 55 MILLER STREET PYRMONT NSW 2009
Telephone	61 2 95160722
Facsimile	(Not specified)
Email	benjamin.yuan@eiaustralia.com.au
Project	**E24716.G03 15 Jubilee Avenue, Warriewood**
Order Number	**E24716.G03**
Samples	3

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE207492 R0**
Date Received	15/6/2020
Date Reported	22/6/2020

COMMENTS

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

SIGNATORIES

Dong LIANG
Metals/Inorganics Team Leader

Shane MCDERMOTT
Inorganic/Metals Chemist

Soluble Anions (1:5) in Soil by Ion Chromatography [AN245] Tested: 19/6/2020

PARAMETER	UOM	LOR	BH2_3.0-3.45 SOIL - 11/6/2020 SE207492.001	BH3M_1.5-1.95 SOIL - 11/6/2020 SE207492.002	BH6_3.0-3.45 SOIL - 12/6/2020 SE207492.003
Chloride	mg/kg	0.25	**5.1**	**80**	**12**
Sulfate	mg/kg	5	**46**	**84**	**62**

pH in soil (1:5) [AN101] Tested: 18/6/2020

PARAMETER	UOM	LOR	BH2_3.0-3.45 SOIL - 11/6/2020 SE207492.001	BH3M_1.5-1.95 SOIL - 11/6/2020 SE207492.002	BH6_3.0-3.45 SOIL - 12/6/2020 SE207492.003
pH	pH Units	0.1	**4.7**	**4.5**	**4.8**

Conductivity and TDS by Calculation - Soil [AN106] Tested: 18/6/2020

PARAMETER	UOM	LOR	BH2_3.0-3.45 SOIL - 11/6/2020 SE207492.001	BH3M_1.5-1.95 SOIL - 11/6/2020 SE207492.002	BH6_3.0-3.45 SOIL - 12/6/2020 SE207492.003
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	**33**	**88**	**43**

Moisture Content [AN002] Tested: 15/6/2020

PARAMETER	UOM	LOR	BH2_3.0-3.45 SOIL - 11/6/2020 SE207492.001	BH3M_1.5-1.95 SOIL - 11/6/2020 SE207492.002	BH6_3.0-3.45 SOIL - 12/6/2020 SE207492.003
% Moisture	%w/w	1	**12.4**	**16.5**	**16.2**

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 of as received sample 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.

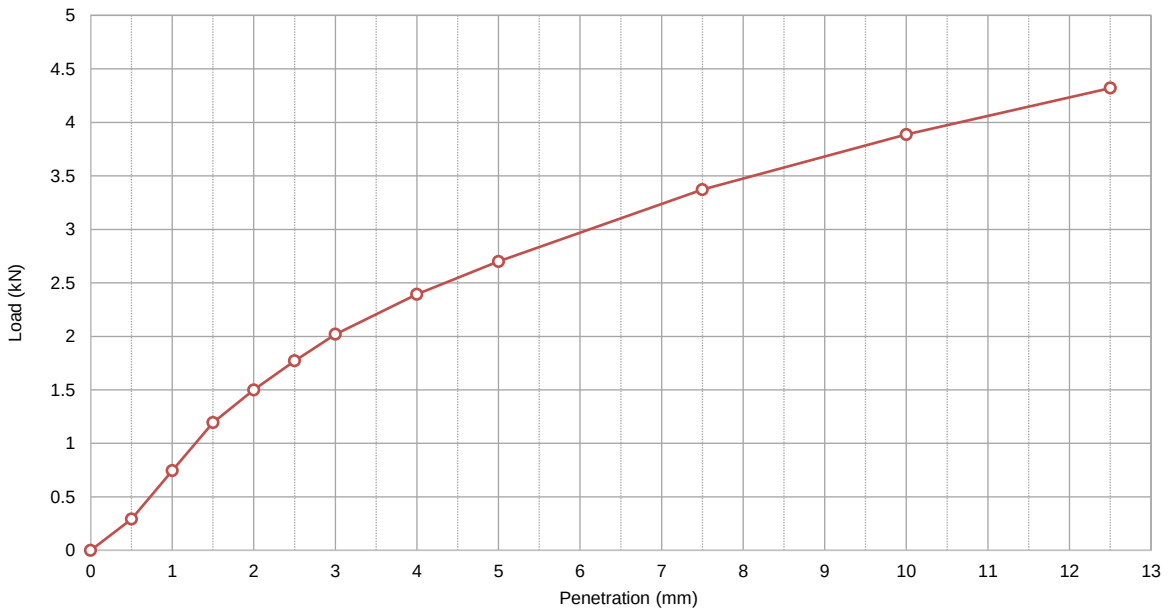
The QC and MU criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: www.sgs.com.au/en-gb/environment-health-and-safety.

