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ASHBURY FMBM PTY LTD

Geotechnical Investigation

149-163 Milton Street, Ashbury, NSW

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Revision	Details	Date	Amended By
	Original	24 February 2016	
1	Updated Drawings	3 September 2020	IW
2	Amended site area and boundary	4 September 2020	IW

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1. Introduction

1.1 Background

At the request of Ashbury FMBM Pty Ltd (Ashbury FMBM), Environmental Investigations Australia Pty Ltd (EI) has carried out a Geotechnical Investigation (GI) for the proposed redevelopment of 149-163 Milton Street, Ashbury, NSW ('the site').

The GI was carried out in accordance with our proposal referenced P13578.4, dated 22 December 2015 and Ashbury FMBM's signed 'Authorisation to Proceed' form, dated 23 December 2015. This GI report has been prepared to provide geotechnical advice and recommendations for design and construction.

This GI is also in response to a letter from City of Canterbury, referenced T-29-175, dated 27 November 2015, in particular with issue 1.2 – Geotechnical Matters. This GI report was prepared to provide comments and recommendations regarding the geotechnical aspects of the proposed development.

EI has also prepared a separate Detailed Site Investigation (DSI) report, referenced E22851 AA, for the proposed development. This GI report should be read in conjunction with the DSI report.

1.2 Proposed Development

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

- Architectural Drawings, prepared by SJB Architects, Job No. 6119;
  - Drawing No. DA-0002, Revision 4, dated 27 August 2020;
  - Drawing No. DA-0004, Revision 5, dated 27 August 2020;
  - Drawing No. DA-0101, Revision 8, dated 27 August 2020;
  - Drawing Nos. DA-0111, DA-0112, DA-0113, DA-0114, DA-0115 and DA-0116, Revision 7, dated 27 August 2020;
  - Drawing Nos. DA-0501, DA-0502 and DA-0503, Revision 5, dated 27 August 2020;
  - Drawing Nos. DA-0504 and DA-0505, Revision 3, dated 27 August 2020;
  - Drawing Nos. DA-0601 and DA-0602 Revision 4, dated 27 August 2020; and
  - Drawing No. DA-2501, Revision 3, dated 27 August 2020;
- Site survey plan, prepared by Beveridge Williams Development and Environment Consultants, Reference No. 1901210, Sheets 1 to 14, Version C, dated 26 May 2020.

Based on the provided documents, EI understands that the proposed development involves the demolition of the existing site structures and the construction of nine residential buildings overlying a common single level stepped basement. The basement level is proposed to have a varying Finished Floor Level (FFL) of between RL 31.26m and 37.60m. A Bulk Excavation Level (BEL) ranging between RL 31.00m and 37.40m is assumed, which includes allowance for the construction of the basement slab. To achieve the BEL, excavation depths of up to 5.80m Below Existing Ground Level (BEGL) have been estimated. Locally deeper excavations may be required for footings, lift overrun pits, crane pads, and service trenches.

The provided architectural drawings show the proposed basement excavation is to be setback between 8.85m and 15.65m from the western boundary, between 5.50m and 9.00m from the northern boundary, 4.00m from the eastern boundary and 12.00m from the southern boundary.

1.3 Objectives

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

- Dilapidation Survey;
- Excavation methodologies and monitoring requirements;
- Groundwater considerations;
- Excavation support requirements, including geotechnical design parameters for retaining walls and shoring systems;
- Vibration considerations;
- Building and retaining wall foundation options, including;
  - Design parameters.
  - Earthquake loading factor in accordance with AS1170.4:2007.
- Basement floor slab;
- Construction considerations regarding Wagener Oval; and
- The requirement for additional geotechnical works.

1.4 Scope of Works

The scope of works for the GI included:

- Review of available information from EI in-house database and information provided by Ashbury FMBM;
- Preparation of appropriate work health and safety plans;
- Review of relevant geological maps for the project area;
- Site walkover by a Geotechnical Engineer to assess topographical features, condition of existing structures 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 10 boreholes (BH1, BH2, BH3M, BH4M, BH5, BH6, BH7, BH8M, BH101, and BH103) by a track-mounted drill rig using solid flight augers equipped with a 'Tungsten-Carbide' (T-C) bit. The approximate surface levels shown on the borehole logs were approximated from spot levels shown on the supplied survey drawing, which formed the basis of Figure 2. Approximate borehole locations are shown on **Figure 2**;
  - BH1, BH2, BH3M, BH4M, BH5 to BH7, and BH8M were auger drilled to depths ranging from about 1.6m to 15.8m BEGL, or RLs ranging from about 34.4m to 20.9m AHD. These boreholes were drilled within the site boundary.

  - BH101 and BH103 were auger drilled to depths between about 2.1m (about RL 29.1m AHD) and 3.7m BEGL (about RL 28.1m AHD), respectively. These boreholes were drilled within Wagener Oval.

- Standard Penetration Testing (SPT) was carried out during auger drilling of the boreholes to assess soil strength/ relative densities. These were augmented, where possible, by hand penetrometer readings on cohesive soil samples collected in the SPT split tube sampler. Soil samples were sent to Macquarie Geotechnical Pty Ltd (Macquarie) and SGS Australia Pty Ltd (SGS), which are National Australian Testing Authority (NATA) accredited laboratories, for testing and storage.
- The strength of the shale bedrock in the augered sections of the boreholes was assessed by observation of the auger penetration resistance using a T-C drill bit, examination of the recovered rock cuttings, and rock moisture content tests. It should be noted that rock strengths assessed from augered boreholes are approximate and strength variances can be expected.
- Continuation of BH1, BH3M, BH4M, BH5, BH6, BH7, and BH8M using NQ coring techniques, to termination depths ranging from about 10.6m to 18.0m BEGL, or RLs ranging from about 28.4m to 18.7m AHD. Rock cores recovered from the boreholes were logged, photographed, boxed, and sent to Macquarie for point load strength index testing and storage. The rock core photographs and point load strength testing results are attached to this report and shown on the borehole logs;
- Measurements of groundwater seepage/levels, where possible, in the boreholes during and shortly on completion of auger drilling;
- Installation of three groundwater monitoring wells in BH3M, BH4M, and BH8M. In addition, a groundwater sample was collected from BH4M, and sent to SGS for groundwater aggressivity testing.
- Backfilling the remaining boreholes with drilling spoil and capped with concrete at surface; and
- Preparation of this GI report.

An EI Geotechnical Engineer was present on site 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 the existing site structures and access constraint. The discussions and advice presented in this report are intended to assist the designers in the preparation of initial designs for the proposed development. Further geotechnical inspections should be carried out during construction to confirm both the geotechnical and groundwater model and the design parameters provided in this report.

2. Site Description

2.1 Site Description and Identification

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

Table 2-1 Summary of Site Information

Information	Detail
Street Address	149-163 Milton Street, Ashbury, NSW
Lot and Deposited Plan (DP) Identification	Lots B and C, DP 30778
Brief Site Description	The site is irregular in shape and occupied by five, one to three-storey, brick, or brick and metal or masonry commercial buildings. The buildings appeared to be in good external condition with no major cracking on the exterior walls. The remaining areas were covered in concrete or Asphaltic Concrete (AC), with small garden beds. All concrete and AC paved surfaces were found to be in good condition. A 1.0m high masonry retaining wall lies to the northeast of the site and appeared to be in good condition. A concrete retaining wall up to 1.5m high lies to the south of the site and appeared to be in good condition.
Site Area	The site area is approximately 16,220m^2

Plate 1: Aerial photograph of the site (source: Sixmap, accessed 28/7/19)

2.2 Local Land Use

The site is situated within an area of industrial and residential use. Current uses on surrounding land at the time of our presence on site are described in **Table 2-2** below.

Table 2-2 Summary of Local Land Use

Direction Relative to Site	Land Use Description
North	Single-storey brick residential dwellings. The closest residential dwellings lie immediately adjacent to the northern site boundary.
East	Milton Street, a two-lane asphaltic-concrete road, followed by single- and two-storey residential dwellings. The residential dwellings are set back about 22m from the eastern site boundary.
South	A large warehouse facility and associated two-storey brick office space. The warehouse is set back about 9m from the southern site boundary. The site to the south is proposed to be developed, which involves the demolition of all existing site structures and the construction of a multi-storey residential building over a two-level basement. The building is proposed to be set back about 9m from the southern site boundary.
West	Open recreational space ("Wagener Oval"). Wagener Oval was previously used as a brick pit which was filled with landfill waste and re-developed into an oval. Beyond the western boundary, the surface level is approximately level with the subject site. From about 2.5m west of the site boundary, the ground slopes down towards the oval at about 30° below the horizontal, falling west towards Wagener Oval from an RL of about 36m AHD to 32m AHD. The batter becomes flat for 8m, and then falls again at about 13° below the horizontal, from an RL of about 32m AHD to 29m AHD. No signs of erosion were observed at the time of our investigation.

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 regional topography typically comprises a north-northwest trending spur line running along the alignment of Milton Street. Site topography slopes down from east to west, from an RL of approximately 40.8m AHD at the eastern side of the site, to approximately 33.2m AHD at the north-west corner of the site
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 1991) indicates the site to be underlain by Ashfield Shale of the Wianamatta Group, which typically comprises black to dark grey shale and laminite. Ashfield Shale generally weathers into silty clay of medium to high plasticity. An excerpt of the geological map is shown in **Plate 2** below. The site is located approximately 100m to the north of the Fairfield Basin anticline.

Attribute	Description
Previous Wagener Oval Land Use	The area to the immediate west of the site was used as a brick pit as shown in 1943 aerial photography of the site available from SIX Maps (maps.six.nsw.gov.au). The site was presumably subsequently used as a landfill and is currently in use as public recreational space (WH Wagener Oval).
Acid Sulfate Soils (ASS)	In accordance with the Canterbury Local Environmental Plan 2012 Acid Sulfate Soils Map, the site is unclassified.

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 observed stratigraphy which comprises fill overlying residual soil and bedrock profile has been grouped into six geotechnical units. A summary of the subsurface conditions across the site, interpreted from the investigation results, is presented in **Table 3-1** below. More detailed descriptions of subsurface conditions at the test locations are available on the borehole logs presented in **Appendix A**. The details of the method of soil and rock classification, explanatory notes and abbreviations adopted in the borehole logs are also presented in **Appendix A**.

Boreholes BH101 and BH103 were drilled within Wagener Oval, as per council requirements. These boreholes are attached to **Appendix A** but will not be discussed in detail within this report.

Table 3-1 Summary of Subsurface Conditions

Unit	Material	Depth to top of Unit (m BEGL)	RL of top of Unit (m AHD)[1]	Observed Thickness (m)	Comments
1	**Fill**	0 (Surface)	33.7 to 40.5 (Surface)	0.3 to 5.4	Concrete hardstand up to 150mm thick or asphaltic concrete up to 150mm thick overlying fill. The fill consists of silty clay, sandy clay, silty sand and gravel, with various content of bricks, concrete fragments, and sandstone gravel. BH7 consisted of deep, crushed sandstone gravel fill up to 5.4m BEGL. SPT N values ranging between 13 to >21. The SPT values may have been affected by the change in moisture conditions and the presence of gravel and obstructions within the fill. Unit 1 fill generally appears to be 'uncontrolled' and poorly compacted. Within BH101, landfill waste was observed up to depths of 2.1m BEGL prior to refusal. BH103 did not encounter landfill waste and refused on natural shale material.
2	**Residual Soil**	0.3 to 1.4	40.0 to 32.5	0.4 to 1.3	Generally very stiff to hard strength, medium plasticity silty clay, grading into extremely low strength shale. SPT N values ranging between 11 to >8. Hand penetrometer readings within disturbed samples ranged from 270 to greater than 600kPa. Unit 2 was not observed in BH7.
3	**Class V Shale**	0.8 to 5.4	39.2 to 31.2	5.1 to 13.4[3]	Extremely low to very low strength, extremely to distinctly weathered shale.
4	**Class IV Shale**	7.7 to 15.8	32.7 to 20.9	0.6 to 2.9	Very low to low strength, distinctly weathered shale, with occasional medium strength bands. Defects in Unit 4 are generally very closely spaced (20-60mm), including sub-horizontal bedding partings, joints inclined up to 90°, and up to 2% decomposed and crushed seams.

Unit	Material	Depth to top of Unit (m BEGL)	RL of top of Unit (m AHD)[1]	Observed Thickness (m)	Comments
5	**Class III Shale**	7.0 to 16.4	32.6 to 20.3	0.4 to 3.3 [4]	Low to medium strength with occasional high strength bands, slightly weathered to fresh shale. Defects in Unit 5 are generally closely spaced (60-200mm), including sub-horizontal bedding partings, joints inclined up to 90°, and up to 4% decomposed and crushed seams.
6	**Class II Shale**	9.9 to 11.1	30.6 to 29.3	N/A [5]	Observed in BH3M and BH6 only Medium to high strength, slightly weathered to fresh shale. Defects in Unit 4 are generally moderately spaced (200-600mm), including sub-horizontal bedding partings, and joints inclined up to 30°.

Note 1 Approximate level below existing ground level at the time of our investigation. Levels may vary across the site.
Note 2 For more detailed descriptions of the subsurface conditions, reference should be made to the borehole logs attached to Appendix A.
Note 3 Unit 3 was observed until termination depth in BH2.
Note 4 Unit 5 was observed until termination depth in BH1, BH4M, BH5, BH7, and BH8M.
Note 5 Unit 6 was observed until termination depth in BH3M and BH6.

The RLs at which the various classes of shale was assessed in the cored boreholes of the GI are further detailed in **Table 3-2** below**.**

Table 3-2 Summary of Shale Class with RL

Unit	Range of Assessed RL of Unit (m AHD)							
	BH1	BH2	BH3M	BH4M	BH5	BH6	BH7	BH8M
3 Class V Shale	31.1 to 25.2	35.1 to 34.4 [1]	38.3 to 31.0	34.3 to 20.9	36.6 to 30.4	39.0 to 32.6	31.8 to 26.7	39.2 to 32.7
4 Class IV Shale	N.O.	N.O.	N.O.	20.9 to 20.3	N.O.	N.O.	26.7 to 23.8	32.7 to 30.6
5 Class III Shale	25.2 to 21.6 [1]	N.O.	31.0 to 30.6	20.3 to 18.7 [1]	30.4 to 26.8 [1]	32.6 to 29.3	23.8 to 20.4	30.6 to 28.4 [1]
6 Class II Shale	N.O.	N.O.	30.6 to 27.3 [1]	N.O.	N.O.	29.3 to 28.4 [1]	N.O.	N.O.

Notes:

1 Unit observed to end of borehole.
N.O. Not observed in borehole.

3.2 Groundwater Observations

Groundwater seepage was not observed during the auger drilling of BH1, BH2, BH3M, BH4M, BH5 to BH7, and BH8M during the GI. The water induced during the coring process of the boreholes precluded further observations of the groundwater levels.

In addition, three monitoring wells were installed in BH3M, BH4M, and BH8M for further groundwater monitoring and these were bailed dry on the day of installation. Similarly, monitoring wells were installed adjacent to BH1 and BH7 as BH1M and BH7M, respectively, as part of the DSI. Furthermore, the groundwater levels were recorded during a site visit on 28 January 2016.

Groundwater measurements taken during the groundwater monitoring visit are presented in **Table 3-3**.

Table 3-3 Summary of Groundwater Levels

Borehole ID	Date of Observation	Depth to Groundwater (m BEGL)	Approximate RL of Groundwater (m AHD)
BH1M	28 January 2016	4.0	29.7
BH3M		3.3	37.2
BH4M		8.4	28.3
BH7M		7.6	29.6
BH8M		1.9	38.5

3.3 Test Results

Four soil samples, nine rock chip samples, and one groundwater sample were selected for laboratory testing to assess the following:

- Atterberg Limits and Linear Shrinkage;
- Rock moisture content;
- Soil and groundwater aggressivity (pH, Chloride and Sulfate content and electrical conductivity).

A summary of soil and groundwater test results is provided in **Table 3-3** below.

Selected rock core samples were tested by Macquarie to estimate the Point Load Strength Index (Is_{50}) values to assist with rock strength assessment. The results of the testing are shown on the attached borehole logs and in **Appendix B**.

Laboratory test certificates are presented in **Appendix B.**

The Atterberg Limits results on selected samples of Unit 2 indicated these clays to be of high plasticity and have a high potential for shrink /swell movements with changes in moisture content (class H1).

The point load strength index and rock moisture content tests correlated reasonably well with our field assessments of rock strength. The approximate Unconfined Compressive Strength (UCS) of the rock core, estimated from correlations with the point load strength index test results, varied from <1 MPa to 57 MPa.

