Aargus

Environmental - Remediation - Engineering - Laboratories - Drilling

GEOTECHNICAL INVESTIGATION REPORT

Malco Site (Site 3)
Rich Street
Marrickville NSW

Prepared for

E & D Danias Pty Ltd

Report No. GS5544/2A

20th December 2013

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3. Australian Standard – AS 2159-2009 Piling - Design and installation.
4. Australian Standard – AS 2870-2011 Residential slabs and footings.
5. Australian Standard – AS3798-2007 Guidelines on Earthworks for Commercial and Residential Developments.
6. Department of Infrastructure, Planning and Natural Resources, “Salinity Potential in Western Sydney 2002”, March 2003.
7. Pells, P.J.N, Mostyn, G. & 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 at Malco Site (Site 3) at Rich Street, Marrickville, NSW 2204. The site investigation was carried out on the 12th and 13th of September 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. AVAILABLE INFORMATION

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

- Drawing titled "Detail and Level Survey" for Lot 53 in DP 868710 Lot A in DP178259, Lot 5 in DP 63446 at Rich and Brompton Streets, Marrickville, prepared by T. J. Gilbert & Associates – Land and Engineering Surveyors, referenced job No.2851 and dated 29th May 2001; and
- Drawing titled "Boundary Pegging Survey", for Lot 53 in DP 868710, Lot A in DP178259, Lot 5 in DP 634461 at Rich and Brompton Streets, Marrickville, prepared by T. J. Gilbert + Associates – Land and Engineering Surveyors, Job No. 28511 and dated 22nd February 2005.

An Environmental Site Assessment (ESA) was carried out at the site by Aargus in August 2013. The results were documented in a report referenced ES5544 and dated 30th August 2013.

Soil sampling for Acid Sulphate Soils (ASS) Assessment at this site was carried out as part of the environmental investigation by Aargus. Results of the ASS assessment were documented in a report referenced ES5544/3 and dated 14th October 2013.

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 carried out by a specialist contractor using electromagnetic detection equipment to ensure that the investigation area is free from underground services;
- Machine drilling of three boreholes identified as BH101 to BH103 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 6.4m to 10.1m and extended to TC bit refusal depths varying from approximately 6.6m to 10.7m. Borehole BH101 was extended further into bedrock using NMLC coring technique to approximately 7.4m 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 Eurofins laboratory for determination of 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 within 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 within the site; and
- General recommendations for design and construction of the future development.

4. SITE DESCRIPTION

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

The site is an irregular shaped land with an approximate area of 1.258 hectares, consisting of amalgamation of the adjoining deposited plans (D.P.) being D.P. 868710, D.P.178259 and D.P. 63446.

The site is bounded by the following properties and infrastructure:

- Victoria Road road reserve and carriageway to the south-east;
- Rich Street road reserve and carriageway to the south-west;
- The properties to the north-west of the site, which are occupied by a warehouse type building, a two storey brick office and warehouse type complex;
- The property to the north of the site, which is occupied by a two storey warehouse type building; and
- Brompton Street road reserve and carriageway and the property to the east of the site, which is occupied by brick office and warehouse type buildings.

The majority of the site is covered by a number of warehouse type buildings with the remainder of the site being covered with concrete hardstand areas.

An open stormwater channel is present across the site, running from the north-western boundary to the south-eastern boundary. The channel consists of brick walls embedded approximately 2.5m bgl and is approximately 3.0m wide. No significant water flow was observed in the stormwater channel during the site investigation.

The ground surface at the site gently slopes to the south within the area north of the channel and south-east within the area to the south of the channel, towards the stormwater channel. The ground surface vary in elevations from approximately RL 7.1m and RL 7.96m in the vicinity of the site northern corner and western corner respectively to approximately RL 6.0m in the vicinity of the site southern corner.

Several cracks and signs of deterioration were observed on the concrete pavement within the site.

