Ref: GS7812-1A
8th January 2020

Bentag Pty Ltd
C/o Daniel Vidal at Lead Architects Pty Ltd
Email: daniel@lead.com.au
Level 2, 197 Clarence Street
Sydney NSW 2000

Dear Daniel,

RE: 3 Birdwood Avenue, Collaroy, NSW, Geotechnical Assessment for Retaining wall

Introduction

Aargus Pty Ltd carried out a site visit on Wednesday 8th Jan 2020 to the above site. The purpose of the site visit was to carry out an assessment of the ground material in the proposed retaining wall and provide any relevant recommendations.

Information received

- Site and Analysis plan, Demolition plan, Erosion & Sediment control plan by Lead Architects with project number 19090, Drawing number A001, Revision number P1.
- External elevation and section by Lead Architects with project number 19090, Drawing number A200, and Revision number P1.
- Information provided by client on site verbally is that Rain water flowing through inclined roof of neighbouring property (5 Birdwood Avenue) might have affected the stability of the existing retaining wall, it was also said that lateral movement of the wall was first observed in the year 2009.

Fieldwork undertaken onsite.

Fieldwork comprised of Three Dynamic Cone Penetration tests DCP tests (DCP1, DCP2 & DCP3). Four Hand Augers (HA1, HA2, HA3 & HA4) carried out on the proposed retaining wall.The locations of the DCP testing and Hand Auger are provided on the attached plan – Figure 1.

Ground Profile

The subsoil conditions encountered within the boreholes are summarised in Table 1 and detailed on the attached Engineering Borehole Logs presented in attachment.

Table 1: Geotechnical Modelling

UNIT	Soil Description	HA1 (m)	HA2 (m)	HA3 (m)	HA4 (m)
FILL	Fine to medium grained gravel, tree rootles	-	-	-	0-0.3
RESIDUAL SOIL	Sandy CLAY, Orange, medium to high plasticity, Mottled.	0.09-0.35	-	-	-
	Sandy CLAY, High plasticity, orange to grey.	0.35-0.5	-	-	-
	Sandy CLAY, High plasticity, dark orange to pale grey, fine to medium grained sand, trace of fine ironstone gravel.	-	0.09-0.3	0.09-0.35	-
	Sandy CLAY, High plasticity, mostly pale grey, trace of dark Orange, fine to medium grained.	-	0.3-0.69	-	-
	Sandy CLAY, Orange, medium to high plasticity, mottled.	-	-	0.35-0.6	-

GEOTECHNICAL ASSESSMENT

Excavation Conditions

Geotechnical investigation indicate that excavation will be through very stiff to hard clay soils (refer to Table 1 and borehole logs). Excavation within these soils is expected to be readily achieved using a hydraulic excavator. Contractors should refer to the engineering logs when assessing the suitability of their excavation equipment.

Earth Pressures

Earth retaining structures should be designed to withstand the lateral earth pressure, hydrostatic and earthquake (if applicable) pressures, and the applied surcharge loads in their zone of influence, including existing structures, traffic and construction related activities.

For the design of flexible retaining structures, where some lateral movement is acceptable, it is recommended the design should be based on active lateral earth pressure. Should it be critical to limit the horizontal deformation of a retaining structure, use of an earth pressure

coefficient "at rest" should be considered such as the case when the shoring wall is in the final permanent state and is restrained by the concrete slab in its final state.

Recommended parameters for the design of earth retaining structures in the soil horizons underlying the site are presented in the below Table 2.

Table 2: Geotechnical Design Parameters

Units	Unit Weight (kN/m^3)	Effective Cohesion c' (kPa)	Angle of Friction ϕ'(°)	Modulus of Elasticity E_{sh} (MPa)
Residual Soil	19	5	24	10

Table 3 below provides coefficients of lateral earth pressure for the soils encountered during the geotechnical investigation. The coefficients provided are based on horizontal ground surface and fully drained conditions.

Table 3: Preliminary Coefficients of Lateral Earth Pressure

Units	Coefficient of Active Lateral Earth Pressure K_a	Coefficient of Lateral Earth Pressure at Rest K_0	Coefficient of Passive Lateral Earth Pressure K_p
Residual Soil	0.42	0.59	2.38

- Coefficient of active and passive lateral earth pressure K_a and K_p, respectively, can be calculated using Rankine's or Coulomb's equations, as appropriate.
- Coefficient of lateral earth pressure at rest K_o for soils, can be calculated using Jacky's equation.

