Douglas Partners
Geotechnics / Environment / Groundwater

# Report on
# Geotechnical Investigation

## Proposed New Liverpool Primary School
## Lachlan Street, Liverpool

Prepared for
School Infrastructure NSW

Project 92370.01
December 2019

Integrated Practical Solutions

## Document History

Document details

| | | | |
|---|---|---|---|
| Project No. | 92370.01 | Document No. | R.001.Rev2 |
| Document title | Report on Geotechnical Investigation<br>Proposed New Liverpool Primary School | | |
| Site address | Lachlan Street, Liverpool | | |
| Report prepared for | School Infrastructure NSW | | |
| File name | 92370.01.R.001.Rev2.docx | | |

Document status and review

| Status | Prepared by | Reviewed by | Date issued |
|---|---|---|---|
| Revision 0 | Konrad Schultz | Michael J Thom | 25/11/2019 |
| Revision 1 | Konrad Schultz | Michael J Thom | 10/12/2019 |
| Revision 2 | Konrad Schultz | Michael J Thom | 17/12/2019 |
| | | | |

Distribution of copies

| Status | Electronic | Paper | Issued to |
|---|---|---|---|
| Revision 0 | 1 | 0 | Mr Richard Bharata, School Infrastructure NSW |
| Revision 1 | 1 | 0 | Mr Richard Bharata, School Infrastructure NSW |
| Revision 2 | 1 | 0 | Mr Richard Bharata, School Infrastructure NSW |
| | | | |
| | | | |

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

| | Signature | Date |
|---|---|---|
| Author | | 17/12/2019 |
| Reviewer | for MJT | 17/12/2019 |

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
18 Waler Crescent
Smeaton Grange NSW 2567
Phone (02) 4647 0075

# Executive Summary

A geotechnical investigation was carried out for the proposed redevelopment of the Liverpool Primary School at Lachlan Street, Liverpool. The investigation included the drilling of six cored boreholes and five augured boreholes.

The interpreted subsurface profile determined in the investigation was relatively uniform with a variable depth of shallow fill and topsoil then alluvial clay and sand over shale and laminite. The rock generally increases in strength with depth.

For excavations, retaining walls will be required to support the overburden soil and weaker layers of rock. For relatively highly loaded footings, it is recommended that all footings be extended to uniform shale or laminite. Deep piers are likely to be required.

The results of the investigation suggest that redevelopment of the site should be feasible from a geotechnical perspective, and design and construction is likely to be possible using conventional techniques.

## Table of Contents

Page

1. Introduction ........ 1
2. Site Description and Regional Geology ........ 1
3. Field Work ........ 3
    3.1 Methods ........ 3
    3.2 Results ........ 3
4. Laboratory Testing ........ 4
5. Proposed Development ........ 8
6. Comments ........ 8
    6.1 Site Conditions ........ 8
    6.2 Site Classification ........ 8
    6.3 Slope Stability ........ 9
    6.4 Excavations ........ 9
        6.4.1 Excavation Conditions ........ 9
        6.4.2 Vibrations ........ 9
        6.4.3 Dilapidation Surveys ........ 10
        6.4.4 Disposal of Excavated Material ........ 10
        6.4.5 Excavation Support ........ 10
    6.5 Site Preparation and Earthworks ........ 13
        6.5.1 Reuse of Excavated Materials ........ 13
        6.5.2 Engineered Fill ........ 13
        6.5.3 Geotechnical Inspections and Testing ........ 14
    6.6 Foundations ........ 14
    6.7 Pavements and Floor Slabs on Ground ........ 15
    6.8 Seismic site Class ........ 15
7. Limitations ........ 15

Appendix A: About This Report
Results of Field Work
Site Photographs
Drawing 1

Appendix B: Results of Laboratory Testing

# Report on Geotechnical Investigation
# Proposed New Liverpool Primary School
# Lachlan Street, Liverpool

## 1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed new Liverpool Primary School at Lachlan Street, Liverpool. The investigation was commissioned by Mr Richard Bharata of School Infrastructure NSW and was undertaken in accordance with Douglas Partners Pty Ltd (DP) proposal MAC190157.P.001.Rev1 dated 13 August 2019.

It is understood that the construction of new school facilities with a capacity of up to 1200 students is proposed. Preliminary information indicates the buildings may be up to four levels in height and include playing fields, carparking and other infrastructure.

Investigation is required to provide information on the subsurface conditions for documentation and the conceptual design of the structures including the foundations, retaining structures and floor slabs and to assess excavation conditions on the site.

The investigation comprised nine boreholes followed by logging, core photography, laboratory testing of selected samples and engineering evaluation. Details of the field and laboratory work are given in the report together with suggested design parameters and comments on design and construction practice.

The investigation was carried out in conjunction with investigation for the proposed redevelopment of the existing Liverpool Boys and Girls High Schools site and to be located in the north eastern corner of that site. The results of the investigation for the Liverpool Boys and Girls High Schools site have been reported separately, however relevant information from the boreholes near the common boundary has been included in this report.

## 2. Site Description and Regional Geology

The existing Liverpool Boys and Girls High Schools site is approximately rectangular in shape with a maximum plan dimensions of approximately 290 m by 260 m. The proposed Liverpool Primary School will be located along the eastern portion of the overall site, and the site as an approximate ‘L’shape with a maximum plan dimensions of approximately 260 m by 155 m. It is bounded to the north by a road reserve, the west by the High Schools, the south by road reserve and Liverpool Hospital and the east by a road reserve and the main South railway line. The approximate extents of the proposed new boundaries are shown on Drawing 1 in Appendix A.

The site slopes gently towards the south east with the ground surface levels falling from the north western corner near Lachlan Street at about RL 10 m relative to the Australian Height Datum (AHD) to about RL 9 m AHD at the south eastern corner.

At the time of the investigation, the subject site was part of an operational high school and was occupied primarily by grassed playing fields with some amenities building near the northern boundary and trees along the northern and eastern boundaries.

Reference to the Penrith 1:100 000 Geology Map for Penrith indicates that the western portion of the site is probably underlain by Bringelly Shale of Triassic age. Bringelly Shale typically comprises siltstone, fine grained sandstone and laminite with some shale bands. The eastern portion is shown on the map as being underlain by more recent alluvium comprising clayey quartzose sand and sand laid down in the floodplain of the nearby Georges River. The geological mapping is shown in Figure 1 below. The detailed logging of the boreholes confirms the mapping with the western area of the site underlain by a relatively shallow depth of filling and silty clay and then weathered siltstone to the full depth of testing. The boreholes in the eastern area of the site encountered extensive alluvial deposits over Bringelly Shale.

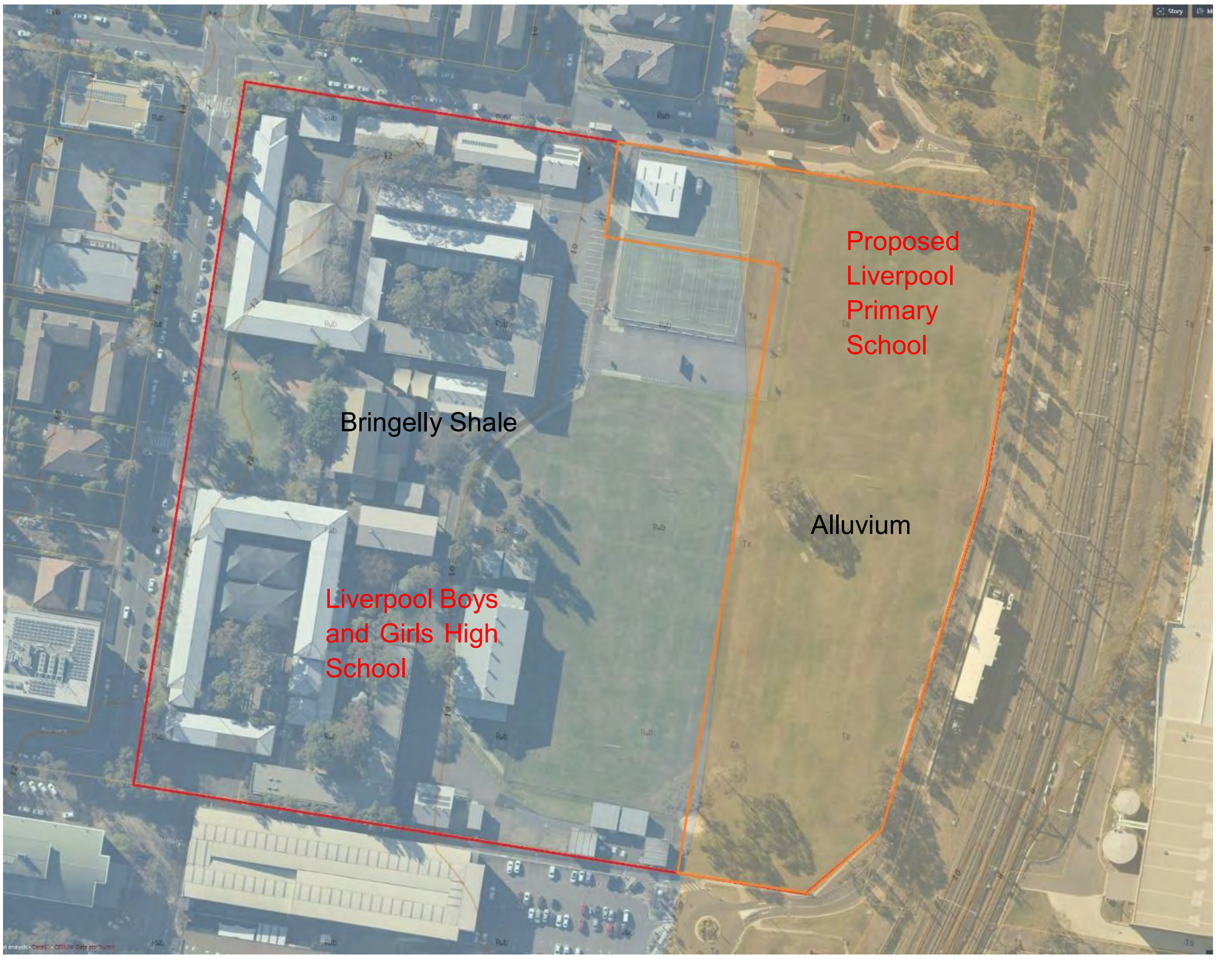


**Figure 1:** **Extract from the Penrith 1:100 000 Geology Map and the approximate site boundary. The locations of the tests are shown in Drawing 1 in Appendix A.**

