SMALL WOOD JOINT VENTURE

Geotechnical Assessment Report

10-14 Smallwood Avenue, Homebush NSW

Report No. E22781 GA
16 December 2015
# Report Distribution

**Geotechnical Assessment Report**

**10-14 Smallwood Avenue, Homebush NSW**

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*Date:* 16 December 2015

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Contamination | Remediation | Geotechnical
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1 INTRODUCTION

1.1 BACKGROUND

At the request of Small Wood Joint Venture (the Client), Environmental Investigations Australia Pty Ltd (EI) has carried out a Geotechnical Assessment (GA) for the proposed development at 10-14 Smallwood Avenue, Homebush NSW (the Site).

This GA report has been prepared to provide preliminary geotechnical advice and recommendations to assist in the preparation of initial designs for the proposed residential development.

The assessment has been carried out in accordance with the scope of works outlined in EI’s proposal referenced P13484.1, dated 3 November 2015 and with the Client’s authorisation to proceed dated 4 November 2015.

1.2 PROPOSED DEVELOPMENT

The following documents, supplied by the Client, were used to assist in the preparation of this report:

Architectural drawings prepared by Ross Howieson Architects Pty Ltd, Project Number 439, Revision P2, dated 23 November 2015:

- Basement 1, 2 and Ground Floor Plan, Drawing Numbers 202 to 204;
- West, South, East, North Elevations; Drawing Numbers 301 to 304; and
- Section AA and BB, Drawing Numbers 401 to 402.

Site survey plan prepared by Harrison Friedmann and Associates Pty Ltd, titled:

- Plan Showing Site Details and Levels for Building Design Purposes at 10-14 Smallwood Avenue, Homebush, Lots 10, 11 and 13 in DP 9481, Reference Number 54012 DT, Amendment Number 1, dated 7 December 2015.

Based on the above drawings provided, EI understands that the proposed development includes the construction of a nine-storey residential building over a two-level basement car park. The proposed building approximately covers about two thirds of the western portion of the Site with the eastern one third being retained for common open space (i.e. deep soil zone.). The lower basement level (B2) is proposed to have a finished floor level (FFL) of Reduced Level (RL) 6.9 m Australian Height Datum (AHD). In order to achieve the latter, bulk excavations are expected to extend up to:

- 8.2 m Below existing Ground surface Levels (BGL) (or an RL of about 6.6 mAHD) towards the eastern half of the Site; and
- 5.9 mBGL (or an RL of about 6.6 mAHD) towards western half of the Site.

The proposed basement outline is shown on Figure 2.

Locally deeper excavations may be required for footings, service trenches and lift overrun pits.

1.3 ASSESSMENT OBJECTIVES

The objective of the GA was to assess site surface and subsurface conditions and to provide preliminary geotechnical advice and recommendations addressing the following:

- Dilapidation Surveys;
- Excavation methodologies, limitations and monitoring requirements, including monitoring of excavation induced vibrations;
- Excavation support requirements, including geotechnical design parameters for retaining walls and shoring systems;
Building and retaining wall foundation options, including:
  - Design parameters.
  - Earthquake loading factor in accordance with AS1170.4:2007.

Groundwater considerations;

Basement floor slab; and

The requirement for additional geotechnical works.

1.4 **SCOPE OF WORKS**

The scope of works for the GA included:

- Review of available information from EI in-house database and the client provided documents;
- Preparation of a work health and safety plan;
- Review of relevant geological maps for the project area;
- Site walkover inspection by a Geotechnical Engineer to assess topographical features, condition of existing structures and site conditions;
- Scanning of proposed borehole locations for buried conductive services using a licensed service locator with reference to Dial Before You Dig (DBYD) plans;
- Auger drilling of two boreholes (BH1 and BH2) by a track-mounted drill rig using solid flight augers equipped with a ‘Tungsten-Carbide’ (T-C) bit. BH1 and BH2, were auger drilled to depths of about 3.0 mBGL (an RL of about 10.4 mAHD) and 5.17 mBGL (an RL of about 9.23 mAHD), respectively. The approximate surface levels shown on the borehole logs were interpolated from spot levels shown on the supplied detailed survey map. Approximate borehole locations are shown on Figure 2;
- Standard Penetration Testing (SPT) during auger drilling of the boreholes at between 0.5 m and 1.5 m depth intervals to assess soil strength/relative densities. These were augmented, where possible, by hand penetrometer readings on cohesive soil samples collected in the SPT split tube sampler. Soil samples were sent to Macquarie Geotechnical Pty Ltd (Macquarie), a National Australian Testing Authority (NATA) accredited laboratory for storage.
- Measurements of groundwater seepage/levels, where possible, in the boreholes during drilling;
- BH1 was converted to monitoring well BH1M and bailed dry of all the water introduced as a result of coring works at the end of the day.
- The strength of the shale bedrock in the augered sections of the boreholes was assessed by observation of the auger penetration resistance using a T-C drill bit, and examination of the recovered rock cuttings. It should be noted that rock strengths assessed from augered boreholes are approximate and strength variances can be expected.
- Subsequent Site visit on 7 December 2015 to measure groundwater levels in BH1M and collect a groundwater aggressivity sample; and
- Preparation of this GA report.

An EI Geotechnical Engineer was present on site to set out the borehole locations, direct the testing and sampling, log the subsurface conditions and record groundwater levels.

Contamination assessment of site soils was not carried out and this was outside the scope of works of this assessment.
1.5 ASSESSMENT CONSTRAINTS

The GA was limited by the intent of the assessment and the presence of the existing structures. Site Access constraint precluded investigation in the Northern parts of the Site, namely No. 10 Smallwood Avenue. The discussions and advice presented in this report are preliminary and intended for the development of initial designs for the development. Further geotechnical investigations in the form of deep cored boreholes should be carried out after demolition and prior to final design to assess the quality of the bedrock, confirm the depth of bedrock, and optimize the bearing pressures. Further discussion is provided in Section 4.8.
2 SITE DESCRIPTION

2.1 SITE DESCRIPTION AND IDENTIFICATION

The site identification details and associated information are presented in Table 2-1 while the site locality is shown in Figure 1.

Table 2-1 Summary of Site Information

<table>
<thead>
<tr>
<th>Information</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Street Address</td>
<td>10-14 Smallwood Avenue, Homebush NSW 2193</td>
</tr>
<tr>
<td>Lot and Deposited Plan (DP) Identification</td>
<td>Lots 10, 11, 12 in DP 9481</td>
</tr>
<tr>
<td>Local Government Authority</td>
<td>Strathfield Council</td>
</tr>
<tr>
<td>Parish</td>
<td>Liberty Plains</td>
</tr>
<tr>
<td>County</td>
<td>Cumberland</td>
</tr>
<tr>
<td>Current Zoning</td>
<td>R4 – High Density Residential (Strathfield Local Environmental Plan 2012))</td>
</tr>
<tr>
<td>Site Description</td>
<td>The site is roughly rectangular in shape. At the time of our assessment, the Site was occupied by three, single-storey brick and fibro buildings and associated structures, such as fibro or metal sheds. The existing buildings at the Site were observed to be in a good external condition based on a cursory inspection. The undeveloped parts of the Site were predominately grass covered. Minor cracking was observed in the concrete pavements/ driveways leading up to the residential buildings.</td>
</tr>
<tr>
<td>Site Area</td>
<td>The site is approximately 2131 m² (from Harrison Friedmann &amp; Associates Pty Ltd, Reference No. 54012DT, dated 7 December 2015).</td>
</tr>
</tbody>
</table>

2.2 LOCAL LAND USE

The site is situated within an area of mixed medium density residential and commercial use. Current uses on surrounding land are described in Table 2-2.

Table 2-2 Summary of Local Land Use

<table>
<thead>
<tr>
<th>Direction Relative to Site</th>
<th>Land Use Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>Single-storey brick residential building with on ground parking, offset by approximately 1.0 m from the common Site boundary.</td>
</tr>
<tr>
<td>East</td>
<td>Three-storey brick residential building over a single-level basement car parking, offset by approximately 8.0 m from the common</td>
</tr>
<tr>
<td>South</td>
<td>Single-storey brick residential building with on ground parking, offset by approximately 0.5 m from the common Site boundary.</td>
</tr>
<tr>
<td>West</td>
<td>Smallwood Avenue comprising two lanes, followed by single-storey residential buildings with on ground parking beyond.</td>
</tr>
</tbody>
</table>
2.3 REGIONAL SETTING

The site topography, geological and hydrogeological information for the locality is summarised in Table 2-3.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topography</td>
<td>The ground topography is gently sloping from the eastern boundary downwards towards the western boundary of the Site at approximately 3-5 degrees.</td>
</tr>
<tr>
<td>Regional Geology</td>
<td>Information on regional sub-surface conditions, referenced from the Department of Mineral Resources Geological Map Sydney 1:100,000 Geological Series Sheet 9130 (DMR 1991) indicates the site is underlain by Ashfield Shale of the Wianamatta Group, which typically comprises of black to dark-grey shale and laminite.</td>
</tr>
<tr>
<td>Acid Sulfate Soils (ASS)</td>
<td>The Strathfield Local Environmental Plan 2012 – Acid Sulfate Soils Risk (ASS) Map (Sheet ASS_004, 1:10,000 scale) indicates that the site lies within a Class 5 ASS area Acid.</td>
</tr>
<tr>
<td></td>
<td>This indicates that council consent is required prior to commencement of any works within 500m of adjacent Class 1,2,3 or 4 land that is below RL 5 mAH which the water table is likely to be lowered below 1m AHD on adjacent Class 1,2,3 or 4 land. The bulk excavation for the Site will extend to approximately RL 6.6 mAH, therefore an acid sulfate soil assessment was considered unwarranted.</td>
</tr>
</tbody>
</table>
3 INVESTIGATION RESULTS

3.1 STRATIGRAPHY

For the development of a site-specific geotechnical model, the observed stratigraphy which comprises fill overlying residual soil and a weathered bedrock profile has been grouped into three geotechnical units with Unit 3 further divided in 2 sub-units. A summary of the subsurface conditions across the site, interpreted from the assessment results, is presented in Table 3-1 below. More detailed descriptions of subsurface conditions at the test locations are available on the borehole logs presented in Appendix A. The details of the method of soil and rock classification, explanatory notes and abbreviations adopted in the borehole logs are also presented in Appendix A.