CALIFORNIA BEARING RATIO REPORT

Client	EI Australia	**Source**	TP2 0.5-1.3m
Address	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Sample Description**	Sandy CLAY
Project	15 Jubilee Avenue Warriewood NSW (E24716 G03)	**Report No.**	S60835-CBR
Job No.	S20269-1	**Sample No.**	S60835

Test Procedure:	☑ AS 1289.6.1.1	☐ RMS T117	California Bearing Ratio
	☑ AS 1289.5.1.1	☐ RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
	☐ AS 1289.5.2.1	☐ RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
	☑ AS 1289.2.1.1	☐ RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client - results apply to the sample as received	**Date Sampled:**	11-12/06/2020
Preparation:	Prepared in accordance with the test method		



Preparation & Specification		Density & Moisture	Achieved	Target
Retained on 19.0mm Sieve (%)	0	Lab Moisture Ratio - LMR (%)	100.0	100.0
Method of Establishing Plasticity Level	Technician Assessment	Lab Density Ratio - LDR (%)	100.0	100.0
Sample Curing Time (hrs)	53 hrs	Dry Density - At Compaction (t/m³)	1.77	1.77
Compaction Hammer Used	Standard	Dry Density - After Soaking (t/m³)	1.77	
Surcharge Mass Applied (kg)	9.0	Specimen Swell (%)	0.3	
Period of Soaking (Days)	4	Moisture Content - At Compaction (%)	15.6	
Maximum Dry Density - MDD (t/m³)	1.77	Moisture Content - Top 30mm (%)	17.3	
Optimum Moisture Content - OMC (%)	15.6	Moisture Content - Remainder (%)	16.4	

Material CBR Value (%): **14** **at a penetration of** **2.5** **mm**

Notes:

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Authorised Signatory:

30/06/2020

Chris Lloyd Date:

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Macquarie Geotechnical
U7/8 10 Bradford Street
Alexandria NSW 2015

DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

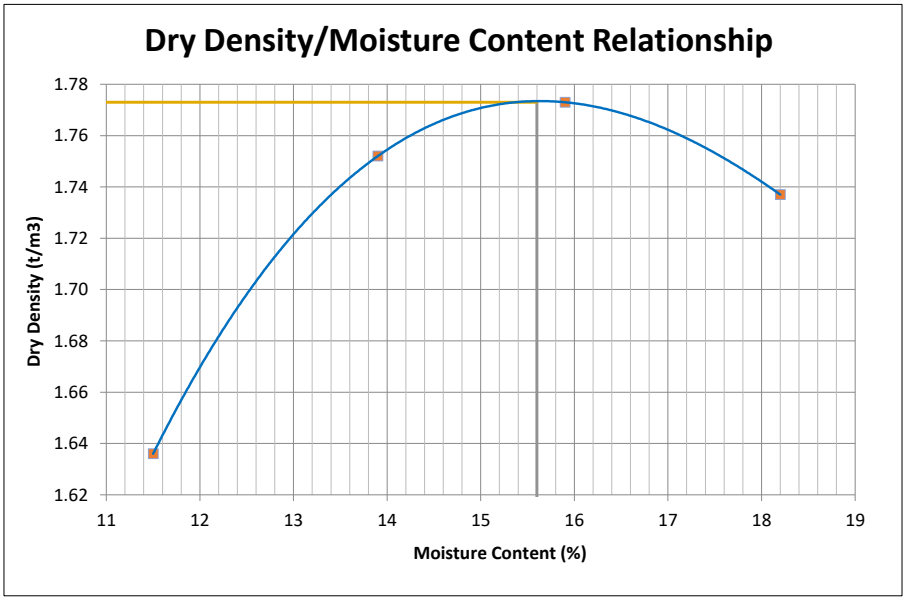
Client	EI Australia	**Source**	TP2 0.5-1.3m
Address	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Sample Description**	Sandy CLAY
Project	15 Jubilee Avenue Warriewood NSW (E24716 G03)	**Report No**	S60835-MDD
Job No	S20269-1	**Sample No**	S60835