# 3. Field Work

## 3.1 Methods

The field investigation comprised eleven boreholes (4 - 6, 10, 11, 15,16, 18, 21, 24 and 27) drilled in an approximate grid pattern across the site to depths in the range 3.0 - 18.1 m below existing surface levels. Following locating of the underground services, nine boreholes (4, 6, 10, 16, 18 and 27) were drilled using a combination of spiral flight augers and rotary drilling in the near surface soils and rotary core drilling in the bedrock. Standard penetration tests (SPT) were conducted at regular depth intervals in the soils down to bedrock level to provide information on the engineering properties of the strata. The SPT also recovers partially disturbed samples which can be utilised for engineering testing.

On reaching the level of the bedrock, rotary core drilling commenced using NMLC sized core barrels to obtain 50 mm diameter samples of the bedrock strata. The boreholes were continued to a depth of about 3 m into rock and were generally terminated in medium strength rock.

Five boreholes (5, 11, 15, 21, and 24) were drilled using a 6 t excavator fitted with a power auger attachment turning 300 mm diameter continuous spiral flight augers.

Upon completion of the investigation, nine of the boreholes were backfilled with spoil material obtained from the boreholes whilst two (Bores 6 and 27) were converted into standpipe piezometers to facilitate measuring of groundwater levels in the longer term. Slotted PVC tubing (50 mm diameter) was inserted into the bore with the annulus between the borehole wall, and the slotted casing filled with coarse sand and then capped to prevent inflow of surface water into the piezometer. The piezometers were finished with a gatic cover to minimize the risk of unauthorized usage.

The location of the bores is given on Drawing 1 in Appendix A, together with selected photographs of area in which augered boreholes were drilled. The locations (to MGA94 Zone 56) and surface levels (to AHD) at each borehole location were determined by surveying using a differential GPS with a nominal accuracy of 0.1 m.

## 3.2 Results

The detailed borehole logs and core photographs are provided in Appendix A which also contains notes defining the classification methods and terms which are used to describe the strata rock.

The boreholes encountered relatively uniform conditions over the site with the typical succession of strata comprising pavement, topsoil and filling up to 0.8 m in depth overlying residual silty clay the shale and laminite. In the eastern and southern portions of the site, the pavement, topsoil and filling were underlain by layers of alluvial clay and sand then shale and laminite, which typically increased in strength with depth. The depth of overburden soil typically increased towards the south eastern corner.

A summary of the levels at which each of the strata was encountered in the cored boreholes is provided in Table 1. These indicate some variation across the site which is typical for sites underlain by Bringelly Shale.

**Table 1 – Summary of Strata in Cored Boreholes**

| Strata Description | RL (m AHD) at Top of Strata | | | | | |
|---|---|---|---|---|---|---|
| | **4** | **6** | **10** | **16** | **18** | **27** |
| FILL/ TOPSOIL | 9.7 | 8.9 | 9.3 | 8.9 | 9.1 | 9.3 |
| ALLUVIAL SOIL | 9.05 | 8.3 | 8.6 | 8.2 | 8.4 | 8.9 |
| RESIDUAL SOIL | - | -4.3 | - | - | - | - |
| SHALE: up to very low strength | - | -4.45 | -2.2 | -5.6 | -1.8 | - |
| SHALE: low to medium strength | - | -4.6 | -2.3 | - | - | - |
| SHALE: medium strength or higher strength | -0.37 | -4.9 | - | -6.1 | -2.4 | -5.4 |
| Borehole Discontinued | -3.38 | -7.45 | -5.24 | -8.76 | -5.45 | -8.78 |

No free groundwater was encountered whilst augering through the near surface soils in any of the boreholes and it was not possible to observe any permanent groundwater levels once rotary core drilling commenced because water was used for flushing and cooling during the coring process.

The results of water level measurements in the standpipe piezometers is summarised in Table 2.

**Table 2 – Results of Water Level Measurements**

| Borehole | Ground Surface RL (m AHD) | Depth to Water (20/11/19) (m) | RL of Water Level (m AHD) |
|---|---|---|---|
| 6 | 8.9 | 6.4 | 2.5 |
| 27 | 9.3 | 7.5 | 1.8 |

## 4. Laboratory Testing

Selected samples were tested in the laboratory for measurement of the soil moisture content, Atterberg limits and linear shrinkage. The detailed results are given in the report sheets in Appendix B, with the results summarised in Table 3.

**Table 3: Results of Soil Moisture Content, Atterberg Limits and Linear Shrinkage Testing**

| Borehole | Depth (m) | Material | Field Moisture Content (%) | Liquid Limit (%) | Plastic Limit (%) | Plasticity Index (%) | Linear Shrinkage (%) |
|---|---|---|---|---|---|---|---|
| 4 | 0.3 | Fill | 20.2 | - | - | - | - |
| | 1.0 (SPT) | Clay | 22.1 | 63 | 17 | 46 | 13.0 |
| | 2.5 (SPT) | Clay | 17.4 | - | - | - | - |
| 5 | 1.0 | Clay | 31.5 | - | - | - | - |
| | 3.0 | Clay | 21.3 | - | - | - | - |
| 6 | 1.0 (SPT) | Clay | 16.6 | 66 | 18 | 48 | 17.0 |
| | 2.5 (SPT) | Clay | 10.9 | - | - | - | - |
| 9 | 3.0 | Clay | 17.1 | - | - | - | - |
| 10 | 0.5 | Fill | 22.0 | 53 | 20 | 33 | 14.5 |
| | 1.0 | Clay | 27.2 | - | - | - | - |
| 11 | 3.0 | Clay | 12.7 | - | - | - | - |
| 14 | 0.5 | Clay | 17.4 | - | - | - | - |
| | 3 | Clay | 12.6 | - | - | - | - |
| 15 | 0.5 | Fill | 3.4 | - | - | - | - |
| | 2.5 | Clay | 12.7 | - | - | - | - |
| 16 | 1.0 (SPT) | Clay | 15.5 | 61 | 17 | 44 | 15.5 |
| | 2.5 (SPT) | Clay | 11.9 | - | - | - | - |
| 18 | 2.5 (SPT) | Clay | 9.1 | - | - | - | - |
| 21 | 0.5 | Clay | 23.1 | - | - | - | - |
| | 3.0 | Sand | 6.3 | - | - | - | - |
| 24 | 0.2 | Fill | 13.7 | - | - | - | - |
| | 1.0 | Clay | 22.1 | 68 | 20 | 48 | 16.0 |
| | 3.0 | Clay | 18.1 | - | - | - | - |
| 27 | 0.7 | Clay | 26.5 | - | - | - | - |
| | 4.0 | Clay | 11.9 | - | - | - | - |

California bearing ratio (CBR) tests were carried out on two composite samples of the clay compacted to approximately 100% dry density ratio relative to standard maximum dry density at near standard optimum moisture content. The samples were soaked for four days under a surcharge loading of 4.5 kg. The detailed results are given in the report sheets and are summarised in Table 4.

**Table 4: Results of CBR and Standard Compaction Testing**

| Composite | Depth (m) | Material | Field Moisture Content (%) | Optimum Moisture Content (%) | Standard Maximum Dry Density ($t/m^3$) | Swell (%) | CBR (%) |
|---|---|---|---|---|---|---|---|
| 1 | 0.5 – 1.5 | Clay | 21.1 | 23.0 | 1.61 | 1.0 | 3.0 |
| 2 | 0.5 – 1.5 | Clay | 22.3 | 22.5 | 1.64 | 1.0 | 3.5 |

Selected samples from the boreholes were tested to determine the pH and electrical conductivity, chloride content and sulfate content. The detailed results are given in the report sheets and are summarised in Table 5.

**Table 5: Results of Aggressivity Testing**

| Borehole | Depth (m) | Material | pH | Electrical Conductivity (µS/cm) | Chloride Content (mg/kg) | Sulfate Content (mg/kg) |
|---|---|---|---|---|---|---|
| 4 | 4.0 (SPT) | Clay | 5.5 | 800 | 1100 | 200 |
| | 8.5 (SPT) | Clayey Sand | 8 | 740 | 1000 | 110 |
| 6 | 1.0 (SPT) | Clay | 5.3 | 130 | 45 | 150 |
| | 4.0 (SPT) | Clayey Sand | 7.8 | 150 | 170 | 43 |
| 18 | 1.0 | Clay | 4.9 | 260 | 230 | 170 |
| | 4.0 | Clayey Sand | 5.9 | 38 | 20 | 27 |
| 27 | 2.5 | Clay | 5.1 | 630 | 910 | 92 |

The results, with reference to AS2159: 2009 Piling Design and Installation, suggest that for the clay above the water table is non aggressive for steel piles and non aggressive to mildly aggressive for steel piles. In sand and below the water table, the soil is non aggressive for steel piles and to mildly aggressive to moderately aggressive for concrete piles.

