Aargus

Environmental - Remediation - Engineering - Laboratories - Drilling

GEOTECHNICAL INVESTIGATION REPORT

Victoria Road and Faversham Street (Site 2) Marrickville NSW 2204

Prepared for

E & D Danias Pty Ltd

Report No. GS5611/1A

22nd January 2014

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

REFERENCES

1. Australian Standard – AS 1170.4-2007 Structural design actions - Earthquake actions in Australia.
2. Australian Standard – AS1726-1993 Geotechnical Site Investigation.
3. Australian Standard – AS 2159-2009 Piling - Design and installation.
4. Department of Infrastructure, Planning and Natural Resources, "Salinity Potential in Western Sydney 2002", March 2003.
5. Pells, P.J.N, Mostyn, G. and Walker B.F., "Foundations on Sandstone and Shale in the Sydney Region", Australian Geomechanics Journal, 1998.

1. INTRODUCTION

Aargus Pty Ltd (Aargus) has been commissioned by E & D Danias Pty Ltd to carry out a geotechnical site investigation within the properties at Victoria Road and Faversham Street, Marrickville, NSW 2204 (Site 2). The site investigation was carried out on the 15th and 17th of October 2013 and was followed by laboratory testing, geotechnical interpretation, assessment and preparation of a geotechnical report.

The purpose of the investigation was to assess the ground conditions and general geotechnical design requirements of the site. The investigation included assessment of the site existing geotechnical conditions and providing recommendations for design and construction of future development at the site.

This report presents results of the geotechnical site investigation, laboratory testing, interpretation and assessment of the site existing geotechnical conditions, as a basis to provide general recommendations for design and construction of ground structures at the site. To assist in reading the report, reference should be made to the "Important Information About Your Geotechnical Report" attached as Appendix A.

2. AVAILBLE INFORMATION

Prior to the preparation of this report, the following information was made available to Aargus by E & D Danias Pty Ltd:

- Surveyor's report for the property at No. 182 Victoria Road, Marrickville prepared by True North Surveys, referenced 5676 and dated 26th October 2007;
- Survey drawing titled "Plan of Land Comprised in Deed BK. No 65 (Lot 1) and No. 66 (Lot 2)" for the property at Nos. 184-186 Victoria Road, Marrickville, referenced map: Marrickville Sheet 9# and dated 11th November 1996;
- Surveyor's report for the property at No. 188 Victoria Road, Marrickville prepared by S.J. Dixon & Associates Pty Ltd, referenced 46433 and dated 21st June 2010;
- Survey report for the property at Nos. 190-198 Victoria Road, Marrickville prepared by T.J. Gilbert & Associates – Land and Engineering Surveyors, referenced 4025 and dated 24th February 2004; and

- Survey report for the property at Nos. 18-26 and 28-30 Faversham Street, Marrickville prepared by T.J. Gilbert & Associates – Land and Engineering Surveyors, referenced 4025A and dated 24th February 2004.

An Environmental Detailed Site Investigation (DSI) was carried out at the site by Aargus on three days 15th, 16th and 17th October 2013. The results are being documented in a report referenced ES5611/2.

Soil sampling for Acid Sulphate Soils (ASS) Assessment at this site was carried out as part of the geotechnical investigation by Aargus. The results of the ASS assessment will be issued in a separate report by Aargus.

3. SCOPE OF WORK

In accordance with the brief, fieldwork for the geotechnical site investigation was carried out by an experienced Geotechnical Engineer from Aargus, following in general the guidelines provided in Australian Standard AS1726-1993 (Reference 2) and comprised the following:

- Collection and review of Dial-Before-You-Dig (DBYD) plans;
- A site walk-over inspection in order to determine the overall surface conditions and to identify any relevant site features;
- Service locating by a specialist contractor using electromagnetic detection equipment to ensure the investigation area is free from underground services;
- Machine drilling of three boreholes identified as BH1 to BH3 inclusive using solid flight auger techniques with V-bit and tungsten carbide (TC) bit. Drilling was carried out using a truck mounted drilling rig owned and operated by Aargus. All boreholes were drilled to V bit refusal at depths varying from approximately 3.8m to 7.6m below ground level (bgl) and were terminated at TC bit refusal or high TC bit resistance at depths varying from approximately 4.3m to 8.0m bgl;
- Standard Penetration Tests (SPT) conducted within the boreholes to assess the in-situ strength of subsurface soil layers;
- Collection of soil samples during drilling; and
- Reinstatement of the boreholes with soil cuttings.

The approximate locations of the three boreholes drilled during the site investigation are shown on Figure 1, “Site Plan” attached as Appendix B.

Selected soil samples collected during the site investigation were tested by Groundswell Laboratories for determination of salinity and aggressivity of the soils underlying the site to concrete and steel foundation elements.

Following completion of the site investigation and laboratory testing, Aargus carried out geotechnical interpretation of the results and assessment of the main potential geotechnical issues that may be associated with future development at the site. A geotechnical report was prepared to summarise the results of the geotechnical site investigation, interpretation and assessment.

The information provided in this report includes:

- Method of investigation;
- Site description, including surface conditions;
- Site plan indicating borehole locations and showing existing relevant site features;
- Subsurface conditions together with material characterisation;
- Borehole logs;
- Results of in-situ and laboratory tests;
- Assessment of potential geotechnical issues that may be associated with the future development at the site and potential effects on the surrounding buildings and infrastructure; and
- General recommendations for design and construction of future development at this site.

4. SITE DESCRIPTION

The site is located within the Marrickville Council area, at approximately six kilometres to the south-west of Sydney Central Business District.

The site consists of amalgamation of the properties at No. 182, nos. 184-186, No. 188, nos. 190-198 Victoria Road together with the properties at nos. 18-26 and nos. 28-30 Faversham Street. The site is bounded by the following roads and properties:

- Victoria Road carriageway and road reserve to the north-west;

- Faversham Street carriageway and road reserve to the south-east;
- Wicks Park and the properties at nos. 12-16 Faversham Street to the south-west. The park is currently occupied by four tennis courts, lawn, a brick (transformer) substation building, a public toilet building and a number of mature trees. The property nos. 12-16 Faversham Street was occupied by a single storey brick building; and
- The properties at nos. 168-180 Victoria Road and nos. 22-38 Fitzroy Street Marrickville to the north-east. The property at nos. 168-180 Victoria Road is occupied by modern two storey buildings of the Victoria Industrial Park. The property at nos. 22-38 Fitzroy Street was occupied by a complex of warehouse type buildings.

The site is an irregular shaped land with an approximate area of 1.037 hectares, consisting of amalgamation of the following adjoining properties:

The properties fronting Victoria Road

- The property at No. 182 Victoria Road, which was occupied by a fibro building, a two storey brick building, an awning, a concrete driveway from Victoria Road and an open hardstand area for car parking;
- The properties at nos. 184-186 Victoria Road, which were occupied by a brick warehouse type building;
- The property at No. 188 Victoria Road, which was occupied by a cement rendered brick cottage and a metal workshop; and
- The properties at nos. 190-198 Victoria Road, which were occupied by a brick warehouse type building with metal roof, a two storey brick office and showroom building and an open hardstand area for car parking and driveway.

