Geotechnical Investigation Report

Proposed Development at
17-23 Merriwa Street, Gordon NSW

prepared for

Meissen Properties

Report No. G2013-026-Rev 0

June 2013

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DOCUMENT HISTORY

Revision Number	Date Issued	Description	Issued By
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Executive Summary

Benviron Group carried out a geotechnical investigation at 17-23 Merriwa Street, Gordon in June 2013 to investigate and assess the site's surface and subsurface conditions in order to provide geotechnical recommendations and advice for the design and construction of the proposed mixed use commercial and residential development.

It is understood the proposed development involves the demolition of all existing site features and the construction of two 7-storeys mixed use commercial and residential development buildings with a 2-level basement car parking facility. Two investigation holes were drilled at accessible parts of the site, namely one near Merriwa Street, and the other on the northern part of the site near Fitzsimons Lane. The investigation holes were drilled to the anticipated basement B2 level which is approximately 2.5m at the southern side of the site adjoining Merriwa Street and approximately 7m at the northern end next to Fitzsimons lane. Rock coring were carried out to enable the stratigraphy of the subsoil profile and engineering properties be mapped in anticipation for the basement excavation works and proposed foundations works.

This report presents and interprets the findings of the geotechnical investigation that was carried out to date. Based on the findings, geotechnical assessments and recommendations are presented.

The proposed development is considered feasible subjected to the recommendations provided in this report are carried out.

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1.0 INTRODUCTION

Benviron Group was engaged to undertake a 17-23 Merriwa Street Gordon. The purpose of this investigation is to assess the site's surface and subsurface conditions within accessible areas in order to provide geotechnical recommendations and advice for the design and construction of the mixed use commercial and residential development in preparation for a development application submission.

The proposed development involves the demolition of all existing site features and the construction of two 7-storeys mixed use commercial and residential development buildings with a 2-level basement car parking facility.

This report presents and interprets the findings of the geotechnical investigation carried out on the 20 June 2013 at the subject site, known as number 17-23 Merriwa Street, Gordon. With the present buildings and site constraints, the fieldwork was carried out using a truck mounted drilling rig with coring facilities to accessible parts of the site. Two boreholes were drilled and cored to provide the following information:

- Method of investigation,
- Site description, including surface and sub-surface conditions,
- Site plan indicating borehole locations and footprint of the proposed roads and buildings within the development,
- Groundwater conditions and management,
- Recommendations on the excavation conditions and temporary slope batters,
- Recommendations on vibration control and management,
- Provision of earth pressure parameters for design of retaining structures,
- Recommendations on footings and serviceability bearing pressures,

2.0 AVAILABLE INFORMATION

At the time of writing this report, a set of architectural Sketch Design drawings from the client as listed below, by Brewster Murray Architects Interior and Urban Designers dated June 2013, reference No. 13-5472, were provided to us: -

- SK01 Calculations
- SK02 Basement 2 Floor Plan
- SK03 Basement 1 Floor Plan
- SK04 Ground Floor Plan
- SK05 Level 1-3 Floor Plan
- SK06 Level 4-5 Floor Plan
- SK07 Level 6 Floor Plan
- SK11 Section 1
- SK12 Section 2
- SK13 North Elevation
- SK14 South Elevation

3.0 PROPOSED DEVELOPMENT

3.1 Site Location and Description

The site is in the suburb of Gordon, approximately 13 Km north northwest of the Sydney CBD (Figure 1). The site is bounded by Merriwa Street in the south and Fitzsimons Lane in the north as shown in the Site Plan (Figure 2). The site is sloping gently from north to south making a level difference of approximately 5 meters from Fitzsimons Lane to Merriwa Street. The proposed Basement 2 footprint, its setbacks from the respective site boundaries and the investigation holes are shown in Figure 3.

3.2 Regional Geology

Reference to the Sydney 1:100,000 Geological Series Sheet 9130 Edition 1, 1983, indicated the site was likely to be underlain by Ashfield Shale overlaying Hawkesbury Sandstone from the Wianamatta Group. Ashfield Shale generally comprises black to dark-grey shale and laminate (interbedded shale and fine grained sandstone). Hawkesbury Sandstone generally comprises medium to coarse-grained quartz sandstone, with minor shale band and laminate lenses.