### Table 3-1 Summary of Inferred Subsurface Conditions

<table>
<thead>
<tr>
<th>Unit</th>
<th>Material 1</th>
<th>Depth to top of Unit (m BGL)</th>
<th>RL of top of Unit (m AHD)</th>
<th>Observed Thickness (m)</th>
<th>Material Description 2</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fill</td>
<td>0.0</td>
<td>14.4 to 13.4</td>
<td>0.1 to 1.1</td>
<td>TOPSOIL/FILL</td>
<td>Topsoil up to 300 mm thick over silty clay fill of medium plasticity with some rootlets throughout. Fill appeared to be 'uncontrolled' and poorly compacted.</td>
</tr>
<tr>
<td>2</td>
<td>Residual Soil and Extremely Weathered Shale</td>
<td>0.1 to 1.1</td>
<td>14.3 to 12.3</td>
<td>1.3 to 2.1</td>
<td>Silty CLAY over SHALE</td>
<td>Generally medium to high plasticity, very stiff to hard silty clay, grading into extremely low strength, extremely weathered shale at depths of approximately 1.4 m to 1.9 mBGL (RL 13.0 to 11.5 mAHD). Hand Penetrometer readings within clay samples range from 340 kPa to 480 kPa. SPT N values within the silty clay ranged from 11 to 20, and encountered refusal to further penetration within the weathered shale in BH1 and BH2.</td>
</tr>
<tr>
<td>3a</td>
<td>Very Low to Low Strength Shale</td>
<td>2.2 to 2.4</td>
<td>12.2 to 11.0</td>
<td>3.0 to 5.3</td>
<td>SHALE</td>
<td>Very low to low strength, distinctly weathered shale. Defects within Unit 3a are generally spaced between 30 mm to 100 mm, and consisted of sub-horizontal bedding partings, joints dipping 15-90º and 14% decomposed seams.</td>
</tr>
<tr>
<td>3b</td>
<td>Medium Strength Shale</td>
<td>5.2 to 7.7</td>
<td>9.2 to 5.7</td>
<td>2.2 to 3.8</td>
<td>SHALE</td>
<td>Medium strength, slightly weathered to fresh shale. Defects within Unit 3b are generally spaced between 30 mm to 1000 mm, and consisted of sub-horizontal bedding partings, joints dipping 30-90º and &lt;1% decomposed seams. The strength of shale within BH1M becomes high from a depth of about 10.2 mBGL (RL 3.2 mAHD) to borehole termination depth of 10.41 mBGL (RL 2.99 mAHD).</td>
</tr>
</tbody>
</table>

Notes:

1. More detailed descriptions of subsurface conditions are available in the borehole logs in Appendix A.
2. Approximate depth / RL below ground level at the time of our investigation. Depths may vary across the site.
3. Unit 3b was observed up to termination depth in BH1 and BH2.
3.2 GROUNDWATER OBSERVATIONS

Groundwater seepage was not observed during the auger drilling of BH1M and BH2. Groundwater level measured within BH1M during a subsequent Site visit is presented in Table 3-2 below.

### Table 3-2 Summary of Groundwater Levels

<table>
<thead>
<tr>
<th>Borehole ID</th>
<th>Date of Observation</th>
<th>Approximate Surface RL (mAHD)</th>
<th>Approximate Depth to Base of Monitoring Well (mBGL)</th>
<th>Approximate RL of Base of Monitoring Well (mAHD)</th>
<th>Proposed Bulk Excavation RL (mAHD)</th>
<th>Approximate Depth to Groundwater (mBGL)</th>
<th>Approximate RL of Groundwater (mAHD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH1M</td>
<td>7 December 2015</td>
<td>13.4</td>
<td>9.0</td>
<td>4.4</td>
<td>6.6</td>
<td>3.6</td>
<td>9.8</td>
</tr>
</tbody>
</table>

Notes:
1. Estimated from surface RL levels shown on the supplied site survey map

3.3 LABORATORY TEST RESULTS

Soil and rock samples were selected for laboratory testing to assess the following:

- Soil Moisture Content – one sample
- Atterberg Limits (Liquid Limit and Plastic Limit) – one sample
- Linear Shrinkage – one sample
- Soil and Groundwater aggressivity (pH, Chloride and Sulfate content and electrical conductivity) – two soil samples and one groundwater.

A summary of the test results is provided in Table 3-3.

Thirteen rock core samples were tested by Macquarie to estimate the Point Load Strength Index (f'ls50) values to assist with rock strength assessment. The results of the testing are shown on the attached borehole logs.

Laboratory test certificates are presented in Appendix B.
Table 3-3  Summary of Laboratory Test Results

<table>
<thead>
<tr>
<th>Test/ Sample ID</th>
<th>BH1 0.5-0.95</th>
<th>BH1 1.5-1.95</th>
<th>BH2 0.5-0.95</th>
<th>BH1M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Material Description</td>
<td>FILL</td>
<td>Silty CLAY</td>
<td>Silty CLAY</td>
<td>GROUNDWATER</td>
</tr>
<tr>
<td>Moisture Content (%)</td>
<td>18</td>
<td>13.6</td>
<td>24</td>
<td>-</td>
</tr>
<tr>
<td>Linear Shrinkage (%)</td>
<td>-</td>
<td>11.5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Soil and Groundwater Aggressivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>5.0</td>
<td>-</td>
<td>4.5</td>
<td>6.7</td>
</tr>
<tr>
<td>Electrical Conductivity (μS/cm)</td>
<td>39</td>
<td>-</td>
<td>39</td>
<td>1000</td>
</tr>
<tr>
<td>Sulfate SO4 (ppm)</td>
<td>76</td>
<td>-</td>
<td>92</td>
<td>21</td>
</tr>
<tr>
<td>Chloride Cl (ppm)</td>
<td>3.6</td>
<td>-</td>
<td>0.79</td>
<td>34</td>
</tr>
<tr>
<td>Atterberg Limits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquid Limit (%)</td>
<td>-</td>
<td>50</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Plastic Limit (%)</td>
<td>-</td>
<td>22</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Plasticity Index (%)</td>
<td>-</td>
<td>28</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes:
1 More detailed descriptions of the subsurface conditions at borehole locations are available in the borehole logs presented in Appendix A.

The Atterberg Limits results on the selected silty clay sample indicated the clays to be of medium to high plasticity.

The approximate Unconfined Compressive Strengths (UCS) of the rock core, estimated from correlations with the point load strength index test results, varied from 0.6 MPa to 26.00 MPa.
4 GEOTECHNICAL DISCUSSIONS AND DESIGN ADVICE

4.1 GEOTECHNICAL ISSUES

Based on the results of the assessment, we consider the following to be the main geotechnical issues for the design of the development:

- Site Access constraint precluded investigation in the Northern parts of the Site, namely No. 10 Smallwood Avenue. Further discussion is given in Section 4.8.
- Groundwater within the depth of the basement excavation;
- Basement excavation retention to prevent potential lateral deflections and ground loss as a result of excavations, resulting in damage to nearby structures;
- Rock excavation;
- Foundation design for building loads.

The advice and parameters presented in this report are preliminary and intended for the development of initial designs. Further geotechnical investigations in the form of deep cored boreholes should be carried out after demolition and prior to final design to assess the quality of the bedrock, confirm the depth of bedrock, and optimize the bearing pressures. Further discussion is provided in Section 4.8.

4.2 DILAPIDATION SURVEYS

Prior to demolition and construction, we recommend that detailed dilapidation surveys be compiled on all buildings, structures and infrastructures surrounding the site that falls within the zone of influence of the excavation. The zone of influence of excavations is defined by a distance back from the excavation perimeter of twice the total depth of the excavation (i.e. within at least 16.4 m of the site boundaries). The reports would provide a record of existing conditions prior to commencement of the work. A copy of each report should be provided to the adjoining property owner who should be asked to confirm that it represents a fair assessment of existing conditions. The reports should be carefully reviewed prior to demolition and construction. Excavations and retention systems will need to be carefully planned and scheduled so as not to have any adverse effects on the buildings and structures adjoining or above the excavation.

4.3 EXCAVATION METHODOLOGY AND VIBRATION MONITORING

4.3.1 Excavation Assessment

Prior to any excavation commencing:

- An appropriate full depth retention system must be installed (Refer Section 4.4); and

To achieve the proposed BEL of RL 6.6 mAHD, bulk excavations in the range of up to 5.9 m to 8.2 mBGL will be required. Based on the borehole logs, the proposed basement excavations will therefore extend through all the geotechnical Units shown in Table 3-1 above.

Units 1 and 2 may be excavated using buckets of medium to large conventional earthmoving Hydraulic Excavators. Unit 3a may be excavated using buckets of a large conventional earthmoving Hydraulic Excavators, particularly if fitted with ‘tiger teeth’. Localised stronger bands/zones may require heavy ripping or the use of hydraulic hammers. Excavation of Unit 3b bedrock is expected to present hard or heavy ripping, or “hard rock” excavation conditions. Ripping would require a high capacity and heavy bulldozer of at least D9 or similar for effective production. Alternatively, rock saws or rotary grinders could be used, though productivity would be lower and equipment wear increases, and this should be allowed for. Such equipment would also be required for detailed excavation, such as footings or service trenches, and for trimming of faces. Final trimming of faces may also be completed using a grinder attachment rather than a rock breaker.
in order to assist in limiting vibrations. The use of rotary grinders generally generates dust and this may be suppressed by spraying with water.

Excavation using rock hammers should commence away from the adjoining structures and the transmitted vibrations monitored to assess how close the hammer can operate to the adjoining structures while maintaining transmitted vibrations within acceptable limits. Alternatively, vibration monitors may be set up on the adjoining buildings to monitor vibrations at all times during rock excavation. Such monitors should be attached to base of external walls of existing building in closest proximity to the excavation and have flashing lights to warn the operator when acceptable limits have been reached. Reference should be made to Appendix C for acceptable limits of transmitted vibrations.

Where the transmitted vibrations are excessive, alternate excavation equipment would need to be used, such as a small rock hammer, ripping hooks, rotary grinders or rock saws. If an alternate rock hammer is to be used, the transmitted vibrations from that hammer should be measured to determine how close each individual hammer can operate to the adjoining buildings. To assist in reducing vibrations and over-break of the sandstone, we recommend that initial saw cuts through the bedrock may be provided using rock saw attachments fitted to the excavator. However, the effectiveness of such approach must be confirmed by the results of vibration monitoring.