The properties fronting Faversham Street

The properties at nos. 18-26 Faversham Street and nos. 28-30 Faversham Street were occupied by two storey brick warehouse type and office complex buildings with metal roof and an open concrete handstand area.

No information was available during preparation of this report on the foundations of the existing buildings within the site. Based on our observations, the existing warehouse buildings within the site are inferred to be likely supported on shallow footings.

A number of mature trees were present in the vicinity of the north-western and south-eastern boundaries and within the site.

The provided survey reports do not provide the ground surface elevations. However, our observation indicated the ground surface within the site slightly slope towards the south. A number of cracks were observed on the concrete pavement at the site.

Selected site photographs recorded during the site investigation are provided in Figure 2, attached as Appendix C.

5. PROPOSED DEVELOPMENT

No drawings for any proposed future development for the site were available during the preparation of this report. However, it is understood that following demolition of the existing building the site may be developed to become part of the Victoria Road Corridor development. A development within this site in the future may consist of construction of two to three basement levels for underground parking and seven to ten storeys above ground building.

6. LOCAL GEOLOGY

Reference to the Sydney 1:100,000 Geological Series Sheet 9130 Edition 1, dated 1983, by the Geological Survey of New South Wales, Department of Mineral Resources, indicated the site is located within an area underlain by alluvial deposits consisting of “peat, sandy peat and mud” and denoted as (Qhs).

In addition, the site is at approximately 60m to the south of the geological boundary with Ashfield Shale, which is denoted as (Rwa) and at approximately 250m to the east of the geological boundary with the Hawkesbury Sandstone, which is denoted as (Rh).

7. INVESTIGATION RESULTS

7.1 Surface Conditions

The majority of the site was covered with approximately 100mm thick concrete pavement. The vehicular access driveway from Victoria Road within the property at No. 182 Victoria Road is covered with silty gravelly road base material.

7.2 Subsurface Conditions

The subsurface conditions encountered within the boreholes are detailed on the attached Engineering Borehole Logs presented in Appendix D.

Subsurface conditions encountered during drilling at the borehole locations consisted of the following:

- Fill, consisting of grey and brown, generally soft and loose and dry to moist silty sandy clay/gravelly sand and silty gravel; overlying
- Reworked insitu soils, consisting of greenish grey with red mottling and dark grey, medium plasticity, soft to firm and moist silty clay; overlying
- Alluvial soils, consisting of grey with reddish mottling, medium to high plasticity, firm to stiff and moist silty clay; overlying
- Residual soils, consisting of grey with red mottling, medium to high plasticity, firm to very stiff and moist silty clay/sandy clay; overlying
- Class V sandstone, grey with dark brown/red mottling and iron-staining, fine to medium grained, extremely weathered, very low strength, with some clay bands.

Classification of the rock was carried out in accordance with the guidelines provided by Pells et al (Reference 5). Horizons of stronger rock such as Class IV sandstone, which typically underlies Class V sandstone, may be present at this site.

Table 1 presents a summary of the subsurface conditions encountered in the boreholes during the site investigation.

Table 1: Summary of Subsurface Conditions

Unit	Depth to Top of Layer (m bgl)	Thickness (m)	SPT N Values (blows/300mm)
Fill	0 to 0.15	0.1 to 0.35	Not tested
Reworked Insitu Soils	0.1 to 0.5	0.6 to 1.0	6
Alluvial Soils	0.9 to 1.2	1.0 to 1.4	6 to 8
Firm to Stiff Residual Soils	2.1 to 2.6	0.5 to 0.9	7 to 13
Stiff to Very Stiff Residual Soils	2.8 to 3.5	1.2 to 4.1	16 to 23
Class V Sandstone	3.8 to 7.6	Unconfirmed	Refusal (+50)

7.3 Groundwater

Groundwater was encountered during drilling of the three boreholes at this site on 15th and 17th October 2013 at depths varying from approximately 2.6m to 4.0m bgl.

Three groundwater monitoring wells identified as GW1 to GW3 inclusive were installed at the site in the boreholes drilled as part of the DSI in 2013 by Aargus. Subsequent groundwater monitoring in the three wells indicated groundwater levels at depths varying from approximately 1.45m to 4.33m bgl on 17th October 2013, and from approximately 1.15m to 1.23m bgl on 29th October 2013.

It should be noted groundwater levels may be subject to seasonal fluctuations influenced by rainfall, future development of the surrounding lands and other factors. Based on the site topography, groundwater flow is inferred to be in a north-east to south-west direction towards the Cook River, which is located approximately 1.7km to the south-west of the site.

7.4 Salinity and Aggressivity

One soil sample recovered during drilling in borehole BH1 at approximately 1.0m bgl and two soil samples in borehole BH2 at approximately 0.5m bgl and 1.5m bgl respectively were tested by Groundswell Laboratories, a NATA accredited testing laboratory. The testing included determination of pH, Chloride, Sulphate and Saline contents. Results of the laboratory testing are attached in Appendix E of this report and are summarised in tables 2 and 3.

Table 2: Electrical Conductivity Test Results

Borehole	Depth(m)	Electrical Conductivity (dS/m) EC	Multiplication Factor [a]	Electrical Conductivity of Saturated Extract (dS/m) EC_e	Soil Type
BH1	1.0 – 1.45	< 0.01	7 - 8	< 0.08	Silty Clay
BH2	0.5 – 1.0	0.25	7 - 8	1.75 - 2.0	Silty Clay
BH2	1.5 – 2.0	0.26	7 - 8	1.82 - 2.08	Silty Clay
Environmental Planning & Assessment Regulation 1994 **Dryland Salinity (1993)**				Saline at >4 dS/m Non-saline <2 dS/m Slightly saline 2-4 dS/m Moderately saline 4-8 dS/m Very saline 8-16 dS/m Highly saline >16 dS/m	

Table 3: Soil pH, Chloride and Sulphate Test Results

Borehole	Depth(m)	MC* %	pH	Chloride (mg/kg)	Sulphate as $S0_4$ (mg/kg)
BH1	1.0 – 1.45	16.0	8.3	<10	25
BH2	0.5 – 1.0	21.6	8.4	117	230
BH2	1.5 – 2.0	22.8	7.9	96	410
AS2159-2009					
Piling - Design and Installation					
Reinforced Concrete Piles					
High Permeability Soils					
Mild			>5.5		<5000
Moderately aggressive			4.5 - 5.5		5000 – 10,000
Severely aggressive			4.0 - 4.5		10,000 – 20,000
Very severely			<4.0		>20,000
Low Permeability Soils					
Non-aggressive			> 5.5		<5000
Mild			4.5 - 5.5		5000 – 10,000
Moderately aggressive			4.0 - 4.5		10,000 – 20000
Severely aggressive			<4.0		>20,000
Steel Piles					
High Permeability Soils					
Non-aggressive			>5.0	<5000	
Mild			4.0 - 5.0	5000 – 20,000	
Moderately aggressive			3.0 - 4.0	20,000-50,000	
Severe			<3	>50,000	
Low Permeability Soils					
Non-aggressive			>5.0	<5000	
Non-aggressive			4.0 - 5.0	5000 – 20,000	
Mild			3.0 - 4.0	20,000-50,000	
Moderately aggressive			<3.0	>50,000	

Note: MC * = Moisture Content

8. GEOTECHNICAL ASSESSMENT

8.1 General

The main geotechnical aspects associated with the future development at this site are assessed to include the following:

- Basement Excavation;
- Retaining Walls;
- Building Foundations;
- Groundwater Management;
- Site Earthquake Classification; and
- Soil Salinity and Aggressivity.

