Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Investigation

Residential Development
4 Mitchell Street, Enfield

Prepared for
Tian An Australia Limited

Project 85921.00
June 2017

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author		27 June 2017
Reviewer		27 June 2017

bsi. ISO 9001 Quality Management

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Report on Geotechnical Investigation
Residential Development
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1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed residential development at the 4 Mitchell Street, Enfield. The investigation was requested in an email dated 30 March 2017 by Nicholas Tao of Tian An Australia Limited and was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal SYD170284, dated 3 April 2017.

It is understood that the options for the proposed development comprise five to seven story residential blocks with a joint single level basement car park. The site is currently occupied by one multi storey and one single storey building and a single level basement carpark. It is understood that the existing basement will be retained and possibly extended by additional excavation

The aim of the investigation was to assess the ground conditions across the site to provide geotechnical information for a development application and early design works.

The geotechnical investigation comprised the drilling of six boreholes and three dynamic cone penetrometer (DCP). The details of the field work are presented in this report, together with geotechnical comments and recommendations.

2. Site Description

The roughly rectangular shaped site, of approximately 11,400m^2 is accessed from Mitchell Street. The site is bound by residential properties along the northern and eastern boundaries, Mitchell Street on the south and Henley Park along the western boundary.

The site slopes to the south-west with a surface level along the north-eastern boundary of approximately RL25.0 m and along the south-western boundary of approximately RL22.0 m, relative to the Australian Height Datum. The site is currently occupied by one multi storey and one single storey building and a single level basement carpark, located on a level platform in the centre of the site.

Access to the basement is via a sealed access track along the eastern edge of the building. Additional ground level car parking is located in the south–western corner. The perimeter of the site is landscaped with medium size trees.

Available information indicates that a 2.5 m diameter water tunnel crosses the site in an east west direction, apparently at a depth of about 56-61 m. A buried Telstra cable is located along the south-western boundary, before it crosses the site nearly parallel to the water tunnel, but close to the surface.

The layout of the site, together with the borehole locations are show on Drawing 1 in Appendix B.

3. Regional Geology

Reference to the Sydney 1:100 000 Geology Sheet indicates that the site is located near the boundary of the Triassic aged Bringelly Shale, comprising shale, carbonaceous claystone, laminite, fine to medium-grained lithic sandstone and rare coal and the Ashfield Shale which comprises black to dark-grey shale, siltstone and laminite.

The field investigations confirmed the presence of filling, underlain by clayey residual soil, which in turn grades into weathered shale, consistent with the Ashfield Shale unit.

4. Field Work Methods

Field work comprised the drilling of six boreholes, identified as BH1-BH6, three along the eastern and three along the western boundary. The boreholes were drilled to between 2.4 m and 5.7 m depth below ground level using a bobcat mounted drilling rig with solid flight auger method. Standard penetration tests (SPT) were carried out at regular intervals to recover samples for material identification and to determine in situ material characteristics.

The borehole locations were selected to provide information for most of the site and adjusted on site based on access restrictions and locations of buried services. Surface elevations (RL) at the test locations were interpolated using supplied survey data.

Three Dynamic cone penetrometer (DCP) tests were carried out adjacent to boreholes BH1, 3 and 5 to determine the in situ consistency of the soil.

During field work, four existing standpipes were identified and the groundwater level was measured in each.

5. Field Work Results

5.1 Subsurface Conditions

The boreholes drilled along the approximate alignment of the proposed retaining wall encountered the following:

- Asphaltic Concrete – 20 - 40 mm of asphaltic concrete in BH1 and BH5;
- Roadbase – 100 to 200 mm of roadbase material underlying the asphaltic concrete;
- Filling – various filling materials comprising ripped shale, sand with traces of roadbase gravel or sandy clay with ferruginous nodules, to a depth of between 0.5 m to 0.7 m, except in BH6 where it extended to a depth of 1.1 m;
- Clay – stiff or very stiff, red-brown mottled pale grey or brown to between 1.1 m and 3.0 m in boreholes BH1, BH4, BH5 and BH6; and
- Shale - extremely low strength, extremely weathered, pale grey-brown shale underlying filling in BH2 and BH3 and residual clay in the other boreholes. The rock graded to very low strength from

between 1.0 m and 2.0 m in BH1 to BH3 and to very low to low strength from between 3.0 m and 5.6 m.

Four existing monitoring wells (identified as MW01 to MW04) were identified on site and groundwater levels were measured on 3 May and a few days later. The measured groundwater levels are shown in Table 1 below.

Table 1: Measured Groundwater Levels

Monitoring Well ID	Groundwater level (m below ground) - 3 May 2017	Groundwater level (m below ground) - 16 May 2017
MW01	1.02	1.04
MW02	5.19	5.55
MW03	5.64	7.72
MW04	4.14	4.06

The DCP test results indicated that the filling is typically well compacted and the residual clays have a very stiff to hard consistency.

The borehole logs and the DCP test result sheet, together with the Notes related to their preparation, are provided in Appendix C.

5.2 Laboratory Testing

Two soil samples were tested for pH, sulphate (SO_4), chloride (Cl) and electrical conductivity (EC) to determine the aggressivity of the soil to buried structural elements. The results of these tests are summarised in Table 2 below.

Table 2: Summary of Aggressivity Test Results on Soil Samples

Test Bore and depth (m)	Soil Description	pH	SO_4 (mg/kg)	Cl (mg/kg)	EC (µS/cm)	Resistivity (Ω.cm)
BH2 (0.4-0.5)	Filling – Clay and shale fragments	7.9	22	13	72	1×10^4
BH3(0.9-1.0)	Clay - Extremely weathered shale	5.2	110	69	140	7×10^3

6. Comments

6.1 Proposed Development

It is understood that the options for the proposed development comprise five to seven story residential blocks with a joint single level basement car park. The works are proposed to comprise demolition of

the existing buildings, excavation for the extension and/or reconfiguration of the single level basement and construction of multi-storey residential blocks with auxiliary access roads and paved areas.

6.2 Pavement Subgrade

It is envisaged that after the removal of the surficial layers, new pavements will use the existing filling or residual clay soil as subgrade. The DCP test results were used to estimate the in situ CBR value of the various soils. It should be noted that the DCP tests results are only applicable for the prevailing soil moisture conditions at the time of testing and are expected to change due to climatic conditions. Based on the DCP test results, the suggested subgrade design values shown in Table 3 could be adopted.

Table 3: Suggested Design CBR Values

Pavement Layer	Range of estimated *in situ* CBR Values (%)	Suggested Subgrade Design CBR*
Filling*	6 - 22	5
Clay, very stiff	10 – 17	8
Extremely weathered shale	12 - 40	10

Note: * Provided the material is uniformly compacted to 98% dry density ratio.

Once the layout of the proposed pavements is known and the subgrade levels identified, a more accurate design CBR value can be determined by using standard laboratory test methods.

6.3 Excavation Characteristics

The filling and clay, together with the extremely low and low strength shale should be readily excavated using conventional earthmoving equipment, such as a hydraulic excavator with a bucket attachment.