Screening tests were also carried out on the soil samples by Envirolab Services Pty Ltd (Envirolab) to provide indications of actual acid sulfate soil (AASS) and potential acid sulfate soil (PASS). The natural field pH of each soil sample was measured after the addition of distilled water ($pH_F$), then the pH ($pH_{FOX}$) was measured following the addition of hydrogen peroxide and oxidisation for at least one hour. The results for the screening tests are summarised in Table 6.

**Table 6: Summary of ASS and PASS Screening Test Results**

| Borehole | Depth (m) | Material | Natural $pH_F$ | Oxidised $pH_{FOX}$ | Change in pH | Reaction |
|---|---|---|---|---|---|---|
| 4 | 4.0 (SPT) | Clay | 5.3 | 4.3 | 1.0 | Slight |
| | 8.5 (SPT) | Clayey Sand | 7.5 | 7.6 | 0.1 | Slight |
| 6 | 1.0 (SPT) | Clay | 5.4 | 4.0 | 1.4 | Moderate |
| | 4.0 (SPT | Clayey Sand | 7.3 | 5.9 | 1.4 | Slight |
| | 7.0 (SPT) | Clayey Sand | 6.5 | 6.1 | 0.4 | Slight |
| | 10.0 (SPT) | Clay | 7 | 5.8 | 1.2 | Slight |
| 18 | 1.0 | Clay | 5.0 | 3.7 | 1.3 | Slight |
| | 4.0 | Clayey Sand | 6.0 | 5.7 | 0.3 | Slight |
| | 7.0 | Clayey Sand | 7.5 | 6.1 | 1.4 | Slight |
| 27 | 0.4 | Clay | 7.6 | 4.2 | 2.4 | Slight |
| | 2.5 | Clay | 5.6 | 4.0 | 1.6 | Slight |
| | 7.0 | Clayey Sand | 6.9 | 6.6 | 0.3 | Slight |
| | 11.5 | Clayey Sand | 6.9 | 6.6 | 0.3 | Slight |
| | 14.5 | Clay | 7.6 | 4.4 | 3.2 | Slight |

Note: yellow highlight potential for exceedance of action criteria

The screening test results were assessed for the possible presence of AASS or PASS using the indicators specified in the ASSMAC Guidelines:

- $pH_F \leq 4$ indicates oxidation has occurred in the past and that AASS are likely to be present;
- $4 < pH_F < 5.5$ indicates the soil is acidic. This may be as a result of limited oxidation of sulphides but may also be as a consequence of the presence of organic acids or naturally acidic soil.
- $pH_{FOX} < 3$, plus a strong reaction with peroxide, plus a $pH_{FOX}$ value of at least one pH unit below $pH_F$, strongly indicates a PASS. The higher the reaction, the lower the drop between $pH_F$ and $pH_{FOX}$, and the lower the $pH_{FOX}$ value, the higher the potential for PASS.
- $3 < pH_{FOX} < 4$ is less positive that the sample is PASS.
- $4 < pH_{FOX} < 5$ is neither positive nor negative, as some sulfides may be present in small quantities.
- $pH_{FOX} > 5$ and little or no drop from $pH_F$ to $pH_{FOX}$ indicate little net acid generating ability.

No samples provided positive indicators of AASS however most of the samples provided slightly positive indicators of PASS however given the elevation of the site and the soil types, the pH change may be due to the oxidation of organic materials rather than sulfides.

## 5. Proposed Development

It is understood that the proposed new Liverpool Primary School site could include the construction of new school buildings may be up to four levels in height and include playing fields, carparking and other infrastructure. At this stage, no information has been provided on the likely foundation loads but given the scope of the development it is likely that loads of the order of 2000 kN to 4000 kN could occur.

The extent of bulk excavations is not known at this stage, although given the gently sloping site topography excavation depths of the order of 4 m may be required. Whilst no basements are proposed, preliminary commentary has been provided on excavation and excavation support.

## 6. Comments

### 6.1 Site Conditions

The results of the investigation indicate that the existing school development on the north western portion of the site is generally underlain by 9 – 14 m of filling, silty clay and clayey sand overlying very low strength to low strength shale which continued to depths of about 10 - 15 m below existing surface level. Below that depth the boreholes intersected low strength to medium strength shale typically increasing in strength with depth.

The top of the bedrock surface encountered in the boreholes was sloping down from RL -0.1 m AHD in Borehole 14 to RL -5.6 m AHD in Borehole 16.

The descriptions given above are simplified and the conditions on the site vary with the depth of weathering and the degree of fracturing being somewhat different in the individual bores.

Groundwater levels measured in the standpipes also sloped downwards from the north western corner at RL 2.5 m in Borehole 6 to RL 1.8 m in Borehole 27.

### 6.2 Site Classification

The results of field work indicate that the site is underlain by fill at all test locations up to 0.7 m in depth, overlying residual clay and alluvial sand and clay soils then weathered shale. As there is uncontrolled fill on the site greater than 0.4 m in depth and there may be mature trees within proposed building footprints, the overall site will be classified as Class ‘P’ when assessed in accordance with the “uncontrolled fill” and “abnormal moisture condition” provisions of AS 2870:2011 Residential Slabs and Footings.

Notwithstanding this classification, the laboratory testing indicates that the clays at the site are of generally high reactivity and likely to be highly susceptible to shrink-swell movements in response to variations in soil moisture content. Based on the soil depth, and the results of laboratory testing, the natural soil profile, prior to cut and fill activities, would generally be consistent with at least a Class ‘H1’ (highly reactive) site.

If the uncontrolled filling is removed beneath proposed structures and replaced with non-reactive material as controlled structural filling, it may be feasible to re-classify the site.

## 6.3 Slope Stability

The site is gently sloping with an average grade of about 1 in 100. Inspection of the site and the site grades indicate an extremely low risk of any instability of any natural slopes. Reference should be made to the following section for support of fill or excavations.

## 6.4 Excavations

### 6.4.1 Excavation Conditions

Whilst the depth and extent of any bulk excavations are not known at this stage, the results of the investigation indicate that bulk excavation to depths of less than 5 m will be through filling, clay and clayey sand. It is anticipated that bulk excavation of the soil could be readily achieved using conventional earthmoving equipment.

Whilst the eastern boundary of the site is near the main south rail line, the site is separated from the line by a roadway and it is considered extremely unlikely that any bulk excavation near the eastern boundary will result in Transport for NSW infrastructure being with the zone of influence of the excavation.

### 6.4.2 Vibrations

During excavation, it will be necessary to use appropriate methods and equipment to keep ground vibrations at adjacent buildings and structures within acceptable limits. The level of acceptable vibration is dependent on various factors including the type of structure, its structural condition, the frequency range of vibrations produced by the construction equipment, the natural frequency of the structure and the vibration transmitting medium.

Ground vibration can be strongly perceptible to humans at levels above 2.5 mm/s peak particle velocity (PPVi). This is generally much lower than the vibration levels required to cause structural damage to buildings. The Australian Standard AS2670.2:1990 “Evaluation of human exposure to whole-body vibrations – continuous and shock induced vibrations in buildings (1-80 Hz)” indicates an acceptable day time limit of 8 mm/s PPVi for human comfort.

Based on previous experience in the area and with reference to AS2670, it is suggested that a maximum PPVi of 8 mm/s (applicable at the foundation level of existing buildings) be adopted at this site for both architectural and human comfort considerations, although this vibration limit may need to be reduced if there are sensitive buildings or equipment in the area.

If rock hammers are used then it is recommended that a vibration trial be undertaken at the commencement of rock excavation (if required). The trial may indicate that smaller or different types of excavation equipment should be used for bulk (or detailed) excavation purposes.

### 6.4.3 Dilapidation Surveys

Dilapidation surveys should be carried out on adjacent buildings, pavements and infrastructure that may be affected by any excavation prior to commencement of the works. The surveys should document any existing defects so that claims for damage due to construction related activities can be accurately assessed.

### 6.4.4 Disposal of Excavated Material

All excavated materials will need to be disposed of in accordance with the provisions of the current legislation and guidelines including the Waste Classification Guidelines (EPA, 2014). It is understood that contamination status and waste classification of the site soils is being carried out by others.

### 6.4.5 Excavation Support

Vertical excavations within the filling, soils and extremely low to low strength rock will require both temporary and permanent lateral support during and after excavation. Excavations in rock are not expected on this site.

Provision will need to be to be made for support any existing buildings proposed to be kept in the redevelopment that are within the zone of influence of the excavation. To limit lateral and vertical soil movement, this may require the design of anchored contiguous pile walls or underpinning of the existing building foundations. Detailed investigation will probably be required once conceptual plans are prepared and potential affected structures are identified.

#### 6.4.5.1 Batter Slopes and Vertical Rock Faces

Suggested temporary and permanent batter slopes for unsupported excavations up to a maximum height of 4 m are shown in Table 7.