4.0 FIELDWORK

Fieldwork for the geotechnical investigation was carried on the 20 June 2013 and comprised the following works:

- A detailed walk-over inspection of the site and surrounding environment to capture any significant geological features.
- Drilling of two (2) boreholes, BH1 and BH2 using a 10 tonne drilling rig mounted with V-bit attached to a solid flight auger and then using NMLC diamond rock coring techniques to drill down to a total depth of 2.5m (BH1) and 7.0 (BH2) respectively below existing ground level .
- Standard Penetration Tests (SPT) was undertaken at regular intervals within the borehole to assess the in-situ strength of subsoil properties.

The approximate locations of the 2 boreholes are shown in Figure2 with respect to the current site conditions and Figure 3 with respect to the future proposed basement footprint. The Engineering Logs are presented in Appendix B.

5.0 FILED WORK RESULTS

5.1 Subsoil Conditions

Based on information gathered and observations made from the site inspection, it can be inferred that it is likely the subsoil profile comprises predominantly a silty clay overlies the shale and laminite of varying strength.

The subsurface soil profile within BH1 indicated a firm silty clay of medium plasticity to a depth of approximately 1.0m overlying extremely low to medium strength shale interbedded with medium strength laminate to a depth of 2.5 below existing ground level . This borehole was terminated at 2.50m below existing ground level.

The subsurface soil profile within BH2 indicated a fill material of up to 1.0m below existing ground level, overlying a firm to very stiff silty clay of low to medium plasticity to a depth of approximately 3.5m. The underlying extremely low to low strength shale starts from 3.5m

to approximately 4.0m and becomes a low to medium strength shale to a depth of approximately 5.5m below existing ground level. From 5.5m onwards, the shale and the interbedded laminite are in general of a medium to high strength nature up to a depth of 7.0m where this borehole terminated at 7.0m below existing ground level.

5.2 Ground Water

Groundwater or seepage was not encountered during the investigation works on the 20 June 2013.

However, it should be noted groundwater levels may be subject to seasonal fluctuations, rainfall, prevailing weather conditions and also future developments of the areas and land forms.

6.0 DISCUSSIONS AND RECOMMENDATIONS

6.1 General

From the result of the investigation obtained on this site (BH1 and BH2), it can be inferred that the subsoil conditions comprise generally a firm to stiff shaly clay overlying a low to medium strength shale in general and local bands of medium to high strength laminite.

The proposed development involves the demolition of all existing site features, followed by the construction of two seven-storeys mixed use commercial and residential development buildings with two levels of below ground basement carpark. Formation of the basement is expected to entail excavations of up to a maximum of 6m deep both at the northern end of the site adjoining Fitzsimons Lane and at the southern end of the site adjoining Merriwa Street. Based on the information provided, the proposed basement B2 will have a setback of approximately 6m from the eastern and western site boundaries, and approximately 3m set back from Fitzsimons Lane in the north and 12m set back from Merriwa Street in the south.

6.2 Excavation Conditions and Vibration Control

Based on provided information, the establishment of basement B2 car park level will involve excavation of materials to depths of approximately 6m below the existing road level of at both Fitzsimons Lane at Merriwa Street. The likely soil profile materials to be encountered within the depths of basement excavation are likely to comprise firm silty clays overlying low to medium strength shale with bands of medium to high strength laminite.

It is expected that excavation of soils and low strength shale can be achieved by conventional excavation methods using conventional earthmoving equipment such as backhoes or tracked excavators. However, for the excavation of medium to high strength rock (shale and laminate), these may be achieved by using saw cutting method followed by rock breaking hammers to ensure the integrity of the nearby structures are safeguarded.

The use of vibratory rock breaking hammer equipment is very common method of excavation works in harder bedrock. In this regard, it is essential to carry out saw cutting along the perimeter of the site using an appropriate excavator mounted rock saw or other approved alternatives prior to excavation so as to minimise transmission of vibrations to adjoining structures to within acceptable levels. Induced vibrations in structures adjacent to the excavation should not exceed a peak particle velocity (PPV) of 10mm/sec for structures in good condition or 2mm/sec for heritage or poor-conditioned structures. Vibration monitoring system should be established at critical locations such as along the road edge of Fitzsimons Lane, Merriwa Street, and along the eastern and western site boundaries next to neighbouring buildings in order to monitor the vibration levels throughout the period of rock excavation.