Analysis of the pH, chloride and sulfate content and electrical conductivity was compared to the criteria outlined in AS 2159:2009, providing the following exposure classifications:

Soil:

- ‘Mild’ for buried concrete structural elements; and
- ‘Non-aggressive’ for buried steel structural elements.

Groundwater:

- ‘Mild’ for buried concrete structural elements; and
- ‘Moderate’ for buried steel structural elements.

Table 3-3 Summary of Laboratory Test Results

Test/ Sample ID		BH3M_1.5-1.8	BH4_1.5-1.95	BH1M_3.0-3.1	BH3M_2.2-2.3	BH3M_2.5-2.6	BH3M_3.7-3.8	BH3M_5.0-5.1	BH4M_3.4-3.5	BH4M_5.5-5.6	BH7_8.0-8.1	BH7_8.6-8.7	BH1_1.5-1.95	BH6M_0.85-0.95	BH4M
Unit		Unit 1	Unit 2	Unit 3					Unit 3	Unit 3	Unit 3	Unit 3	Unit 2	Unit 2	-
Material Description [1]		Silty Sandy CLAY	Silty CLAY	SHALE					SHALE	SHALE	SHALE	SHALE	Silty CLAY	Silty CLAY	GROUND WATER
Atterberg Limits	Liquid Limit (%)	41	62	-	-	-	-	-	-	-	-	-	-	-	-
	Plastic Limit (%)	18	23	-	-	-	-	-	-	-	-	-	-	-	-
	Plasticity Index (%)	23	39	-	-	-	-	-	-	-	-	-	-	-	-
Linear Shrinkage (%)		-	16.0	-	-	-	-	-	-	-	-	-	-	-	-
Aggressivity	pH	-	-	-	-	-	-	-	-	-	-	-	4.7	4.6	5.3
	Electrical Conductivity (uS/cm)	-	-	-	-	-	-	-	-	-	-	-	130	140	3500
	Sulfate SO_4 (mg/kg)	-	-	-	-	-	-	-	-	-	-	-	47	100	620
	Chloride Cl (mg/kg)	-	-	-	-	-	-	-	-	-	-	-	54	67	530
Moisture Content (%)		-	-	5.5	8.2	14.1	7.6	6.3	6.3	4.6	2.3	4.8	20	19	-

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

4. Recommendations

4.1 Geotechnical Issues

The main geotechnical issues for the design of the development include:

- The presence of deep fill encountered in BH7. Bored piers may not be adequate and CFA piles may be required within the vicinity of BH7. Due to this granular fill, a contiguous/secant pile wall may be required within the vicinity of BH7. Investigation of the extent of this fill material using test pits/boreholes is recommended.
- Groundwater considerations.
- Basement excavation retention to prevent potential lateral deflections and ground loss as a result of excavations, resulting in damage to nearby structures;
- Potential vibration risks; and
- Foundation design for building loads.

The advice and parameters presented in this report are intended for the development of initial designs. Further geotechnical inspections should be carried out during construction to confirm the design parameters and geotechnical model provided here.

4.2 Dilapidation Surveys

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

4.3 Excavation Methodology and Vibration Monitoring

4.3.1 Excavation Assessment

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

EI assumes that the proposed development will require a BEL ranging from 31.00m to 37.40m AHD, or an excavation depth of up to 5.80m BEGL. Locally deeper excavations for footings, service trenches and lifts overrun pits may be required.

Based on the borehole logs, the proposed basement excavations will therefore generally extend through Units 1, 2, and 3 outlined in **Table 3-1** above. A full depth retention system must be installed prior to excavation commencing for support of all Units.

Units 1, 2 and 3 could be excavated using buckets of large earthmoving Hydraulic Excavators with some light to moderate ripping.

Should excavation using rock hammers be required, excavation should commence away from adjoining structures/infrastructures and the transmitted vibrations monitored to assess how close the hammer can operate to the adjoining structures/infrastructures while maintaining transmitted vibrations within acceptable limits. Alternatively, vibration monitors may be set up on the adjoining buildings to monitor vibrations at all times during rock excavation. Such monitors

should be attached to flashing lights to warn the operator when acceptable limits have been exceeded.

Where the transmitted vibrations are excessive, alternate excavation equipment would need to be used, such as a small rock hammer, ripping hooks, rotary grinders or rock saws. If an alternate rock hammer is to be used, the transmitted vibrations from that hammer should be measured to determine how close each individual hammer can operate to the adjoining buildings. To assist in reducing vibrations and over-break of the shale, we recommend that initial saw cuts through the bedrock may be provided using rock saw attachments fitted to the excavator. However, the effectiveness of such approach must be confirmed by the results of vibration monitoring.

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

4.3.2 Vibration Considerations

Utmost care must be taken when using excavators with hydraulic impact hammer attachments for any rock excavation, as there will likely be direct transmission of ground vibrations to nearby structures and infrastructures. Guideline levels of vibration velocity for evaluating the effects of vibration in structures are given in the attached Vibration Limits in **Appendix C**. We recommend that the acceptable limit for transmitted vibration be set at quite a low peak particle velocity of 5mm/s for frequencies of less than 10Hz at foundation level. To fall within these limits, we recommend that the size of rock hammers initially used during the trial not exceed medium sized rock hammer, say 900kg. If it is found that transmitted vibrations are unacceptable, then it would be necessary to change to a smaller excavator with a smaller rock hammer, or to a rotary grinder, rock saws, or jackhammers.

If rock hammers are to be used, we recommend that the initial excavation in rock should preferably commence away from likely critical areas and vibration monitoring be carried out. The monitoring program should be confirmed when details of the contractor's excavation methods and sequence are known.

Vibrations induced by excavations can be reduced by alternative methods such as the following:

- Commence the rock excavation away from potentially sensitive areas;
- Keep rock hammer orientation towards the face and enlarge excavation by breaking small wedges off faces;
- Operate hammers in short bursts only;
- Use smaller equipment (resulting in low productivity); and
- Use line sawing, especially along boundaries, to assist in breaking and trimming.

Furthermore, we recommend that only excavation contractors with appropriate insurances and experience on similar projects be used. The contractor should also be provided with a copy of this report to make his own judgement on the most appropriate excavation equipment.

4.3.3 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 structure within bounding properties and the services easement.

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 infrastructure. Measurements should be taken:

- Prior to commencement of excavations;
- Immediately after installation of any temporary or permanent retaining structures;
- Immediately after the excavation has reached a depth of 1.5 m, and each 1.5 m depth increment thereafter;
- Immediately after the excavation has reached bulk excavation level; and
- Immediately after backfilling behind retaining structures.

4.4 Groundwater Considerations

Groundwater was observed within the groundwater wells installed in BH1M, BH3M, BH4M, BH7M and BH8M, at depths ranging from about 1.9m to 8.4m BEGL, or RLs ranging from 38.5m to 28.3m AHD, some of which are above the assumed BELs ranging from 31.00m to 37.40m AHD. The groundwater level appears to have a gradient towards the west, which suggests that the groundwater flow is towards Wagener Oval.

Experience shows that due to the low permeability of the soil and bedrock profile, groundwater should not have an adverse impact on the proposed development or on the neighbouring sites. However, we expect that some groundwater inflows into the excavation along the soil/rock interface and through any defects within the shale bedrock (such as jointing, and bending planes, etc.) particularly following a period of heavy rain. The initial flows into the excavation maybe 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. EI recommends further detailed groundwater monitoring with pump out tests be carried out within the already installed monitoring well for monitoring of groundwater levels, estimation of seepage volumes and to determine the extent of seasonal variation on the groundwater table.

4.5 Excavation Retention

4.5.1 Support Systems

The proposed basement outline has a setback between 8.85m and 15.65m from the western boundary, between 5.50m and 9.00m from the northern boundary, 4.00m from the eastern boundary and 12.00m from the southern boundary.

Based on the above, the encountered subsurface conditions, the depth of excavation, temporary batters of no steeper than a safe angle of 1 Vertical (V) to 1 Horizontal (H) may be feasible where space allows for the fill and residual soil profile along the western and northern boundaries only.

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.

Where space for temporary batters is not available or desirable, such as along the eastern and southern boundaries, a suitable retention system will be required to support of the entire depth of the excavation. For this site, we consider that an anchored or cantilever soldier pile with shotcrete panels in between the piles installed to below BEL and socketed into Unit 4 shale or better to be the most suitable for the majority of the site. Anchors/props and mass concrete must be installed progressively as excavation proceeds.

The use of a more closely spaced shoring system (such as contiguous) is preferred adjacent to neighbouring buildings/infrastructures so as to reduce the lateral movements and the risk of potential damage. This is recommended in the western portion of the southern retaining wall due to the presence of sandy gravelly fill and silty sand fill to 5.40m depth BEGL.

Bored piles may be used for the majority of this site, however due to the presence of deep sandy gravel fill in the south western portion of site, CFA piles may be required to prevent cave in of the fill. We recommend further advice be sought from piling contractors who should be provided with a copy of this report. Working platforms may also be required. Investigation of the extent of this fill material using test pits/boreholes is recommended.

4.5.2 Retaining Walls Design Parameters

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

- 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.
- For progressively anchored or propped walls where minor movements can be tolerated (provided there are no buried movement sensitive services), we recommend the use of a trapezoidal earth pressure distribution of 5H kPa for soil and shale bedrock, where H is the retained height in meters. These pressures should be assumed to be uniform over the central 50% of the support system;
- For progressively anchored or propped walls which support areas which are highly sensitive to movement (such as areas where movement sensitive structures or infrastructures or buried services are located in close proximity), we recommend the use of a trapezoidal earth pressure distribution of 8H kPa for soil and shale bedrock, where 'H' is the retained height in meters. These pressures should be assumed to be uniform over the central 50% of the support system;
- Full hydrostatic pressures must be taken into consideration in the design of retaining walls unless measures are taken to provide complete and permanent drainage behind the walls. Strip drains protected with a non-woven geotextile fabric should be used behind the shotcrete infill panels for soldier pile walls or inserted between gaps in contiguous piles. Alternatively, for the contiguous pile walls, weepholes comprising 20mm diameter PVC pipes grouted into holes or gaps between adjacent piles at 1.2m centres (horizontal and vertical), may be used. The embedded end of the pipes must, however, be wrapped with a non-woven geotextile fabric (such as Bidim A34) to act as a filter against subsoil erosion;
- Appropriate 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, k_o, of 0.58;
- For piles embedded into Unit 4 or better, the allowable lateral toe resistance value outlined in **Table 4-1** below may be adopted. This value assumes excavation is not carried out within the zone of influence of the wall toe and the rock does not contain adverse defects, etc. At least the upper 0.5m depth below bulk excavation level should not be taken into account to allow for tolerance and disturbance effects during excavation;
- If temporary anchors extend beyond the site boundaries, then permission from the neighbouring developments would need to be obtained prior to installation. Also, the presence of neighbouring basements (particularly towards the south, where a new development is proposed) or services and their levels must be confirmed prior to finalising anchor design.
- Anchors should have their bond length within shale bedrock of at least Unit 4 or better. For the design of anchors bonded into shale bedrock, the allowable bond stresses values outlined in **Table 4-1** below may be used, subject to the following conditions:
    1. Anchor bond lengths of at least 3m behind the 'active' zone of the excavation (taken as a 45 degree zone above the base of the excavation) is provided;
    2. Overall stability, including anchor group interaction, is satisfied;
    3. All anchors should be proof loaded to at least 1.3 times the design working load before locked off at working load. Such proof loading is to be witnessed by and engineer independent of the anchoring contractor. We recommend that only

experienced contractors be considered for anchor installation with appropriate insurances;

4 Permanent anchors must have appropriate corrosion provisions for longevity.

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.

Table 4-1 Geotechnical Design Parameters

Material [1]		Unit 1 Fill	Unit 2 Residual Soil	Unit 3 Class V Shale	Unit 4 Class IV Shale	Unit 5 Class III Shale	Unit 6 Class II Shale
RL of Top of Unit (m AHD) [2]		33.7 to 40.5 (Surface)	40.0 to 32.5	39.2 to 31.2	32.7 to 20.9	32.6 to 20.3	30.6 to 29.3
Bulk Unit Weight (kN/m^3) [3]		18	20	22	23	24	24
Earth Pressure Coefficients	At rest, K_o [3]	0.58	0.58	0.50	0.47	0.44	0.41
	Active, K_a [3]	0.41	0.41	0.33	0.31	0.28	0.26
	Passive, K_p [3]	-	-	-	-	-	-
Preliminary Allowable Bearing Pressure (kPa) [4, 5, 8]		-	-	700	1000	1500	5000
Ultimate Vertical End Bearing Pressure (kPa) [5, 6, 8]		-	-	3000	3000	4500	15000
Ultimate Shaft Adhesion (kPa) [5, 6, 7]	in Compression	-	-	70	150	350	600
	in Uplift	-	-	-	75	175	300
Toe Resistance (kPa)		-	-	-	150	200	600
Bond Stress (kPa)		-	-	-	100	200	400
Susceptibility to Liquefaction during an Earthquake [9]		High	Low	Low	Low	Low	Low
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 in **Appendix A.**

2 Approximate levels to top of unit at the time of our investigation. More detailed descriptions of subsurface conditions are available in the borehole logs in **Appendix A.** Levels may vary across the site.

3 Earth pressures are provided on the assumption that the ground behind the retaining walls is horizontal.

4 The bases of all footings must be cleaned of loose debris and water and inspected by a Geotechnical Engineer prior to footing construction to verify that ground conditions meet design requirements.

5 Ultimate geotechnical strengths are provided for use in limit state design. Allowable or serviceability bearing pressures and side adhesions may be estimated using factors of safety of 3 and 2, respectively. These are the factors of safety generally adopted in geotechnical practice to limit settlements to an acceptable level for conventional building structures, typically less than 1% of the minimum footing width. Assumes the base of pile holes are clean and penetrate at least 1.0m or 2 pile diameters, whichever is greater, into the respective Unit. Bearing pressures may vary and must be confirmed by additional geotechnical investigations and foundation inspections during construction by an experienced geotechnical engineer. Higher bearing pressures may be applied upon confirmation by additional geotechnical investigations and subject to an experienced geotechnical engineer carrying out foundation inspections during construction.

6 It must be understood that the use of limit state design to adopt relatively high bearing pressures (above the serviceability criteria described in **Table 4-1** above) is not currently standard practice, and there is an increased risk of inadequate pile performance.

7 Side adhesion values given assume there is intimate contact between the pile and foundation material and should achieve the design roughness specification. Design engineer to check both 'piston' pull-out and 'cone' pull-out mechanics in accordance with AS4678-2002 Earth Retaining Structures.

8 To adopt these parameters we have assumed that:
- Piles have an embedment depth of at least two pile diameters or 1 m, whichever is greater, into the relevant founding material;
- There is intimate contact between the pile and foundation material;
- Potential soil and groundwater aggressivity will be considered in the design of bored piles;

- The bases of all pile excavations are cleaned of loose debris and water and inspected by a suitably qualified 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; and

9 Susceptibility to liquefaction during an earthquake is based on the following definition:

Low	-	Medium to very dense sands, stiff to hard clays, and rock
Medium	-	Loose to medium dense sands, soft to firm clays, or uncontrolled fill below the water table
High	-	Very loose sands or very soft clays below the water table

4.6 Foundations

Following bulk excavations, we generally expect Class V shale to be exposed over the assumed BEL RL ranging from 31.00m to 37.40m AHD. It is recommended that all footings for the building and retaining walls be founded within shale bedrock of similar strength to provide uniform support and reduce the potential for differential settlements.

We recommend that all building footings be founded within Unit 3 (Class V shale) or better material.

Strip/pad footings and/or bored piers founded into Unit 3 shale material may be designed for an allowable bearing capacity of 700kPa, based on serviceability. In some areas, piles may be required to reach the shale bedrock.

For footings founded at or near a crest of an excavation, such as near the step downs in the stepped basement, or for pile foundations outside the basement extent along the western boundary, these footings or piles should be founded below the zone of influence of the lower basement, which may be taken as founding below a line drawn at 1 Vertical to 1 Horizontal from the base of lower basement.

For piles founded in shale bedrock, these must be embedded a minimum of 0.50m into shale and can be designed for using the parameters as outlined in **Table 4-1** above.

Geotechnical inspections of foundations are recommended to determine that the required founding material has been reached and required design parameters has been achieved and determine any variations that may occur between the boreholes and inspected locations. Bearing pressures may be optimised following these geotechnical inspections of foundations.

4.7 Basement Floor Slab

Following bulk excavations for the proposed basement, shale bedrock (Unit 3) is expected to be exposed at BEL. The lowest basement slab should be provided with a granular subbase layer to provide a separation between the shale bedrock and the floor slab. We recommend that the subbase layer comprise at least 100mm thickness of crushed rock to RMS QA specification 3051 (2014) unbound base material (or equivalent good quality and durable fine crushed rock) compacted to at least 100% of Standard Maximum Dry Density (SMDD). Concrete pavements should be designed with an effective shear transmission at all joints by way of either dowelled or keyed joints. The completed excavation should be inspected by the hydraulic engineer to confirm the extent of the drainage required.