**Table 7: Recommended Batter Slopes for Exposed Material**

| Material | Temporary | Permanent |
|---|---|---|
| Stiff to hard clay, extremely weathered shale and compacted filling | 1H:1V | 2H:1V |

*These batter slope angles are subject to inspection by a qualified geotechnical engineer or engineering geologist.

Further analysis will be required where batters greater than 4 m in height are proposed or where surcharge loads will be applied near the crest. Depending upon the conditions encountered during the excavation and the prevailing weather it may also be necessary to pin and shotcrete the temporary batters to prevent erosion fretting and local slumping failures.

As batter slopes in soil are likely to erode over time when exposed to weather, maintenance of long-term batters should include provision periodic cleaning of debris which may block any toe drains. This will require the acceptance of periodic maintenance by the site owner and operator. Alternatively, a 50 mm thick shotcrete lining could be applied to minimise the need for any long term maintenance. Where the slopes are to be vegetated to prevent erosion, a maximum final batter slope of 3(H):1(V) is recommended.

#### 6.4.5.2 Retaining Walls

Where batter slopes cannot be used, shoring walls will be required to support the filling, soils and (possibly) shale. Soldier pile with infill panel walls could be used to provide temporary retaining support to soils and weathered rock. The soldier piles are usually spaced at approximately 2 - 2.5 m centres, however more closely spaced piles may be required to reduce wall movements, or prevent collapse of infill materials, particularly where pavements, structures or services are located in close proximity to the excavation. Shotcrete infill panels are then installed between the soldier piles as the excavation proceeds, usually in 1.5 – 2.4 m drops but subject to the pile spacing and material exposed.

Shoring piles should be founded in rock at least 1 m below the bulk excavation level, or deeper if required for passive resistance.

It is suggested that the design of cantilevered shoring systems and retaining walls (with one row of anchors) be based on a triangular earth pressure distribution using the earth pressure coefficients provided in Table 8. 'Active' earth pressure coefficient (Ka) values may be used where some wall movement is acceptable, and 'at rest' earth pressure (Ko) values should be used where the wall movement needs to be restricted (such as near movement sensitive existing structures).

**Table 8: Suggested Shoring and Retaining Wall Design Parameters**

| Material | Unit Weight (kN/m$^3$) | Effective Cohesion c' (kPa) | Effective Friction Angle (Degrees) | Active Earth Pressure Coefficient Ka | | At Rest Earth Pressure Coefficient Ko | Passive Earth Pressure Coefficient Kp | |
|---|---|---|---|---|---|---|---|---|
| | | | | Temp. | Perm. | | Temp. | Perm. |
| Stiff to hard clay, extremely weathered shale and compacted filling | 20 | 2 | 25 | 0.3 | 0.4 | 0.6 | 4 | 3 |
| Shale and Laminite: very low to low strength | 22 | 10 | 30 | 0.25 | 0.3 | 0.35 | 1000 kPa | 400 kPa |
| Shale and Laminite: medium or greater strength | 24 | 20 | 30 | 0 | 10 kPa uniform | 10 kPa uniform | 3000 kPa | 1500 kPa |

The design of the shoring should allow for all surcharge loads, including building footings, inclined slopes behind the wall, traffic and construction related activities.

Depending on design flood levels and depths of excavation, shoring walls may be required to be designed for hydrostatic pressures unless drainage of the ground behind impermeable walls can be provided. Drainage could comprise 150 mm wide strip drains pinned to the face at 1 m centres behind the shotcrete in-fill panels. The base of the strip drains should extend out from the shoring wall to allow any seepage to flow into a perimeter toe drain which is connected to the stormwater drainage system.

#### 6.4.5.3 Passive Resistance

Passive resistance for piles founded in rock below the base of the bulk excavation (including allowance for services and/or footings) may be based on the ultimate passive restraint value provided in Table 8. This ultimate value represents the pressure mobilised at high displacements and therefore it will be necessary to incorporate a factor of safety of at least 2 to limit wall movement. The top 0.5 m of the socket should be ignored due to possible disturbance and over-excavation.

#### 6.4.5.4 Ground Anchors

The design of temporary and permanent ground anchors/rock bolts for the support of excavations and/or shoring systems may be carried out using the maximum bond stresses given in Table 9.

**Table 9: Recommended Bond Stresses for Rock Anchor Design**

| Material Description | Maximum Allowable Bond Stress (kPa) | Maximum Ultimate Bond Stress (kPa) |
|---|---|---|
| Stiff to hard clay, extremely weathered shale and compacted filling | 25 | 50 |
| Shale and Laminite: very low to low strength | 75 | 150 |
| Shale and Laminite: Medium or greater strength | 300 | 600 |

The parameters given in Table 9 assume that the drilled holes are clean and adequately flushed. The anchors should be bonded behind a line drawn up at 45 degrees from the base of the shoring, and "lift-off" tests should be carried out to confirm the anchor capacities. It is suggested that ground anchors should be proof loaded to 125% of the design working load and locked-off at no higher than 80% of the working load.

#### 6.4.5.5 Groundwater

Monitoring of the groundwater levels during the investigation has indicated that the groundwater is at a depth of at least 6 m below existing surface levels. Consequently, it is considered the design of floor slabs for uplift or for permanent hydraulic loads on retaining walls may be governed by flood levels rather than measured groundwater level. During construction and following rainfall there may be some seepage of perched water through soil and along some bedding planes or highly fractured zones and it will therefore be necessary to make provision for pumping seepage water out of excavations.

During construction and in the long term, it is anticipated that seepage into excavations could be controlled by perimeter and subfloor drainage connected to a sump-and-pump system and, if proposed in the final design, drained basements may be considered for this site. Generally, water collected from dewatering operations should be suitable for disposal by pumping to stormwater drains subject to confirmation testing of groundwater quality and approval from the local council.

It is possible that seepage into excavations including basements, if proposed, may give rise to precipitation of red brown iron oxide residue from the groundwater and therefore perimeter and subfloor drains should be designed for easy access to allow for inspection, maintenance and periodic cleaning.

It is not possible to provide an estimate of the seepage quantity that may be expected within the excavations, and possible basements, based on the available data. This would require large scale packer/permeability testing of the rock and pumping tests over a period of several weeks together with further analysis which would probably include numerical modelling. A more usual approach is to monitor the seepage rates during the excavation to confirm and/or re-assess the proposed sump and pump system capacity over the longer term.

## 6.5 Site Preparation and Earthworks

Where earthworks are required to prepare the site for proposed building platforms, pavements and playing fields, the following procedures are suggested:

- Strip all vegetation, organic topsoil and uncontrolled fill. The organic topsoil could be separately stockpiled for use in landscaping or removed off site. Existing fill may be suitable for reuse as controlled fill;
- Compaction of the exposed surface with at least of 6 passes of a 12 tonne minimum dead weight roller, followed by test rolling in the presence of a geotechnical engineer;
- If any excessively low strength or heaving areas are identified, they should generally be treated by excavation to a sound base and replaced with engineered fill. Should the weak material exceed 500 mm in depth, a bridging layer may be required.

Good site drainage should be maintained at all times by adopting appropriate cross – falls within the site. Surface drainage should be installed as soon as is practicable in order to capture and remove surface flows to prevent erosion and softening of the exposed soils / weathered bedrock. Conventional sediment and erosion control measures should be implemented during the earthworks operation, with final surfaces to be topsoiled and vegetated as soon as practicable following the completion of earthworks.

### 6.5.1 Reuse of Excavated Materials

Generally, the majority of natural soils and filling encountered during the investigation will be suitable for reuse as engineered filling within the site provided that any pre – treatment (moisture conditioning, removal of oversize and deleterious material), is carried out prior to fill placement. The material should not contain any particle sizes greater than 150 mm or excess moisture as these may cause inadequate compaction, and should not contain silts due to their propensity for erosion if it becomes saturated. It is expected that bedrock of low strength or less will break down to a suitable size beneath the construction plant used for placement.

### 6.5.2 Engineered Fill

Controlled filling should be placed in near horizontal layers with a maximum loose thickness of 300 mm then compacted to a minimum density ratio of at least 98% relative to standard maximum dry density. The moisture content should to be maintained within 2% of standard optimum moisture content. Where filling is placed beneath road alignments, the upper 0.5 m depth should be placed at a minimum density ratio of 100% relative to standard maximum dry density.

During inclement weather or if the site is to be left unattended for an extended period, the upper surfaces of fill should be crowned and if possible blinded by smooth wheeled plant. Any stockpiles should be blinded to allow water to run off.

### 6.5.3 Geotechnical Inspections and Testing

It is recommended that the site be inspected by a geotechnical engineer following stripping of vegetation, topsoils and uncontrolled filling and during the test rolling undertaken prior to the placement of filling. Geotechnical testing should be carried out in accordance with AS3798: 'Guidelines on Earthworks for Commercial and Residential Developments. As a minimum, placement of controlled filling beneath structures must be to a Level 1 standard as described in AS3798 whilst Level 2 standard is usually considered appropriate for pavement construction and backfilling of service trenches, unless otherwise specified by the designer. It is also recommended that the Geotechnical Inspection and Testing Authority (GITA) should be engaged directly on behalf of the Principal and not by the earthworks contractor.

## 6.6 Foundations

For lightly loaded or settlement insensitive structures, shallow pad, strip or raft footing founding within very stiff natural clay or control fill may be feasible for this site. However, given that the expected typical loadings for the main structures may be in the order of 4000 kN, footings founding within uniform rock are recommended to limit both total and differential settlements.

If bored piles are used, then allowance should also be made for seepage inflows and removal of water during construction.