A summary for assessment of the geotechnical aspects above and recommendations for design and construction of future development at this site is presented in the following sections.

8.2 Excavation Conditions

The results of the borehole investigation indicated excavation for proposed future basement levels will be predominantly in fill, reworked insitu, alluvial and residual soils and Class V sandstone.

Excavation in the soils and weathered sandstone materials should be typically feasible using conventional earthmoving equipment. Excavation of less fractured Class V sandstone or low strength Class IV sandstone if encountered underlying the upper Class V, may require heavy ripping, high capacity or vibratory rock breaking equipment.

8.3 Vibration Control

To ensure vibration levels remain within acceptable levels and minimise the potential effects of vibration, excavation into low strength Class V and Class IV sandstone or stronger should be complemented with saw cutting or other appropriate methods prior to excavation. Rock saw cutting should be carried out using an excavator mounted rock saw, or the like, so as to minimise transmission of vibrations to any adjoining properties that may be affected. Hammering is not recommended and should be avoided. However, if necessary, hammering should be carried out horizontally along bedding planes of (pre-cut) broken rock blocks or boulders where possible with noise levels restricted to acceptable to comfortable limits to adjacent residents.

Induced vibrations in structures adjacent to the excavation should not exceed a Peak Particle Velocity (PPV) of 10mm/sec for brick or unreinforced structures in good condition, 5mm/sec for residential and low rise buildings or 2mm/sec for historical or structures in sensitive conditions. It is recommended that monitoring is carried out during excavation using a vibration monitoring instrument (seismograph) and alarm levels (being the appropriate PPV) selected in accordance with the type of structures present within the zone of influence of the excavation.

As vibrations are considered possible during the use of heavy ripping and rock hammers, it is recommended dilapidation survey of adjoining structures are undertaken prior to project excavation commencement including as a minimum the adjoining roads and the existing buildings within the adjoining properties.

If vibrations in adjacent structures exceed the values recommended above or appear excessive during construction, excavation should cease and the project geotechnical engineer should be contacted immediately for appropriate reviews.

8.4 Stability of Basement Excavation

Temporary batter slopes may not be feasible for construction of basements at this site if there are no sufficient setbacks between the basement perimeter walls and the site boundaries. Temporary batters slope are not recommended in general for deep excavations in areas surrounded by existing developments, especially where groundwater levels are relatively shallow. Excavation for basements at this site is recommended to be retained by a shoring system prior to excavation along the perimeter walls. Suitable shoring option may consist of any of the two options below:

- Cast insitu reinforced concrete continuous Cutter Soil Mixing (CSM) diaphragm wall; or
- Cast insitu reinforced concrete semi contiguous piles with reinforced concrete panels covering the gaps between the piles, contiguous or secant pile wall.

Other alternative shoring options may be considered subject to assessment by the project structural engineer in consultation with the project geotechnical engineer. If sufficiently embedded into the bedrock, the elements of the shoring wall can be designed to be incorporated into the building foundation system.

If not restrained, lateral movement in the shoring system due to the mobilisation of the active earth pressure will likely occur during construction prior to installation of floor slabs and beams of the ground level. Temporary anchorage or other temporary tie back systems are expected to be required during construction to reduce the potential effects of wall movement on the adjoining properties. Anchor installation beyond the property boundaries will be subject to approval by owners of adjoining properties, roads and infrastructure.

If installation of temporary anchors is not feasible, consideration of other options to control wall lateral movement would be necessary. These options include the following:

- Temporary solutions such as installation of props associated with staged excavation;
- Staged excavation and creating temporary partial berms in front of walls; and
- Top-down construction where floor slabs and beams are constructed at top of shoring wall and at floor level for upper basement levels prior to excavation within the basement level underneath the floor slabs.

With the recommended retention options above, construction of basement levels in the short and long terms is expected to have low effects on the buildings and infrastructure within the adjoining properties and roads.

Vertical excavation for lift shafts may be feasible if temporary shoring is provided. Alternatively, temporary slope batters of 1V:2H to 1V:1H may be suitable for soils and rock respectively subject to availability of sufficient setback distances and confirmation by a geotechnical engineer during construction.

Dilapidation survey will be required to be undertaken for the existing structures within the adjoining properties and adjoining carriageway and road reserve prior to excavation. The dilapidation survey should constitute as a "Hold Point".

Earth retention structures and anchors can be designed using the recommended parameters provided in Section 8.5. Inspection of excavations and installation of shoring walls together with testing of anchors will be required following installation. Monitoring of lateral movement of the basement perimeter wall/ shoring system will be required to be carried out during construction under the supervision of the project geotechnical engineer. The inspections, monitoring of wall movement and testing of anchors should constitute as "Hold Points".

8.5 Retaining Walls

Earth retaining structures, including permanent perimeter walls and excavation shoring walls, should be designed to withstand lateral earth, hydrostatic and earthquake (if applicable) pressures and the applied surcharge 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 preliminary parameters for the design of retaining structures are presented in Table 4.

Table 4: Preliminary Geotechnical Design Parameters for Retaining Walls

Units	Unit Weight (kN/m^3)	Effective Cohesion c' (kPa)	Angle of Effective Internal Friction ϕ' (degree)	Modulus of Elasticity $E_{s (v)}$ (MPa)	Poisson Ratio ν
Fill/ Reworked Insitu	17	0	26	10	0.35
Alluvial Soils	17	0	26	10	0.35
Firm to Stiff Residual Soils	18	5	26	20	0.35
Stiff to Very Stiff Residual Soils	18	5	28	30	0.35
Class V Sandstone	22	15	35	100	0.3
Class IV sandstone	22	20	35	200	0.3

Table 5 provides preliminary coefficients of lateral earth pressure for the soil and rock horizons encountered during the geotechnical site investigation, or horizons inferred to be present underlying the site. The coefficients provided are based on horizontal ground surface and fully drained conditions.