A number of mature trees were present along the southern boundary. Some grassed areas, shrubs and low growing trees are present alongside the stormwater channel.

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, email correspondence from Design Collaborative, the project architects, on 14th August 2013 indicates the development within this site may consist of construction of up to ten storey building with up to three basement levels for underground parking.

Regarding the existing stormwater channel, for basement excavation, it is expected that the channel will be diverted to other areas around the site in order to maintain the natural drainage of the local area. However, if the current alignment of the channel is to be maintained then consideration should be given during the stage to bridge future buildings over the channel.

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, indicates the site is located within an area underlain by Triassic Age Ashfield Shale of the Wianamatta Group, denoted as Rwa. The Ashfield Shale is described as black to dark grey shale and laminate.

However, the site is located at approximately 200m and 500m to the geological boundaries with the Quaternary Alluvial deposits (Qhs), which is described as "peat, sandy peat and mud", and the Hawkesbury Sandstone (Rwa), respectively.

7. INVESTIGATION RESULTS

7.1 Surface Conditions

Except for the area within the existing stormwater channel, the majority of the site was covered with approximately 200mm thick reinforced concrete pavement.

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, dark grey with yellow mottling, soft to firm/ loose becoming medium dense at depth, moist to wet interbeded gravelly silty sand and sandy silty clay. The fill thickness is inferred to be greater in the vicinity of the stormwater channel; overlying
- Alluvial soils, consisting of grey brown, low to medium plasticity, hard and wet sandy clay, which was encountered in borehole BH101 only and is likely to be present in the vicinity of the stormwater channel; overlying
- Residual soils, consisting of grey and reddish grey, medium to high plasticity and firm to stiff silty clay to depths varying from approximately 4.2m to 5.0m bgl, becoming stiff to very stiff silty clay to the top of bedrock; overlying

- Class V sandstone bedrock, grey mottled brown and reddish grey, extremely to highly weathered, very low to low strength. The top of the bedrock within the southern portion of the site is inferred to be deeper than the bedrock within the northern portion. Horizons of stronger rock such as Class IV sandstone, which typically underlies Class V sandstone, may be present at this site.

Classification of the rock was carried out in accordance with the guidelines provided by Pells et al (Reference 7).

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

Table 1: Summary of Subsurface Conditions encountered in the Boreholes

Unit	Depth to Top of Layer (m bgl)	Thickness (m)	RL at Top of Layer (m)	SPT N Values (blows/300mm)
Fill	0.2	2.3 to 3.0 (near the channel) 1.3 (remainder of the site)	5.8 to 6.7	4 to 31
Alluvial Soils	3.2 (only at BH101)	1.0	3.7	Not tested
Firm to Stiff Residual Soils	2.5 to 4.2 (near stormwater channel) 1.5 (remainder of the site)	up to 2.5 (near stormwater channel) up to 3 (remainder of the site)	2.7 to 3.5 (near stormwater channel) 4.8 (remainder of the site)	8 to 13
Stiff to Very Stiff Residual Soils	4.2 to 5.0	2.2 to 5.4	1 to 2.7	16 to 34
Class V Sandstone	6.4 to 10.4	Unconfirmed	-4.4 to 0.5	Not tested

Notes: All depths are approximate.
The surface levels were estimated from the provided survey drawing.
AHD = Australian Height Datum.

7.3 Groundwater

During drilling, groundwater was encountered in the three boreholes at depths varying from approximately 2.3 to 2.7m bgl.

Three groundwater monitoring wells identified as GW1 to GW3 inclusive were installed in the boreholes drilled within the site as part of the ESA in August 2013 by Aargus.

Subsequent groundwater monitoring in the three wells indicated groundwater levels varies from approximately 1.30m to 1.77m bgl.

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.