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

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

5. Further Geotechnical Inputs

The advice and parameters presented in this report are intended for the development of initial designs. Further geotechnical investigations and inspections should be carried out during construction, to confirm the preliminary design parameters and geotechnical model provided here. These services should include:

- Investigation of the extent of the fill material within the vicinity of BH7 using test pits/boreholes.
- Dilapidation surveys;
- Monitoring of groundwater levels within the groundwater monitoring wells during design stage;
- Classification of all excavated material transported off site;
- Design of working platforms (if required) for construction plant by an experienced and qualified geotechnical engineer;
- Ongoing monitoring of groundwater inflows into the excavation;
- Geotechnical inspections of foundations; and
- Witnessing installation and proof-testing of anchors.

6. Statement of Limitations

This report has been prepared for the exclusive use of Rod Dalton and Ashbury FMBM 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 Rod Dalton and Ashbury FMBM Pty Ltd

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

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

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

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

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

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

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

References

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

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

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

AS3600:2009, *Concrete Structures,* Standards Australia

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

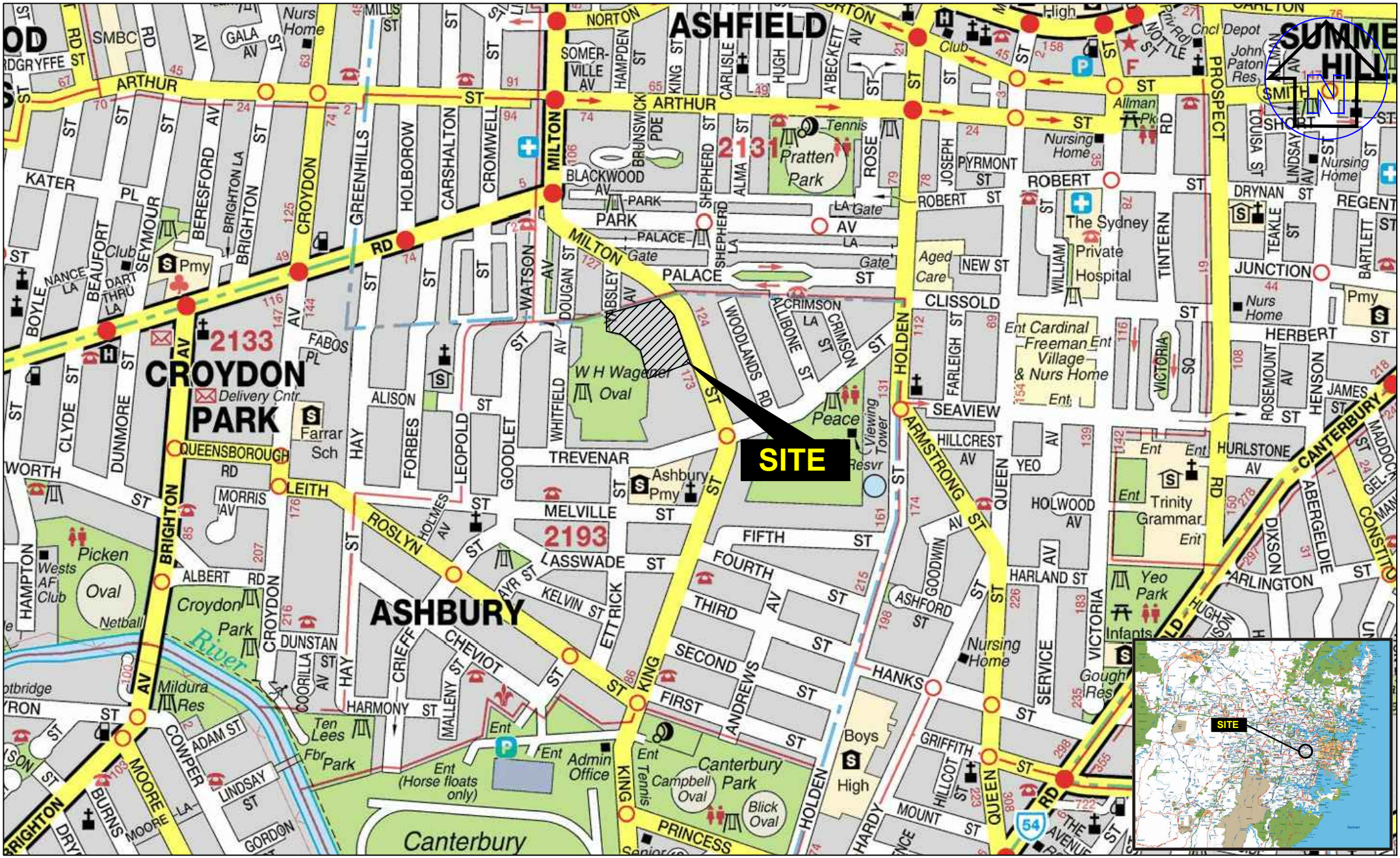
NSW Department of Finance and Service, Spatial Information Viewer, maps.six.nsw.gov.au.

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

Abbreviations

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

Figures



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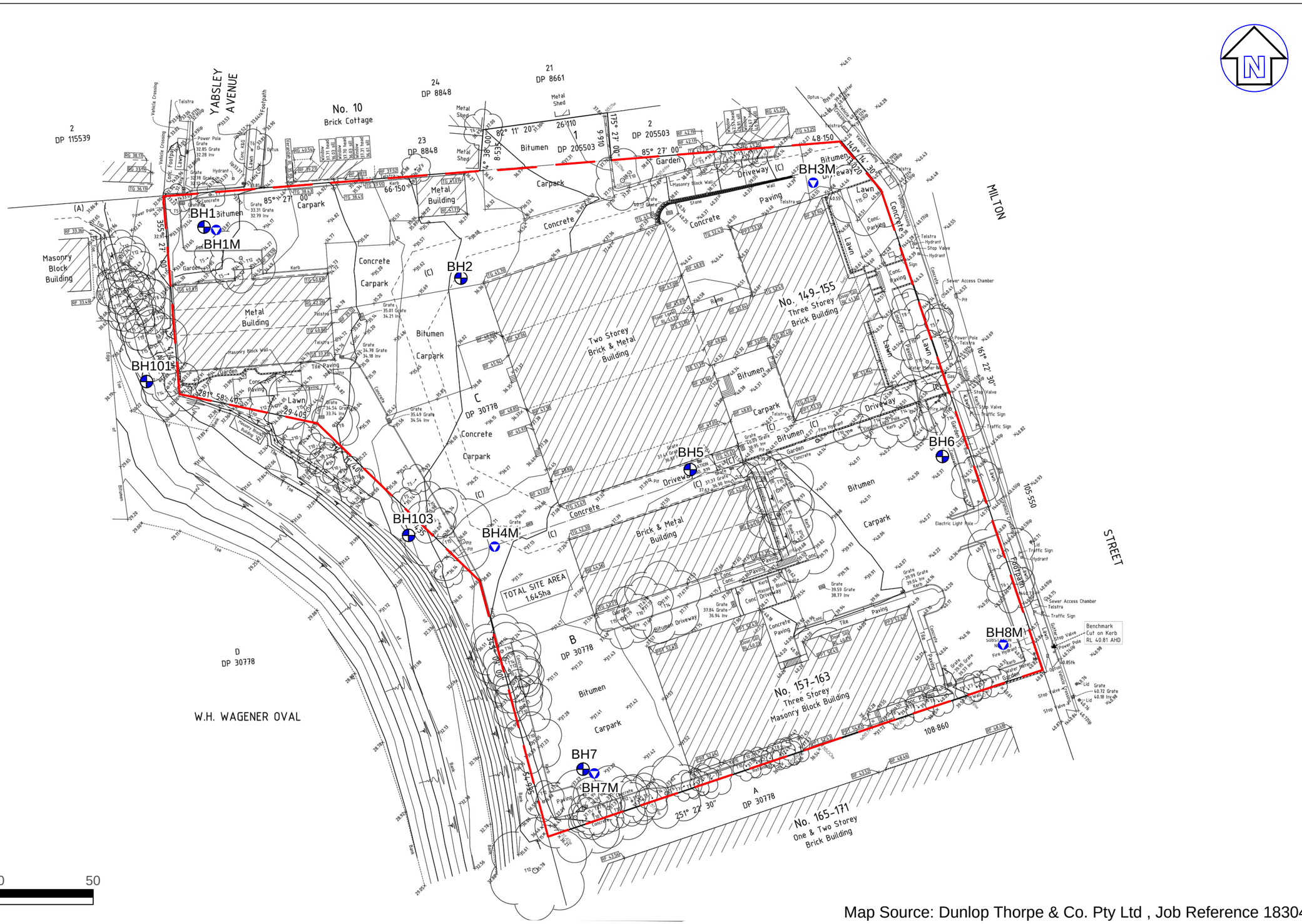
Drawn:	S.Y
Approved:	J.C
Date:	24.2.16
Approx Scale:	N.T.S

Ashbury FMBM Pty Ltd
Geotechnical Investigation
149-163 Milton Street, Ashbury, NSW
Site Location Plan

Figure:
1

Project: E22851 GA



Map Source: Dunlop Thorpe & Co. Pty Ltd , Job Reference 18304

LEGEND

- Approximate Site Boundary
- Approximate Borehole Location
- Approximate Monitoring Well/Borehole location

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Ashbury FMBM Pty Ltd
Geotechnical Investigation
149-163 Milton Street, Ashbury NSW
Borehole Location Plan

Figure: 2

Project: E22851 GA

Appendix A – Borehole Logs And Explanatory Notes

BOREHOLE: BH1

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Project	Proposed Residential Development			Sheet	1 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	15/1/16
Position	Refer to Figure 2	Surface RL	33.60 m AHD	Date Completed	15/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 15/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	*0.10*				-	Asphaltic-concrete: 100mm thick.	-	-	PAVEMENT
				33.50	BH1_0.1-0.2 ES 0.10-0.20 m			-	FILL: Silty CLAY; high plasticity, dark grey-brown, with some concrete fragments, no odour.			FILL Appears poorly compacted
					BH1_0.4-0.5 ES 0.40-0.50 m SPT 0.50-0.95 m 4,6,7 N=13					M (>PL)	-	
			1		BH1_0.5-0.95 0.95 m							
				1.20								
	E			32.40	PP =410-420 kPa BH1_1.0-1.1 ES 1.00-1.10 m SPT 1.50-1.95 m 4,7,8 N=15 BH1_1.5-1.95 1.95 m PP =370-410 kPa BH1_2.0-2.1 ES 2.00-2.10 m			Cl	Silty CLAY; medium plasticity, orange-brown, grey mottled, no odour.	M (>PL)	VSt - H	RESIDUAL SOIL
			2									
				2.50								
	E-F			31.10				-	SHALE; brown, extremely low strength, extremely weathered, with iron indurated bands, no odour.			WEATHERED ROCK
				3.00								
			3	30.60	BH1_3.0-3.1 D 3.00-3.10 m				From 3.0m, very low strength, distinctly weathered, no odour.			ROCK
AD/T	F	GWNE on completion of augering 28/01/16								-	-	
			4		BH1_4.0-4.1 D 4.00-4.10 m							
				4.40								
									Continued as Cored Borehole			
			5									
			6									
			7									
			8									
			9									
			10									

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

BOREHOLE: BH1

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Project	Proposed Residential Development			Sheet	2 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	15/1/16
Position	Refer to Figure 2	Surface RL	33.60 m AHD	Date Completed	15/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 15/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0							
				1							
				2							
				3							
				4	4.40		Continuation from non-cored borehole				
NQ	80-90% RETURN	100	0 (0)	5	29.20		SHALE; grey-brown with orange iron staining, with iron indurated bands.	DW		4.62-4.66: CS 40 mm. 4.75: BP 0 - 5° UN RF Clay VNR GRAVEL infill. 4.82-4.86: CS 40 mm. 4.94: BP 0 - 5° UN RF Clay VNR GRAVEL infill.	
		100	48 (48)	6						5.16-5.48: BP 0 - 5° PR RF Clay VNR 5.53-5.55: DS 20 mm. 5.65-5.70: BPx2 0 - 10° PR RF Clay VNR	
		100	0 (0)	7	6.17 27.43		From 6.17m; bedding dipping 0-5 degrees, <1mm thick, grey with orange iron staining.			5.83: BP 0 - 10° PR RF Clay VNR GRAVEL infill. 5.92-5.95: CS 30 mm. 6.07-6.11: CS 40 mm. 6.42-6.48: DS 60 mm. 6.75: JT 30° PR RF Clay VNR	
		100	60 (69)	8						7.38: JT 30° CU RF Clay VNR 7.46: BP 0 - 10° UN RF Clay VNR 7.54: JT 20 - 30° PR RF CN 7.69: BP 0 - 10° PR RF Clay VNR GRAVEL infill.	
		100	69 (78)	9						7.90-7.97: BPx3 0 - 20° PR RF CN average spacing 30 mm. 8.14: JT 0 - 80° CU RF CN 8.25-8.29: DS 40 mm.	
		100	39 (39)	10	8.36 25.24		SHALE; bedding dipping 0-5 degrees, dark grey with grey laminations, 1-2mm thick, 10-30mm spacing.	SW - FR		8.53: BP 0° PR S CN 8.83: BP 0° PR S CN 8.89: BP 0° PR S CN 9.09: JT 20° PR S CN 9.18-9.19: DS 10 mm, CLAY.	
		100	92 (99)							9.41: BP 0° PR S CN 9.60-9.72: DZ CLAY.	
		100	76 (87)							9.89: BP 0° PR S CN	

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

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BOREHOLE: BH1

Project	Proposed Residential Development			Sheet	3 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	15/1/16
Position	Refer to Figure 2	Surface RL	33.60 m AHD	Date Completed	15/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 15/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
NQ	80-90% RETURN	100	76 (87)	10			SHALE; bedding dipping 0-5 degrees, dark grey with grey laminations, 1-2mm thick, 10-30mm spacing.	SW - FR		10.02: JT 80° PR S CN 10.03: BP 0° PR S CN 10.04: JT 80° PR S CN 10.22: JT 0 - 10° UN S CN 10.60: BP 5° PR S CN 10.67: BP 0° PR S CN 11.04: BP 0° PR S CN 11.09: BP 10° PR S CN 11.46: BP 0° PR S CN 11.88: BP 0° PR S CN	
		100	99 (99)	11							
				12	*12.00* 21.60		Hole Terminated at 12.00 m Backfilled with drilling spoil and concrete capped.				
				13							
				14							
				15							
				16							
				17							
				18							
				19							
				20							

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

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CORE PHOTOGRAPH OF BOREHOLE: BH1

Project:	Proposed Residential Development			Depth Range:	4.40 m to 12.00 m
Location:	149-163 Milton Street, Ashbury, NSW	Surface RL:	33.60 m AHD	Contractor:	Chadwick Geotechnics Pty Ltd
Position:	Refer to Figure 2	Inclination:	-90°	Drill Rig:	Hanjin DB8
Job No. :	E22851	Box:	1-2 of 2	LOGGED: SY	DATE: 15/1/16
Client:	Ashbury FMBM Pty Ltd	Hole Depth:	12.00 m	CHECKED: JC	DATE: 24/2/16

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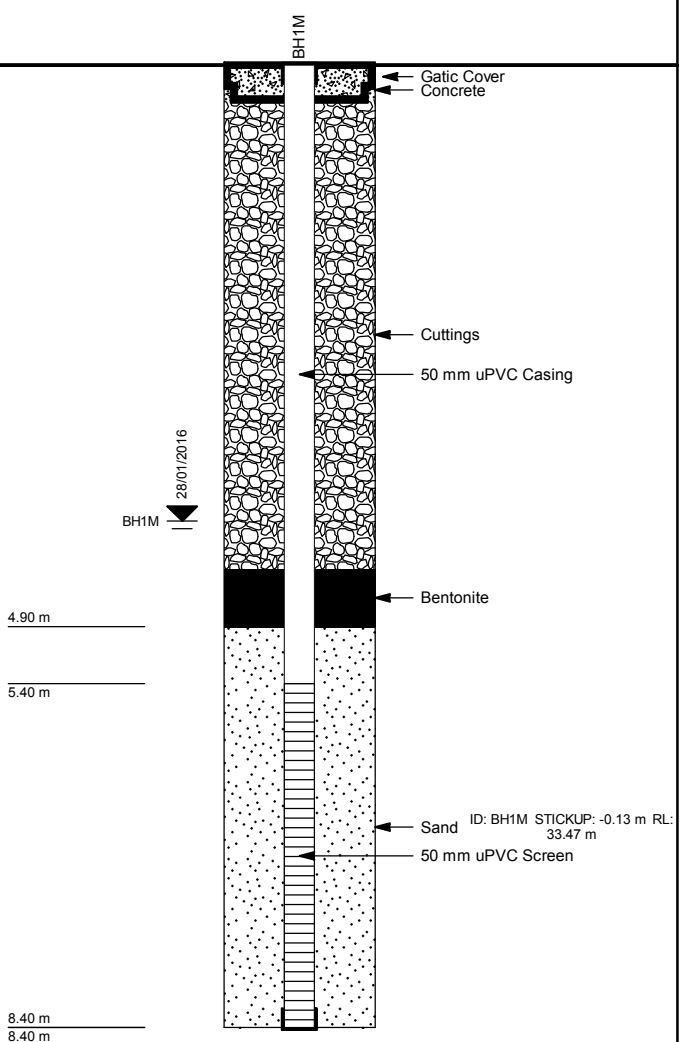
Hole ID
BH1M

CLIENT	: Ashbury FMBM Pty Ltd	POSITION	: Refer to Figure 2	SHEET	: 1 OF 1
CONTRACTOR	: Chadwick Geotechnics Pty Ltd	COORD. SYS.	: MGA94 Zone 56	LOGGED BY	: SY
PROJECT	: Proposed Residential Development	GROUND RL	: 33.60 m AHD	DRILL DATE	: 15/01/2016
LOCATION	: 149-163 Milton Street, Ashbury, NSW				
PROJECT No.	: E22851				

Method	Drilling Water	Depth (m)	Elevation (m AHD)	Graphic Log	Soil / Rock Description
AD/T	GWNE on completion of augering	0	34		Asphaltic-concrete: 100mm thick.
					FILL: Silty CLAY; high plasticity, dark grey-brown, with some concrete fragments, no odour.
		2	32		Silty CLAY; medium plasticity, orange-brown, grey mottled, no odour.
					SHALE; brown, extremely low strength, extremely weathered, with iron indurated bands, no odour.
					From 3.0m, very low strength, distinctly weathered, no odour.
		4	30		
NQ	80-90% RETURN				SHALE; grey-brown with orange iron staining, with iron indurated bands.
		6	28		
					From 6.17m; bedding dipping 0-5 degrees, <1mm thick, grey with orange iron staining.
		8	26		
					SHALE; bedding dipping 0-5 degrees, dark grey with grey laminations, 1-2mm thick, 10-30mm spacing.
		10	24		
		12	22		Hole Terminated at 12.00 m Backfilled with drilling spoil and concrete capped.