It would be prudent to monitor and limit vibrations where excavator mounted hydraulic rock hammers are required during the demolition of the existing structures, in close proximity to adjacent structures. Based on DP's experience and with reference to AS2670, a maximum peak particle velocity of 8 mm/sec (in any component direction) at the foundation level of adjacent structures is suggested for human comfort considerations. Vibration trials are suggested during initial excavation of rock, to verify vibration levels. A dilapidation survey of the structures on the adjacent properties should be carried out prior to commencing with work on site.

6.3.1 Disposal of Excavated Material

The scope of this investigation did not include sampling and testing for Waste Classification or Contamination Assessment purposes. All excess excavated materials will need to be classified and disposed of in accordance with current NSW Environment Protection Authority (EPA) regulations. Classification should be undertaken with reference to NSW EPA (2014) Waste Classification Guidelines prior to disposal. This includes filling and virgin excavated natural materials (VENM), such

as may be removed from this site. Accordingly, environmental testing will need to be carried out to classify spoil prior to disposal. The type and extent of testing undertaken will depend on the final use or destination of the spoil, and requirements of the receiving site. It should be noted that some fill sites, such as those operated by Councils or other bodies might have their own special environmental criteria to be met before admitting any materials.

6.4 Excavation Support

Temporary slopes in filling and soil up to a maximum height of 3 m can be cut at batter slopes shown in Table 4 below.

Table 4: Safe Batter Slopes

Material type	Maximum Temporary Batter Slope (H : V)	Maximum Permanent Batter Slope (H : V)
Filling	1.5 : 1	2 : 1 with erosion protection
Clay, stiff to hard and Shale, extremely low strength	1 : 1	1.5 : 1

It should be noted that both the filling and the clay soil will be prone to erosion, if left unprotected.

Where insufficient room exists for the above batter slopes or where excavating adjacent to existing buildings and services, support to the filling, soil and weathered rock could be provided by shoring, such as soldier piles with infill shotcrete panels with temporary tie-back anchors.

The design of the retaining wall and shoring system can be based on a triangular earth pressure distribution using the earth pressure coefficients provided in Table 5. Active earth pressure coefficient (K_a) values may be used where some wall movement is acceptable. At rest earth pressure (K_o) values should be used where wall movement needs to be limited.

Table 5: Design Parameters for Shoring Systems

Material Type	Unit Weight (kN/m^3)	Active Earth Pressure Coefficient (K_a)		Passive Earth Pressure (Kp)^
		Temporary	Permanent	
Filling and loose sand	18	0.30	0.35	2.5
Silty Clay, stiff to hard and extremely low strength siltstone	22	0.35	0.40	-

Note: ^ Ultimate values, only below bulk excavation level.

The horizontal or lateral pressures acting on the wall can be calculated based on the following triangular earth pressure distribution:

H_z = K (⇑z +p)

Where: H_z = horizontal pressure at depth z

↑ = unit weight of soil or rock

K = Earth pressure coefficient

z = depth (m)

p = vertical surcharge pressure.

Surcharging from adjacent building footings, traffic or other loads should be allowed for. Unless positive drainage measures can be incorporated to prevent water pressure build-up behind the walls, full hydrostatic head should be allowed for in design while, at the same time, allowing for the soil unit weight to be reduced to the buoyant condition.

For preliminary design of anchors, the maximum allowable bond stress shown in Table 6 should be adopted. The parameter given in Table 6 assumes that the drill holes are clean and adequately flushed. The anchors should be bonded behind a line drawn up at 45 degrees from the base of the shoring. Testing should be carried out to confirm the anchor capacities.

Table 6: Bond Stresses for Anchor Design

Material Description	Ultimate Bond Stress (kPa)
Very low to low strength rock	200

6.5 Seepage

No free groundwater was encountered in any of the boreholes though the surficial filling could become saturated following a significant rain event. However, due to the slope of the site away from the central east – west axis, seepage through the filling is likely to be of low intensity and of short duration (1-2 days).

Groundwater levels measured in the existing monitoring wells were between depths of 4.06 m and 7.72 m below surface levels, except in MW01, where it was measured between 1.02 m and 1.04 m. The groundwater level in MW01 indicates perched groundwater within the filling, while the other monitoring bores indicate the groundwater level within the weathered rock.

The groundwater level appears to be below the proposed bulk excavation level however, regular monitoring should be carried out to establish the potential range of groundwater fluctuation.

6.6 Footings

Foundation loads for the buildings were not known at the time of writing this report. The buildings are likely to be founded on pad footings or short bored piers and the material at the foundation level is

expected to be very low or low strength siltstone. Very low to low strength shale (Class III/IV in accordance with Pells et al. 1998), would typically be suitable for allowable bearing pressures of 1,500 kPa and an allowable shaft adhesion of 150 kPa.

The expected load from the proposed development will not have any effect on the existing high pressure water tunnel, which is at a depth of between 57 m and 61 m beneath the surface, nor does the tunnel represent a constraint to the proposed development.

6.7 Soil Aggressivity

Based on the results of the soil analytical tests and reference to table 6.4.2(C) of AS2159-2009 "Piling –Design and Installation" for the two soil samples, an Exposure Classification for concrete piles of "Mild" for soil condition type B (low permeability soil) is indicated.

7. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at 4 Mitchell Street, Enfield in accordance with DP's proposal dated 3 April 2017 and acceptance received from Nicholas Tao on 11 April 2017. The work was carried out under DP's Standard Conditions of Engagement. This report is provided for the exclusive use of Tian An Australia Limited for this project only and for the purposes as described in the report. It should not be used by or be relied upon for other projects or purposes on the same or another site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attachments and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the (geotechnical / environmental / groundwater) components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About This Report

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

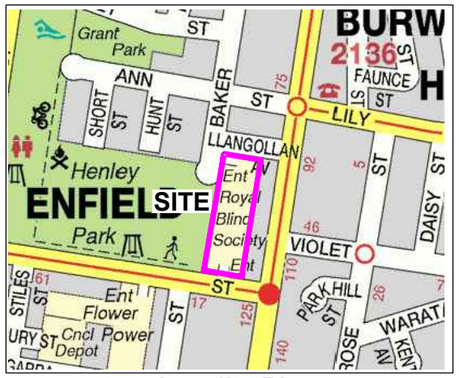
Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