7.4 Salinity and Aggressivity

Three soil samples recovered during drilling in borehole BH102 at approximately 2.0m, 5.0m and 9.5m bgl were tested by Eurofins Laboratories, a NATA accredited testing laboratory. The testing included determination of Saline content, pH, Chloride and Sulphate 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
BH102	2.0 – 2.5	0.40	7 – 8	2.80 – 3.20	Silty Clay
BH102	5.0 – 5.5	0.29	7 – 8	2.03 – 2.32	Silty Clay
BH102	9.5 – 10.0	0.41	7 – 8	2.87 – 3.28	Gravelly 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)	Moisture Content %	pH	Chloride (mg/kg)	Sulphate as $S0_4$ (mg/kg)
BH102	2.0 – 2.5	25	5.1	150	510
BH102	5.0 – 5.5	23	6.7	280	228
BH102	9.5 – 10.0	19	6.9	640	96
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	

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
- Building Foundations
- Groundwater Management
- Retaining Walls
- Site Earthquake Classification
- Soil Salinity and Aggressivity

A summary for assessment of the geotechnical aspects above and recommendations for design and construction of the future development 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, alluvial and residual soils. Excavation into weathered sandstone may be required if basement levels extended below 6.4m to 10.4m bgl, which is the inferred depth of the sandstone bedrock at this site.

Excavation in the soils and weathered sandstone materials should be typically feasible using conventional earthmoving equipment. However, excavation of less fractured Class V sandstone or low strength Class IV sandstone that may be 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 be undertaken prior to project excavation commencement including 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 Aargus should be contacted immediately for appropriate reviews.

8.4 Stability for 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 should 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, contiguous or secant pile wall, with reinforced concrete panels covering the gaps between semi-contiguous piles.

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 system 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 adjacent buildings and infrastructure.

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.

Shoring walls supporting the stormwater channel should be designed and constructed in a manner that would not result in movement in the existing or future diverted stormwater channel structure. The use of "at rest" coefficient of lateral earth pressure in the design of shoring wall supporting the channel is recommended.

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.

Earth retention structures and anchors can be designed using the recommended parameters provided in Section 8.5. 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. Monitoring 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	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	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 foundation options are recommended for future 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 lightly to moderately loaded structures, fill and the alluvial soils 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 or Class V sandstone is expected 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	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 future buildings at site.
4 The actual depth of the underlying Class IV sandstone should be confirmed by further investigation or during construction.

For buildings over the footprint of the existing stormwater channel, foundations consisting of piles, should be design to bridge over the channel and extended to depth sufficient to avoid imposing stresses on the channel structure.

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 proposed future 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 4 to 34 blows/300mm extending to approximately up to 9.7m bgl underlain by sandstone bedrock. 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 6), the resultant electrical conductivity of saturated extracts (ECe) ranges from approximately 2.03 dS/m to 3.28 dS/m, as shown on Table 2, indicating the soil horizons at depths varying from approximately 2.0m to 2.5m, from approximately 5.0m to 5.5m and from approximately 9.5m to 10.0m 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 BH101 and BH102, as presented in Table 3, indicate that the underlying soils at depth varying from approximately 2.0m to 2.5m bgl have "mild aggressivity" to reinforced concrete and "non-aggressivity" to steel foundation elements. The test results indicate the underlying soil horizons from approximately 5.0m to 10.0m bgl have "non-aggressivity" to and concrete steel 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 overlying 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 6.4m to 10.4m bgl. Alluvial soils are present at some locations within the site, mostly in the vicinity of the existing stormwater channel. Stronger rock class, i.e. Class IV sandstone, which typically underlies Class V, may be present underlying the site. The actual depth of the underlying Class IV sandstone should be confirmed by further investigation or during construction.

9.2 Groundwater monitoring carried out for this site indicated the natural groundwater levels varies from approximately 1.30m to 1.77m 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 Excavations for the proposed future basement should be retained prior to excavation along the perimeter walls using a shoring wall 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.

9.4 If the use of heavy ripping, high capacity or vibratory rock breaking equipment are 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.