PIEZOMETER CONSTRUCTION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL	Installation Date	Static Water Level
BH1M	Standpipe	-0.13 m 33.73 m	8.40 m 25.20 m	20/01/2016	3.85m



CHECKED BY : JC
CHECKED DATE : 24/02/2016

REMARK
Backfilled with drilling spoil and concrete capped.

BOREHOLE: BH2

Environmental Investigations Australia
Contamination | Remediation | Geotechnical

Project	Proposed Residential Development			Sheet	1 OF 1
Location	149-163 Milton Street, Ashbury, NSW			Date Started	15/1/16
Position	Refer to Figure 2	Surface RL	36.00 m AHD	Date Completed	15/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 15/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	E	GWNE on completion of augering	0	0.10 35.90 0.30 35.70				-	Asphaltic-concrete: 100mm thick.	-	-	PAVEMENT
								-	FILL: Sandy CLAY; high plasticity, dark grey, sand is fine grained, no odour.	M (>PL)	-	FILL Appears poorly compacted
					SPT 0.50-0.90 m 2,3,7 HB N>10 BH2_0.5-0.9 0.90 m PP =270-300 kPa			CH	Silty CLAY; high plasticity, orange-brown with some grey mottling, no odour.	M (>PL)	VSt	RESIDUAL SOIL
			1	0.90 35.10				-	SHALE; brown, extremely low strength to very low strength, extremely to distinctly weathered, with iron indurated bands, no odour.	-	-	WEATHERED ROCK
	H			1.60	BH2_1.5-1.6 D 1.50-1.60 m				Hole Terminated at 1.60 m Backfilled with drilling spoil and concrete capped.			
			2									
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

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

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BOREHOLE: BH3M

Project	Proposed Residential Development			Sheet	1 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	19/1/16
Position	Refer to Figure 2	Surface RL	40.50 m AHD	Date Completed	19/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 19/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0	0.10				-	Asphaltic-concrete: 100mm thick.	-	-	PAVEMENT
				40.40	BH3M_0.2-0.3 ES 0.20-0.30 m			-	FILL: Silty SAND; fine grained, dark grey with some concrete and brick fragments, no odour.	M		FILL Appears poorly compacted
					SPT 0.50-0.60 m N>2 HB BH3M_0.5-0.6							
			1	0.90 39.60	BH3M_1.0-1.1 ES 1.00-1.10 m			-	FILL: Silty Sandy CLAY; medium plasticity, brown, sand is fine grained, with someconcrete fragments, no odour.	M (>PL)	-	
	E				SPT 1.50-1.95 m 3,6,7 N=13							
				1.80 38.70	BH3M_1.5-1.8			CI	Silty CLAY; medium plasticity, orange-brown, with some grey mottling, no odour.	M (>PL)	H	RESIDUAL SOIL
			2	2.20 38.30	BH3M_1.8-1.95 1.95 m PP =420-600 kPa BH3M_2.0-2.1 ES 2.00-2.10 m			-	SHALE; brown, extremely low strength, extremely weathered, with iron indurated bands, no odour.			WEATHERED ROCK
	E-F				BH3M_2.2-2.3 D 2.20-2.30 m BH3M_2.5-2.6 D 2.50-2.60 m							
			3	3.20 37.30	SPT 3.00-3.08 m N>1 HB BH3M_3.0-3.08			-	SHALE; brown-grey, very low strength, distinctly weathered, interbedded with clay, with iron indurated bands, no odour.			ROCK
AD/T		GWNE on completion of augering			BH3M_3.7-3.8 D 3.70-3.80 m							
			4									
	F		5		BH3M_5.0-5.1 D 5.00-5.10 m					-	-	
			6									
			7	7.60								
			8						Continued as Cored Borehole			
			9									
			10									

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

BOREHOLE: BH3M

Environmental Investigations Australia
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Project	Proposed Residential Development			Sheet	2 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	19/1/16
Position	Refer to Figure 2	Surface RL	40.50 m AHD	Date Completed	19/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 19/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0							
				1							
				2							
				3							
				4							
				5							
				6							
				7							
					7.60		Continuation from non-cored borehole				
NQ	80-90% RETURN	100	49 (49)	8	32.90		SHALE; bedding dipping 0-10 degrees, <1mm thick, grey with orange-brown iron staining.	DW		7.74: BP 0 - 5° PR RF CN 7.90-7.95: JT 50° PR RF Clay VNR 8.13: BP 0 - 10° UN RF Clay VNR 8.21: JT 30° PR RF Clay VNR 8.66-8.75: JT 45 - 60° PR RF Clay VNR 8.76: BP 15° PR RF CN 8.82-8.88: JT 45° PR RF Fe SN	
				9						9.18-9.22: JT 60° PR RF Fe SN 9.32-9.51: DZ 190 mm, CLAY.	
		100	52 (63)		*9.51* 30.99		SHALE; bedding dipping 0-10 degrees, dark grey with grey laminiations 1-2mm thick, 5-20mm spacing.	SW - FR		9.56-9.62: BPx2 0 - 5° PR RF CN 9.65: BP 0 - 5° PR RF CN 9.66: JT 45° PR RF CN 9.69-9.73: JT 90° PR RF CN	
				10							

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

Environmental Investigations Australia
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BOREHOLE: BH3M

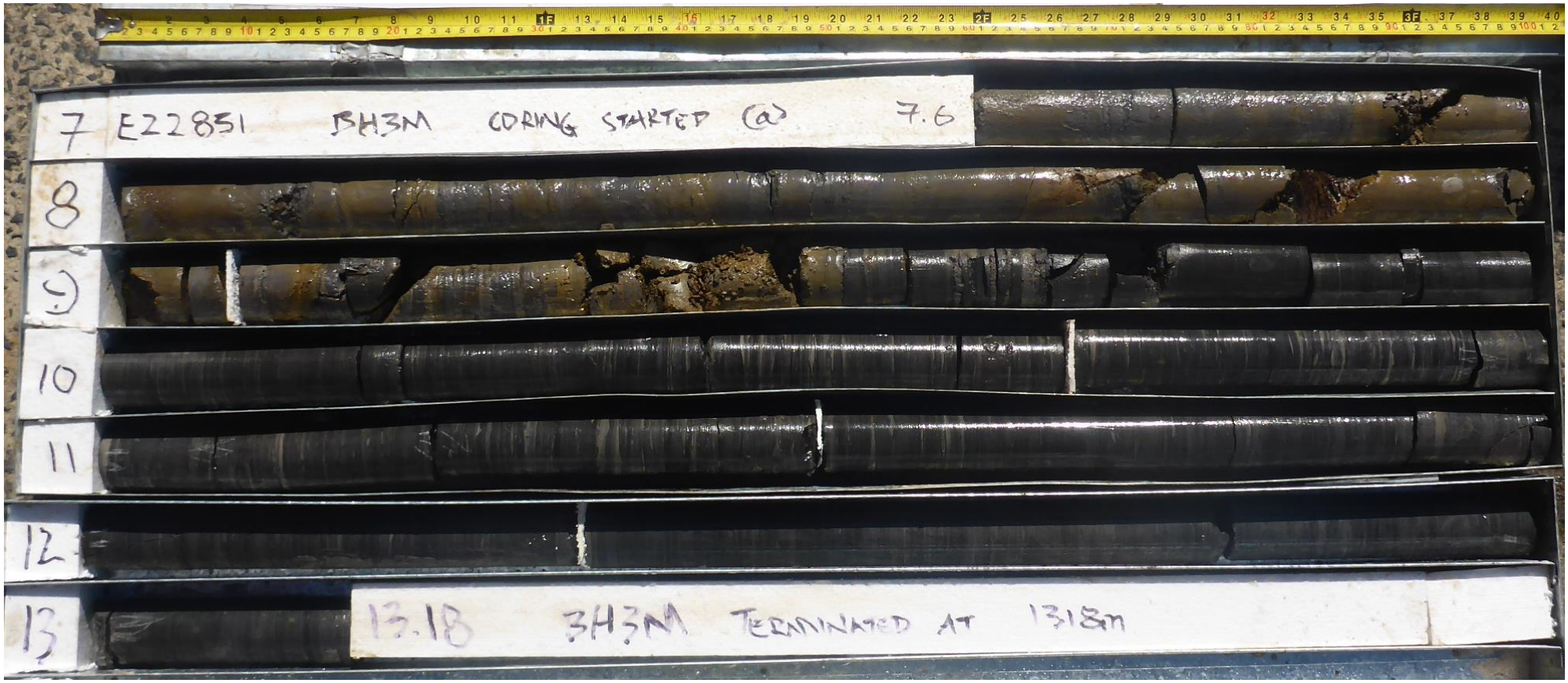
Project	Proposed Residential Development			Sheet	3 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	19/1/16
Position	Refer to Figure 2	Surface RL	40.50 m AHD	Date Completed	19/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 19/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
NQ	80-90% RETURN	100	52 (63)	10			SHALE; bedding dipping 0-10 degrees, dark grey with grey laminiations 1-2mm thick, 5-20mm spacing.	SW - FR		9.83-9.91: BPx2 0° PR RF CN	
										10.20: BP 0° PR RF CN	
										10.41: BP 0° PR RF CN	
										10.59: BP 0° PR RF CN	
		100	96 (96)	11							
										11.41: BP 0° PR RF CN	
		100	98 (98)	12						11.77: BP 0° PR RF CN	
										11.91: BP 0 - 10° PR RF Clay VNR	
		100	97 (97)	13						12.78: JTx2 30° PR RF CN	
					13.18 27.32		Hole Terminated at 13.18 m Converted to monitoring well.				
				14							
				15							
				16							
				17							
				18							
				19							
				20							

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

CORE PHOTOGRAPH OF BOREHOLE: BH3M

Project:	Proposed Residential Development			Depth Range:	7.60 m to 13.18 m
Location:	149-163 Milton Street, Ashbury, NSW	Surface RL:	40.50 m AHD	Contractor:	Chadwick Geotechnics Pty Ltd
Position:	Refer to Figure 2	Inclination:	-90°	Drill Rig:	Hanjin DB8
Job No. :	E22851	Box:	1-2 of 2	LOGGED: SY	DATE: 19/1/16
Client:	Ashbury FMBM Pty Ltd	Hole Depth:	13.18 m	CHECKED: JC	DATE: 24/2/16



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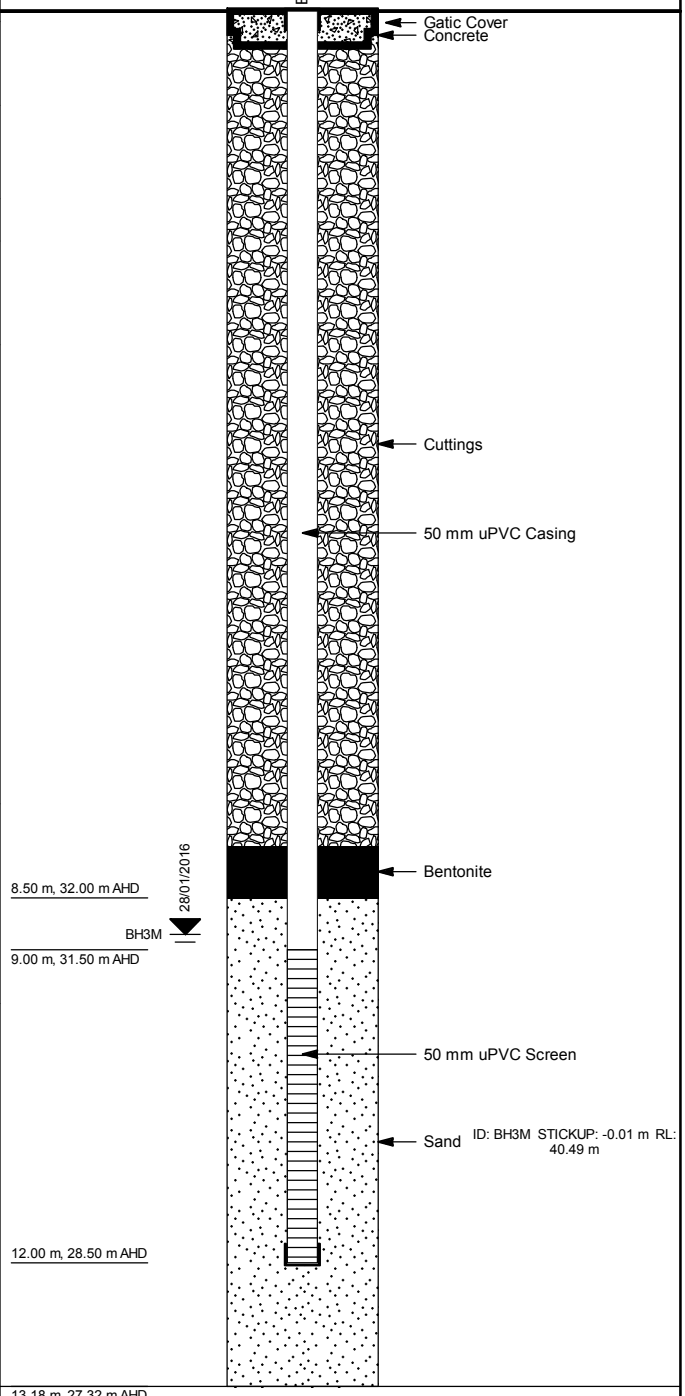
Hole ID
BH3M

CLIENT	: Ashbury FMBM Pty Ltd	POSITION	: Refer to Figure 2	SHEET	: 1 OF 1
CONTRACTOR	: Chadwick Geotechnics Pty Ltd	COORD. SYS.	: MGA94 Zone 56	LOGGED BY	: SY
PROJECT	: Proposed Residential Development	GROUND RL	: 40.50 m AHD	DRILL DATE	: 19/01/2016
LOCATION	: 149-163 Milton Street, Ashbury, NSW				
PROJECT No.	: E22851				

Method	Drilling Water	Depth (m)	Elevation (m AHD)	Graphic Log	Soil / Rock Description
AD/T	GWNE on completion of augering	0	40		Asphaltic-concrete: 100mm thick.
					FILL: Silty SAND; fine grained, dark grey with some concrete and brick fragments, no odour.
					FILL: Silty Sandy CLAY; medium plasticity, brown, sand is fine grained, with someconcrete fragments, no odour.
		2			Silty CLAY; medium plasticity, orange-brown, with some grey mottling, no odour.
			38		SHALE; brown, extremely low strength, extremely weathered, with iron indurated bands, no odour.
		4			SHALE; brown-grey, very low strength, distinctly weathered, interbedded with clay, with iron indurated bands, no odour.
			36		
		6			
			34		
NQ	80-90% RETURN	8			SHALE; bedding dipping 0-10 degrees, <1mm thick, grey with orange-brown iron staining.
			32		
		10			SHALE; bedding dipping 0-10 degrees, dark grey with grey laminiations 1-2mm thick, 5-20mm spacing.
			30		
		12			
			28		
		14			Hole Terminated at 13.18 m Converted to monitoring well.