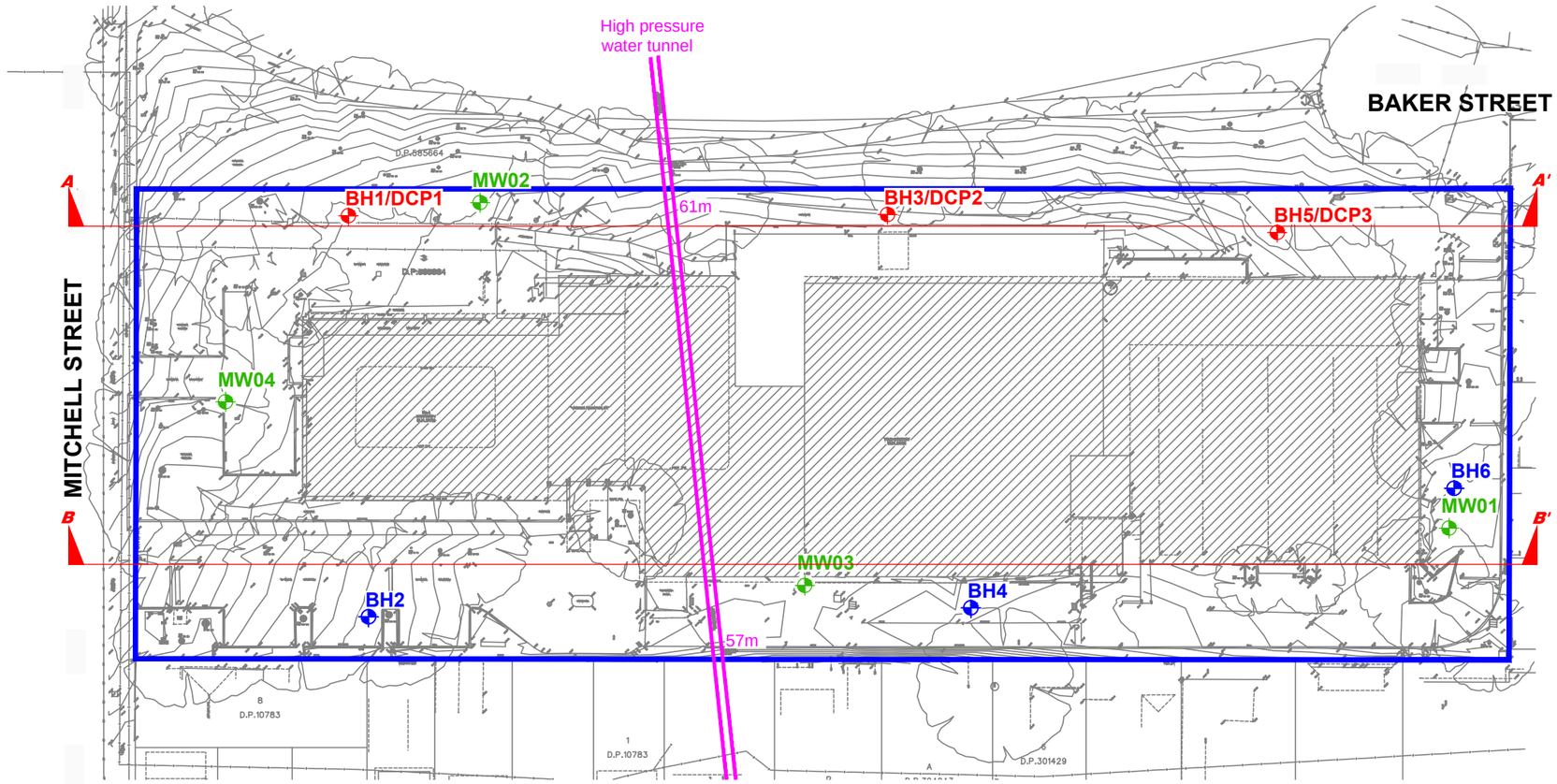
The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Appendix B

Drawings



Locality Plan



LEGEND

- Borehole location
- Borehole and DCP location
- Groundwater monitoring well location
- A — A' Geotechnical Cross Section A-A'
- 57m Depth to invert

NOTE:
1: Base drawing from Northrop (Dwg S170627, dated 28.3.2017)
2: Test locations are approximate only and are shown with reference to existing features.

0 5 10 15 20 30 40 60 80m

1:800 @ A3

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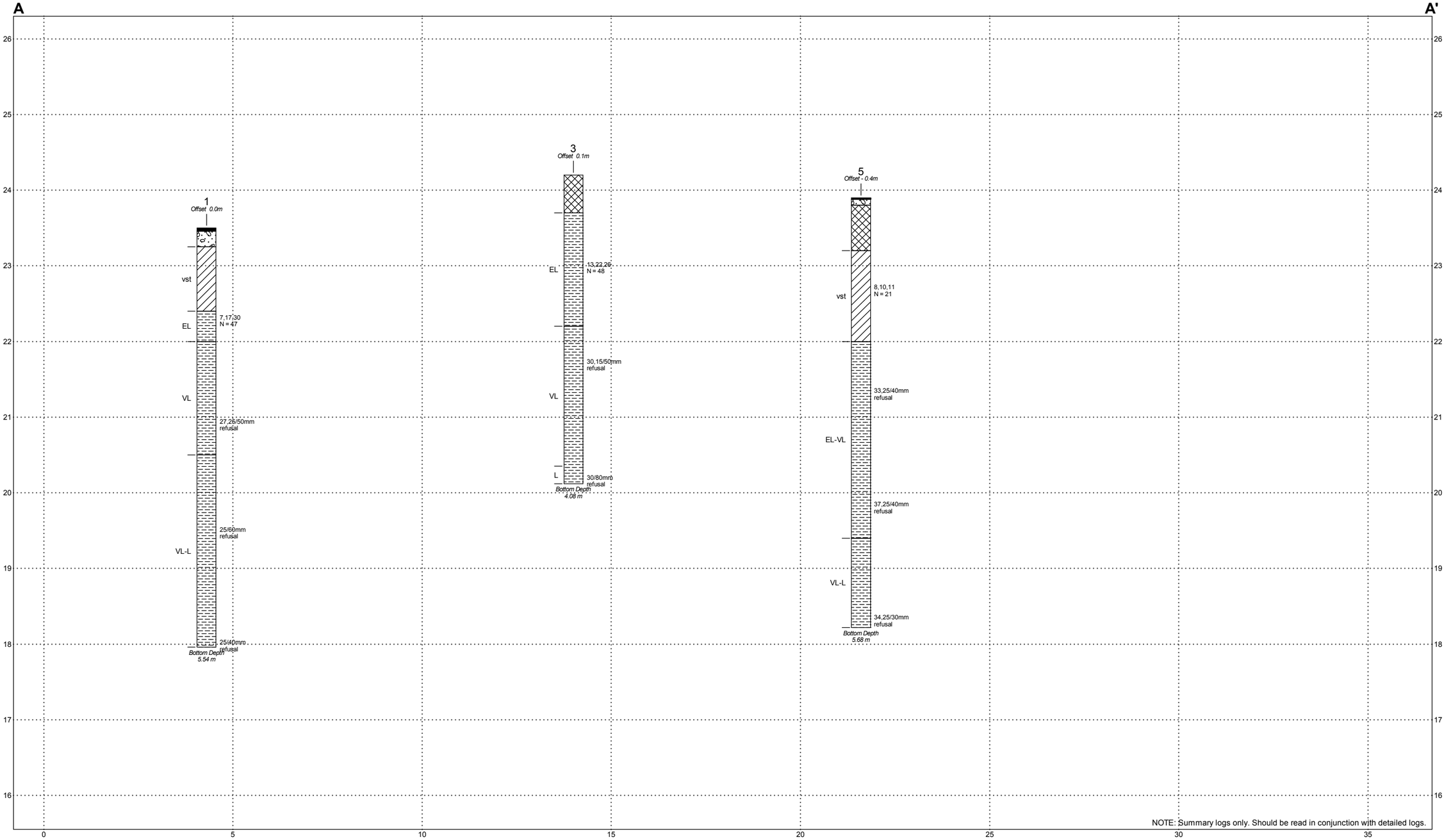
Geotechnics / Environment / Groundwater