9.5 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.
- Piled foundations for basement floors founded in soils.

9.6 Earth retaining structures should be designed to withstand the 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.

9.7 Ground structures should be designed to avoid imposing stresses on the existing or proposed diverted stormwater channel within the site.

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

9.9 Dilapidation surveys for existing building and infrastructure within surrounding properties 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 inspections 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 ABOUT YOUR GEOTECHNICAL REPORT

Aargus

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

Aargus

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.

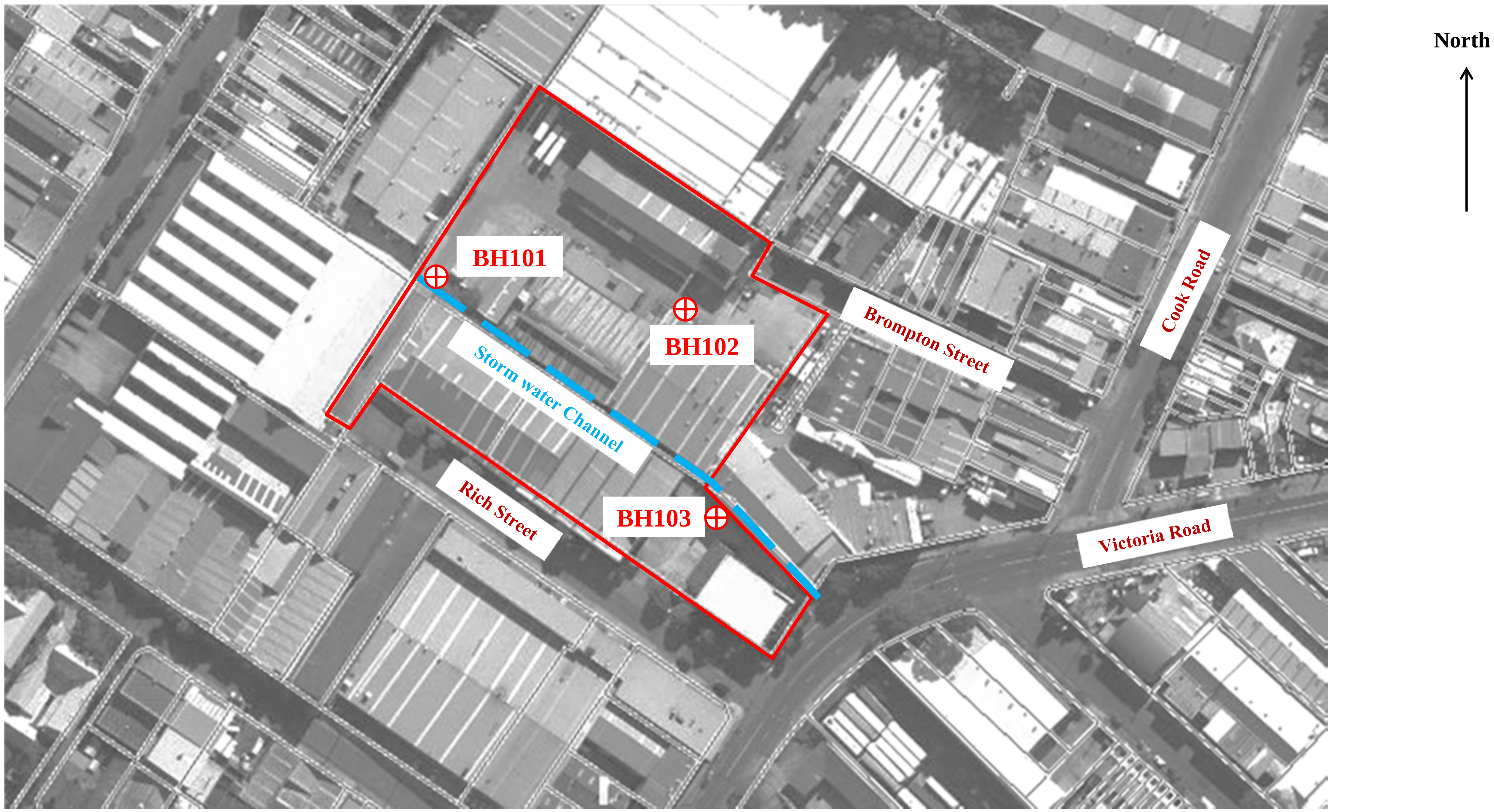
FURTHER GENERAL NOTES

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.

This report is subject to copyright and shall not be reproduced either totally or in part without the express permission of the Company. Where information from this report is to be included in contract documents or engineering specifications for the project, the entire report should be included in order to minimise the likelihood of misinterpretation.

APPENDIX B

SITE PLAN (FIGURE 1)



Legend: ⊕ Approximate locations of the boreholes drilled on 12th and 13th September 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** **Malco Site (Site 3) – Rich Street, Marrickville NSW**	Aargus	Figure 1
Checked	HN			Title Site Plan
Date	20/12/2013			
Scale	NTS			Job No Job No: GS5544/2A

APPENDIX C

SITE PHOTOGRAPHS (FIGURE 2)

Photograph 1
View from the western boundary of the site, adjacent to the location of borehole BH101, towards the east.

Photograph 2
View of the open hardstand area in the middle of the site towards the north-west.

Photograph 3