PIEZOMETER CONSTRUCTION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL	Installation Date	Static Water Level
BH3M	Standpipe	-0.01 m 40.51 m	12.00 m 28.50 m	19/01/2016	8.84m



CHECKED BY : JC
CHECKED DATE : 24/02/2016

REMARK
Converted to monitoring well.

BOREHOLE: BH4M

Environmental Investigations Australia
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Project	Proposed Residential Development			Sheet	1 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	18/1/16
Position	Refer to Figure 2	Surface RL	36.70 m AHD	Date Completed	18/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 18/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	VH	GWNE on completion of augering	0	0.15				-	CONCRETE; 150mm thick	-	-	CONCRETE HARDSTAND
				36.55				-	FILL: Silty SAND; fine grained, brown, with some brick and concrete fragments, no odour.			FILL Appears poorly compacted
			1		BH4M_0.4-0.5 ES 0.40-0.50 m SPT 0.50-0.60 m 3/100mm HB N=SPT BH4M_0.5-0.6 BH4M_1.0-1.1 ES 1.00-1.10 m					M	-	
	E			1.40								
				35.30				CH	Silty CLAY; high plasticity, orange-brown with grey mottling, no odour.			RESIDUAL SOIL
			2		SPT 1.50-1.95 m 4,6,6 N=12 BH4M_1.5-1.95 1.95 m PP >600 kPa BH4M_2.0-2.1 ES 2.00-2.10 m					M (>PL)	H	
				2.40								
	E-F			34.30				-	SHALE; grey-brown, extremely low strength, extremely weathered, no odour.			WEATHERED ROCK
			3		SPT 3.00-3.05 m 2/50mm HB N=SPT							
				3.40	BH4M_3.0-3.05							
				33.30	BH4M_3.4-3.5 D 3.40-3.50 m			-	SHALE; grey-brown, very low strength, distinctly weathered, interbedded with clay, with iron indurated bands, no odour.			ROCK
	F		4									
			5									
					BH4M_5.5-5.6 D 5.50-5.60 m							
			6							-	-	
			7	7.20								
	F-H			29.50					From 7.2m; grey.			
		28/01/16	8									
			9									
			10	10.00								

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

BOREHOLE: BH4M

Environmental Investigations Australia
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Project	Proposed Residential Development			Sheet	2 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	18/1/16
Position	Refer to Figure 2	Surface RL	36.70 m AHD	Date Completed	18/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 18/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	F-H	GWNE on completion of augering	10	26.70				-	SHALE; grey, very low strength, distinctly weathered, interbedded with clay, with iron indurated bands, no odour.	-	-	
			11									
			12									
			13									
			14									
			15	*15.75*								
			16						Continued as Cored Borehole			
			17									
			18									
			19									
			20									

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

Environmental Investigations Australia
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BOREHOLE: BH4M

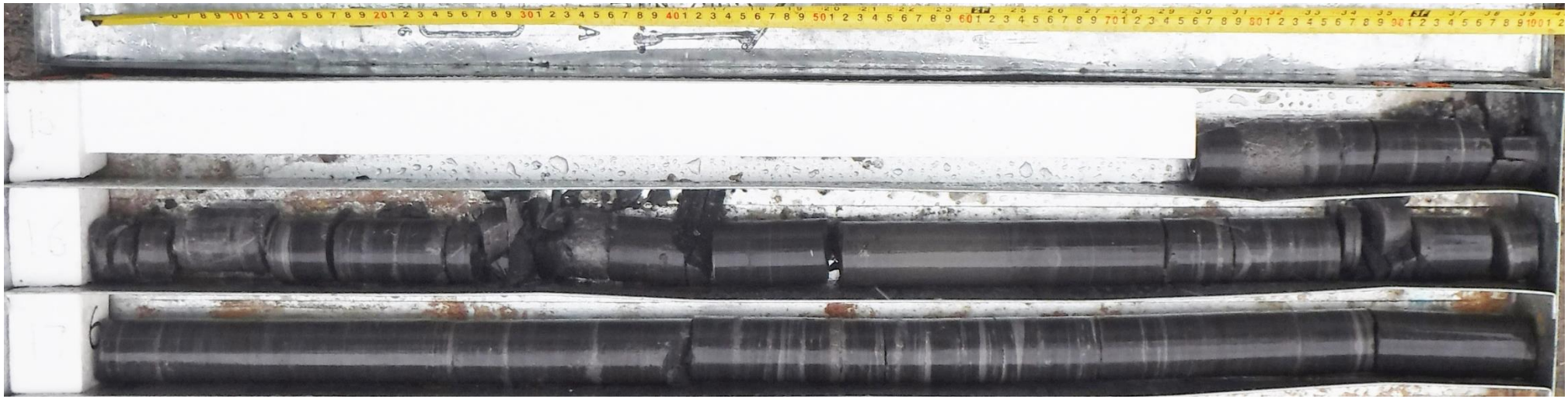
Project	Proposed Residential Development			Sheet	3 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	18/1/16
Position	Refer to Figure 2	Surface RL	36.70 m AHD	Date Completed	18/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 18/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				10							
				11							
				12							
				13							
				14							
				15							
					15.75		Continuation from non-cored borehole				
NQ	80-90% RETURN	100	52 (64)	16	20.95		SHALE; bedding dipping 0-5 degrees, dark grey with grey laminations 1-2mm thick, 10-30mm spacing.	DW		15.86: BP 0° PR S CN 15.88: BP 0° PR S CN 15.96: JT 10° PR S CN 15.98: JT 90° PR S CN 16.00-16.07: DS PR S CN 16.12: BP PR S CN 16.17: BP PR S CN 16.25: BP PR S CN 16.27-16.36: DS with CLAY. 16.40-16.43: JT 50° PR S CN 16.41: BP PR S CN 16.50-16.51: DS 10 mm. 16.73: BP PR S CN 16.78: BP PR S CN 16.86-16.91: SZ 16.96: BP PR S CN 17.40: JT 45° PR S CN 17.41: BP 0° PR S CN 17.54: BP 0° PR S CN 17.88: BP 0° PR S CN	
		100	98 (98)	17				SW - FR			
					18.00						
				18	18.70		Hole Terminated at 18.00 m Converted to monitoring well.				
				19							
				20							

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

CORE PHOTOGRAPH OF BOREHOLE: BH4M

Project:	Proposed Residential Development			Depth Range:	15.75 m to 18.00 m
Location:	149-163 Milton Street, Ashbury, NSW	Surface RL:	36.70 m AHD	Contractor:	Chadwick Geotechnics Pty Ltd
Position:	Refer to Figure 2	Inclination:	-90°	Drill Rig:	Hanjin DB8
Job No. :	E22851	Box:	1 of 1	LOGGED: SY	DATE: 18/1/16
Client:	Ashbury FMBM Pty Ltd	Hole Depth:	18.00 m	CHECKED: JC	DATE: 24/2/16



Environmental Investigations Australia
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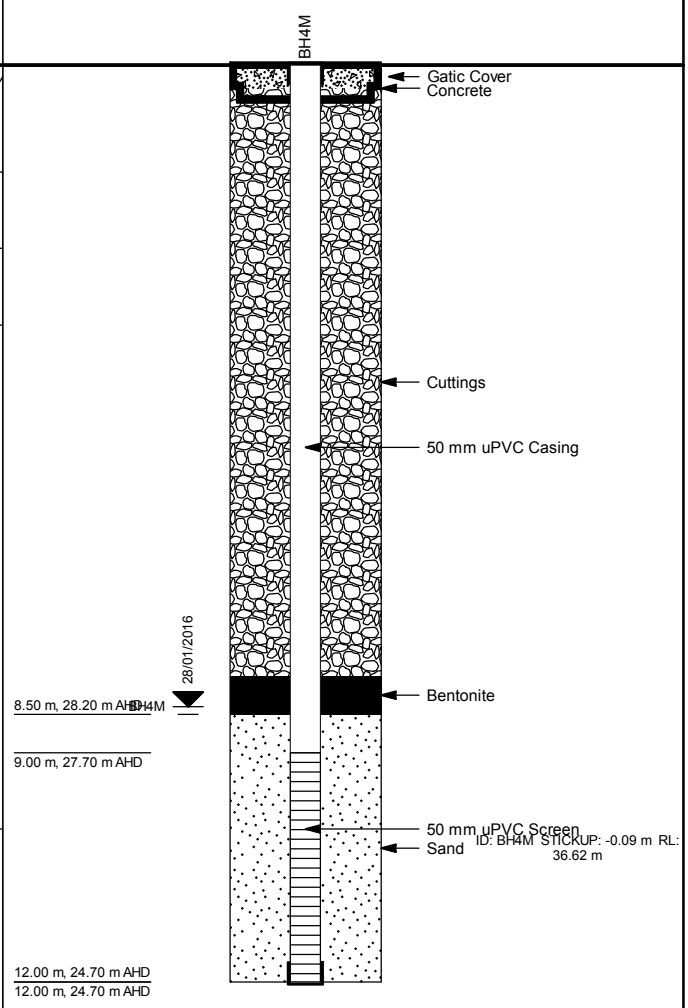
Hole ID
BH4M

CLIENT	: Ashbury FMBM Pty Ltd	POSITION	: Refer to Figure 2	SHEET	: 1 OF 1
CONTRACTOR	: Chadwick Geotechnics Pty Ltd	COORD. SYS.	: MGA94 Zone 56	LOGGED BY	: SY
PROJECT	: Proposed Residential Development	GROUND RL	: 36.70 m AHD	DRILL DATE	: 18/01/2016
LOCATION	: 149-163 Milton Street, Ashbury, NSW				
PROJECT No.	: E22851				

Method	Drilling Water	Depth (m)	Elevation (m AHD)	Graphic Log	Soil / Rock Description
AD/T	GWNE on completion of augering	0	36		CONCRETE; 150mm thick
					FILL: Silty SAND; fine grained, brown, with some brick and concrete fragments, no odour.
		2	34		Silty CLAY; high plasticity, orange-brown with grey mottling, no odour.
					SHALE; grey-brown, extremely low strength, extremely weathered, no odour.
		4	32		SHALE; grey-brown, very low strength, distinctly weathered, interbedded with clay, with iron indurated bands, no odour.
		6	30		From 7.2m; grey.
		8	28		
		10	26		SHALE; grey, very low strength, distinctly weathered, interbedded with clay, with iron indurated bands, no odour.
		12	24		
		14	22		
NQ	80-90% RETURN	16	20		SHALE; bedding dipping 0-5 degrees, dark grey with grey laminations 1-2mm thick, 10-30mm spacing.
		18	18		Hole Terminated at 18.00 m Converted to monitoring well.

PIEZOMETER CONSTRUCTION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL	Installation Date	Static Water Level
BH4M	Standpipe	-0.09 m 36.79 m	12.00 m 24.70 m	18/01/2016	8.32m



CHECKED BY : JC
CHECKED DATE : 24/02/2016

REMARK
Converted to monitoring well.

BOREHOLE: BH5

Environmental Investigations Australia
Contamination | Remediation | Geotechnical

Project	Proposed Residential Development			Sheet	1 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	20/1/16
Position	Refer to Figure 2	Surface RL	37.40 m AHD	Date Completed	20/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 20/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	VH	GWNE on completion of augering	0	0.15				-	CONCRETE; 150mm thick.	-	-	CONCRETE HARDSTAND
				37.25 0.40	BH5_0.2-0.3 ES 0.20-0.30 m			-	FILL: Silty SAND; fine grained, brown with some brick and concrete fragments, no odour.	M	-	FILL Appears poorly compacted
				37.00 0.80	BH5_0.4-0.5 ES 0.40-0.50 m SPT 0.50-0.80 m 3,8/150 HB N>8			CI	Silty CLAY; medium plasticity, orange-brown with grey mottling, with some fine, subangular ironstone gravel, no odour.	M (>PL)	H	RESIDUAL SOIL
			1	36.60	BH5_0.5-0.8 0.80 m PP =540->600 kPa			-	SHALE; brown, extremely low strength, extremely weathered, with iron indurated bands, no odour.			WEATHERED ROCK
	E				BH5_1.3-1.4 D 1.30-1.40 m							
			2									
			3	3.00 34.40				-	SHALE; grey-brown, very low strength, distinctly weathered, with iron indurated bands, no odour.			ROCK
	E-F		4							-	-	
			5									
			6									
	F		7	6.80 30.60 7.00					From 6.8m; dark grey, low to medium strength, slightly weathered to fresh.			
									Continued as Cored Borehole			
			8									
			9									
			10									

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

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BOREHOLE: BH5

Project	Proposed Residential Development			Sheet	2 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	20/1/16
Position	Refer to Figure 2	Surface RL	37.40 m AHD	Date Completed	20/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 20/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0							
				1							
				2							
				3							
				4							
				5							
				6							
				7	*7.00*		Continuation from non-cored borehole				
NQ	80-90% RETURN	100	0 (50)		30.40		SHALE; bedding dipping 0-5 degrees, dark grey with grey laminations 1mm thick, 5-20mm spacing.	SW - FR		7.05-7.15: BPx3 0 - 5° PR RF CN average spacing 50 mm.	
		100	42 (65)							7.30-7.42: BPx2 0 - 5° PR RF CN 7.37: JT 45° PR RF Fe SN	
		100	96 (96)	8						7.66: BP 0 - 5° PR RF Clay VNR 7.78-7.81: BP 0 - 5° PR RF Clay VNR 7.93: BP 0 - 5° PR RF CN 8.09-8.18: BPx2 0 - 5° PR RF Clay VNR 8.47-8.78: BPx2 0 - 5° PR RF CN	
		100	92 (77)	9						9.20-9.52: JT 60° PR RF CN 9.25-9.57: BPx6 0 - 5° PR RF CN average spacing 30-100 mm.	
				10							

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BOREHOLE: BH5

Project	Proposed Residential Development			Sheet	3 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	20/1/16
Position	Refer to Figure 2	Surface RL	37.40 m AHD	Date Completed	20/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 20/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
NQ		100	92 (77)	10			SHALE; bedding dipping 0-5 degrees, dark grey with grey laminations 1mm thick, 5-20mm spacing.	SW - FR			
					10.63 26.77		Hole Terminated at 10.63 m Backfilled with drilling spoil and concrete capped.				
				11							
				12							
				13							
				14							
				15							
				16							
				17							
				18							
				19							
				20							

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

CORE PHOTOGRAPH OF BOREHOLE: BH5

Project:	Proposed Residential Development			Depth Range:	7.00 m to 10.63 m
Location:	149-163 Milton Street, Ashbury, NSW	Surface RL:	37.40 m AHD	Contractor:	Chadwick Geotechnics Pty Ltd
Position:	Refer to Figure 2	Inclination:	-90°	Drill Rig:	Hanjin DB8
Job No. :	E22851	Box:	1 of 1	LOGGED: SY	DATE: 20/1/16
Client:	Ashbury FMBM Pty Ltd	Hole Depth:	10.63 m	CHECKED: JC	DATE: 24/2/16

BOREHOLE: BH6

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Project	Proposed Residential Development			Sheet	1 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	20/1/16
Position	Refer to Figure 2	Surface RL	40.40 m AHD	Date Completed	20/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 20/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	E	GWNE on completion of augering	0	40.34	BH6_0.2-0.3 ES 0.20-0.30 m			-	Asphaltic-concrete; 60mm thick.	-	-	PAVEMENT
					BH6_0.5-0.85			-	FILL: Silty SAND; fine grained, brown, with some brick and concrete fragments, no odour.	M	-	FILL Appears poorly compacted
				0.85								
			1	39.55	BH6_0.85-0.95 0.95 m PP >600 kPa			CI	Silty CLAY; medium plasticity, orange-brown with some grey mottling, no odour.	M (>PL)	H	RESIDUAL SOIL
				1.40	BH6_1.0-1.1 ES 1.00-1.10 m							
	E-F			39.00	BH6_1.5-1.6			-	SHALE; brown, extremely low strength, extremely weathered, with iron indurated bands, no odour.			WEATHERED ROCK
			2									
			3									
			4	*4.10*								
				36.30				-	SHALE; grey-brown, very low strength, distinctly weathered, with iron indurated bands, no odour.	-	-	ROCK
			5									
			6									
			7									
				7.80								
				32.60					From 7.8m; grey, low strength, distinctly weathered.			
			8	*8.00*					Continued as Cored Borehole			
			9									
			10									