Footings may be designed using the values given in Table 10. For bored piles, shaft adhesion values for uplift (tension) may be taken as being equal to 70% of the values for compression.

**Table 10: Recommended Design Parameters for Foundation Design**

| Founding Stratum | Maximum Allowable Pressure (Serviceability) | | Maximum Ultimate Pressure (Ultimate) | | Young's Modulus, E (MPa) |
|---|---|---|---|---|---|
| | End Bearing (kPa) | Shaft Adhesion* (Compression) (kPa) | End Bearing (kPa) | Shaft Adhesion* (Compression) (kPa) | |
| Shale and Laminite: very low to low strength | 700 | 50 | 3000 | 100 | 80 |
| Shale and Laminite: Medium or greater strength | 3500 | 350 | 30 000 | 800 | 1000 |

Note: * shaft adhesion for piles only

Foundations proportioned using the allowable bearing pressure in Table 10 would be expected to have total settlements of less than 1% of the footing width under the applied working load, with differential settlements between adjacent columns expected to be less than half of this value. The serviceability criteria must be considered for footings designed using the values in Table 10.

All footings should be inspected by a geotechnical engineer to confirm that foundation conditions are suitable for the design parameters.

### 6.7 Pavements and Floor Slabs on Ground

The prepared subgrade could be expected to provide adequate support for the pavements and floor slabs. Floor slabs should not bear on uncontrolled filling in the long term. Allowance should be made for differential movement between any slab-on-grade and the structure founded on rock. Based on the results of laboratory testing and field observations, pavement and floor slab design could be based on a CBR of 3% for the clay and controlled filling.

Subfloor drainage should be provided connected to a pump system (if installed) or stormwater drainage. Allowance should be made for water-proofing any permanent excavations such as basements, if proposed, and, if the excavations extend below the likely range of ground water level or design flood levels, uplift due to water pressure on any tanked floor or support.

### 6.8 Seismic site Class

The site stratigraphy typically comprises pavements, filling or topsoil underlain by stiff to hard silty clays and/or medium dense to dense sand overlying bedrock at depths less than 15 m. Therefore, the sub-soil class for the site, when assessed in accordance with AS 1170.4 – 2007 (Ref 4), is considered a shallow soil site and a classification of Class $C_e$ is suggested.

## 7. Limitations

DP has prepared this report for the proposed new Liverpool Primary School in accordance with DP's proposal MAC190157.Rev1 dated 13 August 2019 and acceptance received in an email from Mr Jester Magpayo of PwC dated 11 September 2019. The work was carried out under a NSW Education School Infrastructure Consultancy Services Agreement LM-SI 19063 dated 26 September 2019. This report is provided for the exclusive use of School Infrastructure for this project only and for the purposes as described in the report. It should not be used for other projects or purposes or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

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

The site investigation and report inform the proposed extent of works and design required at the time of reporting. It is intended to assist in construction contractor pricing for site preparation, civil and structural/building works. Notwithstanding this, the report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

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

## Douglas Partners Pty Ltd

# Appendix A

About This Report
Results of Field Work
Site Photographs
Drawing 1

# About this Report

Douglas Partners

## Introduction

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

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

## Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

## Borehole and Test Pit Logs

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

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

## Groundwater

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

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

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

## Reports

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

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

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

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

# About this Report

## Site Anomalies

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

## Information for Contractual Purposes

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

## Site Inspection

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

## Sampling

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

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

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

## Test Pits

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

## Large Diameter Augers

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

## Continuous Spiral Flight Augers

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

## Non-core Rotary Drilling

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

## Continuous Core Drilling

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

## Standard Penetration Tests

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

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

The test results are reported in the following form.

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

  4,6,7
  N=13

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

  15, 30/40 mm

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

### Dynamic Cone Penetrometer Tests / Perth Sand Penetrometer Tests

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

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

# Soil Descriptions

## Description and Classification Methods

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

## Soil Types

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

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

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

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

The proportions of secondary constituents of soils are described as:

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

Definitions of grading terms used are:

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

## Cohesive Soils

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

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

## Cohesionless Soils

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

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

# *Soil Descriptions*

**Soil Origin**

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

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

Transported soils may be further subdivided into:

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

# Rock Descriptions

## Rock Strength

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

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

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

## Degree of Weathering

The degree of weathering of rock is classified as follows:

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

## Degree of Fracturing

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

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

# *Rock Descriptions*

## Rock Quality Designation

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

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

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

## Stratification Spacing

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

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

# Symbols & Abbreviations

## Introduction

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

## Drilling or Excavation Methods

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

## Water

| | |
|---|---|
| ▷ | Water seep |
| $\underline{\triangledown}$ | Water level |

## Sampling and Testing

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

## Description of Defects in Rock

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

### Defect Type

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

### Orientation

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

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

### Coating or Infilling Term

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

### Coating Descriptor

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

### Shape

| | |
|---|---|
| cu | curved |
| ir | irregular |
| pl | planar |
| st | stepped |
| un | undulating |

### Roughness

| | |
|---|---|
| po | polished |
| ro | rough |
| sl | slickensided |
| sm | smooth |
| vr | very rough |

### Other

| | |
|---|---|
| fg | fragmented |
| bnd | band |
| qtz | quartz |

# *Symbols & Abbreviations*

## Graphic Symbols for Soil and Rock

### General

| | |
|---|---|
| ■ | Asphalt |
| ▨ | Road base |
| ▨ | Concrete |
| ▦ | Filling |

### Soils

| | |
|---|---|
| ▨ | Topsoil |
| ▨ | Peat |
| ▨ | Clay |
| ▨ | Silty clay |
| ▨ | Sandy clay |
| ▨ | Gravelly clay |
| ▨ | Shaly clay |
| ▥ | Silt |
| ▨ | Clayey silt |
| ▥ | Sandy silt |
| ▨ | Sand |
| ▨ | Clayey sand |
| ▥ | Silty sand |
| ▨ | Gravel |
| ▨ | Sandy gravel |
| ▨ | Cobbles, boulders |
| ▨ | Talus |

### Sedimentary Rocks

| | |
|---|---|
| ▨ | Boulder conglomerate |
| ▨ | Conglomerate |
| ▨ | Conglomeratic sandstone |
| ▨ | Sandstone |
| ▤ | Siltstone |
| ▤ | Laminite |
| ▤ | Mudstone, claystone, shale |
| ■ | Coal |
| ▦ | Limestone |

### Metamorphic Rocks

| | |
|---|---|
| ▨ | Slate, phyllite, schist |
| ▨ | Gneiss |
| ▨ | Quartzite |

### Igneous Rocks

| | |
|---|---|
| ▨ | Granite |
| ▨ | Dolerite, basalt, andesite |
| ▨ | Dacite, epidote |
| ▨ | Tuff, breccia |
| ▨ | Porphyry |

# BOREHOLE LOG

**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 9.7 mAHD
**EASTING:** 308858
**NORTHING:** 6245150
**DIP/AZIMUTH:** 90°/--

**BORE No:** 4
**PROJECT No:** 92370.00
**DATE:** 2/10/2019
**SHEET** 1 OF 2

| Depth (m) | Description of Strata | Discontinuities | Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|
| | FILL/TOPSOIL: Silty CLAY, low plasticity, dark brown, with rootlets, w~PL | Note: Unless otherwise stated, rock is fractured along sub-horizontal, rough, planar, iron stained or clean joints or bedding planes | D<br>D | | | |
| 0.35 | FILL/Silty CLAY CI: medium plasticity, dark brown, trace building rubble (brick), w~PL, appears to be typically stiff to very stiff | | D | | | |
| 0.65 | Silty CLAY CH: high plasticity, grey, red and brown, w~PL, alluvial | | S/A | 100 | | 3,3,4<br>N = 7 |
| | | | S/A | 100 | | 5,8,11<br>N = 19 |
| | - trace ironstone gravel below 2.85m | | S/A | 100 | | 4,8,13<br>N = 21 |
| | | | /A | 100 | | 8,9,13<br>N = 22 |
| | - with sand below 6.5m | | | | | |
| 7.2 | Clayey SAND SC: well graded, fine grained, sub-rounded, grey brown, medium dense, alluvial | | S/A | 100 | | 7,12,10<br>N = 22 |
| | | | S/A | 100 | | 9,9,11<br>N = 20 |
| | - with sub-rounded gravel below 9.6m | | | | | |

Degree of Weathering: EW HW MW SW FS FR
Rock Strength: Ex Low, Very Low, Low, Medium, High, Very High, Ex High
Fracture Spacing (m): 0.01 0.05 0.10 0.50 1.00
Discontinuities: B - Bedding J - Joint S - Shear F - Fault

**RIG:** Bobcat **DRILLER:** Groundtest **LOGGED:** SE/JHB **CASING:** HW to 2.5m; HQ to 10.0m
**TYPE OF BORING:** SFA to 2.5m, rotary drilling to 10.07m, then NMLC coring to 13.08m
**WATER OBSERVATIONS:** No free groundwater observed whilst augering
**REMARKS:** Location coordinates are in MGA94 Zone 56.