Test Procedure:

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client - results apply to the sample as received	**Date Sampled:**	11-12/06/2020
Preparation:	Prepared in accordance with the test method		



Maximum Dry Density (t/m^3)	1.773
Optimum Moisture Content (%)	15.6
Oversize Retained on 19mm sieve (%)	0.2
Oversize Retained on 37.5mm sieve (%)	0.0
Curing Time	125 hrs
Liquid Limit Determination	Technician Assessment

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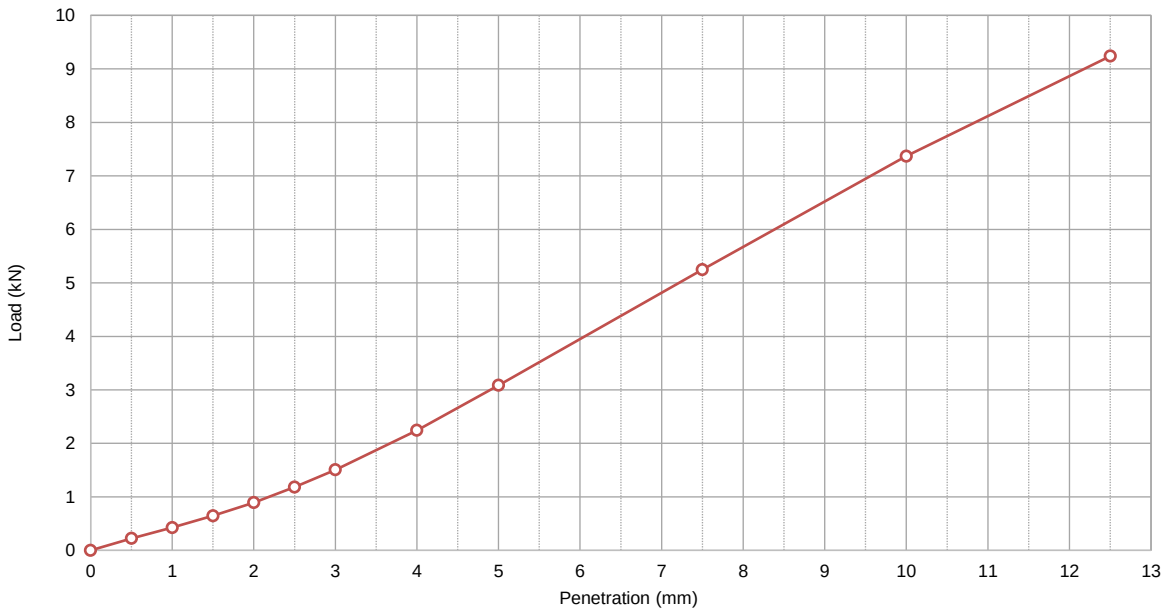
CALIFORNIA BEARING RATIO REPORT

Client	EI Australia	**Source**	TP6 0.8-1.5m
Address	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Sample Description**	Sandy CLAY
Project	15 Jubilee Avenue Warriewood NSW (E24716 G03)	**Report No.**	S60836-CBR
Job No.	S20269-1	**Sample No.**	S60836

Test Procedure:	☑ AS 1289.6.1.1	☐ RMS T117	California Bearing Ratio
	☑ AS 1289.5.1.1	☐ RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
	☐ AS 1289.5.2.1	☐ RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
	☑ AS 1289.2.1.1	☐ RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client - results apply to the sample as received	**Date Sampled:**	11-12/06/2020
Preparation:	Prepared in accordance with the test method		