Groundwater seepage monitoring should be carried out during bulk excavation prior to finalising the design of a pump out facility. Outlets into the stormwater system will require Council approval.

4.3.2 Excavation Monitoring

Consideration should be made to the impact of the proposed development upon neighbouring structures, roadways and services. Basement excavation retention systems should be designed so as to limit lateral deflections to allowable levels.

Contractors should also consider the following limits associated with carrying out excavation and construction activities:

- Limit lateral deflection of temporary or permanent retaining structures;
- Limit vertical settlements of ground surface at common property boundaries and services easement; and
- Limit peak particle velocities (ppv) from vibrations, caused by construction equipment or excavation, experienced by any structure within bounding properties and the services easement.

Monitoring of deflections of retaining structures (if any) and surface settlements should be carried out by a registered surveyor at agreed points along the excavation boundaries and along existing building foundations/services/pavements and other structures located within or near the zone of influence of the excavation. Owners of existing services at the site should be consulted to assess appropriate deflection limits for their infrastructure. Measurements should be taken:

- Prior to commencement of excavations;
- Immediately after installation of any temporary or permanent retaining structures;
- Immediately after the excavation has reached a depth of 1.5 m, and each 1.5 m depth increment thereafter;
- Immediately after the excavation has reached bulk excavation level; and
- Immediately after backfilling behind retaining structures.

4.3.3 Construction Vibration Mitigation

As a guide, safe working distances for typical items of vibration intensive plant are listed in Table 4-1 below. The safe working distances are quoted for both "cosmetic" damage (refer British Standard BS 7385:1993) and human comfort (refer NSW Environmental Protection Agency Vibration Guideline). The safe working distances should be complied with at all times, unless otherwise mitigated to the satisfaction of the relevant stakeholders. However, these should be confirmed by carrying out site specific vibration monitoring.
**Table 4-1**  
Recommended Safe Working Distances for Vibration Intensive Plants

<table>
<thead>
<tr>
<th>Plant Item</th>
<th>Rating/Description</th>
<th>Cosmetic Damage (BS 7385:1993)</th>
<th>Human Response (EPA Vibration Guideline)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibratory Roller</td>
<td>&lt; 50 kN (typically 1-2 tonnes)</td>
<td>5 m</td>
<td>15 m to 20 m</td>
</tr>
<tr>
<td></td>
<td>&lt; 100 kN (typically 2-4 tonnes)</td>
<td>6 m</td>
<td>20 m</td>
</tr>
<tr>
<td></td>
<td>&lt; 200 kN (typically 4-6 tonnes)</td>
<td>12 m</td>
<td>40 m</td>
</tr>
<tr>
<td></td>
<td>&lt; 300 kN (typically 7-13 tonnes)</td>
<td>15 m</td>
<td>100 m</td>
</tr>
<tr>
<td></td>
<td>&lt; 300 kN (typically 13-18 tonnes)</td>
<td>20 m</td>
<td>100 m</td>
</tr>
<tr>
<td></td>
<td>&lt; 300 kN (typically &gt;18 tonnes)</td>
<td>25 m</td>
<td>100 m</td>
</tr>
<tr>
<td>Small Hydraulic Hammer</td>
<td>300 kg – 5 to 12 t excavator</td>
<td>2 m</td>
<td>7 m</td>
</tr>
<tr>
<td>Medium Hydraulic Hammer</td>
<td>900 kg – 12 to 18 t excavator</td>
<td>7 m</td>
<td>23 m</td>
</tr>
<tr>
<td>Large Hydraulic Hammer</td>
<td>1600 kg – 18 to 34 t excavator</td>
<td>22 m</td>
<td>73 m</td>
</tr>
<tr>
<td>Vibratory Pile Driver</td>
<td>Sheet Piles</td>
<td>2 m to 20 m</td>
<td>20 m</td>
</tr>
<tr>
<td>Pile Boring</td>
<td>≤ 800 mm</td>
<td>2 m (nominal)</td>
<td>N/A</td>
</tr>
<tr>
<td>Jackhammer</td>
<td>Hand held</td>
<td>1 m (nominal)</td>
<td>Avoid contact with structure</td>
</tr>
</tbody>
</table>

Notes:
1. More stringent conditions may apply to heritage buildings or other sensitive structures.

In relation to human comfort (response), the safe working distances in **Table 4-1** above relate to continuous vibration and apply to residential receivers. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are permitted, as discussed in British Standard BS 6472-1:2008.

The safe working distances provided in **Table 4-1** above are given for guidance only. These values are general in nature and site specific values by detailed site assessment should be obtained.
4.4 EXCAVATION RETENTION

4.4.1 Support Systems

From a geotechnical perspective, it is critical to maintain the stability of the adjacent structures and infrastructures during demolition and excavation works. Based on the results of the assessment and the fact that the proposed basement footprint extends to all the Site boundaries except the eastern boundary, temporary batter slopes of the soil and weathered rock profile will not be feasible. Therefore, a suitable full depth engineered retention system, such as a soldier pile wall with shotcrete infill panels between the piles, will be required for support of the excavation. The use of a more closely spaced shoring system (such as semi-contiguous or contiguous) is preferred adjacent to neighbouring buildings so as to reduce the lateral movements and the risk of potential damage. The gaps between the contiguous piles must be sealed by shotcrete or mass concrete. The retention system must be installed prior to excavation. If anchors are used, anchors must be installed progressively as the excavation proceeds. The retaining wall systems should be socketed below bulk excavation level and into Unit 3b shale or better.

Bored piles may be used for this site. However, relatively large capacity piling rigs will be required for drilling through Units 3a and 3b. We recommend further advice be sought from piling contractors who should be provided with a copy of this report. Working platforms may be required for heavy piling rigs.

4.4.2 Retaining walls design parameters

In addition, design of retaining walls should consider the following:

- For progressively anchored or propped walls where minor movements can be tolerated (provided there are no buried movement sensitive services), we recommend the use of a trapezoidal earth pressure distribution of 6H kPa for soil and rock, where H is the retained height in meters. These pressures should be assumed to be uniform over the central 50% of the support system;

- For progressively anchored or propped walls which support areas that are highly sensitive to movement (such as areas where movement sensitive structures or infrastructures or buried services are located in close proximity), we recommend the use of a trapezoidal earth pressure distribution of at least 8H kPa for soil and rock, where ‘H’ is the retained height in meters. These pressures should be assumed to be uniform over the central 50% of the support system;

- Care must be taken to ensure that the piles found in rock below neighbouring foundations and services where present;

- Full hydrostatic pressures should be taken into consideration in the design of retaining walls unless measures are taken to provide complete and permanent drainage behind the walls;

- Appropriate surcharge loading from construction equipment and vehicular traffic at finished surface level should be adopted. Any applicable surcharge loads should be taken into account in the retention design as an additional surcharge using an ‘at rest’ earth pressure coefficient, $k_0$, of 0.6.

- Piles must be embedded into Unit 3a bedrock or better below final bulk excavation level (including footing and service excavation). The Allowable lateral toe resistance value outlined in Table 4-2 below may be adopted. This value assumes excavation is not carried out within the zone of influence of the wall toe and the rock does not contain unfavourable defects etc. the upper 0.5 m depth below excavation level should not be taken into account to allow for tolerance and disturbance effects during excavation. Design for lateral restraint should evaluate the sliding resistance of a rock block in front of each rock socket to confirm that the required restraint can be achieved.

- Anchoring may be required for additional lateral support. If temporary anchors extend beyond the site boundaries, then permission from the neighbouring developments would need to be sought. Also, the presence of neighbouring basements (if any) or services and their levels must be confirmed prior to finalising anchor design.
Anchors should have their bond length within shale bedrock of at least Unit 3b – medium strength shale. For the design of anchors bonded into such shale bedrock, the allowable bond stress shown in Table 4-2 above may be used, subject to the following conditions:

1. Anchor bond length of at least 3m behind the ‘active’ zone of the excavation (taken as a 45° zone above the base of the excavation) is provided;
2. Overall stability, including anchor group interaction, is satisfied;
3. All anchors are proof loaded to at least 1.3 times the design working load before locked off at working load. Such proof loading is to be witnessed by an engineer independent of the anchoring contractor;
4. Permanent anchors must have appropriate corrosion provisions for longevity and must make provision for future lift-off tests.

4.5 HYDROLOGICAL CONSIDERATIONS

Groundwater seepage was not observed during auger drilling of the boreholes. Groundwater level was measured at a depth of about 3.6 mBGL, or an RL of about 9.8 mAHD in BH1M on 7 December 2015, which is above the final bulk excavation level.

However, due to the expected low permeability of the residual clay and shale bedrock, we do not expect the groundwater to have a major impact on the proposed development or adjoining structures. However, we expect minor groundwater inflows into the excavation at the soil/rock interface and through any defects within the shale bedrock (such as jointing, and bending planes, etc.) following periods of heavy rain. We expect that any seepage that does occur will be able to be controlled using a conventional sump-and-pump system.

In the long term, drainage should be provided behind all basement retaining walls, around the perimeter of the basement and below the basement slab. The hydraulic engineer should inspect the completed excavation to confirm that adequate drainage has been allowed for. Drainage should be connected to the sump-and-pump system and discharging into the stormwater system. The permanent groundwater control system should take into account any possible soluble iron in the groundwater which may dictate whether or not groundwater can be pumped into the stormwater system.

The design of drainage and pump systems should take the above issues into account along with careful ongoing inspections and maintenance programs.

Notwithstanding, EI recommends further detailed groundwater monitoring with pump out tests be carried out within the already installed monitoring well for monitoring of groundwater levels, estimation of seepage volumes and to determine the extent of seasonal variation on the groundwater table.

4.6 FOUNDATIONS

Following bulk excavations, we expect Unit 3a and 3b to be exposed over the bulk excavation level.

Due to the expected medium to high column loads, the most competent foundation stratum for support of the proposed development is considered to be the medium strength shale encountered in Unit 3b, which is deemed to have an allowable bearing capacity of 3000 kPa based on serviceability.