Table 5: Preliminary Coefficients of Lateral Earth Pressure

Units	Coefficient of Active Lateral Earth Pressure Ka	Coefficient of Lateral Earth Pressure at Rest Ko
Fill/ Reworked Insitu	0.39	0.562
Alluvial Soils	0.39	0.562
Firm to Stiff Residual Soils	0.39	0.562
Stiff to Very Stiff Residual Soils	0.361	0.531
Class V Sandstone	0.271	0.426
Class IV sandstone	0.271	0.426

- Coefficient of active and passive lateral earth pressure Ka and Kp, can be calculated using Coulomb's equations.
- Coefficient of lateral earth pressure at rest Ko, 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) and passive earth pressures can be carried using the Rankine equations shown below:

$Pa = K\,\gamma\,H - 2c\sqrt{K}$ For calculation of Lateral Active or At Rest Earth Pressure

$Pp = K_p\,\gamma\,H + 2c\sqrt{K_p}$ For calculation of Passive Earth Pressure

Where,

P_a = Active (or at rest) Earth Pressure (kN/m^2)

P_p = Passive Earth Pressure (kN/m^2)

γ = Bulk density (kN/m^3)

K = Coefficient of earth pressure (K_a or K_o)

Kp = Coefficient of Passive Earth Pressure

H = Retained height (m)

c = Effective Cohesion (kN/m^2)

Temporary anchors will require embedment in Class V sandstone or stronger. An allowable bond stress of 100kPa may be adopted for temporary anchors within Class V sandstone and 250kPa may be adopted for temporary anchors within Class IV sandstone.

Anchors should undergo proof testing following installation. The anchors can be designed for the parameters recommended above providing:

- The bond (socket) length in Class V or Class IV sandstone is at least 3.0m; and
- Anchors are proof tested to 1.3 times the design working load specified by the structural engineer, before they are locked off at no higher than 75% of working load.

Depending on the magnitude of wall movement predicted, prestressing may be required in order to reduce the potential for any movement-induced damage to adjacent structures.

8.6 Foundations

The following proposed foundation options are recommended for the proposed buildings within the site to account for different ground conditions that may be encountered at different locations and different depths depending on actual depths of future basement levels at the site:

- Where the basement floor will be founded in Class V sandstone or better, shallow reinforced concrete foundations, such as pad or strip footings and/or raft slab on grade with thickened slab under columns and walls are assessed to be applicable. Installation of piles is expected to be required in cases of axial loads on columns and walls exceeding the allowable bearing pressure of the underlying strata. Other cases where piles may be required include the need to increase the stiffness of the founding rock, or increase the resistance against lateral seismic loads.
- For foundations at existing ground level or where the basement floor will be founded in soils cast insitu reinforced concrete bored piles or any similar rigid piling system would be suitable. Piles should be installed through all fills, alluvial residual soils and embedded into Class V sandstone or stronger.

For all type of structures whether, lightly, moderately or heavily loaded, the existing fill and the alluvial soils underlying the site are assessed to be unsuitable as bearing stratum unless improved or treated. Alternatively, installation of piles (reinforced concrete bored piles or similar rigid piling system) embedded in residual soils, Class V sandstone or stronger is assessed to be required.

Table 6 provides geotechnical foundation design capacities and parameters recommended for the soil and rock strata encountered in the boreholes, or inferred to be present underlying the site that may be used for preliminary geotechnical foundation design.

Table 6: Preliminary Geotechnical Foundation Design Capacities and Parameters

Unit	Allowable End Bearing Capacity (kPa) (1)	Allowable Shaft Adhesion in Compression (2) (kPa)	Modulus of Elasticity (Vertical) (MPa)
Fill/ Reworked Insitu	NA(3)	10	10
Alluvial Soils	NA	10	10
Firm to Stiff Residual Soils	100 (shallow footings)	15	20
Stiff to Very Stiff Residual Soils	200 (shallow footings) 375 (piles)	20	30
Class V sandstone	1000	100	100
Class IV sandstone (4)	2000	200	200

1 With a minimum embedment depth of 0.5m for deep foundations and 0.4m for shallow foundations.
2 Clean rock socket of roughness of at least grooves of depth 1mm to 4mm and width greater than 5mm at spacing of 50mm to 200mm. Shaft Adhesion in Tension is 50% of Compression.
3 N/A, Not Applicable, not recommended for the proposed building of this development.
4 The actual depth of the underlying Class IV shale should be confirmed by further investigation or during construction.

Shaft adhesion may be applied to socketed piles adopted for foundations provided socket shaft lengths conform to appropriate classes of sandstone and accepted levels of shaft sidewall cleanliness and roughness. The rock socket sidewalls should be free of soil and/or crushed rock to the extent that natural rock is exposed over at least 80% of the socket sidewall.

Shaft adhesion should not be applied to the upper 0.5m socket length within these bedrock sequences. Shaft adhesion should be reduced or ignored within socket lengths that are smeared and fail to satisfy cleanliness requirements. Additional attention to cleanliness of socket sidewalls may be required where presence of clay seams and extremely weathered rock bands is evident over socket lengths.

To minimise the effects of differential vertical rock deformation under the building loads, it is recommended all foundations should be founded on rock horizons of similar class.

Should groundwater flow, seepages or surface runoff be encountered within foundation excavations, the excavations should be dewatered prior to concrete placement or appropriate underwater placement techniques should be adopted. Any loose debris and wet soils should also be removed from excavations.

A geotechnical engineer should inspect foundation base excavations at the time of excavation to ensure the foundation bases have been taken to suitable materials of appropriate bearing capacity. The inspections should constitute as "Hold Points".

8.7 Groundwater Management

Due to the potential for seepage to occur in the basement excavation below the natural groundwater level, monitoring of groundwater levels prior and during construction is recommended. Dewatering of basement excavation will likely be required. Typically, dewatering would involve excavation of a sump pit within the site to collect and remove intercepted water. Dewatering should be controlled in a manner that reduces the potential detrimental effects on existing structures and infrastructure within adjoining properties and roads. Installation of precautionary recharge spear well points or trenches around the excavations will likely to be required in order to maintain the groundwater levels within the surrounding areas and reduce the potential effects of dewatering induced settlement.

To ensure the long-term water tightness of the basement, the basement walls and floor below the natural groundwater level, plus a free-board estimated based on the predicted flood level for this site, should be constructed as impervious walls and floor with water-tight construction joints. The basement walls and slabs should be designed to withstand hydrostatic pressures taking into consideration the existing groundwater levels and predicted flood levels for this site.

With the recommended procedures and precautionary mitigation measures described above, the potential dewatering-induced effects on the proposed development and surrounding properties and roads are expected to be low. Nevertheless, further assessment on the potential effects of dewatering should be carried out during the construction certificate stage based on the final detailed design drawings of the proposed development.

8.8 Site Earthquake Classification

The site is underlain by fill and natural soils with SPT 'N' values ranging from 6 to 23 blows/300mm extending to top of bedrock which varies in depth from approximately 3.8m to 7.6m bgl as encountered during borehole drilling. Therefore, in accordance with Australian Standards AS1170.4: 2007 (Reference 1) the site can be classified as a "Shallow Soil Site' (Class C_e).