**SAMPLING & IN SITU TESTING LEGEND**

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

Douglas Partners
Geotechnics / Environment / Groundwater

DOUGLAS PARTNERS PTY LTD

SCHOOL INFRASTRUCTURE NSW
LIVERPOOL GIRLS & BOYS HIGH SCHOOL

BORE: 4 DEPTH: 10.07 – 13.08m PROJECT: 92370.00 OCTOBER 2019

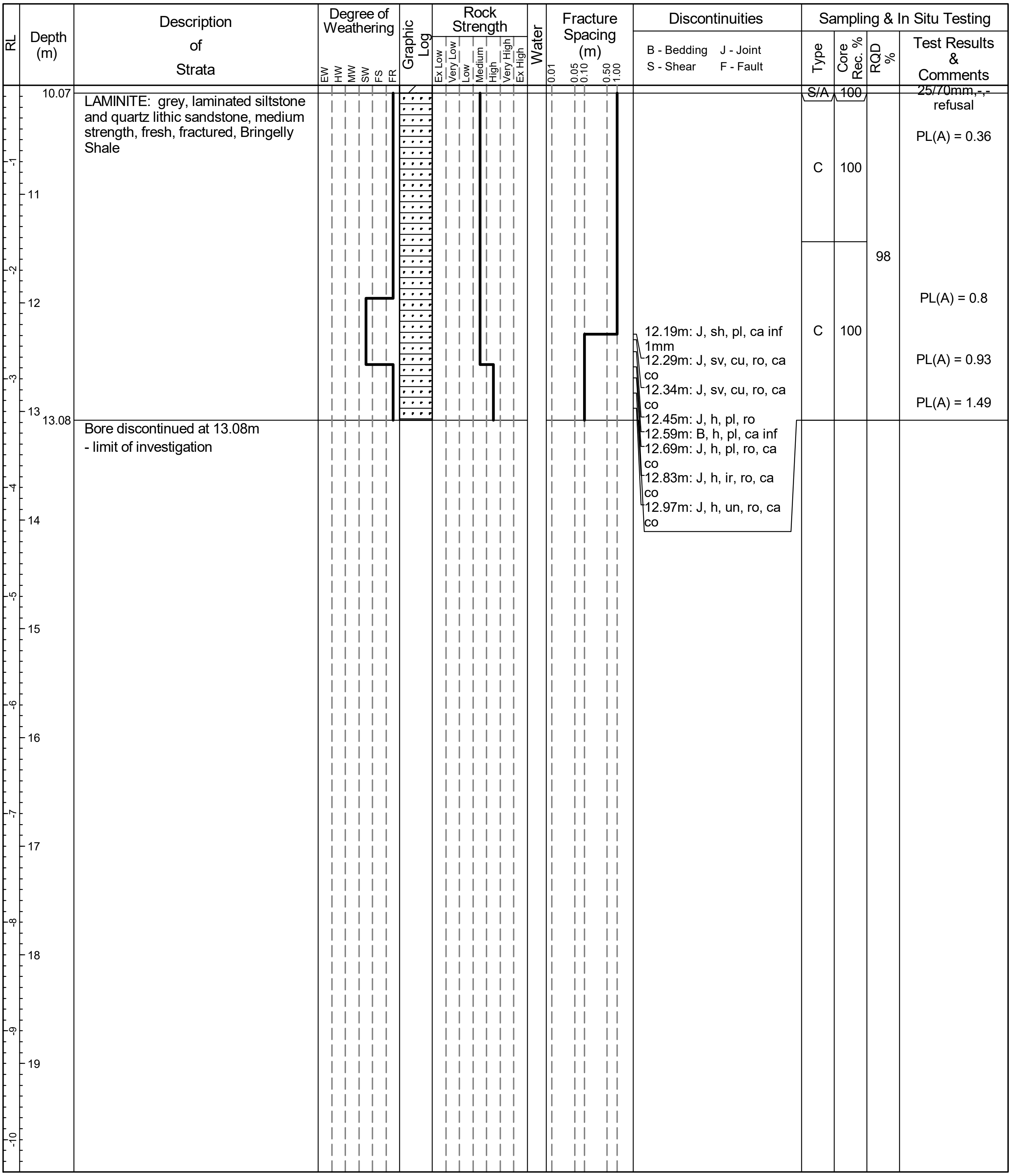
End of Bore at 13.08 m

# BOREHOLE LOG

**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 9.7 mAHD
**EASTING:** 308858
**NORTHING:** 6245150
**DIP/AZIMUTH:** 90°/--

**BORE No:** 4
**PROJECT No:** 92370.00
**DATE:** 2/10/2019
**SHEET** 2 OF 2



| Depth (m) | Description of Strata | Discontinuities<br>B - Bedding J - Joint<br>S - Shear F - Fault | Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|
| 10.07 | LAMINITE: grey, laminated siltstone and quartz lithic sandstone, medium strength, fresh, fractured, Bringelly Shale | | S/A | 100 | | 25/70mm,-,- refusal |
| | | | | | | PL(A) = 0.36 |
| | | | C | 100 | | |
| | | | | | 98 | |
| | | | | | | PL(A) = 0.8 |
| | | 12.19m: J, sh, pl, ca inf 1mm<br>12.29m: J, sv, cu, ro, ca co<br>12.34m: J, sv, cu, ro, ca co<br>12.45m: J, h, pl, ro<br>12.59m: B, h, pl, ca inf<br>12.69m: J, h, pl, ro, ca co<br>12.83m: J, h, ir, ro, ca co<br>12.97m: J, h, un, ro, ca co | C | 100 | | PL(A) = 0.93<br>PL(A) = 1.49 |
| 13.08 | Bore discontinued at 13.08m<br>- limit of investigation | | | | | |

**RIG:** Bobcat **DRILLER:** Groundtest **LOGGED:** SE/JHB **CASING:** HW to 2.5m; HQ to 10.0m

**TYPE OF BORING:** SFA to 2.5m, rotary drilling to 10.07m, then NMLC coring to 13.08m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering

**REMARKS:** Location coordinates are in MGA94 Zone 56.

**SAMPLING & IN SITU TESTING LEGEND**

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

Douglas Partners
Geotechnics | Environment | Groundwater

# BOREHOLE LOG

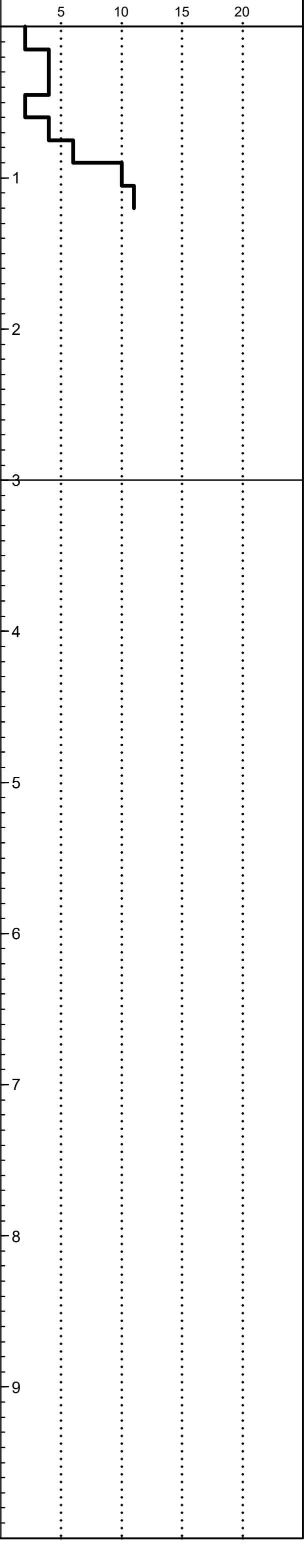
**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 9.4 mAHD
**EASTING:** 308927
**NORTHING:** 6245152
**DIP/AZIMUTH:** 90°/--

**BORE No:** 5
**PROJECT No:** 92370.00
**DATE:** 1/10/2019
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water |
|---|---|---|---|---|---|---|---|---|
| | 0.2 | FILL/TOPSOIL: Clayey SILT ML, low plasticity, dark brown, moist | | | | | | |
| | 0.7 | FILL/Silty CLAY CI: medium plasticity, grey and brown, w>PL, appears to be typically soft to stiff | | | | | | |
| | | Silty CLAY CH: high plasticity, brown, grey and red, w~PL, very stiff, alluvial | | D | 1.0 | | | |
| | | | | D | 1.5 | | pp = 200-300 | |
| | | | | D | 2.0 | | pp = 300 | |
| | | - becoming red and grey, trace ironstone gravel, hard below 2.5m | | D | 2.5 | | pp = 400 | |
| | 3.0 | | | D | 3.0 | | pp = 500 | |
| | | Bore discontinued at 3.0m<br>- limit of investigation | | | | | | |

Dynamic Penetrometer Test (blows per 150mm)



**RIG:** Hyundai 60CR-9 6 tonne excavator **DRILLER:** Quake Excavations **LOGGED:** JHB **CASING:** N/A
**TYPE OF BORING:** 300mm diameter SFA
**WATER OBSERVATIONS:** No free groundwater observed whilst augering
**REMARKS:** Location coordinates are in MGA94 Zone 56.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

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

Douglas Partners
Geotechnics / Environment / Groundwater

# BOREHOLE LOG

**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 8.9 mAHD
**EASTING:** 309000
**NORTHING:** 6245133
**DIP/AZIMUTH:** 90°/--