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BOREHOLE: BH6

Project	Proposed Residential Development			Sheet	2 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	20/1/16
Position	Refer to Figure 2	Surface RL	40.40 m AHD	Date Completed	20/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 20/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (Ei 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0							
				1							
				2							
				3							
				4							
				5							
				6							
				7							
				8	*8.00*		Continuation from non-cored borehole				
NQ	80-90% RETURN	100	27 (65)	8	32.40		SHALE; bedding dipping 0-10 degrees, dark grey with grey laminiations 1-5mm thick, 5-10mm spacing.	SW - FR		8.04: BP 0° PR RF Clay VNR 8.12: BP 0° PR RF Clay VNR 8.20-8.23: DS 30 mm, CLAY. 8.40: BP 0° PR RF Clay VNR	
		100	49 (88)	9						8.69-8.76: BPx4 0 - 10° UN RF CN average spacing 20 mm. 9.09-9.12: BPx2 0° PR RF CN	
		100	40 (82)							9.32: BP 0 - 10° UN RF CN 9.37-9.38: BPx2 0° PR RF CN 9.45-9.61: BPx3 0 - 10° UN RF CN average spacing 80 mm. 9.67: JT 30° PR RF CN 9.88: BP 0° PR RF CN	
		100	69	10							

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BOREHOLE: BH6

Project	Proposed Residential Development			Sheet	3 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	20/1/16
Position	Refer to Figure 2	Surface RL	40.40 m AHD	Date Completed	20/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 20/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
NQ	80-90% RETURN	100	(88) 69 (88)	10			SHALE; bedding dipping 0-10 degrees, dark grey with grey laminiations 1-5mm thick, 5-10mm spacing.	SW - FR		10.14-10.34: BPx3 PR RF Clay VNR average spacing 100 mm. 10.40-10.47: BPx2 0° PR RF CN 10.53-10.62: BPx5 0 - 10° UN RF CN average spacing 10-30 mm.	
		100	97 (97)	11						11.07-11.12: BPx2 0° PR RF CN 11.50: BP 0° PR RF Clay VNR 11.77: BP 0° PR RF CN	
				12	*12.00* 28.40		Hole Terminated at 12.00 m Backfilled with drilling spoil and concrete capped.				
				13							
				14							
				15							
				16							
				17							
				18							
				19							
				20							

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

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CORE PHOTOGRAPH OF BOREHOLE: BH6

Project:	Proposed Residential Development			Depth Range:	8.00 m to 12.00 m
Location:	149-163 Milton Street, Ashbury, NSW	Surface RL:	40.40 m AHD	Contractor:	Chadwick Geotechnics Pty Ltd
Position:	Refer to Figure 2	Inclination:	-90°	Drill Rig:	Hanjin DB8
Job No. :	E22851	Box:	1 of 1	LOGGED: SY	DATE: 20/1/16
Client:	Ashbury FMBM Pty Ltd	Hole Depth:	12.00 m	CHECKED: JC	DATE: 24/2/16

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BOREHOLE: BH7

Project	Proposed Residential Development			Sheet	1 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	19/1/16
Position	Refer to Figure 2	Surface RL	37.20 m AHD	Date Completed	19/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 19/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	E	GWNE on completion of augering	0	0.10 37.10	BH7_0.2-0.3 ES 0.20-0.30 m			-	Asphaltic-concrete: 100mm thick.	-	-	PAVEMENT
					SPT 0.50-0.55 m 1/50mm HB N=SPT BH7_0.5-0.55			-	FILL: Sandy GRAVEL; fine to coarse, sub-angular sandstone gravel, orange-brown, sand is fine to medium grained, no odour.			FILL
			1									
					SPT 1.50-1.60 m 1/100mm HB N=SPT BH7_1.5-1.6							
			2		BH7_2.0-2.1 ES 2.00-2.10 m							
										D - M	-	
			3		SPT 3.00-3.10 m 3/100mm HB N=SPT							
				3.40 33.80	BH7_3.0-3.1				From 3.4m, with some brick fragments.			
				3.80 33.40				-	FILL: Silty SAND; fine grained, brown, with some brick fragments, no odour.			
			4		BH7_4.0-4.1 ES 4.00-4.10 m							
					SPT 4.50-4.70 m 3,4/50mm HB N=4/50mm BH7_4.5-4.7							
			5		BH7_5.0-5.1 ES 5.00-5.10 m							
				5.40 31.80				-	SHALE; pale brown, extremely low to very low strength, extremely to distinctly weathered, with iron indurated bands, no odour.			WEATHERED ROCK
			6									
	E-F	28/01/16	7							-	-	
			8		BH7_8.0-8.1 D 8.00-8.10 m							
	F			8.55	BH7_8.4-8.5 D 8.40-8.50 m				Continued as Cored Borehole			
			9									
			10									

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BOREHOLE: BH7

Project	Proposed Residential Development			Sheet	2 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	19/1/16
Position	Refer to Figure 2	Surface RL	37.20 m AHD	Date Completed	19/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 19/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0							
				1							
				2							
				3							
				4							
				5							
				6							
				7							
				8							
					8.55		Continuation from non-cored borehole				
NQ	80-90% RETURN	100	0 (26)	9	28.65		SHALE; bedding dipping 0-10 degrees, <1mm thick, grey brown with orange iron staining.	XW - DW		8.55-8.88: DZ 330 mm.	
					9.02					8.95: BP 0 - 10° UN RF Clay VNR	
		100	26 (40)		28.18		From 9.02m; dark grey with grey laminations, 1-2mm thick, 10-20mm spacing.	DW		9.09: BP 0 - 5° PR RF CN 9.11-9.16: JT 0 - 90° UN RF Clay VNR 9.20-9.27: BPx3 0 - 10° UN RF CN average spacing 20 mm. 9.31-9.34: CS 30 mm. 9.41-9.48: CS 70 mm. 9.53-9.59: BPx3 0 - 5° PR RF Clay VNR average spacing 20 mm.	
				10	*10.00*						

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

BOREHOLE: BH7

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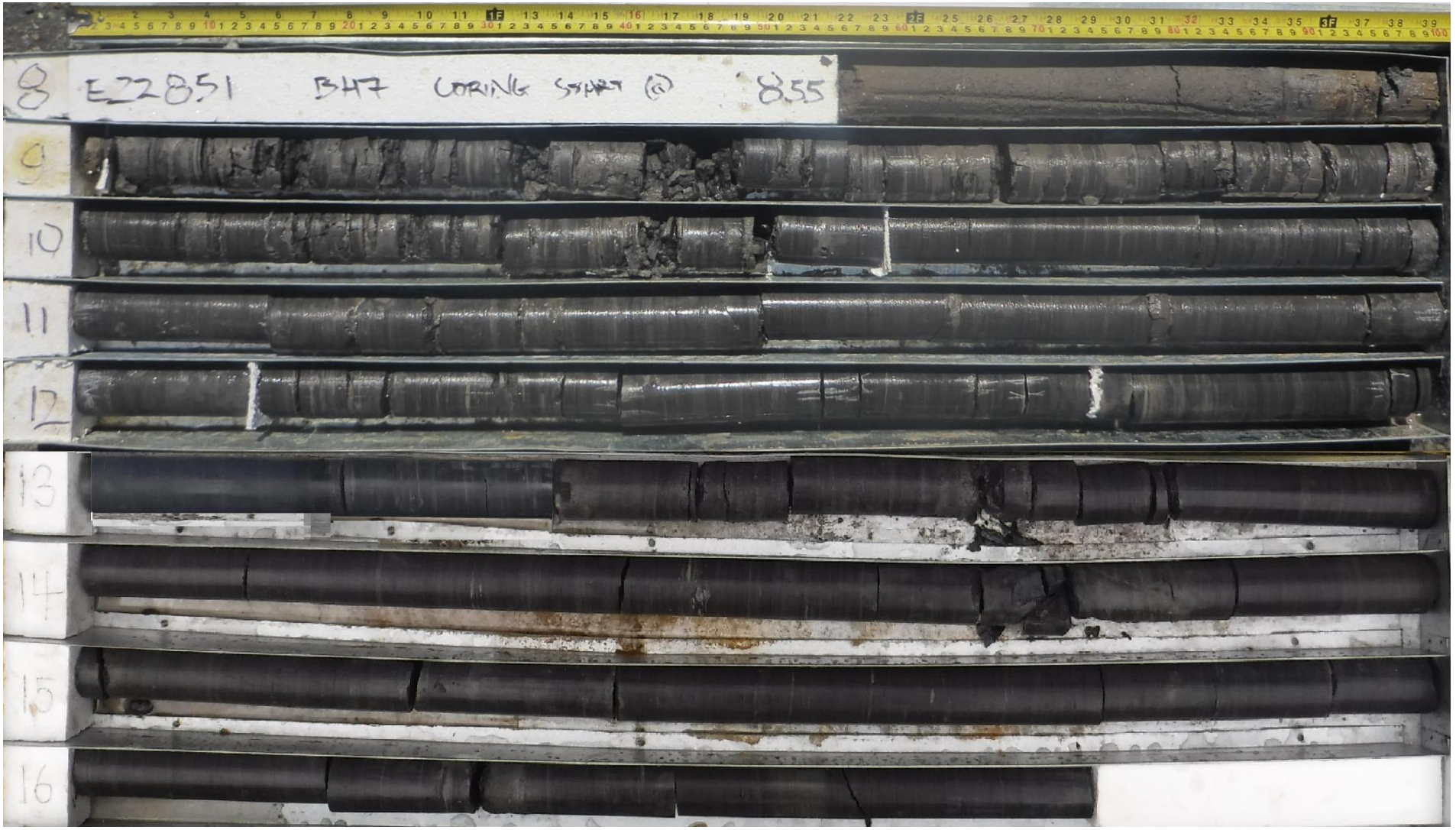
Project	Proposed Residential Development			Sheet	3 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	19/1/16
Position	Refer to Figure 2	Surface RL	37.20 m AHD	Date Completed	19/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 19/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
NQ	80-90% RETURN	100	26 (40)	10	27.20		SHALE; bedding dipping 0-5 degrees, dark grey with grey laminations, 1-2mm thick, 10-30mm spacing.	DW		9.67: BP 0 - 15° UN RF CN 9.79-9.96: BPx4 0 - 10° PR RF Clay VNR average spacing 20-30 mm. 10.15-10.31: BPx3 0 - 10° PR RF Clay VNR average spacing 50 mm. 10.41-10.44: CS 30 mm. 10.49-10.51: CS 20 mm.	
		100	86 (95)	11						10.82: BP 0° PR RF CN 10.94: BP 0° PR RF CN 10.98: BP 0° PR RF CN 11.14: BP 0° PR RF Clay VNR 11.20-11.32: BPx3 0 - 10° PR Clay VNR Closed. 11.48: JT 30° PR RF CN 11.49: BP 0° PR RF CN 11.63: BP 0 - 10° PR RF Clay VNR 11.78: BP 0 - 10° PR RF Clay VNR 11.94: BP 0° PR RF CN	
		100	56 (68)	12						12.15-12.35: BPx5 0 - 10° UN RF CN average spacing 30 mm.	
		100	97 (97)	13						12.76: BP 0 - 10° PR RF CN	
		100	66 (66)					SW - FR		13.40: BP 0° PR S CN 13.45: BP 0° PR S CN 13.48: BP 0° PR S CN 13.53: BP 0° PR S CN 13.64-13.67: DS 30 mm, CLAY. 13.69-13.70: DS 10 mm, CLAY. 13.79: BP PR S CN 13.80: BP PR S CN	
		100	86 (90)	14						14.71: JT 45° PR S CN 14.73: BP PR S CN 14.85: BP PR S CN 15.01-15.03: DZ 20 mm.	
		100	99 (95)	15						15.40: BP PR S CN 15.83: JT 5 - 10° PR S CN 15.92: BP PR S CN 16.19: BP PR S CN 16.29-16.30: DS 10 mm, CLAY. 16.44: BP PR S CN 16.57: JT 40° PR S CN	
				16	16.75						
				17	20.45		Hole Terminated at 16.75 m Backfilled with drilling spoil and concrete capped.				
				18							
				19							
				20							

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

CORE PHOTOGRAPH OF BOREHOLE: BH7

Project:	Proposed Residential Development			Depth Range:	8.55 m to 16.75 m
Location:	149-163 Milton Street, Ashbury, NSW	Surface RL:	37.20 m AHD	Contractor:	Chadwick Geotechnics Pty Ltd
Position:	Refer to Figure 2	Inclination:	-90°	Drill Rig:	Hanjin DB8
Job No. :	E22851	Box:	1-2 of 2	LOGGED: SY	DATE: 19/1/16
Client:	Ashbury FMBM Pty Ltd	Hole Depth:	16.75 m	CHECKED: JC	DATE: 24/2/16



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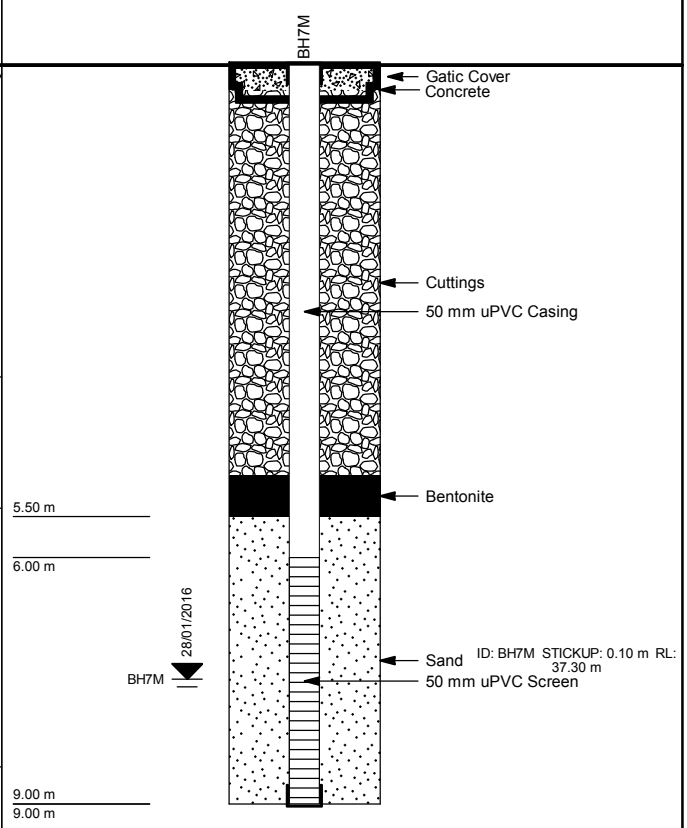
Hole ID
BH7M

CLIENT	: Ashbury FMBM Pty Ltd	POSITION	: Refer to Figure 2	SHEET	: 1 OF 1
CONTRACTOR	: Chadwick Geotechnics Pty Ltd	COORD. SYS.	: MGA94 Zone 56	LOGGED BY	: SY
PROJECT	: Proposed Residential Development	GROUND RL	: 37.20 m AHD	DRILL DATE	: 19/01/2016
LOCATION	: 149-163 Milton Street, Ashbury, NSW				
PROJECT No.	: E22851				

Method	Drilling Water	Depth (m)	Elevation (m AHD)	Graphic Log	Soil / Rock Description
AD/T	GWNE on completion of augering	0	36		Asphaltic-concrete: 100mm thick.
					FILL: Sandy GRAVEL; fine to coarse, sub-angular sandstone gravel, orange-brown, sand is fine to medium grained, no odour.
		2	34		From 3.4m, with some brick fragments.
		4	32		FILL: Silty SAND; fine grained, brown, with some brick fragments, no odour.
		6	30		SHALE; pale brown, extremely low to very low strength, extremely to distinctly weathered, with iron indurated bands, no odour.
NQ	80-90% RETURN	8	28		SHALE; bedding dipping 0-10 degrees, <1mm thick, grey brown with orange iron staining. From 9.02m; dark grey with grey laminations, 1-2mm thick, 10-20mm spacing.
		10	26		SHALE; bedding dipping 0-5 degrees, dark grey with grey laminations, 1-2mm thick, 10-30mm spacing.
		12	24		
		14	22		
		16	20		
		18			Hole Terminated at 16.75 m Backfilled with drilling spoil and concrete capped.

PIEZOMETER CONSTRUCTION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL	Installation Date	Static Water Level
BH7M	Standpipe	0.10 m 37.10 m	9.00 m 28.20 m	20/01/2016	7.58m



CHECKED BY : JC
CHECKED DATE : 24/02/2016

REMARK
Backfilled with drilling spoil and concrete capped.