View of the location of borehole BH102 and the carpark adjacent to the Brompton Street entrance towards the east.

Photograph 4
View of the entrance from Rich Street and the existing building within the southern part of the site.

Photograph 5
View of the area in the vicinity of borehole BH103 towards the east.

Photograph 6
View of the existing building and the pavement area adjacent to the eastern boundary

Photograph 7
View of the parking area in the middle of the site towards the south-west.

Photograph 8
View of the existing storm-water channel within the site.

Figure 2 – Site Photographs

APPENDIX D

ENGINEERING BOREHOLE LOGS

Aargus

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

BOREHOLE NUMBER BH101

CLIENT E&D Danias Pty Ltd
PROJECT NAME Geotechnical Investigation
PROJECT NUMBER GS5544/2A
PROJECT LOCATION Malco Site (Site 3) - Rich Street, Marrickville, NSW

DATE STARTED 12/9/13 **COMPLETED** 12/9/13
R.L. SURFACE 6.9 **DATUM** m AHD
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

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
ADV						Reinforced Concrete approximate 200mm thick.		Pavement
		6	1			FILL, gravelly silty sand, fine to coarse, dark grey, fine to coarse gravel, with some silty clay, moist, loose.	ES	Fill
	Seepage	5	2			FILL, sandy silty clay, medium plasticity, grey with red mottling, fine to coarse sand, with some fine to coarse gravel, moist, soft to firm.	SPT 1, 2, 2 N=4; DS, ES	
		4	3			FILL, clayey sand, fine to coarse, grey, wet, with hydrocarbon odour, medium dense to dense.	SPT 9, 13, 18 N=31	
		3	4		CI	Sandy CLAY, low to medium plasticity, grey brown, wet, very stiff to hard.	ES	Alluvial soil
		2	5		CI	Silty Sandy CLAY, medium plasticity, reddish grey, fine to coarse sand, wet, hard.	SPT 12, 16, 18 N=34	Residual soil
		1	6		CI	Sandy CLAY, medium to high plasticity, fine to coarse sand, grey, wet, hard.		