We recommend that where vibratory or percussive excavation techniques are to be adopted, dilapidation reports are to be carried out on all adjoining buildings, roads and civil structures so that an accurate record of the existing conditions of these elements are mapped prior to the commencement of excavation. These records shall be agreed by the

respective owner in order to reduce the risk of future owner's dispute on subsequent potential damage claims.

6.3 Ground Water Management

Ground water was not observed during the investigation period. It should be noted groundwater conditions of a site might change with climate and development variations. However, should ground water or seepage be encountered during excavation for the basement, it is recommended that a geotechnical engineer be engaged to review the groundwater regime for the design and construction methodology for the foundation and basement works.

6.4 Temporary Batter Slopes

With the proposed basement carpark setback at some 6 meters or more for most part of the basement footprint from the site boundaries, and with an anticipated fairly high rock head level, there is good possibilities for the use of temporary batter slopes during construction. The safe temporary batters are recommended as presented in Table 2, provided that the basement excavation is set back sufficiently from the common site boundaries to facilitate for the formation of the batters.

Table 2: Minimum temporary batter slopes

Materials	Temporary (Horizontal: Vertical)	
	Exposed	Protected
Firm Silty clay	2.0:1.0	1.5:1.0
Extremely Weathered Shale /Laminite	1.0:1.0	-
Distinctly Weathered Shale/Laminite	0.5:1.0	

Temporary surface protection against erosion may be provided by covering the batter

with plastic sheeting, and these should be applied for a limited time only and inspected by Geotechnical Engineers after significant events. It should be noted however that the plastic sheeting should extend at least 1.5m behind the crest of the cut face or at least up to the common site boundaries.

6.5 Retaining Structures

With the proposed basement structure setback with a minimum 6 meters from the site boundaries, and with the ground condition obtained to date, the forming of the majority of the basement excavation is preferably be adopting a construction methodology that ensure the cut faces are supported at all times. These retaining structures should be designed to withstand the applied lateral pressures of the soil and rock strata, the existing surcharges in their zone of influence; including existing structures, and construction related activities.

In areas where there is no building structure in close proximity to the excavation, and assuming some wall movement is acceptable, a soldier pile solution with shorcreted infill panels can be considered. In areas where there is a potential risk of damage to nearby structures or buildings (which are sensitive to any ground movements), it is considered a contiguous pile wall system is more appropriate for the basement wall prior to bulk excavation works.

The pressure distribution on cantilever retaining structures may be assumed to be triangular and estimated as follows:

$p_h = \gamma kH + qk$

Where,

p_h = Horizontal pressure (kN/m^2)

γ = Wet density (kN/m^3)

k = Coefficient of earth pressure (k_a or k_o)

H = Retained height (m)

q = Surcharge pressure behind retaining wall (kN/m^2)

For the design of flexible retaining structures, where some lateral movement is acceptable, an active earth pressure coefficient is recommended. Should it be critical to limit the horizontal deformation of a retaining structure, use of an earth pressure coefficient at rest should be considered. Recommended parameters for the design of retaining structures are presented in the following Table 3.

Table 3: Geotechnical Design Parameters

Materials	Unit Weight (kN/m^3)	Active Earth Pressure coefficient (K_a)	At Rest Earth Pressure Coefficient (K_o)
Stiff Silty Clay	18	0.35	0.50
Extremely Weathered Shale (Class V or IV)	20	0.25	0.40
Distinctly Weathered Shale(Class IV or III)	22	0.20	0.3

The above coefficients assume that ground level behind the retaining structures is horizontal and the retained material is effectively drained. It should be noted that hydrostatic pressures due to ground water table (if present) and surcharge due to nearby structures (within the influence zone) should also be taken into the account in the design of the retaining structures. This is particularly the case for the retaining walls located immediately adjacent to the neighboring buildings.