CLIENT: Tian Australia Limited		TITLE: **Site Layout and Tests Locations**	PROJECT No: 85921.00
OFFICE: Sydney	DRAWN BY: PSCH	**Proposed Development**	DRAWING No: 1
SCALE: 1:800 @ A3	DATE: 27.6.2017	**4 Mitchell Street, ENFIELD**	REVISION: 1

A

A'



DISTANCE ALONG PROFILE (m)

LEGEND

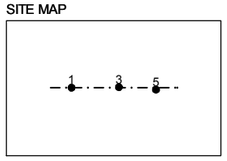
- Asphaltic Concrete
- Roadbase
- Clay
- Shale
- Filling

ROCK STRENGTH
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High

SOIL CONSISTENCY
vs - very soft
s - soft
f - firm
st - stiff
vst - very stiff
h - hard
vl - very loose
l - loose
md - medium dense
d - dense
vd - very dense

TESTS / OTHER
N - Standard penetration test value
▽ - Water level

SITE MAP



STANDARD CROSS-SECTION_85921.00 ENFIELD CROSS SECTIONS_DP2012_V1-1.GPJ_DPTEMPLATE2012_V1_SYDMET.GDT 10/5/17

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Tian An Australia Limited		TITLE: **Geotechnical Cross Section A-A'**	PROJECT No: 85921.00
OFFICE: Sydney	DRAWN BY: CE/LD	**Proposed Residential Development**	DRAWING No: 2
SCALE: 1:100 (H) 1:50 (V) @ A3	DATE: 10.05.2017	**4 Mitchell Street, Enfield**	REVISION: 0

B

B'

ELEVATION (m AHD*)

28
27
26
25
24
23
22
21
20
19
18

0
5
10
15
20
25
30
35

DISTANCE ALONG PROFILE (m)

2
Offset - 0.7m
EL
VL
30/130mm
refusal
Bottom Depth
2.4 m

4
Offset - 1.3m
st-vst
1,3,7
N = 10
vst
3,6,14
N = 20
EL
10,14,30
N = 44
VL-L
30/150mm
refusal
Bottom Depth
5.65 m

6
Offset 0.0m
st
2,5,8
N = 13
EL
17,30,30/145mm
refusal
7,11,34
N = 45
EL-VL
L
90/100mm
refusal
Bottom Depth
5.6 m

NOTE: Summary logs only. Should be read in conjunction with detailed logs.

LEGEND

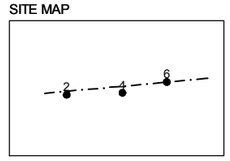
- Roadbase
- Filling
- Shale
- Clay

ROCK STRENGTH
EL - Extremely Low
VL - Very Low
L - Low
M - Medium
H - High
VH - Very High

SOIL CONSISTENCY
vs - very soft
s - soft
f - firm
st - stiff
vst - very stiff
h - hard
vl - very loose
l - loose
md - medium dense
d - dense
vd - very dense

TESTS / OTHER
N - Standard penetration test value
▽ - Water level

SITE MAP



STANDARD CROSS-SECTION 85921.00 ENFIELD CROSS SECTIONS DP2012 V1-1.GPJ DPTEMPLATE2012 V1 SYDMET.GDT 18/5/17

Douglas Partners
Geotechnics / Environment / Groundwater

CLIENT: Tian An Australia Limited		TITLE: **Cross-section B-B'**	PROJECT No: 85921.00
OFFICE: Sydney	DRAWN BY: JAM/LD	**Proposed Residential Development**	DRAWING No: 3
SCALE: 1:100 (H) 1:50 (V) @ A3	DATE: 18.05.2017	**4 Mitchell Street, Enfield**	REVISION: 0

Appendix C

Borehole Logs

DCP Report Sheets

Sampling Methods

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Sampling

Sampling is carried out during drilling or test pitting to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing it to obtain a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Test Pits

Test pits are usually excavated with a backhoe or an excavator, allowing close examination of the in-situ soil if it is safe to enter into the pit. The depth of excavation is limited to about 3 m for a backhoe and up to 6 m for a large excavator. A potential disadvantage of this investigation method is the larger area of disturbance to the site.

Large Diameter Augers

Boreholes can be drilled using a rotating plate or short spiral auger, generally 300 mm or larger in diameter commonly mounted on a standard piling rig. The cuttings are returned to the surface at intervals (generally not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube samples.

Continuous Spiral Flight Augers

The borehole is advanced using 90-115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are disturbed and may be mixed with soils from the sides of the hole. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively low reliability, due to the remoulding, possible mixing or softening of samples by groundwater.

Non-core Rotary Drilling

The borehole is advanced using a rotary bit, with water or drilling mud being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from the rate of penetration. Where drilling mud is used this can mask the cuttings and reliable identification is only possible from separate sampling such as SPTs.

Continuous Core Drilling

A continuous core sample can be obtained using a diamond tipped core barrel, usually with a 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in weak rocks and granular soils), this technique provides a very reliable method of investigation.

Standard Penetration Tests

Standard penetration tests (SPT) are used as a means of estimating the density or strength of soils and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, Methods of Testing Soils for Engineering Purposes - Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of, say, 4, 6 and 7 as:

  4,6,7
  N=13

- In the case where the test is discontinued before the full penetration depth, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm as:

  15, 30/40 mm

The results of the SPT tests can be related empirically to the engineering properties of the soils.

Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

Dynamic penetrometer tests (DCP or PSP) are carried out by driving a steel rod into the ground using a standard weight of hammer falling a specified distance. As the rod penetrates the soil the number of blows required to penetrate each successive 150 mm depth are recorded. Normally there is a depth limitation of 1.2 m, but this may be extended in certain conditions by the use of extension rods. Two types of penetrometer are commonly used.

- Perth sand penetrometer - a 16 mm diameter flat ended rod is driven using a 9 kg hammer dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands and is mainly used in granular soils and filling.
- Cone penetrometer - a 16 mm diameter rod with a 20 mm diameter cone end is driven using a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). This test was developed initially for pavement subgrade investigations, and correlations of the test results with California Bearing Ratio have been published by various road authorities.

Soil Descriptions

Douglas Partners

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard AS 1726-1993, Geotechnical Site Investigations Code. In general, the descriptions include strength or density, colour, structure, soil or rock type and inclusions.