**BORE No:** 6
**PROJECT No:** 92370.00
**DATE:** 1/10/2019
**SHEET** 1 OF 2

| RL | Depth (m) | Description of Strata | Water | Discontinuities<br>B - Bedding J - Joint<br>S - Shear F - Fault | Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|---|
| | 0.1 | FILL/TOPSOIL: Silty CLAY, low plasticity, dark brown, with rootlets, trace gravel, w<PL | | Note: Unless otherwise stated, rock is fractured along sub-horizontal, planar, rough or smooth, iron stained or clean joints or bedding planes | D | | | |
| | 0.4 | FILL/Silty CLAY CL: low plasticity, brown, trace gravel, w<PL, appears to be typically stiff | | | D | | | |
| | | | | | D | | | |
| 8 | 1 | Silty CLAY CH: high plasticity, grey mottled orange, w<PL, stiff, alluvial<br>- becoming very stiff below 0.8m<br>- trace ironstone gravel below 1.2m | | | S/A | 100 | | 5,9,11<br>N = 20 |
| 7 | 2 | | | | | | | |
| | | | | | S/A | 100 | | 6,16,23<br>N = 39 |
| 6 | 3 | | | | | | | |
| 5 | 4 | | | | S/A | 100 | | 7,11,16<br>N = 27 |
| 4 | 5 | | | | | | | |
| | 5.3 | Clayey SAND SC: well graded, fine grained, sub-rounded, pale grey mottled orange, medium dense, alluvial | | | S/A | 100 | | 8,13,21<br>N = 34 |
| 3 | 6 | - becoming brown below 6.0m | | | | | | |
| | | | 20-11-19 | | | | | |
| 2 | 7 | | | | S/A | 100 | | 7,4,13<br>N = 17 |
| | | - trace ironstone gravel below 7.4m | | | | | | |
| 1 | 8 | | | | | | | |
| | | - becoming medium grained, dense below 8.4m | | | S/A | 100 | | 4,6,9<br>N = 15 |
| 0 | 9 | | | | | | | |
| -1 | 10.0 | | | | | | | |

**RIG:** Scout IV **DRILLER:** Groundtest **LOGGED:** SE/JHB **CASING:** HW to 2.5m; HQ to 13.42m

**TYPE OF BORING:** SFA to 2.5m, rotary drilling to 13.42m, then NMLC coring to 16.35m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering

**REMARKS:** Location coordinates are in MGA94 Zone 56. Well installed: 0 - 0.1 gatic cover; 0.1 - 6.85m backfill; 6.85 - 7.35m bentonite; 7.35 - 16.35m gravel;
0 - 7.35m casing; 7.35 - 16.35m screen

**SAMPLING & IN SITU TESTING LEGEND**

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

Douglas Partners
Geotechnics / Environment / Groundwater

DOUGLAS PARTNERS PTY LTD

SCHOOL INFRASTRUCTURE NSW
LIVERPOOL GIRLS & BOYS HIGH SCHOOL

BORE: 6 DEPTH: 13.35 – 16.35m PROJECT: 92370.00 OCTOBER 2019

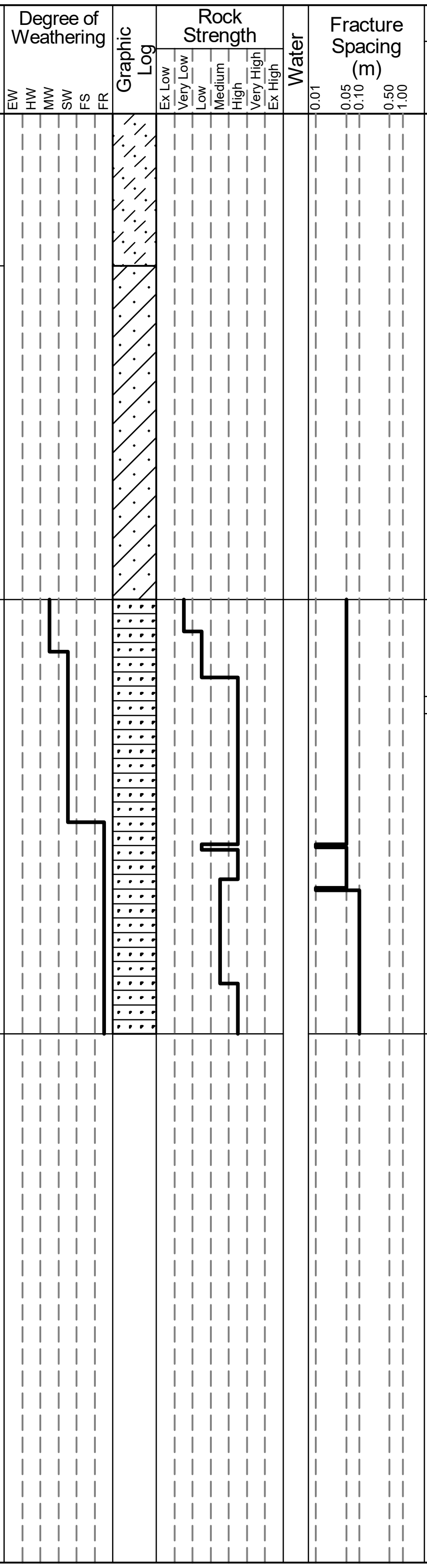
End of Bore at 16.35 m

# BOREHOLE LOG

**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 8.9 mAHD
**EASTING:** 309000
**NORTHING:** 6245133
**DIP/AZIMUTH:** 90°/--

**BORE No:** 6
**PROJECT No:** 92370.00
**DATE:** 1/10/2019
**SHEET** 2 **OF** 2



| RL | Depth (m) | Description of Strata | Discontinuities<br>B - Bedding J - Joint<br>S - Shear F - Fault | Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|
| | | Clayey SAND SC: well graded, medium grained, sub-rounded, brown, dense, alluvial (*continued*) | | S/A | 100 | | 11,13,24<br>N = 37 |
| -2 | 11 | - with sub-rounded gravel below 11.0m | | | | | |
| | 11.05 | Sandy CLAY CL: low plasticity, dark grey, w>PL, very stiff, alluvial | | S/A | 100 | | 5,8,10<br>N = 18 |
| -3 | 12 | | | | | | |
| -4 | 13 | - trace sub-rounded gravel below 12.75m | | S/A | 100 | | 10,25,7/147mm refusal |
| | 13.35 | LAMINITE: grey, laminated siltstone and fine-grained, quartz-lithic sandstone, medium to high strength, slightly weathered, highly fractured, Bringelly Shale | 13.51m: Ds, clay inf 50mm<br>13.82m: laminated, h, pl, clay co, fg 15mm<br>14.02m: B, sh, pl, silt co<br>14.14m: J, sh, cu, fg<br>14.56m: B, h, pl, fg<br>14.75m: J, h, cu, fg<br>15.04m: Ds, silt inf, fg 20mm<br>15.34m: fg zone 20mm<br>15.76m: J, v, ro, ca co 40mm | C | 100 | 46 | PL(A) = 0.24<br>PL(A) = 1.14<br>PL(A) = 1.68<br>PL(A) = 1.11<br>PL(A) = 1.28<br>PL(A) = 2.43<br>PL(A) = 0.54<br>PL(A) = 2.37 |
| -5 | 14 | | | | | | |
| -6 | 15 | | | | | | |
| -7 | 16 | | | | | | |
| | 16.35 | Bore discontinued at 16.35m<br>- limit of investigation | | | | | |
| -8 | 17 | | | | | | |
| -9 | 18 | | | | | | |
| -10 | 19 | | | | | | |
| -11 | | | | | | | |

**RIG:** Scout IV **DRILLER:** Groundtest **LOGGED:** SE/JHB **CASING:** HW to 2.5m; HQ to 13.42m

**TYPE OF BORING:** SFA to 2.5m, rotary drilling to 13.42m, then NMLC coring to 16.35m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering

**REMARKS:** Location coordinates are in MGA94 Zone 56. Well installed: 0 - 0.1 gatic cover; 0.1 - 6.85m backfill; 6.85 - 7.35m bentonite; 7.35 - 16.35m gravel;
0 - 7.35m casing; 7.35 - 16.35m screen.

**SAMPLING & IN SITU TESTING LEGEND**

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

**Douglas Partners**
Geotechnics / Environment / Groundwater

# BOREHOLE LOG

**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 9.3 mAHD
**EASTING:** 308921
**NORTHING:** 6245104
**DIP/AZIMUTH:** 90°/--

**BORE No:** 10
**PROJECT No:** 92370.00
**DATE:** 30/9/2019
**SHEET** 1 OF 2

| Depth (m) | Description of Strata | Degree of Weathering<br>EW HW MW SW FS FR | Rock Strength<br>Ex Low, Very Low, Low, Medium, High, Very High, Ex High | Water | Fracture Spacing (m)<br>0.01 0.05 0.10 0.50 1.00 | Discontinuities<br>B - Bedding J - Joint<br>S - Shear F - Fault | Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.3 | FILL/TOPSOIL: Silty CLAY CL, low plasticity, dark brown, with rootlets and organics, w~PL | | | | | | D | | | |
| 0.7 | FILL/Silty CLAY CI: medium plasticity, red brown, with gravel w~PL, appears to be typically stiff | | | | | | D | | | |
| | Silty CLAY CH: high plasticity, dark grey mottled orange-red, w~PL, stiff, alluvial | | | | | | D | | | |
| | | | | | | | S/A | 100 | | 4,6,7<br>N = 13 |
| | | | | | | | D | | | |
| | - trace ironstone gravel, becoming very stiff below 2.5m | | | | | | S/A | 100 | | 6,12,15<br>N = 27 |
| | | | | | | Note: Unless otherwise stated, rock is fractured along sub-horizontal, planar, rough or smooth, iron stained or clean joints or bedding planes | | | | |
| | | | | | | | S/A | 100 | | 6,9,13<br>N = 22 |
| 5.65 | Clayey SAND SW: well graded, fine grained, sub-rounded, grey mottled orange-red, medium dense, alluvial | | | | | | S/A | | | 8,8,6<br>N = 14 |
| | | | | | | | S/A | 100 | | 4,6,7<br>N = 13 |
| | - becoming brown below 8.0m | | | | | | | | | |
| | | | | | | | S/A | 100 | | 12,16,17<br>N = 33 |
| 9.8 | Silty CLAY CL: (*see next page*) | | | | | | | | | |
| 10.0 | | | | | | | | | | |