8.9 Site Salinity and Aggressivity

Through introduction of a multiplying factor to the test results, as stipulated in the Department of Natural Resources (DNR) publication "Site Investigations for Urban Salinity" – 2002 (Reference 4), the resultant electrical conductivity of saturated extracts (ECe) ranged from approximately < 0.08 dS/m to 2.08 dS/m, as shown on Table 2, indicating the soil horizons at depths varying from approximately 0.5m to 2.0m to be "Slightly Saline". As saline soils are likely to be encountered during the excavation works, an appropriate saline soil management plan should be implemented during earthworks.

Reference to AS2159-2009, "Piling – Design and Installation" (Reference 3), and the results of soil pH, Chloride, and Sulphate tests on three soil samples collected from boreholes BH1 and BH2, as presented in Table 3, indicate that the underlying soil horizons have "Non-Aggressivity" to steel and reinforced concrete foundation elements.

9. CONCLUSIONS AND RECOMMENDATIONS

The results of the geotechnical site investigation and assessment for this site indicate the ground conditions in general are suitable for the future development subject to adoption of the recommendations made in this report. The following is a summary of Aargus conclusions and recommendations:

9.1 The site is underlain by fill/ reworked in situ overlying alluvial and residual soils to the top of horizons of very low to low strength weathered Class V sandstone bedrock, which is present at depths ranging from approximately 3.8m to 7.6m bgl as encountered during borehole drilling. Stronger rock class, i.e. Class IV shale, which typically underlies Class V, may be present underlying the site. The actual depth of the underlying Class IV shale should be confirmed by further investigation or during construction.

9.2 Groundwater monitoring carried out for this site indicated the natural groundwater levels varies and can rise to approximately 1.15m bgl. Monitoring of groundwater levels prior and during construction is recommended. Dewatering of basement excavation will likely be required and should be controlled in a manner that reduces the potential detrimental effects on existing structures and infrastructure within adjoining properties and roads. Installation of precautionary recharge spear well points or trenches around the excavations will likely to be required. To ensure the long-term water tightness of the basement, the basement walls and floor below the natural groundwater level, plus a free-board estimated based on the predicted flood level for this site, should be constructed as impervious walls and floor with water-tight construction joints. The basement walls and slabs should be designed to withstand hydrostatic pressures taking into consideration the existing groundwater levels and predicted flood levels for this site.

9.3 Results of chemical laboratory testing indicate the fill, alluvial and residual soil horizons underlying the site are likely to be “Slightly Saline”. The soil horizons underlying the site are assessed as likely to have “Non- Aggressivity” to reinforced concrete and steel foundation elements.

9.4 Earth retaining structures should be designed to withstand the lateral earth, hydrostatic and earthquake (if applicable) pressures, and the applied surcharge loads in their zone of influence, including existing structures, traffic and construction related activities. Recommended parameters for the design of earth retaining structures and anchors are provided.

9.5 Excavations for the proposed future basement should be retained prior to excavation along the perimeter walls using a shoring wall system such as cast insitu reinforced concrete CSM diaphragm wall or semi-contiguous/ contiguous or secant pile wall. If sufficiently embedded into the underlying bedrock, the elements of the shoring wall can be designed to be incorporated into the building foundation system. Temporary anchorage will likely to be required in order to limit the magnitude of lateral movement in the shoring system. If installation of temporary anchors is not feasible, consideration of other options to control wall lateral movement would be necessary.

9.6 If the use of heavy ripping, high capacity or vibratory rock breaking equipment is requited, in order to reduce the induced vibrations in structures in the vicinity of the excavation, excavation into the less fractured Class V sandstone or low strength Class IV sandstone or stronger should be complemented with saw cutting or other appropriate method prior to excavation. A vibration monitoring programme should be planned and implemented to ensure Peak Particle Velocity (PPV) levels for all activities are within prescribed acceptable limits.

9.7 Recommended foundation systems for the proposed future building at this consist of:

- Shallow reinforced concrete footings and/or raft slab on grade with thickened slab under columns and walls for basement floors founded in sandstone bedrock. Piled foundations may be required in cases of axial loads on columns and walls exceeding the allowable bearing pressure of the underlying strata and other cases described in the report.
- Piled foundations for basement floors founded in soils.

9.8 Earth retaining structures should be designed to withstand lateral earth, hydrostatic and earthquake (if applicable) pressures, and the applied surcharges in their zone of influence, including existing structures, traffic and construction related activities. Recommended parameters for the design of earth retaining structures are provided.

9.9 In accordance with Australian Standard AS1170.4: 2007, the site can be classified as a “Shallow Soil Site’ (Class Ce).

9.10 Dilapidation surveys for existing building and infrastructure within surrounding properties and roads are recommended to be carried out prior to construction involving basement excavation. It is recommended the design drawings be provided to Aargus for further assessment and confirmation of a suitable foundations and retaining walls. Inspections of the ground retention system, anchors and foundations, with possible anchor testing, should be carried out under supervision of a geotechnical engineer during construction. The dilapidation survey, inspections, monitoring and testing should constitute as “Hold Points”.

10. LIMITATIONS

The geotechnical assessment of the subsurface profile and geotechnical conditions within the proposed development area and the conclusions and recommendations presented in this report have been based on available information obtained during the work carried out by

Aargus and in the provided documents listed in Section 2 of this report. Inferences about the nature and continuity of ground conditions away from and beyond the locations of field exploratory tests are made, but cannot be guaranteed.

It is recommended that should ground conditions including subsurface and groundwater conditions, encountered during construction and excavation vary substantially from those presented within this report, Aargus Pty Ltd 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 **E & D Danias Pty Ltd** 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 Pty Ltd, directors or employees.

The conclusions and recommendations of this report should be read in conjunction with the entire report.

For and on behalf of
Aargus Pty Ltd

Mark Kiryakos
BScEng MEngSt
National Engineering Manager
Principal Geotechnical Engineer

APPENDIX A

IMPORTANT INFORMATION GEOTECHNICAL REPORT

Aargus

Aargus

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.