The coefficients of lateral earth pressure should be verified by the project Structural Engineer prior to use in the design of retaining walls. Simplified calculations of lateral active (or at rest) earth pressures can be carried out for braced retaining walls using a uniform lateral earth pressure as follows;

$P_a = 0.65\ K\ \gamma\ H$ For calculation of active earth pressure

Where,

P_a = Active (or at rest) Earth Pressure (kN/m^2)
P_p = Passive Earth Pressure (kN/m^2)
□ = Bulk density (kN/m^3)
K = Coefficient of Earth Pressure (K_a or K_o)
K_p = Coefficient of Passive Earth Pressure
H = Retained height (m)
c = Effective Cohesion (kN/m^2)

Temporary Batter Angle

Batter angle of slope ratio of 1H: 1V is recommended for the construction of a retaining wall in the existing soil profile with the dry ground condition. During the rainy condition encountered during the construction of the retaining wall, better material must keep in dry condition, such as using the Geofabric or plastic sheet.

Slope Risk Assessment

The stability of a site is generally governed by site factors such as slope angles, depth of soils, strength of sub-surface material, drainage, movements of groundwater and surface runoff, potential sliding planes such as interface of rock/soil and faults in bedrock.

The observations made during the investigation indicate the existing concrete structure covered the majority of the area. Excavation is expected to be through fill and residual soil in shallow depth and then into sandstone bedrock of generally extremely low and medium strength.

Structurally design retaining wall will be constructed to support the area where required, there is no unsupported slope will remain after the construction completion.

Limitations

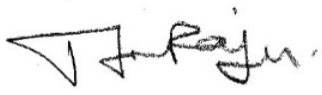
The geotechnical assessment, the conclusions and recommendations presented in this report have been based on available information obtained before and during the site inspection, and are limited to the locations assessed. It is recommended that should site features, surface and groundwater conditions encountered during excavation and construction vary substantially from those anticipated within this report, Aargus be contacted immediately for further advice and any necessary review of recommendations.

Aargus does not accept any liability for site conditions not observed or accessible during the time of the inspection. This report and associated documentation and the information herein have been prepared solely for the use of **Daniel Vidal** and any reliance assumed by third parties on this report shall be at such parties' own risk. Any ensuing liability resulting from use of the report by third parties cannot be transferred to Aargus.

If you have any questions or queries regarding this report, please do not hesitate to contact us.

For and on behalf of

Aargus Pty Ltd



Sai Turlapati

Geotechnical Engineer

Reviewed By

Rafael Furniss

BSc (Applied Geology), Hons, MSc, AGS ISSMGE

Senior Engineering Geologist

Attachments

- Important Information about Your Report.
- DCP and Hand Auger Location Plan (Figure 1)
- Results of DCP Tests
- Borehole logs

APPENDIX A

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL REPORT

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IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions than any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, due in large measure to programs and publications of ASFE/ The Association of Engineering Firms Practicing in the Geosciences.

The following suggestions and observations are offered to help you reduce the geotechnical-related delays, cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A geotechnical engineering report is based on a subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include the general nature of the structure involved, its size and configuration, the location of the structure on the site and its orientation, physical concomitants such as access roads, parking lots, and underground utilities, and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program.

To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of the report may affect its recommendations.

Unless your consulting geotechnical engineer indicates otherwise, *your geotechnical engineering report should NOT be used:*

- when the nature of the proposed structure is changed: for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an un-refrigerated one,
- when the size or configuration of the proposed structure is altered,
- when the location or orientation of the proposed structure is modified,
- when there is a change of ownership, or

for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their report's development have changed.

Geotechnical reports present the results of investigations carried out for a specific project and usually for a specific phase of the project. The report may not be relevant for other phases of the project, or where project details change.

The advice herein relates only to this project and the scope of works provided by the Client.