Soil Types

Soil types are described according to the predominant particle size, qualified by the grading of other particles present:

Type	Particle size (mm)
Boulder	>200
Cobble	63 - 200
Gravel	2.36 - 63
Sand	0.075 - 2.36
Silt	0.002 - 0.075
Clay	<0.002

The sand and gravel sizes can be further subdivided as follows:

Type	Particle size (mm)
Coarse gravel	20 - 63
Medium gravel	6 - 20
Fine gravel	2.36 - 6
Coarse sand	0.6 - 2.36
Medium sand	0.2 - 0.6
Fine sand	0.075 - 0.2

The proportions of secondary constituents of soils are described as:

Term	Proportion	Example
And	Specify	Clay (60%) and Sand (40%)
Adjective	20 - 35%	Sandy Clay
Slightly	12 - 20%	Slightly Sandy Clay
With some	5 - 12%	Clay with some sand
With a trace of	0 - 5%	Clay with a trace of sand

Definitions of grading terms used are:

- Well graded - a good representation of all particle sizes
- Poorly graded - an excess or deficiency of particular sizes within the specified range
- Uniformly graded - an excess of a particular particle size
- Gap graded - a deficiency of a particular particle size with the range

Cohesive Soils

Cohesive soils, such as clays, are classified on the basis of undrained shear strength. The strength may be measured by laboratory testing, or estimated by field tests or engineering examination. The strength terms are defined as follows:

Description	Abbreviation	Undrained shear strength (kPa)
Very soft	vs	<12
Soft	s	12 - 25
Firm	f	25 - 50
Stiff	st	50 - 100
Very stiff	vst	100 - 200
Hard	h	>200

Cohesionless Soils

Cohesionless soils, such as clean sands, are classified on the basis of relative density, generally from the results of standard penetration tests (SPT), cone penetration tests (CPT) or dynamic penetrometers (PSP). The relative density terms are given below:

Relative Density	Abbreviation	SPT N value	CPT qc value (MPa)
Very loose	vl	<4	<2
Loose	l	4 - 10	2 -5
Medium dense	md	10 - 30	5 - 15
Dense	d	30 - 50	15 - 25
Very dense	vd	>50	>25

Soil Descriptions

Soil Origin

It is often difficult to accurately determine the origin of a soil. Soils can generally be classified as:

- Residual soil - derived from in-situ weathering of the underlying rock;
- Transported soils - formed somewhere else and transported by nature to the site; or
- Filling - moved by man.

Transported soils may be further subdivided into:

- Alluvium - river deposits
- Lacustrine - lake deposits
- Aeolian - wind deposits
- Littoral - beach deposits
- Estuarine - tidal river deposits
- Talus - scree or coarse colluvium
- Slopewash or Colluvium - transported downslope by gravity assisted by water. Often includes angular rock fragments and boulders.

Rock Strength

Rock strength is defined by the Point Load Strength Index ($Is_{(50)}$) and refers to the strength of the rock substance and not the strength of the overall rock mass, which may be considerably weaker due to defects. The test procedure is described by Australian Standard 4133.4.1 - 2007. The terms used to describe rock strength are as follows:

Term	Abbreviation	Point Load Index $Is_{(50)}$ MPa	Approximate Unconfined Compressive Strength MPa*
Extremely low	EL	<0.03	<0.6
Very low	VL	0.03 - 0.1	0.6 - 2
Low	L	0.1 - 0.3	2 - 6
Medium	M	0.3 - 1.0	6 - 20
High	H	1 - 3	20 - 60
Very high	VH	3 - 10	60 - 200
Extremely high	EH	>10	>200

* Assumes a ratio of 20:1 for UCS to $Is_{(50)}$. It should be noted that the UCS to $Is_{(50)}$ ratio varies significantly for different rock types and specific ratios should be determined for each site.

Degree of Weathering

The degree of weathering of rock is classified as follows:

Term	Abbreviation	Description
Extremely weathered	EW	Rock substance has soil properties, i.e. it can be remoulded and classified as a soil but the texture of the original rock is still evident.
Highly weathered	HW	Limonite staining or bleaching affects whole of rock substance and other signs of decomposition are evident. Porosity and strength may be altered as a result of iron leaching or deposition. Colour and strength of original fresh rock is not recognisable
Moderately weathered	MW	Staining and discolouration of rock substance has taken place
Slightly weathered	SW	Rock substance is slightly discoloured but shows little or no change of strength from fresh rock
Fresh stained	Fs	Rock substance unaffected by weathering but staining visible along defects
Fresh	Fr	No signs of decomposition or staining

Degree of Fracturing

The following classification applies to the spacing of natural fractures in diamond drill cores. It includes bedding plane partings, joints and other defects, but excludes drilling breaks.

Term	Description
Fragmented	Fragments of <20 mm
Highly Fractured	Core lengths of 20-40 mm with some fragments
Fractured	Core lengths of 40-200 mm with some shorter and longer sections
Slightly Fractured	Core lengths of 200-1000 mm with some shorter and longer sections
Unbroken	Core lengths mostly > 1000 mm

Rock Descriptions

Rock Quality Designation

The quality of the cored rock can be measured using the Rock Quality Designation (RQD) index, defined as:

$$\text{RQD \%} = \frac{\text{cumulative length of 'sound' core sections} \geq 100 \text{ mm long}}{\text{total drilled length of section being assessed}}$$

where 'sound' rock is assessed to be rock of low strength or better. The RQD applies only to natural fractures. If the core is broken by drilling or handling (i.e. drilling breaks) then the broken pieces are fitted back together and are not included in the calculation of RQD.

Stratification Spacing

For sedimentary rocks the following terms may be used to describe the spacing of bedding partings:

Term	Separation of Stratification Planes
Thinly laminated	< 6 mm
Laminated	6 mm to 20 mm
Very thinly bedded	20 mm to 60 mm
Thinly bedded	60 mm to 0.2 m
Medium bedded	0.2 m to 0.6 m
Thickly bedded	0.6 m to 2 m
Very thickly bedded	> 2 m

Symbols & Abbreviations

Introduction

These notes summarise abbreviations commonly used on borehole logs and test pit reports.

Drilling or Excavation Methods

C	Core drilling
R	Rotary drilling
SFA	Spiral flight augers
NMLC	Diamond core - 52 mm dia
NQ	Diamond core - 47 mm dia
HQ	Diamond core - 63 mm dia
PQ	Diamond core - 81 mm dia

Water

▷	Water seep
▽	Water level

Sampling and Testing

A	Auger sample
B	Bulk sample
D	Disturbed sample
E	Environmental sample
U_{50}	Undisturbed tube sample (50mm)
W	Water sample
pp	Pocket penetrometer (kPa)
PID	Photo ionisation detector
PL	Point load strength Is(50) MPa
S	Standard Penetration Test
V	Shear vane (kPa)

Description of Defects in Rock

The abbreviated descriptions of the defects should be in the following order: Depth, Type, Orientation, Coating, Shape, Roughness and Other. Drilling and handling breaks are not usually included on the logs.