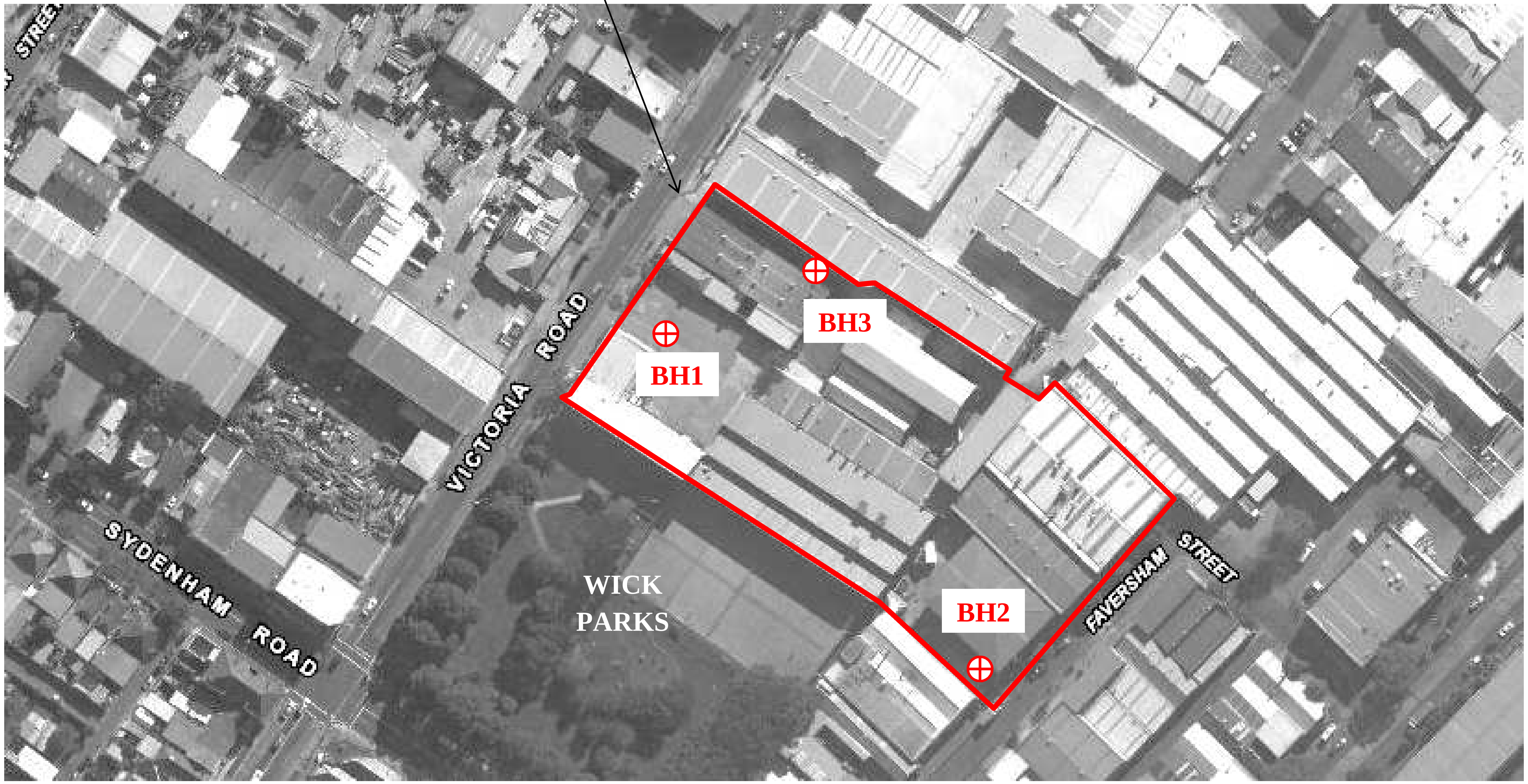
FURTHER GENERAL NOTES

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)

Aargus



North ↑

Legend: ⊕ Approximate locations of boreholes drilled on 15th and 17th October 2013 by Aargus

Image Source: www.maps.six.nsw.gov.au

Aargus Environmental- Remediation- Engineering- Drilling - Laboratories

Drawn	MM	**E & D Danias Pty Ltd** **Geotechnical Investigation** **Victoria Road and Faversham Street (Site 2), Marrickville, NSW 2204**	Aargus	Figure 1
Checked	HN			Title: Site Plan
Date	22/01/2014			Job No: Job No: GS5611/1A
Scale	NTS			

APPENDIX C

SITE PHOTOGRAPHS (FIGURE 2)

Aargus

Photograph 1
View of the north-western boundary of the site along the Victoria Road.

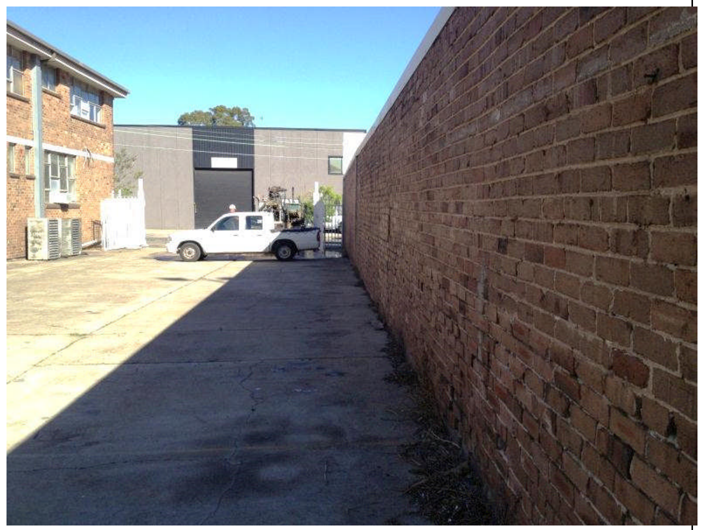
Photograph 2
View of the existing buildings within the south-western area and entrance to the carpark from the Victoria Road.

Photograph 3
View of the car park area and entrance to the site from Victoria Road.

Photograph 4
View of the existing building at the western corner and adjacent carpark area within the site.

Photograph 5
View of the site from Victoria Road towards the north-east.

Photograph 6
View of the existing buildings and carpark within the southern corner of the site towards the north-east.



Photograph 7
View of the existing building and carpark within the southern corner of the site towards the south-east.

Photograph 8
View of the existing building within the eastern corner of the site towards the north-east.

Figure 2 – Site Photographs

APPENDIX D

ENGINEERING BOREHOLE LOGS

Aargus

Aargus Pty Ltd
446 Parramatta Road
PETERSHAM N.S.W.
Telephone: (61) 1300137038
Fax: (61) 1300136038

BOREHOLE NUMBER BH1

CLIENT E&D Danias Pty Ltd
PROJECT NAME Geotechnical Investigation
PROJECT NUMBER GS5611/1A
PROJECT LOCATION Victoria Road Corridor - Site 2, Marrickville, NSW

DATE STARTED 15/10/13 **COMPLETED** 15/10/13
R.L. SURFACE
DATUM
DRILLING CONTRACTOR Aargus Pty Ltd
SLOPE 90°
BEARING ---
EQUIPMENT Aargus Drilling Rig
HOLE LOCATION Refer to Site Plan Figure 1
HOLE SIZE 100mm diameter
LOGGED BY MM
CHECKED BY HN
NOTES RL top of borehole is approximate