Soil and Rock Descriptions are based on AS1726-1993, using visual and tactile assessment except at discrete locations where field and/or laboratory tests have been carried out. Refer to the attached terms and symbols sheets for definitions.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are extrapolated by geotechnical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed construction activity, and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those inferred to exist, because no geotechnical engineer, no matter how

qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimize their impact. For this reason, most experienced owners retain their geotechnical consultants through the construction stage,* to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

SUBSURFACE CONDITIONS CAN CHANGE

Subsurface conditions may be modified by constantly changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.* Speak with the geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations may also affect subsurface conditions, and thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

Subsurface conditions can change with time and can vary between test locations. Construction activities at or adjacent to the site and natural events such as flood, earthquake or groundwater fluctuations can also affect the subsurface conditions.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Geotechnical engineers' reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems.
No individual other than the client should apply this report for its intended purpose without first conferring with the geotechnical engineer. No person should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professional develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

The interpretation of the discussion and recommendations contained in this report are based on extrapolation/interpretation from data obtained at discrete locations. Actual conditions in areas not sampled or investigated may differ from those predicted

BORING LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs (assembled by site personnel) and laboratory evaluation of field samples. Only final boring logs customarily are included in geotechnical engineering reports. These logs should not under any circumstances be redrawn for inclusion in architectural or other design drawings because drafters may commit errors or omissions in the

transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To minimise the likelihood of boring log misinterpretation, give contractors ready access in the complete geotechnical engineering report prepared or authorized for their use. Those who do not provide such access may proceed under mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes which aggravate them to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical consultants. To help prevent this problem, geotechnical engineers have developed model clauses for use in written transmittals. These are not exculpatory clauses designed to foist geotechnical engineers' liabilities onto someone else. Rather, they are definitive clauses which identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report, and you are encouraged to read them closely. Your geotechnical engineer will be pleased to give full and frank answers to your questions.

OTHER STEPS YOU CAN TAKE TO REDUCE RISK

Your consulting geotechnical engineer will be pleased to discuss other techniques which can be employed to mitigate risk. In addition, ASFE has developed a variety of materials which may be beneficial. Contact ASFE for a complimentary copy of its publications directory.

FURTHER GENERAL NOTES

Groundwater levels indicated on the logs are taken at the time of measurement and may not reflect the actual groundwater levels at those specific locations. It should be noted that groundwater levels can fluctuate due to seasonal and tidal activities.

APPENDIX B

SITE PLAN (FIGURE 1)

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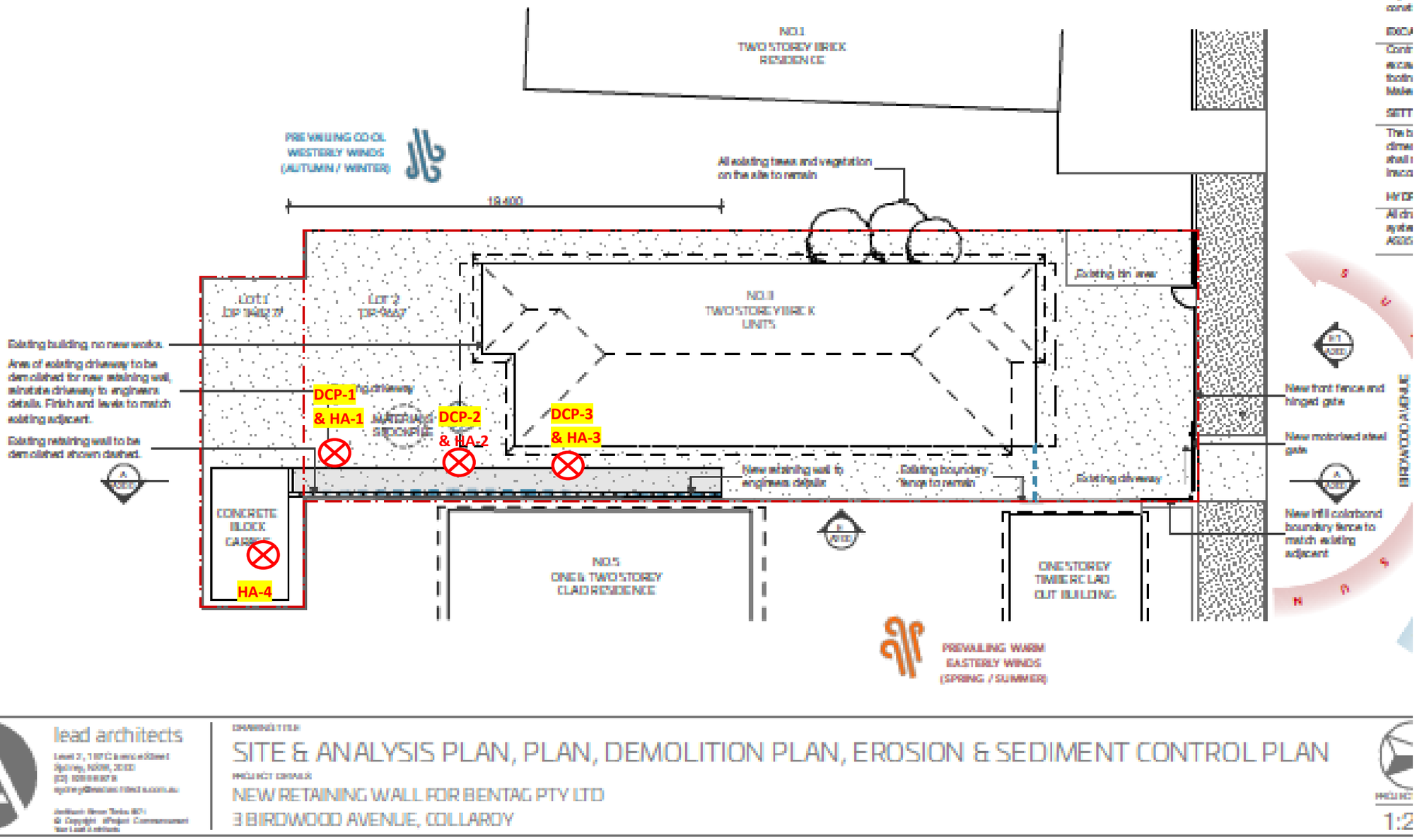