Preparation & Specification		Density & Moisture	Achieved	Target
Retained on 19.0mm Sieve (%)	0	Lab Moisture Ratio - LMR (%)	100.0	100.0
Method of Establishing Plasticity Level	Technician Assessment	Lab Density Ratio - LDR (%)	100.0	100.0
Sample Curing Time (hrs)	52 hrs	Dry Density - At Compaction (t/m³)	1.95	1.95
Compaction Hammer Used	Standard	Dry Density - After Soaking (t/m³)	1.95	
Surcharge Mass Applied (kg)	9.0	Specimen Swell (%)	0.0	
Period of Soaking (Days)	4	Moisture Content - At Compaction (%)	11.3	
Maximum Dry Density - MDD (t/m³)	1.95	Moisture Content - Top 30mm (%)	13.1	
Optimum Moisture Content - OMC (%)	11.3	Moisture Content - Remainder (%)	4.0	

Material CBR Value (%): **20** **at a penetration of** **5.0** **mm**

Notes:

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DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

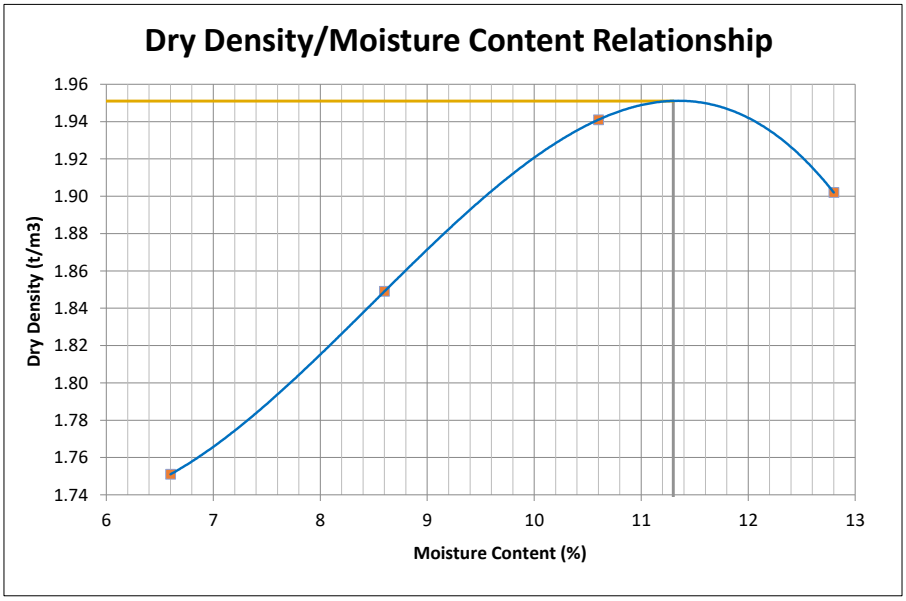
Client	EI Australia	**Source**	TP6 0.8-1.5m
Address	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Sample Description**	Sandy CLAY
Project	15 Jubilee Avenue Warriewood NSW (E24716 G03)	**Report No**	S60836-MDD
Job No	S20269-1	**Sample No**	S60836

Test Procedure:

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling:	Sampled by Client - results apply to the sample as received	**Date Sampled:**	11-12/06/2020
Preparation:	Prepared in accordance with the test method		



Maximum Dry Density (t/m^3)	1.951
Optimum Moisture Content (%)	11.3
Oversize Retained on 19mm sieve (%)	0.0
Oversize Retained on 37.5mm sieve (%)	0.0
Curing Time	120 hrs
Liquid Limit Determination	Technician Assessment

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MOISTURE CONTENT TEST REPORT

Client:	EI Australia	**Job No:**	S20269-1
Address:	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Report No:**	S60837-MC
Project:	15 Jubilee Avenue Warriewood NSW (E24716 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 - results apply to the sample as received	**Date Sampled:**	11-12/06/2020
Preparation:	Prepared in accordance with the test method		

Sample No.	Source	Sample Description	Moisture Content %
S60837	BH1 0.5-0.95m	Sandy CLAY	**22.3**
S60838	BH4M 1.50-1.95m	Sandy CLAY	**18.8**
S60839	BH5M 1.50-1.95m	Sandy CLAY	**17.3**

Notes:

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SOIL CLASSIFICATION REPORT

Client	EI Australia	**Source**	BH1 0.5-0.95m
Address	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Sample Description**	Sandy CLAY
Project	15 Jubilee Avenue Warriewood NSW (E24716 G03)	**Report No**	S60837-PI
Job No	S20269-1	**Lab No**	S60837