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
ADV						Concrete 150mm thick.		PAVEMENT
						FILL, silty sandy clay, low plasticity, dark grey, moist, soft.	ES	FILL
						REWORKED INSITU SOILS, silty clay, medium plasticity, greenish grey with red mottling, with some fine to medium ironstained gravel, moist, firm.	DS, ES	REWORKED INSITU SOILS
			1		CH	Silty CLAY, medium to high plasticity, dark grey and grey with red mottling, with some fine to medium ironstained gravel, moist, firm to stiff.	SPT 2, 3, 5 N=8 ES	ALLUVIUM SOILS
			2		CH	Silty CLAY, medium to high plasticity, grey with reddish brown mottling, with some fine to medium ironstained gravel, moist, stiff.	DS, ES SPT 4, 6, 7 N=13	RESIDUAL SOILS
	Seepage		3		CI	Sandy CLAY, medium plasticity, grey with red mottling, fine to medium sand, with some ironstained gravel, moist, stiff.	ES DS, ES SPT 10, 8/20mm Bouncing	
ADT			4			SANDSTONE, fine to medium grained, grey with red and dark brown mottling, extremely low strength, extremely weathered, with silty clay bands. becoming very low strength from 4.5m bgl.	ES	BEDROCK 'V' bit refusal at 4.5m bgl. 'TC' bit refusal at 4.9m bgl.
			5			Borehole BH1 terminated at 4.9m		
			6					
			7					
			8					
			9					

Aargus Pty Ltd
446 Parramatta Road
PETERSHAM N.S.W.
Telephone: (61) 1300137038
Fax: (61) 1300136038

BOREHOLE NUMBER BH2

CLIENT E&D Danias Pty Ltd
PROJECT NAME Geotechnical Investigation
PROJECT NUMBER GS5611/1A
PROJECT LOCATION Victoria Road Corridor - Site 2, Marrickville, NSW

DATE STARTED 15/10/13 **COMPLETED** 15/10/13
R.L. SURFACE
DATUM
DRILLING CONTRACTOR Aargus Pty Ltd
SLOPE 90°
BEARING ---
EQUIPMENT Aargus Drilling Rig
HOLE LOCATION Refer to Site Plan Figure 1
HOLE SIZE 100mm diameter
LOGGED BY MM
CHECKED BY HN
NOTES RL top of borehole is approximate

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
ADV						Concrete 150mm thick.		PAVEMENT
						FILL, silty gravelly sand, fine to coarse, grey and brown, fine to coarse gravel, moist, loose.	ES	FILL
			1			REWORKED INSITU SOILS, silty clay, medium plasticity, dark grey, moist, soft to firm.	ES SPT 2, 2, 4 N=6	REWORKED INSITU SOILS
	Seepage		2		CH	Silty CLAY, medium to high plasticity, grey with red mottling, with some fine to medium ironstained gravel, moist, firm.	ES DS, ES	ALLUVIUM SOILS
			3		CH	Silty CLAY, medium to high plasticity, grey with reddish brown mottling, with some fine to medium ironstained gravel, moist, firm.	SPT 2, 2, 5 N=7 ES	RESIDUAL SOILS
			4 5		CI	Sandy CLAY, medium plasticity, grey with red mottling, fine to medium sand, with some fine to medium ironstained gravel, moist, very stiff.	DS, ES SPT 7, 9, 14 N=23 ES	
			6 7		CH	Gravelly Sandy CLAY, medium to high plasticity, grey with reddish yellow mottling, fine to coarse sand, with some fine to medium ironstained gravel, moist, very stiff to hard.	ES DS, ES	'V' bit refusal at 7.6m bgl.
ADT			8			SANDSTONE, fine to medium grained, grey and dark brown with red mottling, very low strength, extremely weathered, with silty clay bands.		BEDROCK high 'TC' bit resistance.
			9			Borehole BH2 terminated at 8m		

Aargus Pty Ltd
446 Parramatta Road
PETERSHAM N.S.W.
Telephone: (61) 1300137038
Fax: (61) 1300136038

BOREHOLE NUMBER BH3

CLIENT E&D Danias Pty Ltd **PROJECT NAME** Geotechnical Investigation
PROJECT NUMBER GS5611/1A **PROJECT LOCATION** Victoria Road Corridor - Site 2, Marrickville, NSW

DATE STARTED 17/10/13 **COMPLETED** 17/10/13 **R.L. SURFACE** **DATUM**
DRILLING CONTRACTOR Aargus Pty Ltd **SLOPE** 90° **BEARING** ---
EQUIPMENT Aargus Drilling Rig **HOLE LOCATION** Refer to Site Plan Figure 1
HOLE SIZE 100mm diameter **LOGGED BY** MM **CHECKED BY** HN
NOTES RL top of borehole is approximate

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
ADV						FILL, silty gravel, fine to medium, grey and brown, dry to moist, loose.		FILL
						REWORKED INSITU SOILS, silty clay, medium plasticity, greenish grey with red mottling, with some fine to medium ironstained gravel, moist, soft.	ES ES	REWORKED INSITU SOILS
			1		CH	Silty CLAY, medium to high plasticity, grey with red mottling, with some fine to medium ironstained gravel, moist, firm to stiff.	SPT 2, 3, 5 N=8 ES	ALLUVIUM SOILS
			2		CH	Silty CLAY, medium to high plasticity, grey with reddish brown mottling, with some fine to medium ironstained gravel, moist, stiff.	DS	RESIDUAL SOILS
			3		CI	Sandy CLAY, medium plasticity, grey with red and brown mottling, fine to medium sand, with some fine to medium ironstained gravel, moist, stiff to very stiff.	SPT 3, 7, 9 N=16 DS	'V' bit refusal at 3.8m bgl.
ADT	Seepage		4			SANDSTONE, fine to medium grained, grey and dark brown with red mottling, very low strength, extremely weathered, with silty clay bands.	DS	BEDROCK high 'TC' bit resistance.
						Borehole BH3 terminated at 4.3m		
			5					
			6					
			7					
			8					
			9					

APPENDIX E

LABORATORY TEST RESULTS

Aargus

CERTIFICATE OF ANALYSIS

Client Name :	Aargus	**Groundswell Batch # :**	GS13620
Client Address :	446 Parramatta Road, Petrsham, NSW, 2049	**Project Name :**	Site 2 - Victoria Road, Marrickville, NSW
Client Phone # :	1300 137 038	**Project # :**	GS5611/1
Client Fax # :	1300 136 038	**Date Samples Received :**	16/12/2013
Project Manager :	Murali Muralitharan	**Sample Matrix :**	Soil
E-mail :	muralimu@aargus.net	**Sample # Submitted :**	3
Project Sample Manager :	Murali Muralitharan	**Groundswell Quote # :**	Not Applicable
E-mail :	muralimu@aargus.net	**Date CofA Issued :**	7/01/2014

Paul Woodward
Managing Director
paul@groundswelllabs.com.au

Chris De Luca
Senior Chemist
chris@groundswelllabs.com.au

NATA Accredited Laboratory 17067

Accredited for compliance with ISO/IEC 17025

Reference AF56.Rev4 Date Issued : 3/11/2010

Analytical Results

Client Sample ID				BH1 1.0-1.45m	BH2 0.5-1.0m	BH2 1.5-2.0m							
Laboratory Sample Number				**GS13620-1**	**GS13620-2**	**GS13620-3**							
Date Sampled				**15/10/2013**	**17/10/2013**	**17/10/2013**							
Analytes	**Literature Reference**	**Units**	**LOR**										
Moisture	NEPC 6.1	%	0.1	16.0	21.6	22.8							
pH	NEPC 6.2	pH Units	0.1	8.3	8.4	7.9							
Electrical Conductivity	NEPC 6.3	dS/m	0.01	<0.01	0.25	0.26							
Chloride	NEPC 6.5	mg/Kg	10	<10	117	96							
Sulphate	NEPC 9.3	mg/Kg	10	25	230	410							

Reference AF56.Rev4 Date Issued : 3/11/2010

Comments :

1- pH determined & reported on a 1:5 soil:0.01M calcium chloride extraction

2- EC determined & reported on a 1:5 soil:water extraction

3- Chloride & sulphate results reported on a dry weight basis.