It is recommended that all footings for the building and retaining walls be founded within shale bedrock of similar strength to provide uniform support and reduce the potential for differential settlements (i.e. all footings to be founded within one Unit). Hybrid systems, i.e. footing founded on different Units is not recommended.

Given the above, foundation options considered for the proposed development includes, but is not limited to, the below options or a combination of them:

- Piled foundations, using Continuous Flight Augers (CFA) socketed into Unit 3b shale; and/or
- Strip and/or pad footings on short piles within the basement area founded into Unit 3b.
Where piles are to be socketed into the shale, we recommend that heavy drilling rigs with rock augers and coring buckets be used. Working platforms may be required for heavy piling rigs.

For the portions of the building near the eastern portion of the Site, which extends outside the footprint of the basement, the building will need to be supported on footings founded within the Unit 3b shale bedrock to provide uniform support. Piles will be required to reach the shale bedrock and these should be founded below the zone of influence of the lower basement retaining walls, which may be taken as founding below a line drawn at 1 Vertical to 1 Horizontal from the base of the lower basement retaining walls. Specific geotechnical advice should be obtained for such footings taken into consideration the basement excavation and the quality of shale at the particular footing location.

A geotechnical engineer must inspect the initial stages of the retention pile installations (i.e. drilling) and footing excavations in order to:

- Ascertain that the required foundation material has been reached; and
- Check foundation conditions and possible variations that may occur.

We recommend that a Preliminary Geotechnical Strength Reduction Factor (GSRF) of 0.4 is used for the preliminary design of piled support in accordance with AS 2159:2009. The GSRF may be increased upon pile testing during construction. For pile design, also consider the notes detailed in Table 4-2.
**Table 4-2: Geotechnical Design Parameters**

<table>
<thead>
<tr>
<th>Material</th>
<th>Unit 1 Fill</th>
<th>Unit 2 Residual Soils and Extremely Weathered Shale</th>
<th>Unit 3a Very Low to Low Strength Shale</th>
<th>Unit 3b Medium Strength Shale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth to Top of Unit (mBGL)</td>
<td>0.1</td>
<td>0.1 to 1.1</td>
<td>2.2 to 2.4</td>
<td>5.2 to 7.7</td>
</tr>
<tr>
<td>RL of Top of Unit (mAHD)</td>
<td>14.4 to 13.4</td>
<td>14.4 to 13.4</td>
<td>14.4 to 13.4</td>
<td>14.4 to 13.4</td>
</tr>
<tr>
<td>Bulk Unit Weight (kN/m³)</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>23.2</td>
</tr>
</tbody>
</table>

| Earth Pressure Coefficients | At rest, Kₐ | 0.69 | 0.58 | 0.50 | 0.43 |
|                           | Active, Kₐ | 0.53 | 0.41 | 0.33 | 0.27 |
|                           | Passive, Kₐ | - | - | - | - |

**Shallow Foundations**

| Preliminary Allowable Bearing Pressure (kPa) | 700 | 3000 |

**Deep Foundations**

| Ultimate Vertical End Bearing Pressure (kPa) | - | - | 2100 | 9000 |
| Allowable Toe Resistance (kPa) | - | - | 100 | 300 |
| Ultimate Shaft Adhesion (kPa) | - | 5 | 140 | 600 |
| in Uplift | - | 2.5 | 70 | 300 |
| Bond Stress (kPa) | - | - | 150 | 300 |

| Susceptibility to Liquefaction during an Earthquake | High | Low | Low | Low |

**Earthquake Site Risk Classification**

- AS 1170.4:2007 indicates an earthquake subsoil class of Class D. (Soft Soil)
- AS 1170.4:2007 indicates that the hazard factor (z) for Sydney is 0.08.

**Notes:**

1. More detailed descriptions of subsurface conditions are available in the borehole logs in Appendix A. Depths may vary across the site.
2. Approximate depths / RL to top of unit at the time of our assessment. More detailed descriptions of subsurface conditions are available in the borehole logs in Appendix A. Depths may vary across the site.
3. Unit Weight is based on visual estimate only, order of accuracy is about 10%.
4. Earth pressures are provided on the assumption that the ground behind the retaining wall is horizontal.
5. The bases of all footings must be cleaned of loose debris and water and inspected by a Geotechnical Engineer prior to footing construction to verify that ground conditions meet design requirements.
6. Ultimate geotechnical strengths are provided for use in limit state design. Allowable or serviceability bearing pressures and side adhesions may be estimated using factors of safety of 3 and 2, respectively. These are the factors of safety generally adopted in geotechnical practice to limit settlements to an acceptable level for conventional building structures, typically less than 1% of the minimum footing width. Assumes the base of pile holes are clean and penetrate at least 1.0m or 2 pile diameters, whichever is greater, into the respective Unit. Bearing pressures may vary and must be confirmed by additional geotechnical investigations and foundation inspections during construction by an experienced geotechnical engineer. Higher bearing pressures may be applied upon confirmation by additional geotechnical investigations and subject to an experienced geotechnical engineer carrying out foundation inspections during construction.
7. Ultimate geotechnical strengths are provided for use in limit state design. Allowable or serviceability bearing pressures and side adhesions may be estimated using factors of safety of 3 and 2, respectively. These are the factors of safety generally adopted in geotechnical practice to limit settlements to an acceptable level for conventional building structures, typically less than 1% of the minimum footing width. Assumes the base of pile holes are clean and penetrate at least 1.0m or 2 pile diameters, whichever is greater, into the respective Unit. Bearing pressures may vary and must be confirmed by additional geotechnical investigations and foundation inspections during construction by an experienced geotechnical engineer. Higher bearing pressures may be applied upon confirmation by additional geotechnical investigations and subject to an experienced geotechnical engineer carrying out foundation inspections during construction.
8. To adopt these parameters we have assumed that:
   - There is intimate contact between the pile and foundation material;
   - The bases of all pile excavations are cleaned of loose debris and water and inspected by a suitably qualified Geotechnical Engineer prior to pile construction to verify that ground conditions meet design assumptions. Where groundwater ingress is encountered during pile excavation, concrete is to be placed as soon as possible upon completion of pile excavation. Pile excavations should be pumped dry of water prior to pouring concrete, or alternatively a tremmie system could be used; and
   - An experienced Geotechnical Engineer has reviewed the pile designs to assess whether all recommendations presented in this report have been incorporated in the design.
9. Side adhesion values given assume there is intimate contact between the pile and foundation material and should achieve the design roughness specification. Design engineer to check both piston pull-out and ‘cone’ pull-out mechanics in accordance with AS4678-2002 Earth Retaining Structures.
10. Should any Unit 3b parameters (provided in Table 4-1) be used for the design of the proposed development additional geotechnical investigations in the formed of three cored boreholes with point load testing must be completed. Further discussion is provided in Section 4.8.
4.7 **LOWER BASEMENT FLOOR SLAB**

Following bulk excavations for the proposed basement, Unit 3a and 3b shale is expected to be exposed at BEL. The lowest basement slab should be provided with a granular sub-base layer to provide a separation between the rock and the floor slab. We recommend that the sub-base layer comprise at least 100mm thickness of crushed rock to RMS QA specification 3051 (2013) unbound base material (or equivalent good quality and durable fine crushed rock) compacted to at least 100% of Standard Maximum Dry Density (SMDD). The hydraulic engineer should inspect the completed excavation and confirm the extent of the drainage required.

In addition, a system of sub-soil drains comprising a durable single sized aggregate with perforated drains/pipes leading to sumps should be provided. The basement floor slab should be isolated from columns.

Permission may need to be obtained from the NSW Department of Primary Industries (DPI) and possibly Council for any permanent discharge of seepage into the drainage system. Given the subsurface conditions, we expect that seepage volumes would be low and within the DPI limits. However, if permission for discharge is not obtained, the basement may need to be designed as a tanked basement.

4.8 **ADDITIONAL GEOTECHNICAL INVESTIGATION**

Should any Unit 3b parameters (provided in Table 4-1) be used for the design of the proposed development, additional geotechnical investigations in the form of cored boreholes (at least three) with point load testing must be completed. The purpose of these additional cored boreholes would be to confirm the depth and quality of shale bedrock beneath the Site to a depth of at least 3m below bulk excavation levels. We recommend that a more comprehensive geotechnical and hydrogeological investigation of the site be carried out.

Once the results of the additional geotechnical investigation become available, this report should be reviewed, and amplified, as appropriate.

4.9 **SOIL AND GROUNDWATER AGGRESSIVITY**

The proposed development will incorporate buried concrete and steel elements. AS2159:2009 gives guidelines for foundation susceptibility to soil and groundwater aggressivity. The investigation indicated low permeability soils were present above and below the groundwater table. An Analysis of the pH, chloride and sulfate content and electrical conductivity of the soil and groundwater was compared with criteria in AS 2159:2009, providing the following exposure classifications:

For Soil:
- 'Mild to Moderate' for buried concrete structural elements; and
- 'Non-Aggressive' for buried steel structural elements.

For Groundwater:
- 'Non-Aggressive' for buried concrete structural elements; and
- 'Mild to Moderate' for buried steel structural elements.
5 RECOMMENDATIONS FOR FURTHER GEOTECHNICAL SERVICES

The adopted investigation scope was limited by the investigation intent and the presence of structures (i.e. no access to No. 10 Smallwood Avenue) at the time of the investigation. Further geotechnical investigations should be carried out prior to final design to confirm the preliminary results and address any limitations. These investigations should be carried out once preliminary design and construction details are available and should include:

- Dilapidation surveys;
- Vibration monitoring during excavation;
- Should any Unit 3b parameters (provided in Table 4-1) be used for the design of the proposed development, additional geotechnical investigations in the form of additional cored boreholes (at least three) should be drilled to at least 3m below BEL with point load testing must be completed;
- All excavated material transported off site should be classified in accordance with NSW EPA 2014 - Waste Classification Guideline Part 1; Classifying Waste;
- Design of working platforms for construction plant by an experienced and qualified geotechnical engineer;
- Ongoing monitoring of groundwater inflows into the excavation;
- Geotechnical inspection of footing excavations; and
- Witnessing installation and proof-testing of anchors, if required.
6 STATEMENT OF LIMITATIONS

This report has been prepared for the exclusive use of Small Wood Joint Venture who is the only intended beneficiary of EI’s work. The scope of the investigations carried out for the purpose of this report is limited to those agreed with Mr. Smallwood Joint Venture.