lead architects

SITE & ANALYSIS PLAN, PLAN, DEMOLITION PLAN, EROSION & SEDIMENT CONTROL PLAN

NEW RETAINING WALL FOR BENTAG PTY LTD
3 BIRDWOOD AVENUE, COLLAROY

1:2

Aargus ENVIRONMENTAL - ENGINEERING - DRILLING - LABORATORIES - ASBESTOS

Drawn	BA	**Geotechnical Investigation for proposed dwelling** **Geotechnical Investigation** **3 Birdwood Avenue, Collaroy NSW**	Aargus	**Figure**	1
Checked	SG			**Title**	Site Plan
Date	08/01/2020			**Job No**	GS7812-1A
Scale @ A3	NTS				

APPENDIX C

DCP LOGS

DYNAMIC CONE PENETROMETER TEST RESULTS

Client:	Lead Architects	Test Type		Job No:	GS7812
Project:	Geotechnical Site Investigation	DCP	■	Date:	8/01/2020
Location:	3 Birwood Ave, Collaroy	PSP		Sheet:	1 of 1

Depths (mm)	DCP No. 1	2	3	4	Depths (mm)	DCP No. 5	6	7	8
0-100	-	-	-		0-100				
100-200	2	11	6		100-200				
200-300	3	15	8		200-300				
300-400	4	14	12		300-400				
400-500	10	12	9		400-500				
500-600	16	13	13		500-600				
600-700	26/60mm	22	21		600-700				
700-800	Bouncing	19	29		700-800				
800-900		15/30mm	30/80mm/R		800-900				
900-1000		Bouncing			900-1000				
1000-1100					1000-1100				
1100-1200					1100-1200				
1200-1300					1200-1300				
1300-1400					1300-1400				
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2500-2600					2500-2600				
2600-2700					2600-2700				
2700-2800					2700-2800				
2800-2900					2800-2900				
2900-3000					2900-3000				

APPENDIX D

BOREHOLE LOGS

Aargus Pty Ltd
6 Carter Street
Lidcombe NSW 2141
Telephone: 1300137038

BOREHOLE NUMBER BH1

CLIENT LEAD ARCHITECTS **PROJECT NAME** Geotechnical investigation

PROJECT NUMBER GS7812 **PROJECT LOCATION** 3 Birdwood Avenue, Collaroy

DATE STARTED 8/1/20 **COMPLETED** 8/1/20 **R.L. SURFACE** **DATUM**

DRILLING CONTRACTOR Aargus **SLOPE** 90° **BEARING** N.A.