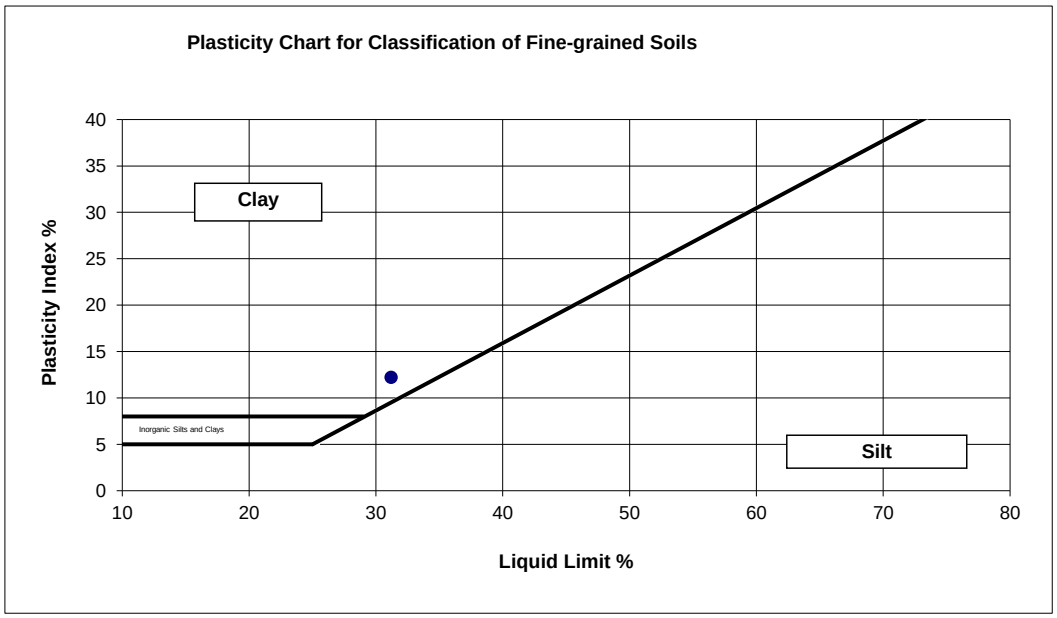
Test Procedure:

- ☐ 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 - results apply to the sample as received **Date Sampled:** 11-12/06/2020

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	31	**Linear Shrinkage (%)**	6.5
Plastic Limit (%)	19	**Plasticity Index**	12



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

Notes

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22/06/2020

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SOIL CLASSIFICATION REPORT

Client	EI Australia	**Source**	BH4M 1.50-1.95m
Address	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Sample Description**	Sandy CLAY
Project	15 Jubilee Avenue Warriewood NSW (E24716 G03)	**Report No**	S60838-PI
Job No	S20269-1	**Lab No**	S60838

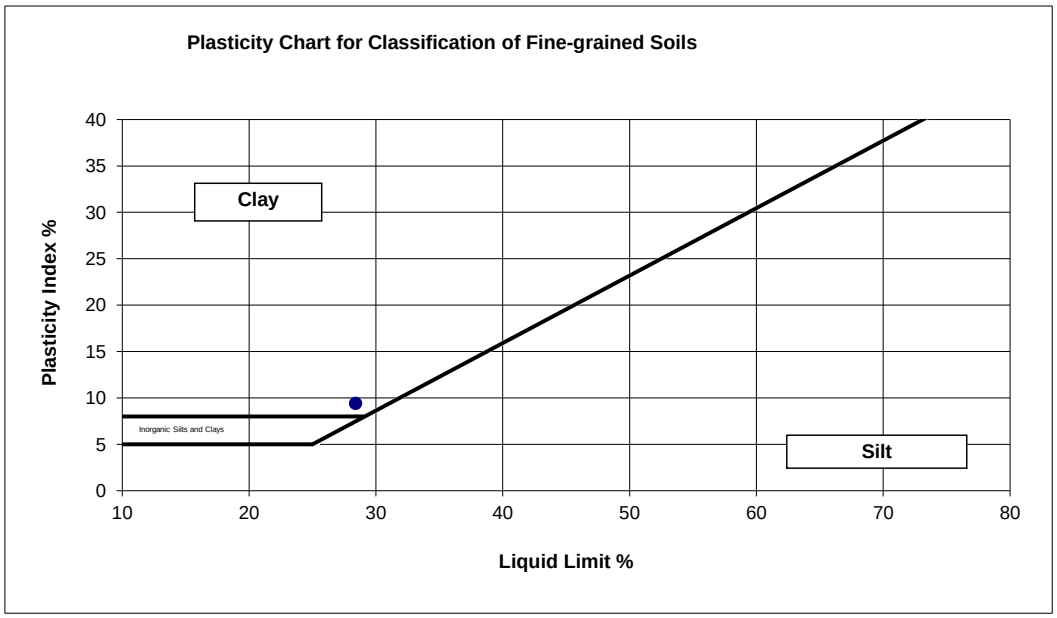
Test Procedure:

- ☐ 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 - results apply to the sample as received **Date Sampled:** 11-12/06/2020

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	28	**Linear Shrinkage (%)**	6.5
Plastic Limit (%)	19	**Plasticity Index**	9



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

Notes

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SOIL CLASSIFICATION REPORT

Client	EI Australia	**Source**	BH5M 1.50-1.95m
Address	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Sample Description**	Sandy CLAY
Project	15 Jubilee Avenue Warriewood NSW (E24716 G03)	**Report No**	S60839-PI
Job No	S20269-1	**Lab No**	S60839

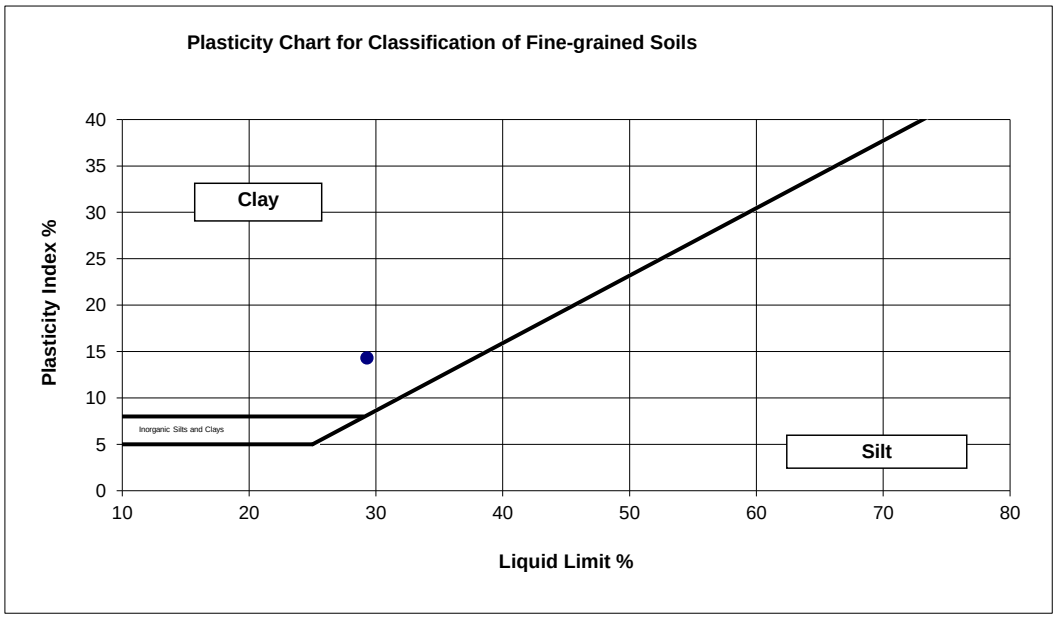
Test Procedure:

- ☐ 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 - results apply to the sample as received **Date Sampled:** 11-12/06/2020

Preparation: Prepared in accordance with the test method

Liquid Limit (%)	29	**Linear Shrinkage (%)**	9.0
Plastic Limit (%)	15	**Plasticity Index**	14



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

Notes

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Authorised Signatory:

Chris Lloyd

22/06/2020

Date:

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Alexandria NSW 2015

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.

REPRODUCTION OF REPORTS

 Where information from the accompanying report is to be included in contract documents or engineering specification for the project, the entire report should be included in order to minimize the likelihood of misinterpretation from logs.

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.