No other party should rely on the document without the prior written consent of EI, and EI undertakes no duty, or accepts any responsibility or liability, to any third party who purports to rely upon this document without EI’s approval.

EI has used a degree of care and skill ordinarily exercised in similar investigations by reputable members of the environmental industry in Australia as at the date of this document. No other warranty, expressed or implied, is made or intended. Each section of this report must be read in conjunction with the whole of this report, including its appendices and attachments.

The conclusions presented in this report are based on a limited investigation of conditions, with specific sampling locations chosen to be as representative as possible under the given circumstances.

EI’s professional opinions are reasonable and based on its professional judgment, experience, training and results from analytical data. EI may also have relied upon information provided by the Client and other third parties to prepare this document, some of which may not have been verified by EI.

EI’s professional opinions contained in this document are subject to modification if additional information is obtained through further investigation, observations, or validation testing and analysis during remedial activities. In some cases, further testing and analysis may be required, which may result in a further report with different conclusions.

We draw your attention to the document “Important Information”, which is included in Appendix D of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by EI, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.
7 REFERENCES


Excavation Work Code of Practice – July 2015 – WorkCover NSW,


8 ABBREVIATIONS

AHD  Australian Height Datum
ASS  Acid Sulfate Soils
BGL  Below Ground Level
BH  Borehole
DBYD  Dig Before You Dial
DP  Deposited Plan
EI  Environmental Investigations
EPA  NSW Environmental Protection Agency
FFL  Finished Floor Level
GA  Geotechnical Assessment
NATA  National Association of Testing Authorities, Australia
PPV  Peak Particle Velocity
RL  Reduced Level
T-C  Tungsten-Carbide
FIGURES
Smallwood Joint Venture Pty Ltd
Geotechnical Assessment
10-14 Smallwood Avenue, Homebush, NSW
Site Location Plan
Map Source: Harrison Friedmann and Associates Pty Ltd, Surveyor's Reference 54012.DT, Dated 25/6/2015

LEGEND
- Approximate monitoring well location
- Approximate borehole location
- Approximate site boundary
- Approximate Basement 1 and 2 boundary

Project: E22781 GA
10-14 Smallwood Avenue, Homebush, NSW
Borehole Location Plan

Smallwood Joint Venture Pty Ltd
Geotechnical Assessment

Environment Investigations Australia

Figure: 2

Approx. Scale (m)

Drawn: M.G.
Approved: J.C.
Date: 16.12.15
Approx. Scale: 1:250

Smallwood Joint Venture Pty Ltd

10-14 Smallwood Avenue, Homebush, NSW

Ph (02) 9516 0722 Fax (02) 9518 5088

Project: E22781 GA
APPENDIX A

BOREHOLE LOGS AND EXPLANATORY NOTES
**BOREHOLE: BH1M**

**Project:** Proposed New Residential Development  
**Location:** 10-14 Smallwood Avenue, Homebush, NSW  
**Job No.:** E22781  
**Client:** Smallwood Joint Venture Pty Ltd

**Proposed New Residential Development**  
10-14 Smallwood Avenue, Homebush, NSW

**Surface RL:** 13.40 m AHD  
**Date Started:** 27/11/15  
**Date Completed:** 27/11/15  
**Logged:** SY  
**Logged Date:** 27/11/15  
**Checked:** JC  
**Checked Date:** 16/12/15

---

<table>
<thead>
<tr>
<th>METHODOLOGY</th>
<th>PENETRATION RESISTANCE</th>
<th>CONSISTENCY</th>
<th>DENSITY</th>
<th>GRAPHIC LOG</th>
<th>SOIL/ROCK MATERIAL DESCRIPTION</th>
<th>MOISTURE CONDITION</th>
<th>STRUCTURE AND ADDITIONAL OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>WATER</td>
<td>DEPTH</td>
<td>DEPTH (m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.30</td>
<td>0.30</td>
<td></td>
<td></td>
<td>TOPSOIL: Silty SAND; fine grained, brown with rootlets; 300 mm thick.</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.10</td>
<td>1.10</td>
<td></td>
<td></td>
<td>FILL: Silty CLAY: medium to high plasticity, brown with some rootlets throughout (appears moderately compacted).</td>
<td>M</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Silty CLAY: medium plasticity, pale-brown mottled brown.</td>
<td>M</td>
<td>RESIDUAL SOIL</td>
</tr>
<tr>
<td></td>
<td>0.90</td>
<td>0.90</td>
<td></td>
<td></td>
<td>SHALE: extremely low strength, extremely weathered, pale-grey.</td>
<td>M</td>
<td>WEATHERED ROCK</td>
</tr>
<tr>
<td></td>
<td>1.40</td>
<td>1.40</td>
<td></td>
<td></td>
<td>From 2.4 m, very low strength, distinctly weathered.</td>
<td>M</td>
<td>ROCK</td>
</tr>
<tr>
<td>E-F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Continued as Cored Borehole</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.
Sheet 2  OF  2
Date Started 27/11/15
Date Completed 27/11/15
Logged SY
Date: 27/11/15
Checked JC
Date: 16/12/15

This borehole log should be read in conjunction with Environmental Investigations Australia's accompanying standard notes.
Project: Proposed New Residential Development
Location: 10-14 Smallwood Avenue, Homebush, NSW
Position: Refer to Figure 2
Job No.: E22781
Client: Smallwood Joint Venture Pty Ltd

- East: 322191.2 m
- North: 6251329.7 m MGA94 Zone 56
- Surface RL: 13.4 m AHD
- Inclination: -90°
- Box: 1-2 of 2
- Borehole Termination Depth: 10.41 m

- Depth Range: 3 m to 10.41 m
- Contractor: Terratest Pty Ltd
- Drill Rig: Comacchio Geo 205
- LOGGED BY: SY
- DATE: 27/11/2015
- CHECKED BY: -
- DATE: -
TOPSOIL: Silty SAND, fine grained, brown with rootlets; 300 mm thick.

FILL: Silty CLAY: medium to high plasticity, brown with some rootlets throughout (appears moderately compacted).

Silty CLAY: medium plasticity, pale-brown mottled brown.

SHALE: extremely low strength, extremely weathered, pale-grey.

From 2.4 m, very low strength, distinctly weathered.

SHALE: pale-grey, with orange iron staining.

From 4.5 m, brown-grey with orange staining, bedding dipping 10-15 degrees.

From 7.7 m, dark-grey, bedding dipping 0-5 degrees.

Hole Terminated at 10.41 m
Converted to Monitoring Well.

PEIZOMETER CONSTRUCTION DETAILS

ID: BH1M
Static Water Level: 3.50 m
Tip Depth & RL: 9.00 m 4.40 m
Installation Date: 27/11/2015
Static Water Level: 13.40 m AHD

Gatic Cover

ID: BH1M
Static Water Level: 3.50 m
Tip Depth & RL: 9.00 m 4.40 m
Installation Date: 27/11/2015
Static Water Level: 13.40 m AHD

BH1M
Converted to Monitoring Well.
**BOREHOLE: BH2**

---

**Drilling**

<table>
<thead>
<tr>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>VST</td>
</tr>
</tbody>
</table>

**Sampling**

<table>
<thead>
<tr>
<th>Sample or Field Test</th>
<th>Graphic Log</th>
<th>URS Symbol</th>
<th>Soil/Rock Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOPSOIL: Silty SAND; fine grained, brown with rootlets; 100 mm thick.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silty CLAY: medium plasticity, brown with some rootlets/roots (appears moderately compacted).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From 1.2 m, pale-brown, with some extremely low strength, extremely weathered shale.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHALE: extremely low strength, extremely weathered, grey-brown with orange iron staining.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From 2.2 m, very low strength, distinctly weathered.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From 3 m, very low to low strength, distinctly weathered.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Field Material Description**

<table>
<thead>
<tr>
<th>Sample or Field Test</th>
<th>Graphic Log</th>
<th>URS Symbol</th>
<th>Soil/Rock Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOPSOIL</td>
<td></td>
<td></td>
<td>TOPSOIL RESEUAL SOIL</td>
</tr>
<tr>
<td>SHALE</td>
<td></td>
<td></td>
<td>WEATHERED ROCK</td>
</tr>
<tr>
<td>ROCK</td>
<td></td>
<td></td>
<td>ROCK</td>
</tr>
</tbody>
</table>

---

**Continued as Cored Borehole**

This borehole log should be read in conjunction with Environmental Investigations Australia’s accompanying standard notes.
BOREHOLE: BH2

Project: Proposed New Residential Development
Location: 10-14 Smallwood Avenue, Homebush, NSW
Position: Refer to Figure 2

Southwest 32223.9 m
North 6251329.5 m MGA94 Zone 56
Surface RL 14.40 m AHD

Client: Smallwood Joint Venture Pty Ltd
Drill Rig: Cornacchio Geo 205
Inclination: -90°

Date Started: 27/11/15
Date Completed: 27/11/15
Logged: SY
Checked: JC
Date: 16/12/15

<table>
<thead>
<tr>
<th>DEPTH (RL)</th>
<th>ROCK / SOIL MATERIAL DESCRIPTION</th>
<th>INFERRED STRENGTH ( f_{ik} ) MPa</th>
<th>DEFECT DESCRIPTION &amp; Additional Observations</th>
<th>AVERAGE DEFECT SPACING (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03</td>
<td>SHALE: dark-grey, bedding dipping 0-5 degrees.</td>
<td>5.24: BP 0° PR RF CN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.10</td>
<td></td>
<td>5.80: BP 0° PR RF CN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.30</td>
<td></td>
<td>6.30: BP 0° PR RF CN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td></td>
<td>6.66: BP 0° PR RF CN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.00</td>
<td></td>
<td>6.88: BP 0° PR RF CN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.00</td>
<td></td>
<td>7.37: BP 0° PR RF CN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.45-7.50</td>
<td></td>
<td>7.45-7.50: BPx2 0° - 10° PR RF CN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.73-7.91</td>
<td></td>
<td>7.72-7.91: JT 80° - 90° UN RF CN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.73-7.92</td>
<td></td>
<td>7.73-7.92: BPx4 30° PR RF CN 50 mm spacing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.49</td>
<td></td>
<td>8.49: BP 10° PR RF CN</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This borehole log should be read in conjunction with Environmental Investigations Australia’s accompanying standard notes.
Project: Proposed New Residential Development
Location: 10-14 Smallwood Avenue, Homebush, NSW
Position: Refer to Figure 2
Job No.: E22781
Client: Smallwood Joint Venture Pty Ltd