Defect Type

B	Bedding plane
Cs	Clay seam
Cv	Cleavage
Cz	Crushed zone
Ds	Decomposed seam
F	Fault
J	Joint
Lam	Lamination
Pt	Parting
Sz	Sheared Zone
V	Vein

Orientation

The inclination of defects is always measured from the perpendicular to the core axis.

h	horizontal
v	vertical
sh	sub-horizontal
sv	sub-vertical

Coating or Infilling Term

cln	clean
co	coating
he	healed
inf	infilled
stn	stained
ti	tight
vn	veneer

Coating Descriptor

ca	calcite
cbs	carbonaceous
cly	clay
fe	iron oxide
mn	manganese
slt	silty

Shape

cu	curved
ir	irregular
pl	planar
st	stepped
un	undulating

Roughness

po	polished
ro	rough
sl	slickensided
sm	smooth
vr	very rough

Other

fg	fragmented
bnd	band
qtz	quartz

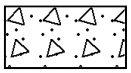
Symbols & Abbreviations

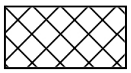
Graphic Symbols for Soil and Rock

General

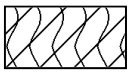

Asphalt

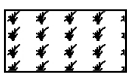

Road base

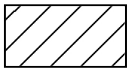

Concrete

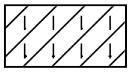

Filling

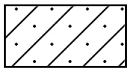
Soils


Topsoil

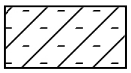

Peat

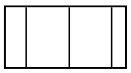

Clay

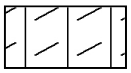

Silty clay

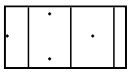

Sandy clay

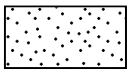

Gravelly clay

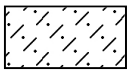

Shaly clay

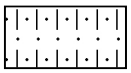

Silt


Clayey silt


Sandy silt

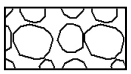

Sand

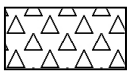

Clayey sand


Silty sand


Gravel

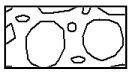

Sandy gravel


Cobbles, boulders

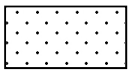

Talus

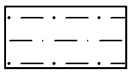
Sedimentary Rocks

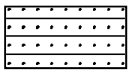

Boulder conglomerate

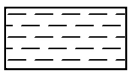

Conglomerate


Conglomeratic sandstone

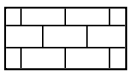

Sandstone


Siltstone

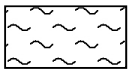

Laminite

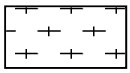

Mudstone, claystone, shale

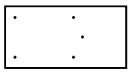

Coal


Limestone

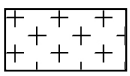
Metamorphic Rocks

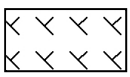

Slate, phyllite, schist

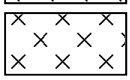

Gneiss

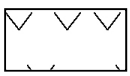

Quartzite

Igneous Rocks


Granite


Dolerite, basalt, andesite


Dacite, epidote


Tuff, breccia


Porphyry

BOREHOLE LOG

CLIENT: Tian An Australia Limited
PROJECT: Proposed Residential Development
LOCATION: 4 Mitchell Street, Enfield

SURFACE LEVEL: 23.5 m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 1
PROJECT No: 85921.00
DATE: 1/5/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
23	0.04	ASPHALTIC CONCRETE		A	0.1				
	0.25	ROADBASE GRAVEL							
		CLAY - apparently very stiff, red-brown clay, slightly silty with a trace of ironstone gravel, moist		A	0.5				
22	1.1			A	1.0				
		SHALE - extremely low strength, extremely weathered, light grey-brown shale with ironstone bands, damp		S			7,17,30 N = 47		
	1.5	SHALE - very low strength, pale grey shale			1.45				
21				S	2.5		27,25/50mm refusal		
					2.7				
20	3.0	SHALE - very low and low strength, grey shale							
19				S	4.0		25/60mm refusal		
					4.06				
18	5.54			S	5.5		25/40mm refusal		
		Bore discontinued at 5.54m - refusal on TC-bit			5.54				

RIG: Scout 1 **DRILLER:** LC **LOGGED:** SI **CASING:** Uncased

TYPE OF BORING: Solid flight auger to 5.54m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *Surface RL determined from supplied survey data

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Tian An Australia Limited
PROJECT: Proposed Residential Development
LOCATION: 4 Mitchell Street, Enfield

SURFACE LEVEL: 25.0 m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 2
PROJECT No: 85921.00
DATE: 28/4/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
25	0.05	ROADBASE GRAVEL		A	0.0				
		FILLING - grey ripped shale filling, moist		A	0.3				
	0.5	SHALE - extremely low strength, pale grey-brown shale with ironstone bands		A	0.5				
24	1	1.0m: becoming very low strength		S	1.0 1.13		30/130mm refusal		
23	2								
	2.4	Bore discontinued at 2.4m - refusal on TC-bit							
22	3								
21	4								
20	5								
19	6								
18	7								
17	8								
16	9								

RIG: Bobcat **DRILLER:** GM **LOGGED:** SI **CASING:** HW to 1.5m

TYPE OF BORING: Solid flight auger to 1.5m; Rotary to 2.4m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *Surface RL determined from supplied survey data

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Tian An Australia Limited
PROJECT: Proposed Residential Development
LOCATION: 4 Mitchell Street, Enfield

SURFACE LEVEL: 24.2 m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 3
PROJECT No: 85921.00
DATE: 28/4/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
24	0.0	FILLING - grey to grey-brown silty clay and fine sand filling with some roadbase gravel, damp		A	0.0				
				A	0.2				
	0.5	SHALE - extremely low strength, extremely weathered, light grey-brown shale, damp		A	0.5				
23	1			S	1.0		13,22,26 N = 48		
				A	1.45 1.5				
22	2.0	SHALE - very low strength, light grey to light grey-brown shale		S	2.5 2.52		30,15/50mm refusal		
21	3								
	4.0	4.0m: becoming low strength		S	4.0 4.08		30/80mm refusal		
20	4.08	Bore discontinued at 4.08m - refusal on TC-bit							
19	5								
18	6								
17	7								
16	8								
15	9								

RIG: Bobcat **DRILLER:** GM **LOGGED:** SI **CASING:** Uncased

TYPE OF BORING: Solid flight auger to 4.08m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *Surface RL determined from supplied survey data

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Tian An Australia Limited
PROJECT: Proposed Residential Development
LOCATION: 4 Mitchell Street, Enfield

SURFACE LEVEL: 26.8 m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 4
PROJECT No: 85921.00
DATE: 28/4/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
26	0.0	ROADBASE GRAVEL		A	0.0				
				A	0.2				
	0.3	FILLING - grey to grey-brown clay and shale fragments filling, moist			0.5				
	0.6	CLAY - stiff then very stiff, red-brown then mottled brown-light grey clay, moist		A					
	1				1.0				1
				S			1,3,7 N = 10		
25					1.45				
	2								2
		2.5m: becoming very stiff			2.5				
24				S			3,6,14 N = 20		
	3				2.95				3
	3.0	SHALE - extremely low strength, extremely weathered, light grey and brown, shale with a trace of ironstone bands							
23					4.0				
	4			S			10,14,30 N = 44		4
					4.45				
22	5								5
	5.0	SHALE - very low to low strength, grey-brown shale							
				S	5.5		30/150mm refusal		
21	5.65	Bore discontinued at 5.65m - refusal on TC-bit			5.65				
	6								6
20	7								7
19	8								8
18	9								9
17									