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BOREHOLE NUMBER BH101

CLIENT E&D Danias Pty Ltd
PROJECT NAME Geotechnical Investigation
PROJECT NUMBER GS5544/2A
PROJECT LOCATION Malco Site (Site 3) - Rich Street, Marrickville, NSW

DATE STARTED 12/9/13 **COMPLETED** 12/9/13 **R.L. SURFACE** 6.9 **DATUM** m AHD
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

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
ADV					CI	Sandy CLAY, medium to high plasticity, fine to coarse sand, grey, wet, hard. *(continued)*		'V' bit refusal at 6.4m
ADT						SANDSTONE, grey mottled brown, very low to low strength, highly weathered.		Bedrock 'TC' bit refusal at 6.6m
NMLC		0	7			SANDSTONE, grey, low strength, highly weathered.	DS (from coring)	Coring started at 6.6m, bedrock material was recovered as thin bands of cores and gravel
		-1	8			Borehole BH101 terminated at 7.2m		
		-2	9					
		-3	10					
		-4	11					
		-5	12					

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BOREHOLE NUMBER BH102

CLIENT E&D Danias Pty Ltd
PROJECT NAME Geotechnical Investigation
PROJECT NUMBER GS5544/2A
PROJECT LOCATION Malco Site (Site 3) - Rich Street, Marrickville, NSW

DATE STARTED 13/9/13 **COMPLETED** 13/9/13
R.L. SURFACE 6.3 **DATUM** m AHD
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

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
ADV			0.0–0.2			Reinforced Concrete approximate 200mm thick.		Pavement
		6	0.2–1.5			FILL, gravelly silty sand, fine to coarse, dark grey, fine to coarse gravel, with some silty clay, moist, loose.	ES	Fill
		5	1.5–4.5		CI	Silty CLAY, medium to high plasticity, grey with red mottling, moist, firm to stiff.		Residual soil
	Seepage	4				becoming wet.	DS, ES	
							SPT 2, 4, 5 N=9	
		3, 2						
		1	4.5–6.0		CI	Silty CLAY, medium to high plasticity, grey with red mottling, with some silty gravel, fine to coarse gravel, wet, stiff to very stiff.	DS	
							SPT 4, 7, 9 N=16	

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BOREHOLE NUMBER BH102

CLIENT E&D Danias Pty Ltd
PROJECT NAME Geotechnical Investigation
PROJECT NUMBER GS5544/2A
PROJECT LOCATION Malco Site (Site 3) - Rich Street, Marrickville, NSW

DATE STARTED 13/9/13 **COMPLETED** 13/9/13 **R.L. SURFACE** 6.3 **DATUM** m AHD
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

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
ADV		0			CI	Silty CLAY, medium to high plasticity, grey with red mottling, with some silty gravel, fine to coarse gravel, wet, stiff to very stiff. *(continued)*		
		-1, -2	7, 8, 9		CI	Silty CLAY, medium to high plasticity, grey with yellow and red mottling, interbedded with siltstone layers, wet, very stiff.		'V' bit refusal at 9.2m
ADT		-3			CL	Gravelly Silty CLAY, medium plasticity, red and grey, with hard ironstone layers, gravel up to 40mm in size.	DS	
			10			SANDSTONE, reddish grey, extremely weathered, very low strength, with ironstone layers.		Bedrock 'TC' bit refusal at 10.1m
		-4, -5	11, 12			Borehole BH102 terminated at 10.1m		

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BOREHOLE NUMBER BH103

CLIENT E&D Danias Pty Ltd
PROJECT NAME Geotechnical Investigation
PROJECT NUMBER GS5544/2A
PROJECT LOCATION Malco Site (Site 3) - Rich Street, Marrickville, NSW

DATE STARTED 13/9/13 **COMPLETED** 13/9/13 **R.L. SURFACE** 6.0 **DATUM** m AHD
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