6.6 Foundation Systems

The loading conditions for the proposed development are not known at the time of preparation of this report. However, it is anticipated that the bulk excavation level for majority of the Basement B2 level is likely to be within the medium to high shale and/or laminite stratum. It is therefore anticipated that strip or pad footings founded on this material can be designed for a serviceability end bearing capacity of 3000 kPa with a minimum socket length of 0.5m.

It is recommended that a further drilling for assessment of the foundation material of the proposed footings be carried out once excavation to the final basement level has been reached. The footing inspection and assessment requirement can be referred to the guidelines given in accordance with Pells, Douglas et al. (Reference 5).

Footing inspections by a Geotechnical Engineer will be required during footing excavation to confirm appropriate founding materials, that the recommended serviceability bearing pressures could be met and to ensure that all soft and wet materials have been removed from the foundation footprint prior to concrete placement.

7.0 CONCLUSIONS

This report presents the findings and recommendations for the proposed mixed use commercial and residential development at 17-23 Merriwa Street, Gordon, NSW. It is based on the geotechnical investigation results available to date. It considers that the proposed development is feasible subjected to the recommendations presented in this report are followed.

For and on behalf of

Benviron Group

Noriman Mak

Geotechnical Engineer

MIEAust., RPE (Civ, Geo), NPER (Civ, Geo)

LIMITATIONS

The assessment of the sub-surface profile within the proposed development area and the recommendations presented in this report are based on limited information available to date.

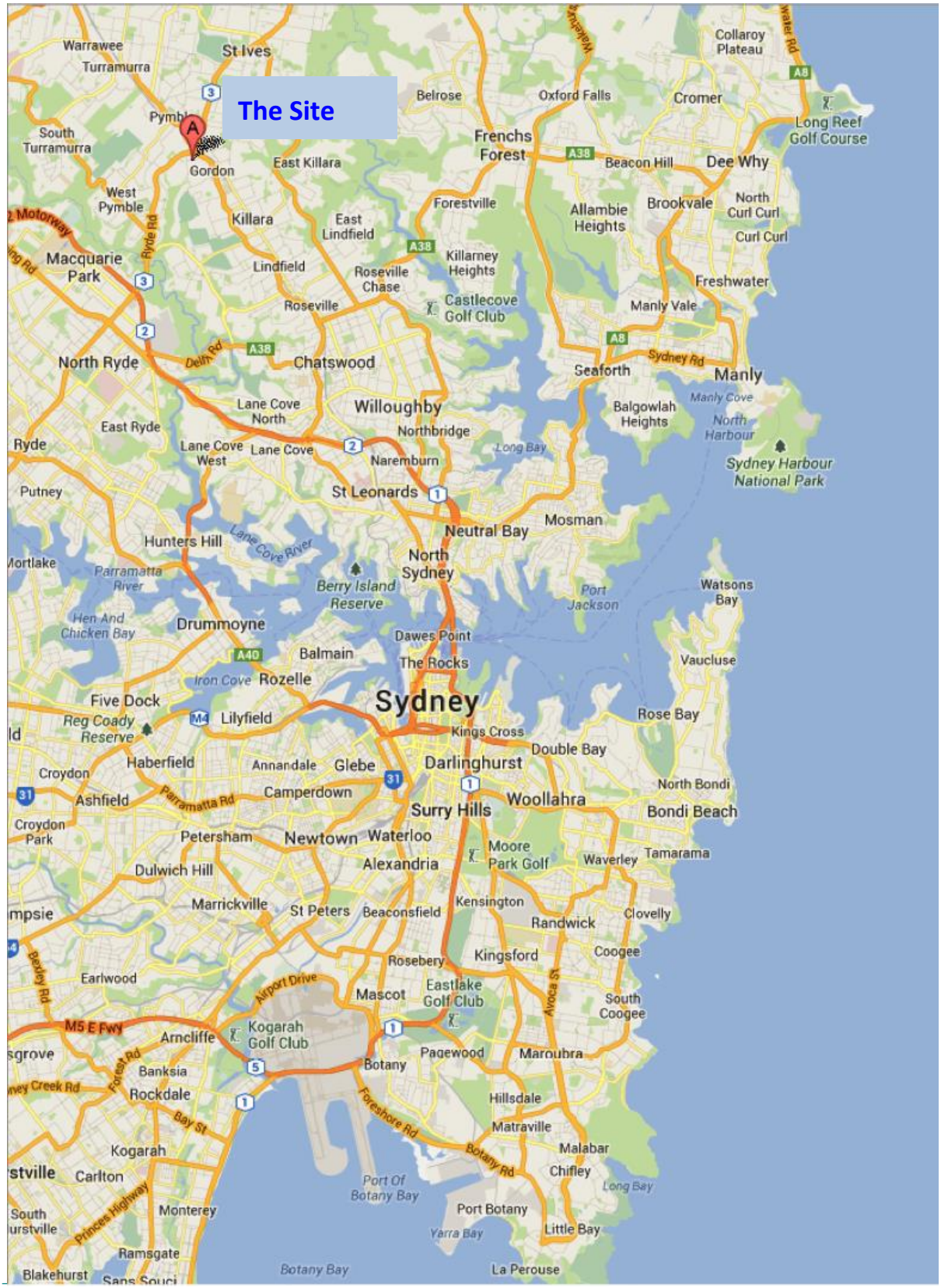
The recommendations and advice presented in this report on soil and rock condition is considered to be indicative only as only very limited areas were assessed on site to date. Site inspection by a consulting Geotechnical Engineer or Engineering Geologist are to be undertake when further investigation works are to be carried out to confirm the condition of founding materials in which this geotechnical assessment recommends.