EQUIPMENT Hand auger **HOLE LOCATION** Refer to Figure 1 - Site Plan

HOLE SIZE 60mm **LOGGED BY** RF **CHECKED BY** SG

NOTES Surface RL and depths of subsurface conditions are approximate.

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture	Con. / Den.	Additional Observations
HA						Sandy CLAY, medium to high plasticity, pale grey to orange, mottled.			FIRM	RESIDUAL Soil
						Sandy CLAY, orange to brown, high plasticity.			STIFF	
						Sandy CLAY, medium to high plasticity, brown to pale grey.			HARD	
			0.5			Borehole BH1 terminated at 0.5m				
			1.0							

Aargus Pty Ltd
6 Carter Street
Lidcombe NSW 2141
Telephone: 1300137038

BOREHOLE NUMBER BH2

CLIENT LEAD ARCHITECTS **PROJECT NAME** Geotechnical investigation

PROJECT NUMBER GS7812 **PROJECT LOCATION** 3 Birdwood Avenue, Collaroy

DATE STARTED 8/1/20 **COMPLETED** 8/1/20 **R.L. SURFACE** **DATUM**

DRILLING CONTRACTOR Aargus **SLOPE** 90° **BEARING** N.A.

EQUIPMENT Hand auger **HOLE LOCATION** Refer to Figure 1 - Site Plan

HOLE SIZE 60mm **LOGGED BY** RF **CHECKED BY** SG

NOTES Surface RL and depths of subsurface conditions are approximate.

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture	Con. / Den.	Additional Observations
HA	Not encountered		0.0			Concrete pavement				Pavement
						Sandy CLAY, High Plasticity, dark oranage to pale grey, fine to medium grained sand, trace of fine ironstone gravel.				RESIDUAL Soil
									HARD	
			0.5			Sandy CLAY, High Plasticity, dark orange to pale grey, fine to medium sand.				
									HARD	
			1.0			Borehole BH2 terminated at 0.69m				

Aargus Pty Ltd
6 Carter Street
Lidcombe NSW 2141
Telephone: 1300137038

BOREHOLE NUMBER BH3

CLIENT LEAD ARCHITECTS **PROJECT NAME** Geotechnical investigation

PROJECT NUMBER GS7812 **PROJECT LOCATION** 3 Birdwood Avenue, Collaroy

DATE STARTED 8/1/20 **COMPLETED** 8/1/20 **R.L. SURFACE** _____ **DATUM** _____

DRILLING CONTRACTOR Aargus **SLOPE** 90° **BEARING** N.A.

EQUIPMENT Hand auger **HOLE LOCATION** Refer to Figure 1 - Site Plan

HOLE SIZE 60mm **LOGGED BY** RF **CHECKED BY** SG

NOTES Surface RL and depths of subsurface conditions are approximate.

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture	Con. / Den.	Additional Observations
HA						Sandy CLAY, orange colour, medium to high plasticity, mottled.			VERY STIFF	RESIDUAL Soil
						Sandy CLAY, orange to grey, high plasticity, mottled.			VERY STIFF	
			0.5			Sandy CLAY, high plasticity, orange to grey.			HARD	
			1.0			Borehole BH3 terminated at 0.6m				

Aargus Pty Ltd
6 Carter Street
Lidcombe NSW 2141
Telephone: 1300137038

BOREHOLE NUMBER BH4

CLIENT LEAD ARCHITECTS **PROJECT NAME** Geotechnical investigation

PROJECT NUMBER GS7812 **PROJECT LOCATION** 3 Birdwood Avenue, Collaroy

DATE STARTED 8/1/20 **COMPLETED** 8/1/20 **R.L. SURFACE** **DATUM**

DRILLING CONTRACTOR Aargus **SLOPE** 90° **BEARING** N.A.

EQUIPMENT Hand auger **HOLE LOCATION** Refer to Figure 1 - Site Plan

HOLE SIZE 60mm **LOGGED BY** RF **CHECKED BY** SG

NOTES Surface RL and depths of subsurface conditions are approximate.

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture	Con. / Den.	Additional Observations
HA						Medium to coarse grained gravel, tree rootles.				FILL
			0.5			Borehole BH4 terminated at 0.3m				
			1.0							