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
ADV						Reinforced Concrete approximate 200mm thick.		Pavement
						FILL, gravelly silty sand, fine to coarse, dark grey with yellow mottling, fine to coarse gravel, with some silty clay, moist, very loose to loose.	DS, ES	Fill
		5	1				SPT 1, 2, 2 N=4	
		4	2				DS, ES	
	Seepage				CI	Silty CLAY, medium to high plasticity, reddish brown, with some silty gravel, fine to coarse gravel, moist, firm to stiff. becoming wet.	SPT 1, 3, 5 N=8	Residual soil
		3	3					
					CI	Silty CLAY, medium plasticity, grey with red mottling, some fine sand.	DS, ES	
		2	4				SPT 3, 6, 7 N=13	
		1	5				DS, ES	
					CI	Silty CLAY, medium plasticity, grey and yellow with red mottling, with some silty gravel, fine to coarse gravel, wet, very stiff.	SPT 3, 10, 12 N=22	
		0	6					

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Telephone: (61) 1300137038
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BOREHOLE NUMBER BH103

CLIENT E&D Danias Pty Ltd
PROJECT NAME Geotechnical Investigation
PROJECT NUMBER GS5544/2A
PROJECT LOCATION Malco Site (Site 3) - Rich Street, Marrickville, NSW

DATE STARTED 13/9/13 **COMPLETED** 13/9/13 **R.L. SURFACE** 6.0 **DATUM** m AHD
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

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
ADV					CI	Silty CLAY, medium plasticity, grey and yellow with red mottling, with some silty gravel, fine to coarse gravel, wet, very stiff. *(continued)*	DS	
		-1	7					
					CI	Silty Gravelly CLAY, medium to high plasticity, grey and yellow with red mottling, reddish brown ironstained gravel layers, wet, very stiff.	SPT 3, 9, 13 N=22	
		-2	8				DS	
							SPT 4, 11, 14 N=25	
		-3	9					
					CL	Silty Gravelly CLAY, medium to high plasticity, grey and yellow with red mottling, reddish brown ironstained gravel layers, wet, hard.		
ADT		-4	10				DS	'V' bit refusal at 10.1m
						SANDSTONE, grey mottled brown, very low strength, extremely weathered, with clay bands and ironstone.		Bedrock 'TC' bit refusal at 10.7m
						Borehole BH103 terminated at 10.7m		
		-5	11					
		-6	12					

APPENDIX E

LABORATORY TEST RESULTS

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Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 18217

Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Aargus P/L
446 Parramatta Road
Petersham
NSW 2049

Attention: **Lubos Melicharek**

Report **393400-S**
Client Reference SITE INVESTIGATION GS5544/2
Received Date Sep 19, 2013

Client Sample ID			**BH102 2.0-2.5**	**BH102 5.0-5.5**	**BH102 9.5-10.0**
Sample Matrix			**Soil**	**Soil**	**Soil**
Eurofins | mgt Sample No.			**S13-Se13975**	**S13-Se13976**	**S13-Se13977**
Date Sampled			**Sep 13, 2013**	**Sep 13, 2013**	**Sep 13, 2013**
Test/Reference	LOR	Unit			
Chloride	10	mg/kg	150	280	640
Conductivity (1:5 aqueous extract at 25°C)	5	uS/cm	400	290	410
pH (1:5 Aqueous extract)	0.1	units	5.1	6.7	6.9
Sulphate (as S)	10	mg/kg	170	76	32
% Moisture	0.1	%	25	23	19

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Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

Description	Testing Site	Extracted	Holding Time
Chloride	Sydney	Sep 23, 2013	28 Day
- Method: E033 /E045 /E047 Chloride			
Conductivity (1:5 aqueous extract at 25°C)	Sydney	Sep 24, 2013	7 Day
- Method: E032.2 Electrical Conductivity (EC)			
pH (1:5 Aqueous extract)	Sydney	Sep 24, 2013	7 Day
- Method: E018.2 pH			
Sulphate (as S)	Sydney	Sep 23, 2013	28 Day
- Method: E045 Sulphate			
% Moisture	Sydney	Sep 19, 2013	28 Day
- Method: E005 Moisture Content			

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3-5 Kingston Town Close
Oakleigh VIC 3166
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NATA # 1261
Site # 1254 & 14271