Anecdotal evidence and Information provided by client is assumed to be relevant and to the best of knowledge be appropriate for its interpretation.

There is a possibility that the actual geotechnical and groundwater conditions across the site could differ from the inferred geotechnical assumptions and derivations on which our recommendations are presented in this report.

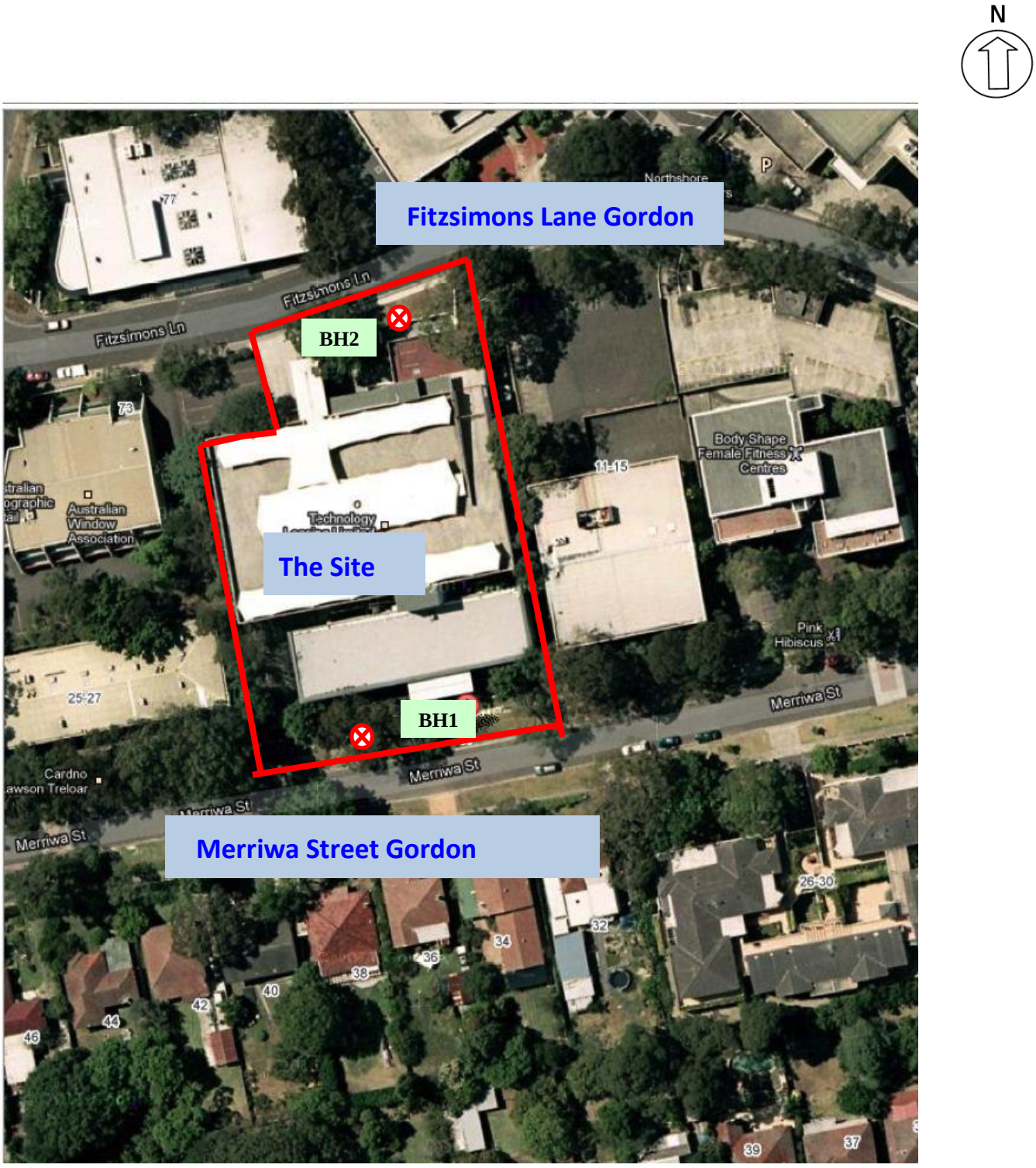
REFERENCES

1. Australian Standard AS1726-1993 'Geotechnical Site Investigation'; and
2. Australian Standard AS2870-2011 'Residential Slabs and Footings';
3. Australian Standards – Guidelines on Earthworks for Commercial and Residential Developments, AS3798-2007.
4. Pells, P.J.N, Mostyn, E and Walker , B F – Foundations on Sandstone and Shale in the Sydney Region, Australian Geomechanics Journal, Dec 1998
5. Pells, P.J.N, Douglas D.J, Rodway, B, Thorne C, McManon B.K – Design Loadings for Foundations on Shale and Sandstone in the Sydney Region.oundations on Sandstone and Shale in the Sydney Region, Australian Geomechanics Journal, 1978



Locality Plan

G2013-026 Figure 1



Site Plan

P2013-026 Figure 2

Proposed Site Investigation

P2013-026 Figure 3

Job No:	G2013-026
Hole No:	BH1
Sheet	1 of 1

ENGINEERING LOG OF DRILLED BOREHOLE

Client:	Meissen Properties	Test Location: Refer to Figure 3	