BOREHOLE: BH8M

Environmental Investigations Australia
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Project	Proposed Residential Development			Sheet	1 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	21/1/16
Position	Refer to Figure 2	Surface RL	40.40 m AHD	Date Completed	21/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 21/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling					Sampling		Field Material Description				
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T			0	40.32				-	Asphaltic-concrete; 80mm thick	-	-	PAVEMENT
				0.40				-	FILL: Silty SAND; fine grained, brown, no odour.	M	-	FILL Appears poorly compacted
	E			40.00	SPT 0.50-0.95 m 3,4,7 N=11 BH8_0.5-0.95 0.95 m PP =420-460 kPa			CI	Silty CLAY; medium plasticity, orange-brown with grey mottling, no odour.	M (>PL)	H	RESIDUAL SOIL
			1	*1.20*								
	E-F	28/01/16 GWNE on completion of augering		39.20				-	SHALE; brown, extremely low to very low strength, extremely to distinctly weathered, with iron indurated bands, no odour.	-	-	WEATHERED ROCK
			2									
			3									
			4									
			5									
			6									
			7	*7.50*								
	F			32.90 *7.70*					From 7.5m; grey, low strength, distinctly weathered.			ROCK
									Continued as Cored Borehole			
			8									
			9									
			10									

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

BOREHOLE: BH8M

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Project	Proposed Residential Development			Sheet	2 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	21/1/16
Position	Refer to Figure 2	Surface RL	40.40 m AHD	Date Completed	21/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 21/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	*DEPTH* RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
				0							
				1							
				2							
				3							
				4							
				5							
				6							
				7							
					7.70		Continuation from non-cored borehole				
NQ	80-90% RETURN	100	79 (85)	8	32.70		SHALE; bedding dipping 0-5 degrees, dark grey to dark brown with grey laminations, 1-2mm thick, 5-30mm spacing.	DW - SW		7.74-8.49: BPx10 0 - 5° PR RF CN average spacing 50-80 mm.	
				9						8.56-8.75: BPx3 0 - 5° PR RF Clay VNR average spacing 15-20 mm. 8.86: BP 0 - 10° PR RF Clay VNR 8.90: BP 0 - 10° UN RF CN 8.93-8.94: CS 10 mm, fine to medium, sub-angular GRAVEL. 8.96-8.99: CS 30 mm, fine to medium, sub-angular GRAVEL. 9.11-9.18: BPx2 PR RF Clay VNR 9.34-9.57: BPx5 0 - 5° PR RF CN average spacing 50-60 mm. 9.60-9.62: BPx2 0 - 15° UN RF CN	
		100	85 (85)	10							

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

BOREHOLE: BH8M

Environmental Investigations Australia
Contamination | Remediation | Geotechnical

Project	Proposed Residential Development			Sheet	3 OF 3
Location	149-163 Milton Street, Ashbury, NSW			Date Started	21/1/16
Position	Refer to Figure 2	Surface RL	40.40 m AHD	Date Completed	21/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 21/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling						Field Material Description				Defect Information	
METHOD	WATER	TCR	RQD (SCR)	DEPTH (metres)	DEPTH RL	GRAPHIC LOG	ROCK / SOIL MATERIAL DESCRIPTION	WEATHERING	INFERRED STRENGTH $Is_{(50)}$ MPa (EL 0.03, VL 0.1, L 0.3, M 1, H 3, VH 10, EH 10)	DEFECT DESCRIPTION & Additional Observations	AVERAGE DEFECT SPACING (mm) (10, 30, 100, 300, 1000, 3000)
NQ	80-90% RETURN	100	85 (85)	10			SHALE; bedding dipping 0-5 degrees, dark grey to dark brown with grey laminations, 1-2mm thick, 5-30mm spacing.	SW - FR		9.72-9.95: BPx3 0 - 5° PR RF Clay VNR average spacing 100 mm. 10.14-10.20: BPx2 0 - 10° UN RF Clay VNR 10.47-10.49: DS 20 mm, CLAY. 10.55: BP 0 - 5° PR RF Clay VNR 10.67-10.70: DS 30 mm, CLAY. 10.77-10.98: BPx4 0 - 5° PR RF CN average spacing 80 mm. 10.80: JT 45° PR RF CN 11.06-11.15: BPx2 0 - 5° PR RF Clay VNR 11.25-11.29: BPx2 0 - 5° PR RF Clay VNR 11.33-11.34: CS 10 mm, fine, sub-angular. 11.44-11.57: BPx2 0 - 5° PR RF CN 11.78: BP 0 - 5° PR RF Clay VNR 11.88: JT 45° PR RF CN	
		100	76 (80)	11							
				12	*12.00* 28.40		Hole Terminated at 12.00 m Converted to monitoring well.				
				13							
				14							
				15							
				16							
				17							
				18							
				19							
				20							

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

CORE PHOTOGRAPH OF BOREHOLE: BH8M

Project:	Proposed Residential Development			Depth Range:	7.70 m to 12.00 m
Location:	149-163 Milton Street, Ashbury, NSW	Surface RL:	40.40 m AHD	Contractor:	Chadwick Geotechnics Pty Ltd
Position:	Refer to Figure 2	Inclination:	-90°	Drill Rig:	Hanjin DB8
Job No. :	E22851	Box:	1 of 1	LOGGED: SY	DATE: 21/1/16
Client:	Ashbury FMBM Pty Ltd	Hole Depth:	12.00 m	CHECKED: JC	DATE: 24/2/16

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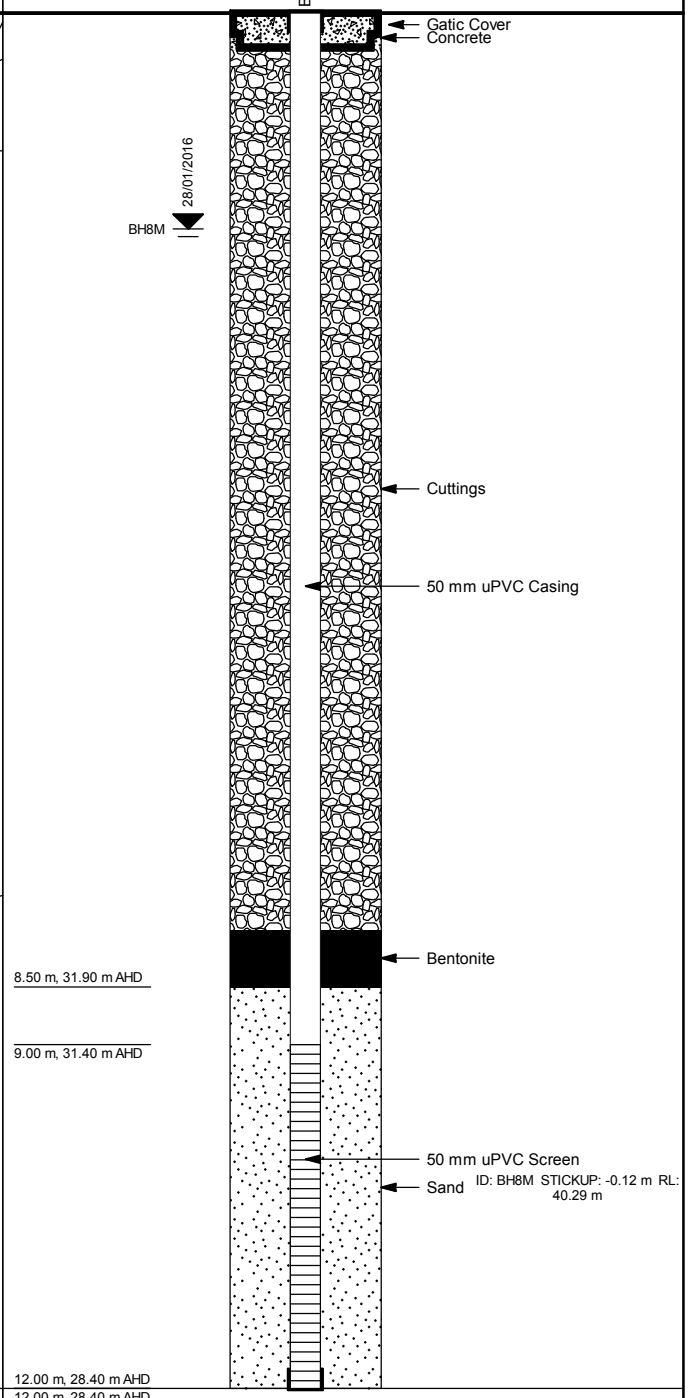
Hole ID
BH8M

CLIENT	: Ashbury FMBM Pty Ltd	POSITION	: Refer to Figure 2	SHEET	: 1 OF 1
CONTRACTOR	: Chadwick Geotechnics Pty Ltd	COORD. SYS.	: MGA94 Zone 56	LOGGED BY	: SY
PROJECT	: Proposed Residential Development	GROUND RL	: 40.40 m AHD	DRILL DATE	: 21/01/2016
LOCATION	: 149-163 Milton Street, Ashbury, NSW				
PROJECT No.	: E22851				

Method	Drilling Water	Depth (m)	Elevation (m AHD)	Graphic Log	Soil / Rock Description
AD/T	GWNE on completion of augering	0	40		Asphaltic-concrete; 80mm thick
					FILL: Silty SAND; fine grained, brown, no odour.
					Silty CLAY; medium plasticity, orange-brown with grey mottling, no odour.
		2	38		SHALE; brown, extremely low to very low strength, extremely to distinctly weathered, with iron indurated bands, no odour.
		4	36		
		6	34		
					From 7.5m; grey, low strength, distinctly weathered.
NQ	80-90% RETURN	8	32		SHALE; bedding dipping 0-5 degrees, dark grey to dark brown with grey laminations, 1-2mm thick, 5-30mm spacing.
		10	30		
		12	28		Hole Terminated at 12.00 m Converted to monitoring well.

PIEZOMETER CONSTRUCTION DETAILS

ID	Type	Stick Up & RL	Tip Depth & RL	Installation Date	Static Water Level
BH8M	Standpipe	-0.12 m 40.52 m	12.00 m 28.40 m	21/01/2016	1.77m



CHECKED BY : JC
CHECKED DATE : 24/02/2016

REMARK
Converted to monitoring well.

BOREHOLE: BH101

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Project	Proposed Residential Development			Sheet	1 OF 1
Location	149-163 Milton Street, Ashbury, NSW			Date Started	21/1/16
Position	Refer to Figure 2	Surface RL	31.80 m AHD	Date Completed	21/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 21/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	E	GWNE on completion of augering	0	0.10 31.70				-	TOPSOIL: Silty SAND; fine grained, brown, with some rootlets, no odour.	D	-	TOPSOIL
								-	FILL: Silty CLAY; medium plasticity, brown, with some medium to coarse, sub-angular sandstone gravel, and brick fragments, no odour.	M (>PL)	-	FILL
			1	1.10 30.70	SPT 0.50-0.65 m 21/150mm N=SPT BH101_0.5-0.65			-	LANDFILL; plastic, metal, brick, and concrete fragments, strong odour.	-	-	LANDFILL
			2	2.10					Hole Terminated at 2.10 m T-C bit refusal on obstructions within landfill. Backfilled with drilling spoil, Bentonite Capped.			
			3									
			4									
			5									
			6									
			7									
			8									
			9									
			10									

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

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BOREHOLE: BH103

Project	Proposed Residential Development			Sheet	1 OF 1
Location	149-163 Milton Street, Ashbury, NSW			Date Started	21/1/16
Position	Refer to Figure 2	Surface RL	35.20 m AHD	Date Completed	21/1/16
Job No.	E22851	Contractor	Chadwick Geotechnics Pty Ltd	Logged SY	Date: 21/1/16
Client	Ashbury FMBM Pty Ltd	Drill Rig	Hanjin DB8	Checked JC	Date: 24/2/16
		Inclination	-90°		

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
AD/T	E	GWNE on completion of augering	0	0.10 35.10				-	TOPSOIL: Silty SAND; fine grained, brown, with some rootlets, no odour.			TOPSOIL
								-	FILL: Silty SAND; fine grained, brown, with some brick, gravel, and metal fragments, no odour.			FILL
			1	1.20 34.00				-	FILL: Sandy GRAVEL; medium to coarse, sub-angular basalt gravel, sand is fine grained, brown, with some metal and brick fragments, no odour.	D	-	
			2	2.50 32.70	BH103_2.6-2.7 D 2.60-2.70 m	■		CH	Silty CLAY; high plasticity, pale grey with red mottling, no odour.	M (>PL)	-	RESIDUAL SOIL
			3	3.40 31.80 3.70				-	SHALE; brown, extremely low strength, extremely weathered, with iron indurated bands, no odour.	-	-	WEATHERED ROCK
			4						Hole Terminated at 3.70 m Backfilled with drilling spoil.			
			5									
			6									
			7									
			8									
			9									
			10									

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

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			

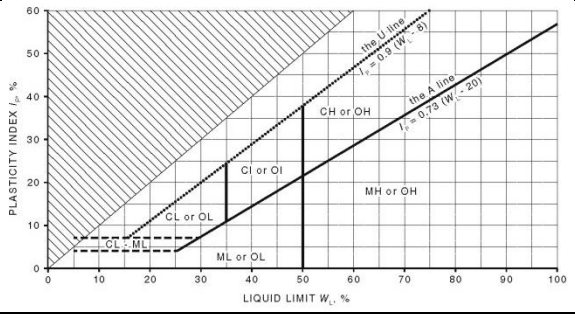
CLASSIFICATION AND INFERRED STRATIGRAPHY

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

POINT LOAD STRENGTH INDEX REPORT

Client:	Environmental Investigations	**Moisture Content Condition:**	As received
Address:	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Storage History:**	Core boxes
Project:	149-163 Milton Street, Ashbury (E22851)	**Report No:**	S8451-PL
Job No:	S16044	**Date Tested:**	15/02/2016

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

Sampling: Sampled by Client **Date Sampled:** 18-22/01/2016

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Notes
S8451	BH1 8.5m	Shale	Diametral	-	45.0	0.21	0.10	0.10	
			Axial	45.0	32.0	1.42	0.77	0.72	
S8452	BH1 9.2m	Shale	Diametral	-	45.0	0.29	0.14	0.14	
			Axial	45.0	36.0	1.51	0.73	0.70	
S8453	BH1 10.05m	Shale	Diametral	-	45.0	0.11	0.05	0.05	
			Axial	45.0	35.0	1.73	0.86	0.82	
S8454	BH1 10.3m	Shale	Diametral	-	45.0	0.92	0.45	0.43	
			Axial	45.0	24.0	0.37	0.27	0.23	
S8455	BH1 10.8m	Shale	Diametral	-	45.0	0.20	0.10	0.09	
			Axial	45.0	28.0	0.48	0.30	0.27	
S8456	BH1 11.3m	Shale	Diametral	-	45.0	0.54	0.26	0.25	
			Axial	45.0	38.0	1.05	0.48	0.47	
S8457	BH1 11.8m	Shale	Diametral	-	45.0	0.99	0.49	0.46	
			Axial	45.0	26.0	0.53	0.36	0.32	

Comments:

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Authorised Signatory:

Chris Lloyd

16/02/2016

Date:

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Alexandria NSW

POINT LOAD STRENGTH INDEX REPORT

Client:	Environmental Investigations	**Moisture Content Condition:**	As received
Address:	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Storage History:**	Core boxes
Project:	149-163 Milton Street, Ashbury (E22851)	**Report No:**	S8458-PL
Job No:	S16044	**Date Tested:**	15/02/2016

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

Sampling: Sampled by Client **Date Sampled:** 18-22/01/2016

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Notes
S8458	BH3M 7.8m	Shale	Diametral	-	45.0	0.02	0.01	0.01	
			Axial	45.0	33.0	0.12	0.06	0.06	
S8459	BH3M 8.6m	Shale	Diametral	-	47.0	0.05	0.02	0.02	
			Axial	47.0	40.0	0.14	0.06	0.06	
S8460	BH3M 9.3m	Shale	Diametral	-	47.0	0.02	0.01	0.01	
			Axial	47.0	30.0	0.06	0.03	0.03	
S8461	BH3M 9.8m	Shale	Diametral	-	45.0	0.27	0.13	0.13	
			Axial	45.0	29.0	1.01	0.61	0.55	
S8462	BH3M 10.2m	Shale	Diametral	-	45.0	0.34	0.17	0.16	
			Axial	45.0	35.0	1.73	0.86	0.82	
S8463	BH3M 10.9m	Shale	Diametral	-	45.0	0.14	0.07	0.07	
			Axial	45.0	42.0	5.11	2.12	2.10	
S8464	BH3M 11.3m	Shale	Diametral	-	45.0	0.80	0.39	0.37	
			Axial	45.0	35.0	1.89	0.94	0.89	
S8465	BH3M 11.8m	Shale	Diametral	-	45.0	0.23	0.11	0.11	
			Axial	45.0	34.0	3.56	1.82	1.73	
S8466	BH3M 12.2m	Shale	Diametral	-	45.0	0.32	0.16	0.15	
			Axial	45.0	29.0	2.67	1.61	1.47	
S8467	BH3M 12.8m	Shale	Diametral	-	45.0	0.39	0.19	0.18	
			Axial	45.0	29.0	2.19	1.32	1.20	