RIG: Bobcat **DRILLER:** GM **LOGGED:** SI **CASING:** Uncased

TYPE OF BORING: Solid flight auger to 5.65m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *Surface RL determined from supplied survey data

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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BOREHOLE LOG

CLIENT: Tian An Australia Limited
PROJECT: Proposed Residential Development
LOCATION: 4 Mitchell Street, Enfield

SURFACE LEVEL: 23.9 m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 5
PROJECT No: 85921.00
DATE: 1/5/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
23	0.02	ASPHALTIC CONCRETE		A	0.1				
	0.1	ROADBASE GRAVEL							
		FILLING - dark grey then light grey, sand filling with some roadbase gravel, damp		A	0.5				
	0.7	CLAY - very stiff, red-brown clay with a trace of ironstone gravel, moist		A	1.0				
	1			S	1.45		8,10,11 N = 21		
22	1.9	SHALE - extremely low to very low strength, light grey-red-brown shale with ironstone bands		S	2.5		33,25/40mm refusal		
	2				2.69				
21	3								
20	4			S	4.0		37,25/40mm refusal		
					4.19				
	4.5	SHALE - very low and low strength, grey-brown shale							
19	5								
	5.68	Bore discontinued at 5.68m - refusal on TC-bit		S	5.5		34,25/30mm refusal		
					5.68				
18	6								
17	7								
16	8								
15	9								
14									

RIG: Scout 1 **DRILLER:** LC **LOGGED:** SI **CASING:** Uncased

TYPE OF BORING: Solid flight auger to 5.68m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *Surface RL determined from supplied survey data

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

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Geotechnics / Environment / Groundwater

BOREHOLE LOG

CLIENT: Tian An Australia Limited
PROJECT: Proposed Residential Development
LOCATION: 4 Mitchell Street, Enfield

SURFACE LEVEL: 25.5 m AHD*
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: 6
PROJECT No: 85921.00
DATE: 28/4/2017
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
25	0.2	ROADBASE GRAVEL		A	0.0				
		FILLING - brown to red-brown, sandy clay filling with ironstone gravel, moist		A	0.2				
					0.5				
	1.1	CLAY - stiff, mottled brown, light grey clay, slightly silty with a trace of ironstone gravel, moist		S	1.0		2,5,8 N = 13		
24					1.45				
23	2.5	SHALE - extremely low strength, extremely weathered, light grey-brown shale with ironstone bands		S	2.5		17,30,30/145mm refusal		
					2.9				
22				S	4.0		7,11,34 N = 45		
21					4.45				
20	5.0	SHALE - extremely low to very low strength, grey shale 5.5m: becoming low strength		S	5.5		30/100mm refusal		
	5.6	Bore discontinued at 5.6m - refusal on TC-bit			5.6				

RIG: Bobcat **DRILLER:** GM **LOGGED:** SI **CASING:** Uncased

TYPE OF BORING: Solid flight auger to 5.6m

WATER OBSERVATIONS: No free groundwater observed whilst augering

REMARKS: *Surface RL determined from supplied survey data

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	G	Gas sample	PID	Photo ionisation detector (ppm)
B	Bulk sample	P	Piston sample	PL(A)	Point load axial test Is(50) (MPa)
BLK	Block sample	U_x	Tube sample (x mm dia.)	PL(D)	Point load diametral test Is(50) (MPa)
C	Core drilling	W	Water sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	▷	Water seep	S	Standard penetration test
E	Environmental sample	▼	Water level	V	Shear vane (kPa)

Douglas Partners
Geotechnics / Environment / Groundwater

Douglas Partners Pty Ltd
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www.douglaspartners.com.au

Results of Dynamic Penetrometer Tests

Client Tian An Australia Limited
Project Residential Development
Location 4 Mitchell Street, Enfeild

Project No. 85921.00
Date 28/04/17
Page No. 1 of 1

Test Location	BH1	BH3	BH5							
RL of Test (AHD)	23.5	24.2	23.2							
Depth (m)	**Penetration Resistance** Blows/150 mm									
0 - 0.15	5	3	1							
0.15 - 0.30	15	11	5							
0.30 - 0.45	10	12	8							
0.45 - 0.60	12	5	11							
0.60 - 0.75	12	15	12							
0.75 - 0.90	9	14	11							
0.90 - 1.05	8	25	10							
1.05 - 1.20	9	20	12							
1.20 - 1.35	D	D	D							
1.35 - 1.50										
1.50 - 1.65										
1.65 - 1.80										
1.80 - 1.95										
1.95 - 2.10										
2.10 - 2.25										
2.25 - 2.40										
2.40 - 2.55										
2.55 - 2.70										
2.70 - 2.85										
2.85 - 3.00										
3.00 - 3.15										
3.15 - 3.30										
3.30 - 3.45										
3.45 - 3.60										

Test Method AS 1289.6.3.2, Cone Penetrometer ☑
AS 1289.6.3.3, Sand Penetrometer ☐

Tested By CE
Checked By CE

Remarks: D = Discontinued, Ref = Refusal, 25/110 indicates 25 blows for 110 mm penetration, B = Bouncing

Appendix D

Laboratory Test Results

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Certificate of Analysis

JBS & G Australia (NSW) P/L
Level 1, 50 Margaret St
Sydney
NSW 2000

NATA Accredited
Accreditation Number 1261
Site Number 18217

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

Attention: **Nicola Wells**

Report **546925-S**
Project name ADDITIONAL - MITCHELL STREET ENFIELD DSI
Project ID 52680
Received Date May 19, 2017

Client Sample ID			**BH04_0.4-0.5**	**BH04_0.9-1.0**
Sample Matrix			**Soil**	**Soil**
Eurofins | mgt Sample No.			**S17-My19970**	**S17-My19971**
Date Sampled			**Apr 28, 2017**	**Apr 28, 2017**
Test/Reference	LOR	Unit		
Chloride	10	mg/kg	13	69
Conductivity (1:5 aqueous extract at 25°C)	5	uS/cm	72	140
pH (1:5 Aqueous extract)	0.1	pH Units	7.9	5.2
Resistivity*	0.5	ohm.m	690	370
Sulphate (as SO4)	10	mg/kg	28	110
% Moisture	1	%	11	7.8

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).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Chloride	Sydney	May 26, 2017	28 Day
- Method: E033 /E045 /E047 Chloride			
Conductivity (1:5 aqueous extract at 25°C)	Sydney	May 26, 2017	7 Day
- Method: LTM-INO-4030			
pH (1:5 Aqueous extract)	Sydney	May 26, 2017	7 Day
- Method: LTM-GEN-7090 pH in soil by ISE			
Sulphate (as SO4)	Sydney	May 26, 2017	28 Day
- Method: E045 Sulphate			
% Moisture	Sydney	May 19, 2017	14 Day
- Method: LTM-GEN-7080 Moisture			