East: 322223.9 m
North: 6251329.5 m MGA94 Zone 56
Surface RL: 14.4 m AHD
Inclination: -90°
Box: 1 of 1
Borehole Termination Depth: 9 m

Depth Range: 5.17 m to 9 m
Contractor: Terratest Pty Ltd
Drill Rig: Comacchio Geo 205
LOGGED BY: SY DATE: 27/11/2015
CHECKED BY: - DATE: -

Borehole Termination Depth: 9 m
### EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT LOGS

#### DRILLING/ EXCAVATION METHOD
- **HA**: Hand Auger  
- **DTC**: Diatube Coring  
- **NDD**: Non-destructive digging  
- **AS***: Auger Screwing  
- **AD**: Auger Drilling  
- **ADH**: Hollow Auger  
- **RT**: Rotary blade or drag bit  
- **RAB**: Rotary Air Blast  
- **RC**: Reverse Circulation  
- **PT**: Push Tube  
- **CT**: Cable Tool Rig  
- **JET**: Jetting  
- **WB**: Washbore or Bailer

#### PENETRATION/ EXCAVATION RESISTANCE
- **L**: Low resistance. Rapid penetration/ excavation possible with little effort from equipment used.  
- **M**: Medium resistance. Penetration/excavation possible at an acceptable rate with moderate effort from equipment used.  
- **H**: High resistance. Penetration/excavation is possible but at a slow rate and requires significant effort from equipment used.  
- **R**: Refusal/Practical Refusal. No further progress possible without risk of damage or unacceptable wear to equipment used.

These assessments are subjective and are dependent on many factors, including equipment power and weight, condition of excavation or drilling tools and experience of the operator.

#### WATER
- **↓**: Water level at date shown  
- **△**: Partial water loss  
- **▽**: Complete water loss

#### GROUNDWATER
- **NOT OBSERVED**: Observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave-in of the borehole/test pit.  
- **NOT ENCOUNTERED**: Borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

#### SAMPLING AND TESTING
- **SPT**: Standard Penetration Test to AS1289.6.3.1-2004  
  - 4.7,11 N=18  
  - 4.7,11 = Blows per 150mm. N = Blows per 300mm penetration following 150mm seating 30/80mm  
  - Where practical refusal occurs, the blows and penetration for that interval are reported  
- **RW**: Penetration occurred under the rod weight only  
- **HW**: Penetration occurred under the hammer and rod weight only  
- **HB**: Hammer double bouncing on anvil

#### Sampling
- **DS**: Disturbed Sample  
- **BDS**: Bulk disturbed Sample  
- **GS**: Gas Sample  
- **WS**: Water Sample  
- **U63**: Thin walled tube sample - number indicates nominal sample diameter in millimetres

#### Testing
- **FP**: Field Permeability test over section noted  
- **FVS**: Field Vane Shear test expressed as uncorrected shear strength (sv = peak value, sr = residual value)  
- **PID**: Photoionisation Detector reading in ppm  
- **PM**: Pressuremeter test over section noted  
- **PP**: Pocket Penetrometer test expressed as instrument reading in kPa  
- **WPT**: Water Pressure tests  
- **DCP**: Dynamic Cone Penetrometer test  
- **CPT**: Static Cone Penetration test  
- **CPTu**: Static Cone Penetration test with pore pressure (u) measurement

#### RANKING OF VISUALLY OBSERVABLE CONTAMINATION AND ODOUR (for specific soil contamination assessment)

<table>
<thead>
<tr>
<th>R</th>
<th>Description</th>
<th>R</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No visible evidence of contamination</td>
<td>A</td>
<td>No non-natural odours identified</td>
</tr>
<tr>
<td>1</td>
<td>Slight evidence of visible contamination</td>
<td>B</td>
<td>Slight non-natural odours identified</td>
</tr>
<tr>
<td>2</td>
<td>Visible contamination</td>
<td>C</td>
<td>Moderate non-natural odours identified</td>
</tr>
<tr>
<td>3</td>
<td>Significant visible contamination</td>
<td>D</td>
<td>Strong non-natural odours identified</td>
</tr>
</tbody>
</table>

#### ROCK CORE RECOVERY
- **TCR** = Total Core Recovery (%) = \( \frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100 \)  
- **SCR** = Solid Core Recovery (%) = \( \frac{\sum \text{Length of cylindrical core recovered}}{\text{Length of core run}} \times 100 \)  
- **RQD** = Rock Quality Designation (%) = \( \frac{\sum \text{Axial Lenghts of core>100mm}}{\text{Length of core run}} \times 100 \)

#### MATERIAL BOUNDARIES
- **=** inferred boundary  
- **- - - - - -** = probable boundary  
METHOD OF SOIL DESCRIPTION
USED ON BOREHOLE AND TEST PIT LOGS

FILL
ORGANIC SOILS
(OL, OH or Pt)
COUBLES or
BOULDERS
SILT (ML or MH)
GRAVEL (GP or GW)
CLAY (CL, Cl or CH)
SAND (SP or SW)

CLASSIFICATION AND INFERRED STRATIGRAPHY
Soil is broadly classified and described in Borehole and Test Pit Logs using the preferred method given in AS1726 – 1993, (Amdt1 – 1994 and Amdt2 – 1994), Appendix A. Material properties are assessed in the field by visual/tactile methods.

PARTICLE SIZE CHARACTERISTICS

<table>
<thead>
<tr>
<th>Major Division</th>
<th>Sub Division</th>
<th>Particle Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOULDERS</td>
<td></td>
<td>&gt;200 mm</td>
</tr>
<tr>
<td>COBBLES</td>
<td></td>
<td>63 to 200 mm</td>
</tr>
<tr>
<td>GRAVEL</td>
<td>Coarse</td>
<td>20 to 63 mm</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>6 to 20 mm</td>
</tr>
<tr>
<td></td>
<td>Fine</td>
<td>2 to 6 mm</td>
</tr>
<tr>
<td>SAND</td>
<td>Coarse</td>
<td>0.6 to 2 mm</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>0.2 to 0.6 mm</td>
</tr>
<tr>
<td></td>
<td>Fine</td>
<td>0.075 to 0.2mm</td>
</tr>
<tr>
<td>Silt</td>
<td>0.002 to 0.075mm</td>
<td></td>
</tr>
<tr>
<td>Clay</td>
<td>&lt;0.002 mm</td>
<td></td>
</tr>
</tbody>
</table>

PLASTICITY PROPERTIES

MOISTURE CONDITION

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>Dry</td>
<td>Sands and gravels are free flowing. Clays &amp; Silts may be brittle or friable and powdery.</td>
</tr>
<tr>
<td>M</td>
<td>Moist</td>
<td>Soils are darker than in the dry condition &amp; may feel cool. Sands and gravels tend to cohere.</td>
</tr>
<tr>
<td>W</td>
<td>Wet</td>
<td>Soils exude free water. Sands and gravels tend to cohere.</td>
</tr>
</tbody>
</table>

Consistency and density may be assessed from correlations with the observed behaviour of the material. # SPT correlations are not stated in AS1726 – 1993, and may be subject to corrections for overburden pressure and equipment type.

MINOR COMPONENTS

<table>
<thead>
<tr>
<th>Term</th>
<th>Assessment Guide</th>
<th>Proportion by Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>Presence just detectable by feel or eye but soil properties little</td>
<td>Coarse grained soils: ≤ 5%</td>
</tr>
<tr>
<td></td>
<td>or no different to general properties of primary component</td>
<td>Fine grained soil: ≤15%</td>
</tr>
<tr>
<td>Some</td>
<td>Presence easily detectable by feel or eye but soil properties little</td>
<td>Coarse grained soils: 5 - 12%</td>
</tr>
<tr>
<td></td>
<td>or no different to general properties of primary component</td>
<td>Fine grained soil: 15 - 30%</td>
</tr>
</tbody>
</table>
ABBREVIATIONS AND DESCRIPTIONS FOR ROCK MATERIAL AND DEFECTS

CLASSIFICATION AND INFERRED STRATIGRAPHY

ROCK MATERIAL DESCRIPTION

<table>
<thead>
<tr>
<th>Layering</th>
<th>Description</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massive</td>
<td>No layering apparent</td>
<td>Thlinly laminated</td>
</tr>
<tr>
<td></td>
<td>Layering just visible; little effect on properties</td>
<td>Laminated</td>
</tr>
<tr>
<td>Poorly Developed</td>
<td>Layering (bedding, foliation, cleavage) distinct; rock breaks more easily parallel to layering</td>
<td>Very thinly bedded</td>
</tr>
<tr>
<td>Well Developed</td>
<td>Layering (bedding, foliation, cleavage) distinct; rock breaks more easily parallel to layering</td>
<td>Thlinly bedded</td>
</tr>
<tr>
<td></td>
<td>Layering (bedding, foliation, cleavage) distinct; rock breaks more easily parallel to layering</td>
<td>Medium bedded</td>
</tr>
<tr>
<td></td>
<td>Layering (bedding, foliation, cleavage) distinct; rock breaks more easily parallel to layering</td>
<td>Thickly bedded</td>
</tr>
<tr>
<td></td>
<td>Layering (bedding, foliation, cleavage) distinct; rock breaks more easily parallel to layering</td>
<td>Very thickly bedded</td>
</tr>
</tbody>
</table>