Comments:

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Alexandria NSW

POINT LOAD STRENGTH INDEX REPORT

Client:	Environmental Investigations	**Moisture Content Condition:**	As received
Address:	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Storage History:**	Core boxes
Project:	149-163 Milton Street, Ashbury (E22851)	**Report No:**	S8468-PL
Job No:	S16044	**Date Tested:**	15/02/2016

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

Sampling: Sampled by Client **Date Sampled:** 18-22/01/2016

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Notes
S8468	BH4 15.8m	Shale	Diametral	-	45.0	0.21	0.10	0.10	
			Axial	45.0	40.0	0.22	0.10	0.09	
S8469	BH4 16.2m	Shale	Diametral	-	45.0	0.31	0.15	0.14	
			Axial	45.0	32.0	0.31	0.17	0.16	
S8470	BH4 16.6m	Shale	Diametral	-	45.0	0.15	0.07	0.07	
			Axial	45.0	35.0	0.28	0.14	0.13	
S8471	BH4 17.2m	Shale	Diametral	-	45.0	0.29	0.14	0.14	
			Axial	45.0	34.0	0.35	0.18	0.17	
S8472	BH4 17.6m	Shale	Diametral	-	45.0	0.37	0.18	0.17	
			Axial	45.0	33.0	0.44	0.23	0.22	

Comments:

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POINT LOAD STRENGTH INDEX REPORT

Client:	Environmental Investigations	**Moisture Content Condition:**	As received
Address:	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Storage History:**	Core boxes
Project:	149-163 Milton Street, Ashbury (E22851)	**Report No:**	S8473-PL
Job No:	S16044	**Date Tested:**	15/02/2016

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

Sampling: Sampled by Client **Date Sampled:** 18-22/01/2016

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Notes
S8473	BH5 7.4m	Shale	Diametral	-	45.0	0.29	0.14	0.13	
			Axial	45.0	40.0	3.01	1.31	1.29	
S8474	BH5 8.1m	Shale	Diametral	-	45.0	0.32	0.16	0.15	
			Axial	45.0	30.0	0.50	0.29	0.27	

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POINT LOAD STRENGTH INDEX REPORT

Client:	Environmental Investigations	**Moisture Content Condition:**	As received
Address:	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Storage History:**	Core boxes
Project:	149-163 Milton Street, Ashbury (E22851)	**Report No:**	S8475-PL
Job No:	S16044	**Date Tested:**	15/02/2016

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

Sampling: Sampled by Client **Date Sampled:** 18-22/01/2016

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Notes
S8475	BH6 8.1m	Shale	Diametral	-	45.0	0.08	0.04	0.04	
			Axial	45.0	30.0	0.34	0.20	0.18	
S8476	BH6 8.8m	Shale	Diametral	-	45.0	0.11	0.05	0.05	
			Axial	45.0	31.0	0.82	0.46	0.43	
S8477	BH6 9.1m	Shale	Diametral	-	45.0	0.09	0.04	0.04	
			Axial	45.0	30.0	0.83	0.48	0.44	
S8478	BH6 9.9m	Shale	Diametral	-	45.0	0.05	0.02	0.02	
			Axial	45.0	29.0	0.57	0.34	0.31	
S8479	BH6 10.1m	Shale	Diametral	-	45.0	0.49	0.24	0.23	
			Axial	45.0	32.0	1.16	0.63	0.59	
S8480	BH6 10.8m	Shale	Diametral	-	45.0	0.33	0.16	0.16	
			Axial	45.0	334.0	1.49	0.08	0.12	
S8481	BH6 11.1m	Shale	Diametral	-	45.0	0.37	0.18	0.17	
			Axial	45.0	32.0	1.74	0.95	0.88	
S8482	BH6 11.8m	Shale	Diametral	-	45.0	0.26	0.13	0.12	
			Axial	45.0	36.0	6.18	3.00	2.87	

Comments:

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POINT LOAD STRENGTH INDEX REPORT

Client:	Environmental Investigations	**Moisture Content Condition:**	As received
Address:	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Storage History:**	Core boxes
Project:	149-163 Milton Street, Ashbury (E22851)	**Report No:**	S8483-PL
Job No:	S16044	**Date Tested:**	15/02/2016

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

Sampling: Sampled by Client **Date Sampled:** 18-22/01/2016

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Notes
S8483	BH7 13.4m	Shale	Diametral	-	45.0	4.02	1.98	1.89	
			Axial	45.0	39.0	1.68	0.75	0.73	
S8484	BH7 13.8m	Shale	Diametral	-	45.0	0.39	0.19	0.18	
			Axial	45.0	32.0	1.41	0.77	0.72	
S8485	BH7 14.2m	Shale	Diametral	-	45.0	0.65	0.32	0.31	
			Axial	45.0	33.0	0.70	0.37	0.35	
S8486	BH7 14.6m	Shale	Diametral	-	45.0	0.07	0.03	0.03	
			Axial	45.0	38.0	0.40	0.18	0.18	
S8487	BH7 15.2m	Shale	Diametral	-	45.0	0.79	0.39	0.37	
			Axial	45.0	37.0	0.95	0.45	0.43	
S8488	BH7 15.7m	Shale	Diametral	-	45.0	0.69	0.34	0.32	
			Axial	45.0	38.0	0.52	0.24	0.23	
S8489	BH7 16.1m	Shale	Diametral	-	45.0	0.31	0.15	0.15	
			Axial	45.0	35.0	0.61	0.30	0.29	
S8490	BH7 16.7m	Shale	Diametral	-	45.0	0.22	0.11	0.10	
			Axial	45.0	43.0	0.78	0.31	0.31	

Comments:

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POINT LOAD STRENGTH INDEX REPORT

Client:	Environmental Investigations	**Moisture Content Condition:**	As received
Address:	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Storage History:**	Core boxes
Project:	149-163 Milton Street, Ashbury (E22851)	**Report No:**	S8491-PL
Job No:	S16044	**Date Tested:**	15/02/2016

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

Sampling: Sampled by Client **Date Sampled:** 18-22/01/2016

Preparation: Prepared in accordance with the test method

Sample Number	Sample Source	Sample Description	Test Type	Average Width (mm)	Platen Separation (mm)	Failure Load (kN)	Point Load Index Is (MPa)	Point Load Index $Is_{(50)}$ (MPa)	Notes
S8491	BH8 7.9m	Shale	Diametral	-	45.0	0.02	0.01	0.01	
			Axial	45.0	33.0	0.15	0.08	0.07	
S8492	BH8 8.3m	Shale	Diametral	-	45.0	0.02	0.01	0.01	
			Axial	45.0	35.0	0.15	0.07	0.07	
S8493	BH8 8.8m	Shale	Diametral	-	45.0	0.07	0.03	0.03	
			Axial	45.0	29.0	0.68	0.41	0.37	
S8494	BH8 9.3m	Shale	Diametral	-	45.0	0.01	0.00	0.00	
			Axial	45.0	34.0	0.14	0.07	0.07	
S8495	BH8 9.8m	Shale	Diametral	-	45.0	0.02	0.01	0.01	
			Axial	45.0	28.0	0.27	0.17	0.15	
S8496	BH8 10.3m	Shale	Diametral	-	45.0	0.03	0.01	0.01	
			Axial	45.0	39.0	1.11	0.50	0.48	
S8497	BH8 10.8m	Shale	Diametral	-	45.0	0.76	0.37	0.36	
			Axial	45.0	33.0	3.54	1.87	1.76	
S8498	BH8 11.2m	Shale	Diametral	-	45.0	0.10	0.05	0.05	
			Axial	45.0	36.0	0.78	0.38	0.36	
S8499	BH8 11.7m	Shale	Diametral	-	45.0	0.29	0.14	0.13	
			Axial	45.0	20.0	0.14	0.12	0.10	

Comments:

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SOIL CLASSIFICATION REPORT

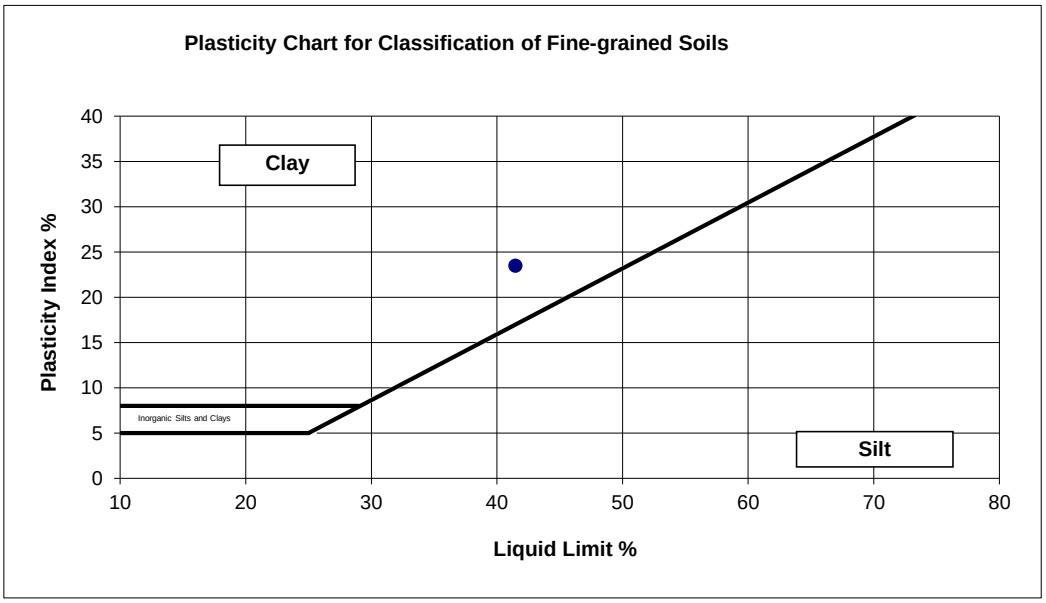
Client:	Environmental Investigations	**Source:**	BH3 1.5-1.8m
Address:	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Sample Description:**	gravelly sandy CLAY
Project:	149-163 Milton Street, Ashbury (E22851)	**Report No:**	S8500-PI
Job No:	S16044	**Lab No:**	S8500

Test Procedure:

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

Sampling:	Sampled by Client	**Date Sampled:**	18-22/01/2016
Preparation:	Prepared in accordance with the test method		

Liquid Limit (%):	41	**Linear Shrinkage (%):**	-
Plastic Limit (%):	18	**Field Moisture Content (%):**	-
Plastic Index:	23		



Soil Preparation Method: Dry Sieved
Soil History: Air Dried
Soil Condition: NA

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SOIL CLASSIFICATION REPORT

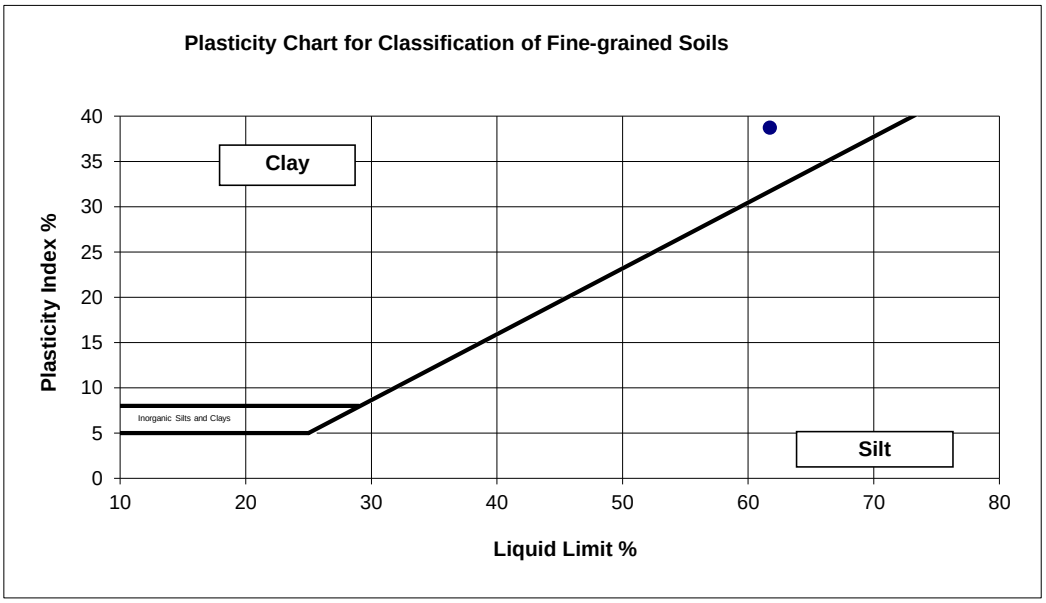
Client:	Environmental Investigations	**Source:**	BH4 1.5-1.95m
Address:	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Sample Description:**	silty CLAY
Project:	149-163 Milton Street, Ashbury (E22851)	**Report No:**	S8501-PI
Job No:	S16044	**Lab No:**	S8501

Test Procedure:

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

Sampling:	Sampled by Client	**Date Sampled:**	18-22/01/2016
Preparation:	Prepared in accordance with the test method		

Liquid Limit (%):	62	**Linear Shrinkage (%):**	16.0
Plastic Limit (%):	23	**Field Moisture Content (%):**	-
Plastic Index:	39		



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

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Date:

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MOISTURE CONTENT TEST REPORT

Client:	Environmental Investigations	**Job No:**	S16044
Address:	Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009	**Report No:**	S8502-MC
Project:	149-163 Milton Street, Ashbury (E22851)		

Test Procedure:

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

Sampling:	Sampled by Client	**Date Sampled:**	18-22/01/2016
Preparation:	Prepared in accordance with the test method		

Sample No.	Source	Sample Description	Moisture Content %
S8502	BH1 3.0-3.1m	GRAVEL	**5.5**
S8503	BH3 2.2-2.3m	GRAVEL	**8.2**
S8504	BH3 2.5-2.6m	clayey GRAVEL	**14.1**
S8505	BH3 3.7-3.8m	GRAVEL	**7.6**
S8506	BH3 5-5.1m	GRAVEL	**6.3**
S8507	BH4 3.4-3.5m	GRAVEL	**6.3**
S8508	BH4 5.5-5.6m	GRAVEL	**4.6**
S8509	BH7 8.0-8.1m	GRAVEL	**2.3**
S8510	BH7 8.6-8.7m	GRAVEL	**4.8**

Notes:

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Date: 16/02/2016

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ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	James Zhao
Client	Environmental Investigations
Address	Suite 6.01, 55 Miller Street NSW 2009
Telephone	02 9516 0722
Facsimile	02 9516 0741
Email	James. Zhao@eiaustralia.com.au
Project	**E22851 - 149-163 Milton St, Ashbury**
Order Number	**E22851**
Samples	2

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
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SGS Reference	**SE148644 R0**
Date Received	4/2/2016
Date Reported	9/2/2016

COMMENTS

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

SIGNATORIES

Andy Sutton
Senior Organic Chemist

Huong Crawford
Production Manager

pH in soil (1:5) [AN101] Tested: 5/2/2016

PARAMETER	UOM	LOR	BH1 1.5-1.95 SOIL - 18/1/2016 SE148644.001	BH6 0.85-0.95 SOIL - 20/1/2016 SE148644.002
pH	pH Units	-	**4.7**	**4.6**

Conductivity and TDS by Calculation - Soil [AN106] Tested: 5/2/2016

PARAMETER	UOM	LOR	BH1 1.5-1.95 SOIL - 18/1/2016 SE148644.001	BH6 0.85-0.95 SOIL - 20/1/2016 SE148644.002
Conductivity of Extract (1:5 dry sample basis)	µS/cm	1	**130**	**140**

Soluble Anions (1:5) in Soil by Ion Chromatography [AN245] Tested: 5/2/2016

PARAMETER	UOM	LOR	BH1 1.5-1.95 SOIL - 18/1/2016 SE148644.001	BH6 0.85-0.95 SOIL - 20/1/2016 SE148644.002
Chloride	mg/kg	0.25	**54**	**67**
Sulphate	mg/kg	5	**47**	**100**

Moisture Content [AN002] Tested: 5/2/2016

PARAMETER	UOM	LOR	BH1 1.5-1.95 SOIL - 18/1/2016 SE148644.001	BH6 0.85-0.95 SOIL - 20/1/2016 SE148644.002
% Moisture	%w/w	0.5	**20**	**19**

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

FOOTNOTES

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

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

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is 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 criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/ Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

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.