Sydney
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Lane Cove West NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

Brisbane
1/21 Smallwood Place
Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

Company Name:	Aargus P/L	**Order No.:**		**Received:**	Sep 19, 2013 12:40 PM
Address:	446 Parramatta Road Petersham NSW 2049	**Report #:**	393400	**Due:**	Sep 26, 2013
		Phone:	1300 137 038	**Priority:**	5 Day
		Fax:	1300 136 038	**Contact Name:**	Lubos Melicharek
Client Job No.:	SITE INVESTIGATION GS5544/2				

Eurofins | mgt Client Manager: Ruth Callander

Sample Detail					% Moisture	Chloride	Conductivity (1:5 aqueous extract at 25°C)	pH (1:5 Aqueous extract)	Sulphate (as S)
Laboratory where analysis is conducted									
Melbourne Laboratory - NATA Site # 1254 & 14271									
Sydney Laboratory - NATA Site # 18217					X	X	X	X	X
Brisbane Laboratory - NATA Site # 20794									
External Laboratory									
Sample ID	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**					
BH102 2.0-2.5	Sep 13, 2013		Soil	S13-Se13975	X	X	X	X	X
BH102 5.0-5.5	Sep 13, 2013		Soil	S13-Se13976	X	X	X	X	X
BH102 9.5-10.0	Sep 13, 2013		Soil	S13-Se13977	X	X	X	X	X

Eurofins | mgt Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. Actual PQLs are matrix dependant. Quoted PQLs may be raised where sample extracts are diluted due to interferences.
4. Results are uncorrected for matrix spikes or surrogate recoveries.
5. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
6. Samples were analysed on an 'as received' basis. 7. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Acknowledgment.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

****NOTE:** pH duplicates are reported as a range NOT as RPD

UNITS

mg/kg: milligrams per Kilogram

ug/l: micrograms per litre

ppb: Parts per billion

org/100ml: Organisms per 100 millilitres

MPN/100mL: Most Probable Number of organisms per 100 millilitres

mg/l: milligrams per litre

ppm: Parts per million

%: Percentage

NTU: Units

TERMS

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery
CRM	Certified Reference Material - reported as percent recovery
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands. In the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
Batch Duplicate	A second piece of analysis from a sample outside of the clients batch of samples but run within the laboratory batch of analysis.
Batch SPIKE	Spike recovery reported on a sample from outside of the clients batch of samples but run within the laboratory batch of analysis.
USEPA	United States Environment Protection Authority
APHA	American Public Health Association
ASLP	Australian Standard Leaching Procedure (AS4439.3)
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within

QC - ACCEPTANCE CRITERIA

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries : Recoveries must lie between 50-150% - Phenols 20-130%.

QC DATA GENERAL COMMENTS

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxophene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxophene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Arochlor 1260 in Matrix Spikes and LCS's.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPD's are calculated from raw analytical data thus it is possible to have two sets of data.

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank									
Chloride			mg/kg	< 10			10	Pass	
Sulphate (as S)			mg/kg	< 10			10	Pass	
LCS - % Recovery									
Chloride			%	108			70-130	Pass	
Sulphate (as S)			%	105			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
				Result 1					
Chloride	S13-Se13975	CP	%	120			70-130	Pass	
Sulphate (as S)	S13-Se13975	CP	%	109			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
Chloride	S13-Se11426	NCP	mg/kg	17	17	<1	30%	Pass	
Conductivity (1:5 aqueous extract at 25°C)	S13-Se13975	CP	uS/cm	400	400	2.0	30%	Pass	
Sulphate (as S)	S13-Se13975	CP	mg/kg	170	170	1.0	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Organic samples had Teflon liners	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised By

Ruth Callander	Client Services
Bob Symons	Senior Analyst-Inorganic (NSW)

Dr. Bob Symons

Laboratory Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Uncertainty data is available on request