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT TYPES

<table>
<thead>
<tr>
<th>Defect Type</th>
<th>Abbr.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint</td>
<td>J</td>
<td>Surface of a fracture or parting, formed without displacement, across which the rock has little or no tensile strength. May be closed or filled by air, water or soil or rock substance, which acts as cement.</td>
</tr>
<tr>
<td>Bedding Parting</td>
<td>B</td>
<td>Surface of fracture or parting, across which the rock has little or no tensile strength, parallel or sub-parallel to layering/bedding. Bedding refers to the layering or stratification of a rock, indicating orientation during deposition, resulting in planar anisotropy in the rock material.</td>
</tr>
<tr>
<td>Foliation</td>
<td>X</td>
<td>Repetitive planar structure parallel to the shear direction or perpendicular to the direction of higher pressure, especially in metamorphic rock, e.g. Schistosity (S) and Gneissosity.</td>
</tr>
<tr>
<td>Contact</td>
<td>C</td>
<td>The surface between two types or ages of rock.</td>
</tr>
<tr>
<td>Cleavage</td>
<td>L</td>
<td>Cleavage planes appear as parallel, closely spaced and planar surfaces resulting from mechanical fracturing of rock through deformation or metamorphism, independent of bedding.</td>
</tr>
<tr>
<td>Sheared Seam/Zone (Fault)</td>
<td>SS/SZ</td>
<td>Seam or zone with roughly parallel almost planar boundaries of rock substance cut by closely spaced (often &lt;50 mm) parallel and usually smooth or slickensided joints or cleavage planes.</td>
</tr>
<tr>
<td>Crushed Seam/Zone (Fault)</td>
<td>CS/CZ</td>
<td>Seam or zone composed of disoriented usually angular fragments of the host rock substance, with roughly parallel near-planar boundaries. The fragments may be of clay, silt, sand or gravel sizes or mixtures of these.</td>
</tr>
<tr>
<td>Decomposed Seam/Zone</td>
<td>DS/DZ</td>
<td>Seam of soil substance, often with gradational boundaries, formed by weathering of the rock material in places.</td>
</tr>
<tr>
<td>Infilled Seam</td>
<td>IS/IZ</td>
<td>Seam of soil substance, usually clay or clayey, with very distinct roughly parallel boundaries, formed by soil migrating into joint or open cavity.</td>
</tr>
<tr>
<td>Schistocity</td>
<td>S</td>
<td>The foliation in schist or other coarse grained crystalline rock due to the parallel arrangement of platy or prismatic mineral grains, such as mica.</td>
</tr>
<tr>
<td>Vein</td>
<td>V</td>
<td>Distinct sheet-like body of minerals crystallised within rock through typically open-space filling or crack-seal growth.</td>
</tr>
</tbody>
</table>

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT SHAPE AND ROUGHNESS

<table>
<thead>
<tr>
<th>Shape</th>
<th>Abbr.</th>
<th>Description</th>
<th>Roughness</th>
<th>Abbr.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planar</td>
<td>Pl</td>
<td>Consistent orientation</td>
<td>Polished</td>
<td>Po</td>
<td>Shiny smooth surface</td>
</tr>
<tr>
<td>Curved</td>
<td>Cu</td>
<td>Gradual change in orientation</td>
<td>Slickensided</td>
<td>Sl</td>
<td>Grooved or striated surface, usually polished</td>
</tr>
<tr>
<td>Undulating</td>
<td>Un</td>
<td>Wavy surface</td>
<td>Smooth</td>
<td>Sm</td>
<td>Smooth to touch. Few or no surface irregularities</td>
</tr>
<tr>
<td>Stepped</td>
<td>St</td>
<td>One or more well defined steps</td>
<td>Rough</td>
<td>Ro</td>
<td>Many small surface irregularities (amplitude generally &lt;1mm). Feels like fine to coarse sandpaper</td>
</tr>
<tr>
<td>Irregular</td>
<td>Irr</td>
<td>Many sharp changes in orientation</td>
<td>Very Rough</td>
<td>VRo</td>
<td>Many large surface irregularities, amplitude generally &gt;1mm. Feels like very coarse sandpaper</td>
</tr>
</tbody>
</table>

Orientation: Vertical Boreholes – The dip (inclination from horizontal) of the defect.
Inclined Boreholes – The inclination is measured as the acute angle to the core axis.

ABBREVIATIONS AND DESCRIPTIONS FOR DEFECT COATING

<table>
<thead>
<tr>
<th>Coating</th>
<th>Abbr.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean</td>
<td>Cn</td>
<td>No visible coating or infilling</td>
</tr>
<tr>
<td>Stain</td>
<td>Sn</td>
<td>No visible coating but surfaces are discoloured by staining, often limonite (orange-brown)</td>
</tr>
<tr>
<td>Veneer</td>
<td>Vr</td>
<td>A visible coating of soil or mineral substance, usually too thin to measure (&lt; 1 mm); may be patchy</td>
</tr>
</tbody>
</table>

DEFECTION APERTURE

<table>
<thead>
<tr>
<th>Aperture</th>
<th>Abbr.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed</td>
<td>Cl</td>
<td></td>
</tr>
<tr>
<td>Open</td>
<td>O</td>
<td>Without Infill</td>
</tr>
<tr>
<td>Infilled</td>
<td>-</td>
<td>Soil or rock i.e. clay, talc, pyrite, quartz, etc.</td>
</tr>
</tbody>
</table>
APPENDIX B

LABORATORY CERTIFICATES
SOIL CLASSIFICATION REPORT

Client: Environmental Investigations

Source: BH1_1.5-1.9m

Address: Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009

Sample Description: silty CLAY

Project: 10-14 Smallwood Avenue, Homebush NSW (E22781)

Report No: S7673-PI

Job No: S15365

Lab No: S7673

Test Procedure:
- AS1289 2.1.1 Soil moisture content tests (Oven drying method)
- AS1289 3.1.1 Soil classification tests - Determination of the liquid limit of a soil - Four point Casagrande method
- AS1289 3.1.2 Soil classification tests - Determination of the liquid limit of a soil - One point Casagrande method (subsidary method)
- AS1289 3.2.1 Soil classification tests - Determination of the plastic limit of a soil - Standard method
- AS1289 3.3.1 Soil classification tests - Calculation of the plasticity index of a soil
- AS1289 3.4.1 Soil classification tests - Determination of the linear shrinkage of a soil - Standard method

Sampling: Sampled by Client

Preparation: Prepared in accordance with the test method

Date Sampled: 27/11/2015

Liquid Limit (%): 50

Linear Shrinkage (%): 11.5

Plastic Limit (%): 22

Field Moisture Content (%): 13.6

Plastic Index: 28

Plasticity Chart for Classification of Fine-grained Soils

Soil Preparation Method: Dry Sieved

Soil History: Air Dried

Soil Condition: Linear

Authorised Signatory: Chris Lloyd

Date: 11/12/2015

NATA Accredited Laboratory Number: 14874

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

Macquarie Geotechnical
Unit 8/10 Bradford Street
Alexandria NSW 2015

Report Form: PI LS

Issue 1 - Revision C - Issue Date 20/4/15

Page 1 of 1
### POINT LOAD STRENGTH INDEX REPORT

**Client:** Environmental Investigations  
**Moisture Content Condition:** As received  
**Address:** Suite 6.01, 55 Miller Street, Pyrmont, NSW 2009  
**Storage History:** Core boxes  
**Project:** 10-14 Smallwood Avenue, Homebush NSW (E22781)  
**Report No:** S7674-PL  
**Job No:** S15365  
**Date Tested:** 7/12/2015  

**Test Procedure:**  
1. **Test Type:** Diametral and Axial  
2. **Sample Source:** BH1_3.48-3.54m, BH1_4.49-4.54m, BH1_5.52-5.58m, BH1_6.43-6.48m, BH1_7.80-7.86m, BH1_8.49-8.54m, BH1_8.65-8.72m, BH1_9.49-9.56m, BH1_10.18-10.25m  
3. **Sample Description:** Shale  

#### Sample Table

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Sample Source</th>
<th>Sample Description</th>
<th>Test Type</th>
<th>Average Width (mm)</th>
<th>Platen Separation (mm)</th>
<th>Failure Load (kN)</th>
<th>Point Load Index Is (MPa)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>S7674</td>
<td>BH1_3.48-3.54m</td>
<td>Shale</td>
<td>Diametral</td>
<td>41.0</td>
<td>0.13</td>
<td>0.08</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Axial</td>
<td>41.0</td>
<td>0.17</td>
<td>0.19</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>S7675</td>
<td>BH1_4.49-4.54m</td>
<td>Shale</td>
<td>Diametral</td>
<td>45.0</td>
<td>0.02</td>
<td>0.01</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Axial</td>
<td>45.0</td>
<td>0.39</td>
<td>0.27</td>
<td>0.24</td>
<td></td>
</tr>
<tr>
<td>S7676</td>
<td>BH1_5.52-5.58m</td>
<td>Shale</td>
<td>Diametral</td>
<td>50.0</td>
<td>0.02</td>
<td>0.01</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Axial</td>
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<tr>
<td>S7677</td>
<td>BH1_6.43-6.48m</td>
<td>Shale</td>
<td>Diametral</td>
<td>49.0</td>
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<tr>
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<tr>
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<tr>
<td>S7679</td>
<td>BH1_8.49-8.54m</td>
<td>Shale</td>
<td>Diametral</td>
<td>38.0</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Axial</td>
<td>38.0</td>
<td>0.07</td>
<td>0.03</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>S7679b</td>
<td>BH1_8.65-8.72m</td>
<td>Shale</td>
<td>Diametral</td>
<td>51.0</td>
<td>0.26</td>
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<td>51.0</td>
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<td></td>
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<tr>
<td>S7680</td>
<td>BH1_9.49-9.56m</td>
<td>Shale</td>
<td>Diametral</td>
<td>51.0</td>
<td>0.06</td>
<td>0.02</td>
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</tr>
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<td>S7681</td>
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<tr>
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<td>Axial</td>
<td>51.0</td>
<td>2.22</td>
<td>1.49</td>
<td>1.32</td>
<td></td>
</tr>
</tbody>
</table>

### Comments:

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025. This document shall not be reproduced, except in full.