Project:	Proposed Residential Development	Test Method: Truck Mounted Drill Rig	
Project Location:	17-23 Merriwa Street Gordon	Date: 20/06/2013	Logged by: NM
		Existing Ground Level : approx +107mAHD	

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
		0.1			Concrete Pavement			Auger Drilling	0.1
		0.2							0.2
		0.3							0.3
		0.4		CL	Silty CLAY, yellowish brown, low to medium plasticity	D	F	Low V-bit Resistance	0.4
		0.5							0.5
	SPT	0.6					St/H		0.6
	Boucing	0.7							0.7
		0.8							0.8
		0.9							0.9
		1.0						V-bit Refusal	1.0
		1.1			LAMINITE, brownish grey, closely to moderately spaced,		H/D	Start NMLC Core Drilling	1.1
		1.2			low to medium strength with weathered seams of 20-30mm			at 1.0m	1.2
		1.3			thick at 1.4m and 1.9m			High Core Bit Resistance	1.3
		1.4							1.4
		1.5							1.5
		1.6							1.6
		1.7							1.7
		1.8							1.8
		1.9							1.9
		2.0							2.0
		2.1							2.1
		2.2							2.2
		2.3							2.3
		2.4			Highly weathered sandy clay seam at 2.45m to 2.5m				2.4
		2.5			Borehole Terminated at 2.5m as instructed				2.5
		2.6							2.6
		2.7							2.7
		2.8							2.8
		2.9							2.9
		3.0							3.0
		3.1							3.1
		3.2							3.2
		3.3							3.3
		3.4							3.4
		3.5							3.5

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Job No:	G2013-026
Hole No:	BH2
Sheet	1 of 2