4- Sulphate analysis performed by SAL, report #SAL24899A, NATA accreditation #1884.

Quality Control Report

Client Sample ID			BH2 1.5-2.0m									
Laboratory Sample Number			**GS13620-3**									
QC Parameter			**Laboratory Duplicate**					**Method Blank**		**Laboratory Control Standard (LCS)**		
			Original Result	**Duplicate**	**%RPD**	**%RPD Acceptance Criteria**	**Within GSL Acceptance Criteria (Pass/Fail)**	**Method Blank**	**Within GSL Acceptance Criteria (<LOR) (Pass/Fail)**	**LCS (%R)**	**LCS Acceptance Criteria**	**Within GSL Acceptance Criteria (Pass/Fail)**
Analytes	**Units**	**LOR**										
Moisture	%	0.1	21.6	22.8	5%	≤20%	Pass	NA	NA	NA	NA	NA
pH	pH Units	0.1	7.9	7.9	<0.1	±0.2 pH Units	pass	NA	NA	6.96	7.00±0.1 pH Units	Pass
Electrical Conductivity	dS/m	0.01	0.26	0.26	<1%	≤30%	Pass	<0.01	Pass	101%	70-130%	Pass
Chloride	mg/kg	10	96	96	<1%	≤20%	Pass	<10	Pass	102%	70-130%	Pass
Sulphate	mg/kg	10	---	---	---	≤30%	---	<10	Pass	---	70-130%	---

Reference AF56.Rev4   Date Issued : 3/11/2010

Comments :

Technical Holding Time Compliance Report

Client Sample ID			BH1 1.0-1.45m	BH2 0.5-1.0m	BH2 1.5-2.0m							
Laboratory Sample Number			**GS13620-1**	**GS13620-2**	**GS13620-3**							
Date Sampled			**15/10/2013**	**17/10/2013**	**17/10/2013**							
Analyte	**THT Parameters**	**THT (Days)**										
Moisture	Date Analysed	14	23/12/2013	23/12/2013	23/12/2013							
	Analysis Time (Days)		>14	>14	>14							
	THT Compliant		No	No	No							
pH	Date Analysed	7	23/12/2013	23/12/2013	23/12/2013							
	Analysis Time (Days)		>7	>7	>7							
	THT Compliant		Yes	Yes	Yes							
EC	Date Digested	7	23/12/2013	23/12/2013	23/12/2013							
	Analysis Time (Days)		>7	>7	>7							
	THT Compliant		Yes	Yes	Yes							
Chloride	Date Analysed	28	30/12/2013	30/12/2013	30/12/2013							
	Analysis Time (Days)		>28	>28	>28							
	THT Compliant		No	No	No							
Sulphate	Date Extracted	28	6/01/2014	6/01/2014	6/01/2014							
	Analysis Time (Days)		>28	>28	>28							
	THT Compliant		No	No	No							

Reference AF56.Rev4 Date Issued : 3/11/2010

Groundswell Laboratories

116 Moray Street, South Melbourne, Victoria, 3205.
Ph (03) 8669 1450   Fax (03) 8669 1451   (M) 0416 203 845 e-mail : admin@groundswelllabs.com.au

Sample Receipt Notice

Client Name	Aargus
Client Project Manager	Murali Muralitharan
Client e-mail	muralimu@aargus.net
Client Address	446 Parramatta Road, Petersham, NSW, 2049
Client Phone	1300 137 038
Project Name	Site 2 Victoria Road, Marrickville, NSW
Project Number	GS5611/1
CofC Serial Number	Not Applicable
Purchase Order Number	Not Applicable
Date Sampled / Sampling Period	15-17/12/2013
Date Samples Received	16/12/2013
Date Sample Receipt Notice Issued	23/12/2013
Date Analytical Report Due	7/01/2014
Groundswell Batch Number	GS13620
Groundswell Quote Number	Not Applicable
Groundswell Sample Receipt Contact	Chris De Luca
E-mail	chris@groundswelllabs.com.au
Groundswell Reporting Contact	Paul Woodward
E-mail	paul@groundswelllabs.com.au
Reporting Requirements	pdf, xlsx
Sample Condition	Samples at ambient temperature when received COC received with samples & samples detailed on the COC match those received Analytical request on the CofC clear Samples were received in appropriate containers, and appropriately preserved Samples were received within the THT's adopted by Groundswell

Comments

Subcontracted Analysis

Secondary Laboratory Analysis

Thanks for choosing Groundswell Laboratories

AARGUS PTY LTD

Laboratory Test Request / Chain of Custody Record

446 Parramatta Road
PETERSHAM NSW 2049

P O Box 398
DRUMMOYNE NSW 1470

Tel: 1300 137 038
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email: admin@aargus.net & MuraliMu@aargus.net

TO: **Groundswell Laboratories**
116 Moray Street
South Melbourne VIC 3205

PH: **03 8669 1450** **FAX:** **03 8669 1451**

ATTN:

Sampling Date: 15-17/10/2013 **Job No:** GS5611/1

Sampled By: MM **Project:** Geotechnical Investigation

Project Manager:
Report to be sent to: MuraliMu@aargus.net **Location:** Site 2 - Victoria Road, Marrickville, NSW
include admin

Results required by: STANDARD

Sampling details: Location	Depth (m)	Sampling Date	Sample type: Soil	Sample type: Water	Electical Conductivity	pH	Chloride	Sulphate						KEEP SAMPLE
GS13620-1 BH1	1.0-1.45m	15/10/2013	DSG		✓	✓	✓	✓						Yes
-2 BH2	0.5-1.0m	17/10/2013	DSG		✓	✓	✓	✓						Yes
-3 BH2	1.5-2.0m	17/10/2013	DSG		✓	✓	✓	✓						Yes

Relinquished by: Name	Signature	Date	Received by: Name	Signature	Date
Murali Muralitharan	R.C.M.J. [signature]	13/12/2013	Penny M	[signature]	16/12/13 12.30pm

Legend:

WG	Water sample, glass bottle	USG	Undisturbed soil sample (glass jar)	GV	Glass Vial	P	Plastic Bag
WP	Water sample, plastic bottle	DSG	Disturbed soil sample (glass jar)	✓	Test required		

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