ABN– 50 005 085 521
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NATA # 1261 Site # 18217

Brisbane
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NATA # 1261 Site # 20794

Perth
2/91 Leach Highway
Kewdale WA 6105
Phone : +61 8 9251 9600
NATA # 1261
Site # 18217

Company Name:	JBS & G Australia (NSW) P/L	**Order No.:**		**Received:**	May 19, 2017 5:27 PM
Address:	Level 1, 50 Margaret St Sydney NSW 2000	**Report #:**	546925	**Due:**	May 26, 2017
		Phone:	02 8245 0300	**Priority:**	5 Day
		Fax:		**Contact Name:**	Nicola Wells
Project Name:	ADDITIONAL - MITCHELL STREET ENFIELD DSI				
Project ID:	52680				

Eurofins | mgt Analytical Services Manager : Nibha Vaidya

Sample Detail						Aggressivity Soil Set	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271							
Sydney Laboratory - NATA Site # 18217						X	X
Brisbane Laboratory - NATA Site # 20794							
Perth Laboratory - NATA Site # 18217							
External Laboratory							
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**		
1	BH04_0.4-0.5	Apr 28, 2017		Soil	S17-My19970	X	X
2	BH04_0.9-1.0	Apr 28, 2017		Soil	S17-My19971	X	X
Test Counts						2	2

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. All biota results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. 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 Advice.

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

mg/L: milligrams per litre

ug/L: micrograms per litre

ppm: Parts per million

ppb: Parts per billion

%: Percentage

org/100mL: Organisms per 100 millilitres

NTU: Nephelometric Turbidity Units

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

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 Environmental Protection Agency
APHA	American Public Health Association
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.
TEQ	Toxic Equivalency Quotient

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 & PFASs 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, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene 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 Aroclor 1260 in Matrix Spikes and LCS.
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 RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Chloride	mg/kg	< 10			10	Pass	
Sulphate (as SO4)	mg/kg	< 10			10	Pass	
LCS - % Recovery							
Chloride	%	103			70-130	Pass	
Sulphate (as SO4)	%	103			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
				Result 1					
Chloride	S17-My20034	NCP	%	103			70-130	Pass	
Sulphate (as SO4)	S17-My20034	NCP	%	99			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1	Result 2	RPD	Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
				Result 1	Result 2	RPD			
Chloride	S17-My20034	NCP	mg/kg	120	130	5.0	30%	Pass	
Conductivity (1:5 aqueous extract at 25°C)	S17-My19970	CP	uS/cm	72	71	2.0	30%	Pass	
pH (1:5 Aqueous extract)	S17-My19970	CP	pH Units	7.9	7.9	pass	30%	Pass	
Resistivity*	S17-My19970	CP	ohm.m	690	710	2.0	30%	Pass	
Sulphate (as SO4)	S17-My20034	NCP	mg/kg	2900	3000	2.0	30%	Pass	
% Moisture	S17-Ap21073	NCP	%	12	12	2.0	30%	Pass	

Comments

Sample Integrity

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

Authorised By

Nibha Vaidya	Analytical Services Manager
Ryan Hamilton	Senior Analyst-Inorganic (NSW)
Ryan Hamilton	Senior Analyst-Metal (NSW)

Glenn Jackson
National Operations Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

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

Measurement uncertainty of test data is available on request or please click here.

544928

COC NSW

From: Nibha Vaidya
Sent: Friday, 19 May 2017 5:27 PM
To: Enviro Sample NSW; COC NSW; Rupan Virk
Subject: 5 DAY TAT - FW: 544088 Further Analysis

Additional analysis please

Kind Regards,

Nibha Vaidya
Phone : +61 2 9900 8415
Mobile : +61 499 900 805
Email : NibhaVaidya@eurofins.com

From: Nicola Wells [mailto:NWells@jbsg.com.au]
Sent: Friday, 19 May 2017 5:14 PM
To: Nibha Vaidya
Cc: Seth Molinari
Subject: 544088 Further Analysis

Hi Nibha,

We require further analysis on lab samples within lab report 544088.

Could we please schedule the following samples for aggressivity (pH, EC, chloride and sulfate content).

- BH04_0.4-0.5; and
- BH04_0.91.0

Please place these on a standard turnaround time.

Kind Regards,

19/5 VL

Nicola Wells | Environmental Consultant | JBS&G
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Contaminated Land | Groundwater Remediation | Environmental Impact Assessment | Auditing and Compliance | Hygiene and Hazardous Materials | Due Diligence and Liability

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NATA # 1261
Site # 18217

Company Name: JBS & G Australia (NSW) P/L
Address: Level 1, 50 Margaret St
Sydney
NSW 2000

Project Name: ADDITIONAL - MITCHELL STREET ENFIELD DSI
Project ID: 52680

Order No.:
Report #: 546925
Phone: 02 8245 0300
Fax:

Received: May 19, 2017 5:27 PM
Due: May 26, 2017
Priority: 5 Day
Contact Name: Nicola Wells

Eurofins | mgt Analytical Services Manager : Nibha Vaidya

Sample Detail						Aggressivity Soil Set	Moisture Set
Melbourne Laboratory - NATA Site # 1254 & 14271							
Sydney Laboratory - NATA Site # 18217						X	X
Brisbane Laboratory - NATA Site # 20794							
Perth Laboratory - NATA Site # 18217							
External Laboratory							
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**		
1	BH04_0.4-0.5	Apr 28, 2017		Soil	S17-My19970	X	X
2	BH04_0.9-1.0	Apr 28, 2017		Soil	S17-My19971	X	X
Test Counts						2	2

eurofins | mgt

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NATA # 1261 Site # 18217

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NATA # 1261 Site # 20794

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NATA # 1261 Site # 18217

ABN – 50 005 085 521 e.mail : EnviroSales@eurofins.com web : www.eurofins.com.au

Sample Receipt Advice

Company name: **JBS & G Australia (NSW) P/L**

Contact name: Nicola Wells
Project name: ADDITIONAL - MITCHELL STREET ENFIELD DSI
Project ID: 52680
COC number: Not provided
Turn around time: 5 Day
Date/Time received: May 19, 2017 5:27 PM
Eurofins | mgt reference: **546925**

Sample information

☑ A detailed list of analytes logged into our LIMS, is included in the attached summary table.

☑ All samples have been received as described on the above COC.

☑ COC has been completed correctly.

☑ Attempt to chill was evident.

☑ Appropriately preserved sample containers have been used.

☑ All samples were received in good condition.

☑ Samples have been provided with adequate time to commence analysis in accordance with the relevant holding times.

☑ Appropriate sample containers have been used.

☒ Some samples have been subcontracted.

N/A Custody Seals intact (if used).

Contact notes

If you have any questions with respect to these samples please contact:

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Results will be delivered electronically via e.mail to Nicola Wells - NWells@jbsg.com.au.