ENGINEERING LOG OF DRILLED BOREHOLE

Client:	Meissen Properties	Test Location: Refer to Figure 1	
Project:	Proposed Residential Development	Test Method: Truck Mounted Drill Rig	
Project Location:	17-23 Merriwa Street Gordon	Date: 20/06/2013	Logged by: NM
		Existing Ground Level: Approx 111.5mAHD	

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
		0.1			Silty CLAY FILL, orangy brown, moist, medium plasticity,	M	S	Auger Drilling	0.1
		0.2			trace with sand and grass roots			Low V-bit Resistance	0.2
		0.3							0.3
		0.4			Silty CLAY FILL, orangy brown, moist, medium plasticity,				0.4
		0.5							0.5
		0.6							0.6
		0.7							0.7
		0.8							0.8
		0.9							0.9
		1.0							1.0
	SPT	1.1		CL	Silty CLAY, fine grained, grey, moist	M	H	High V-bit Resistance	1.1
	4,13,17	1.2							1.2
	N=34	1.3							1.3
		1.4							1.4
		1.5							1.5
		1.6							1.6
		1.7							1.7
		1.8							1.8
		1.9							1.9
		2.0							2.0
		2.1							2.1
		2.2							2.2
		2.3							2.3
		2.4							2.4
		2.5							2.5
	SPT	2.6		CL	Silty CLAY, brownish grey, moist	M	H	High V-bit Resistance	2.6
	6,12,24	2.7							2.7
	N=42	2.8							2.8
		2.9							2.9
		3.0			Silty CLAY, brownish light grey, moist			Start NMLC Core Drilling	3.0
		3.1						at 3.05m	3.1
		3.2							3.2
		3.3							3.3
		3.4							3.4
		3.5							3.5

Continued on Sheet 2 of 2

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						

Job No:	G2013-026
Hole No:	BH2
Sheet	2 of 2

ENGINEERING LOG OF DRILLED BOREHOLE

Client:	Meissen Properties	Test Location: Refer to Figure 1	
Project:	Proposed Residential Development	Test Method: Truck Mounted Drill Rig	
Project Location:	17-23 Merriwa Street Gordon	Date: 20/06/2013	Logged by: NM
		Existing Ground Level: Approx 111.5mAHD	

Groundwater	Samples/ Field Tests	Depth (m)	Graphic Log	Unified Classification	Description	Moisture Condition	Consistency/ Rel. Density	Additional Comments	Depth (m)
		3.6		CL	Silty CLAY, brownish light grey, moist (cont.)	-	H/D		3.6
		3.7							3.7
		3.8							3.8
		3.9			LAMINITE, brownish grey, closely to moderately spaced,				3.9
		4.0			low to medium strength with weathered seams at:				4.0
		4.1			4.2m (20mm thick), 4.85m (15mm thick), 5.3m (35mm thick),				4.1
		4.2			5.6m (40mm thick), 5.75m (10mm thick)				4.2
		4.3							4.3
		4.4							4.4
		4.5							4.5
		4.6							4.6
		4.7							4.7
		4.8							4.8
		4.9							4.9
		5.0							5.0
		5.1							5.1
		5.2							5.2
		5.3							5.3
		5.4							5.4
		5.5							5.5
		5.6							5.6
		5.7							5.7
		5.8							5.8
		5.9							5.9
		6.0							6.0
		6.1							6.1
		6.2							6.2
		6.3							6.3
		6.4			LAMINITE, brownish grey, moderately spaced,				6.4
		6.5			medium to high strength with mostly clean joints				6.5
		6.6							6.6
		6.7							6.7
		6.8							6.8
		6.9							6.9
		7.0							7.0
					Borehole BH2 terminated at 7.0m as instructed				

Explanatory Notes:

Consistency		Density Index		Samples		Moisture	
VS	Very Soft	**VL**	Very Loose	**B**	Bulk Sample	**D**	Dry
S	Soft	**L**	Loose	**D**	Disturbed Sample	**M**	Moist
F	Firm	**MD**	Medium Dense	**U50**	Undisturbed Sample	**W**	Wet
St	Stiff	**D**	Dense		(50mm diam.)	**Wp**	Plastic Limit
VSt	Very Stiff	**VD**	Very Dense	**N**	S.P.T. Value	**Wl**	Liquid Limit
H	Hard						