**Authorised Signatory:**  
**Date:** 16/12/2015

Macquarie Geotechnical  
Unit 8/10  
Bradford Street  
Alexandria NSW

---

**NATA Accredited Laboratory Number:** 14874

---

**Report Form:** PL - ASM  
**Issue 1 - Revision A - Issue Date 1/6/14**
**POINT LOAD STRENGTH INDEX REPORT**

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Sample Source</th>
<th>Sample Description</th>
<th>Test Type</th>
<th>Average Width (mm)</th>
<th>Platen Separation (mm)</th>
<th>Failure Load (kN)</th>
<th>Point Load Index Is (MPa)</th>
<th>Point Load Index Is(50) (MPa)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>S7682</td>
<td>BH2_5.50-5.59m</td>
<td>Shale</td>
<td>Diametral</td>
<td>-</td>
<td>50.0</td>
<td>0.06</td>
<td>0.02</td>
<td>0.02</td>
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<tr>
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<td>BH2_6.50-6.59m</td>
<td>Shale</td>
<td>Diametral</td>
<td>-</td>
<td>49.0</td>
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<td>Axial</td>
<td>49.0</td>
<td>37.0</td>
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<td>Diametral</td>
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<td>Axial</td>
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<td>1.48</td>
<td>0.51</td>
<td>0.52</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

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NATA Accredited Laboratory Number: 14874

Authorised Signatory: [Signature]

11/12/2015

Macquarie Geotech
Unit 8/10
Bradford Street
Alexandra NSW
CLIENT DETAILS

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Client: Environmental Investigations
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              NSW 2009
Telephone: 02 9516 0722
Facsimile: 02 9516 0741
Email: david.rizkalla@eiaustralia.com.au

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Laboratory: SGS Alexandria Environmental
Address: Unit 16, 33 Maddox St
              Alexandria NSW 2015
Telephone: +61 2 8594 0400
Facsimile: +61 2 8594 0499
Email: au.environmental.sydney@sgs.com

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(4354).

SIGNATORIES

Andy Sutton
Senior Organic Chemist

Dong Liang
Metals/Inorganics Team Leader
## Soluble Anions (1:5) in Soil by Ion Chromatography [AN245] Tested: 9/12/2015

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>UOM</th>
<th>LOR</th>
<th>BH1_0.5-0.95</th>
<th>BH2_0.5-0.95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride</td>
<td>mg/kg</td>
<td>0.25</td>
<td><strong>3.6</strong></td>
<td><strong>0.79</strong></td>
</tr>
<tr>
<td>Sulphate</td>
<td>mg/kg</td>
<td>5</td>
<td><strong>76</strong></td>
<td><strong>92</strong></td>
</tr>
</tbody>
</table>
### pH in soil (1:5) [AN101]

**Tested:** 9/12/2015

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>UOM</th>
<th>BH1_0.5-0.95</th>
<th>BH2_0.5-0.95</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>pH Units</td>
<td>5.0</td>
<td>4.5</td>
</tr>
</tbody>
</table>

**LOR:**
- BH1_0.5-0.95: SE146777.001
- BH2_0.5-0.95: SE146777.002
Conductivity and TDS by Calculation - Soil [AN106]  
Tested: 9/12/2015

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>UOM</th>
<th>LOR</th>
<th>BH1_0.5-0.95</th>
<th>BH2_0.5-0.95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductivity of Extract (1:5 dry sample basis)</td>
<td>µS/cm</td>
<td>1</td>
<td>39</td>
<td>39</td>
</tr>
</tbody>
</table>
## Moisture Content [AN002]  Tested: 4/12/2015

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>UOM</th>
<th>LOR</th>
<th>BH1_0.5-0.95</th>
<th>BH2_0.5-0.95</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Moisture</td>
<td>%/w</td>
<td>0.5</td>
<td>18</td>
<td>24</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th>SOIL</th>
<th>SOIL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>27/11/2015</td>
<td>27/11/2015</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SE146777.001</td>
<td>SE146777.002</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11/12/2015
The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.

pH in Soil Sludge Sediment and Water: pH is measured electrometrically using a combination electrode and is calibrated against 3 buffers purchased commercially. For soils, sediments and sludges, an extract with water (or 0.01M CaCl2) is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.

Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as umhos/cm or μS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Salinity can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. Reference APHA 2510 B.

Anions by Ion Chromatography: A water sample is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B

Samples analysed as received. Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the *Total* LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~media/LocalAustralia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

This document is issued, on the Client’s behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/en/Terms-and-Conditions/General-Conditions-of-Services-English.aspx. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

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Analysed for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(4354).
pH in water [AN101]  Tested: 3/12/2015

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>UOM</th>
<th>LOR</th>
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</thead>
<tbody>
<tr>
<td>pH**</td>
<td>No unit</td>
<td>2/12/2015</td>
<td>6.7</td>
</tr>
</tbody>
</table>
### Conductivity and TDS by Calculation - Water [AN106]  
**Tested:** 3/12/2015

<table>
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<th>PARAMETER</th>
<th>UOM</th>
<th>LOR</th>
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</thead>
<tbody>
<tr>
<td>Conductivity @ 25 C</td>
<td>µS/cm</td>
<td>2</td>
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**BH1M**
**WATER**
*2/12/2015*
**SE146703.001**

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Cl⁻</td>
<td>mg/L</td>
<td>0.05</td>
<td>34</td>
</tr>
<tr>
<td>SO₄²⁻</td>
<td>mg/L</td>
<td>1</td>
<td>21</td>
</tr>
</tbody>
</table>

*Note: BH1M WATER - 2/12/2015 SE146703.001*
METHOD

**METHOD SUMMARY**

**pH in Soil Sludge Sediment and Water:** pH is measured electrometrically using a combination electrode (glass plus reference electrode) and is calibrated against 3 buffers purchased commercially. For soils, an extract with water is made at a ratio of 1:5 and the pH determined and reported on the extract. Reference APHA 4500-H+.

**Conductivity and TDS by Calculation:** Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Total Dissolved Solids can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. SGS use 0.6. Reference APHA 2510 B.

**Anions by Ion Chromatography:** A water sample is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B.

**FOOTNOTES**

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

**Indicative data, theoretical holding time exceeded.**

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Samples analysed as received.

Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total QC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Total" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the "Total" LOR will be the sum of those two LORs.

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APPENDIX C

Vibration Emission Design Goals
VIBRATION EMISSION DESIGN GOALS

German Standard DIN 4150 – Part 3: 1999 provides guideline levels of vibration velocity for evaluating the effects of vibration in structures. The limits presented in this standard are generally recognised to be conservative.

The DIN 4150 values (maximum levels measured in any direction at the foundation, OR, maximum levels measured in (x) or (y) directions, in the plane of the uppermost floor), are summarised in Table A below.

It should be noted that peak vibration velocities higher than the minimum figures in Table A for low frequencies may be quite ‘safe’, depending on the frequency content of the vibration and the actual conditions of the structures.

It should also be noted that these levels are ‘safe limits’, up to which no damage due to vibration effects has been observed for the particular class of building. ‘Damage’ is defined by DIN 4150 to include even minor non-structural cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls. Should damage be observed at vibration levels lower than the ‘safe limits’, then it may be attributed to other causes. DIN 4150 also states that when vibration levels higher than the ‘safe limits’ are present, it does not necessarily follow that damage will occur. Values given are only a broad guide.

Table A  DIN 4150 – Structural Damage – Safe Limits for Building Vibration

<table>
<thead>
<tr>
<th>Group</th>
<th>Type of Structure</th>
<th>Peak Vibration Velocity (mm/s)</th>
<th>Plane of Floor of Uppermost Storey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>At Foundation Level at a Frequency of:</td>
<td>Less than 10 Hz</td>
</tr>
<tr>
<td>1</td>
<td>Buildings used for commercial purposes, industrial buildings and buildings of similar design</td>
<td>20</td>
<td>20 to 40</td>
</tr>
<tr>
<td>2</td>
<td>Dwellings and buildings of similar design and/or use</td>
<td>5</td>
<td>5 to 15</td>
</tr>
<tr>
<td>3</td>
<td>Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Group 1 and 2 and have intrinsic value (e.g. buildings that are under a preservation order)</td>
<td>3</td>
<td>3 to 8</td>
</tr>
</tbody>
</table>

Note: For frequencies above 100 Hz, the higher values in the 50 Hz to 100 Hz column should be used.
APPENDIX D

IMPORTANT INFORMATION
Important Information

SCOPE OF SERVICES

The geotechnical report ("the report") has been prepared in accordance with the scope of services as set out in the contract, or as otherwise agreed, between the Client and Environmental Investigations ("EI"). The scope of work may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

RELIANCE ON DATA

EI has relied on data provided by the Client and other individuals and organizations, to prepare the report. Such data may include surveys, analyses, designs, maps and plans. EI has not verified the accuracy or completeness of the data except as stated in the report. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations ("conclusions") are based in whole or part on the data, EI will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to EI.

GEOTECHNICAL ENGINEERING

Geotechnical engineering is based extensively on judgment and opinion. It is far less exact than other engineering disciplines. Geotechnical engineering reports are prepared for a specific client, for a specific project and to meet specific needs, and may not be adequate for other clients or other purposes (e.g. a report prepared for a consulting civil engineer may not be adequate for a construction contractor). The report should not be used for other than its intended purpose without seeking additional geotechnical advice. Also, unless further geotechnical advice is obtained, the report cannot be used where the nature and/or details of the proposed development are changed.

LIMITATIONS OF SITE INVESTIGATION

The investigation programme undertaken is a professional estimate of the scope of investigation required to provide a general profile of subsurface conditions. The data derived from the site investigation programme and subsequent laboratory testing are extrapolated across the site to form an inferred geological model, and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite investigation, the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

The engineering logs are the subjective interpretation of subsurface conditions at a particular location and time, made by trained personnel. The actual interface between materials may be more gradual or abrupt than a report indicates.

SUBSURFACE CONDITIONS ARE TIME DEPENDENT

Subsurface conditions can be modified by changing natural forces or man-made influences. The report is based on conditions that existed at the time of subsurface exploration. Construction operations adjacent to the site, and natural events such as floods, or ground water fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report. EI should be kept appraised of any such events, and should be consulted to determine if any additional tests are necessary.

VERIFICATION OF SITE CONDITIONS

Where ground conditions encountered at the site differ significantly from those anticipated in the report, either due to natural variability of subsurface conditions or construction activities, it is a condition of the report that EI be notified of any variations and be provided with an opportunity to review the recommendations of this report. Recognition of change of soil and rock conditions requires experience and it is recommended that a suitably experienced geotechnical engineer be engaged to visit the site with sufficient frequency to detect if conditions have changed significantly.

REPRODUCTION OF REPORTS

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

REPORT FOR BENEFIT OF CLIENT

The report has been prepared for the benefit of the Client and no other party. EI assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of EI or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

OTHER LIMITATIONS

EI will not be liable to update or revise the report to take into account any events or emergent circumstances or fact occurring or becoming apparent after the date of the report.