**RIG:** Scout IV **DRILLER:** Groundtest **LOGGED:** SE/JHB **CASING:** HW to 2.5m; HQ to 10.45m

**TYPE OF BORING:** SFA to 2.5m, rotary drilling to 10.45m, then NMLC coring to 14.54m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering

**REMARKS:** Location coordinates are in MGA94 Zone 56.

**SAMPLING & IN SITU TESTING LEGEND**

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

Douglas Partners
Geotechnics / Environment / Groundwater

DOUGLAS PARTNERS PTY LTD

SCHOOL INFRASTRUCTURE NSW
LIVERPOOL GIRLS & BOYS HIGH SCHOOL

BORE: 10 DEPTH: 11.5 – 14.54m PROJECT: 92370.00 OCTOBER 2019

End of Bore at 14.54 m

# BOREHOLE LOG

**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 9.3 mAHD
**EASTING:** 308921
**NORTHING:** 6245104
**DIP/AZIMUTH:** 90°/--

**BORE No:** 10
**PROJECT No:** 92370.00
**DATE:** 30/9/2019
**SHEET** 2 OF 2

| RL | Depth (m) | Description of Strata | Degree of Weathering<br>EW HW MW SW FS FR | Graphic Log | Rock Strength<br>Ex Low, Very Low, Low, Medium, High, Very High, Ex High | Water | Fracture Spacing (m)<br>0.01 0.05 0.10 0.50 1.00 | Discontinuities<br>B - Bedding J - Joint<br>S - Shear F - Fault | Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Silty CLAY CL: low plasticity, black, with sand, w>PL, very stiff, alluvial (*contimued*)<br>- with sub-rounded gravel between 10.8 - 10.9m | | | | | | | S/A | 100 | | 4,7,13<br>N = 20 |
| | 11.5 | LAMINITE: grey, laminated siltstone and fine-graine, quartz-lithic sandstone, medium to high strength, slightly weathered, fractured, Bringelly Shale | | | | | | 11.64m: B, sh, pl, ro, clay co<br>12.35m: J, sv, ro, clay co 30mm<br>12.36m: Ds, clay inf 15mm<br>12.44m: Ds, clay inf 5mm<br>12.45m: J, v, ro, 25mm<br>12.48m: J, v 115mm<br>14.42m: B, sh, pl, ro, cln, fg | C | 100 | 73 | PL(A) = 0.49<br>PL(A) = 0.59<br>PL(A) = 1.89<br>PL(A) = 1.03<br>PL(A) = 1.09 |
| | 14.54 | Bore discontinued at 14.54m<br>- limit of investigation | | | | | | | | | | |

**RIG:** Scout IV **DRILLER:** Groundtest **LOGGED:** SE/JHB **CASING:** HW to 2.5m; HQ to 10.45m
**TYPE OF BORING:** SFA to 2.5m, rotary drilling to 10.45m, then NMLC coring to 14.54m
**WATER OBSERVATIONS:** No free groundwater observed whilst augering
**REMARKS:** Location coordinates are in MGA94 Zone 56.

**SAMPLING & IN SITU TESTING LEGEND**

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

Douglas Partners
Geotechnics / Environment / Groundwater

# BOREHOLE LOG

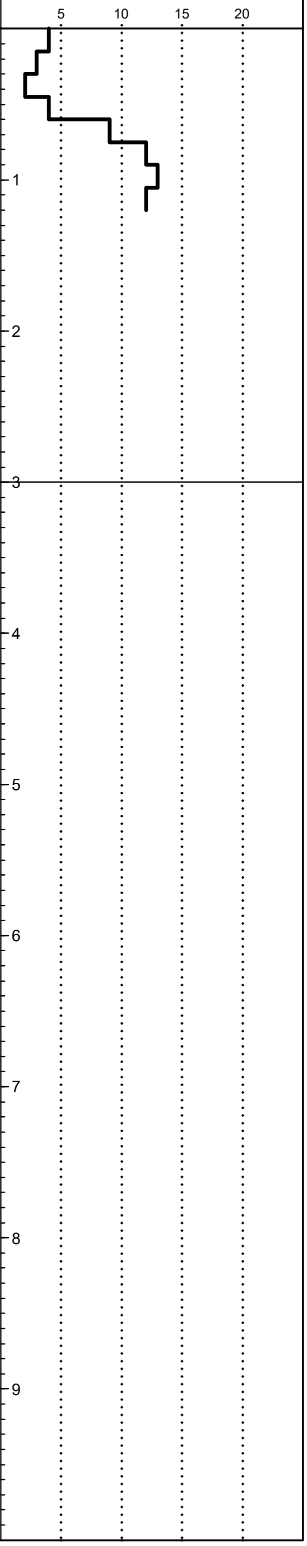
**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 9.0 mAHD
**EASTING:** 308991
**NORTHING:** 6245093
**DIP/AZIMUTH:** 90°/--

**BORE No:** 11
**PROJECT No:** 92370.00
**DATE:** 1/10/2019
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Type | Depth | Sample | Results & Comments | Water |
|---|---|---|---|---|---|---|---|
| 9 | 0.3 | FILL/TOPSOIL: Clayey SILT ML, low plasticity, dark brown, moist | | | | | |
| | | Silty CLAY CH: high plasticity, pale brown, trace sand, w~PL, soft to stiff, alluvial | D | 0.5 | | | |
| 8 | 1 | | D | 1.0 | | | |
| | | - becoming pale brown and grey, w<PL, hard below 1.3m | D | 1.5 | | pp = 500 | |
| 7 | 2 | - trace ironstone gravel below 2.0m | D | 2.0 | | pp = 500 | |
| | | | D | 2.5 | | pp = 500 | |
| 6 | 3.0 | Bore discontinued at 3.0m<br>- limit of investigation | D | 3.0 | | pp = 500 | |
| 5 | 4 | | | | | | |
| 4 | 5 | | | | | | |
| 3 | 6 | | | | | | |
| 2 | 7 | | | | | | |
| 1 | 8 | | | | | | |
| 0 | 9 | | | | | | |

Dynamic Penetrometer Test (blows per 150mm)



**RIG:** Hyundai 60CR-9 6 tonne excavator **DRILLER:** Quake Excavations **LOGGED:** JHB **CASING:** N/A
**TYPE OF BORING:** 300mm diameter SFA
**WATER OBSERVATIONS:** No free groundwater observed whilst augering
**REMARKS:** Location coordinates are in MGA94 Zone 56.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

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

**Douglas Partners**
Geotechnics / Environment / Groundwater

# BOREHOLE LOG

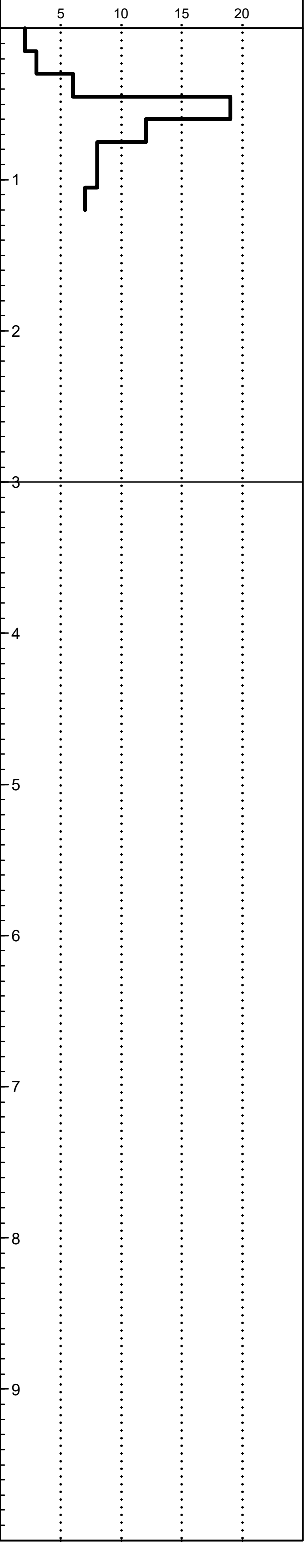
**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 9.1 mAHD
**EASTING:** 308912
**NORTHING:** 6245051
**DIP/AZIMUTH:** 90°/--

**BORE No:** 15
**PROJECT No:** 92370.00
**DATE:** 1/10/2019
**SHEET** 1 OF 1

| Depth (m) | Description of Strata | Type | Depth | Sample | Results & Comments | Water |
|---|---|---|---|---|---|---|
| | FILL/TOPSOIL: Silty CLAY CL, low plasticity, brown, dry | | | | | |
| 0.3 | FILL/Silty CLAY CL: low plasticity, pale grey, w<PL, appears to be typically stiff to hard | D | 0.5 | | | |
| 0.7 | Silty CLAY CH: high plasticity, red, grey and brown, w~PL, very stiff, alluvial | D | 1.0 | | | |
| | - becoming hard below 1.5m | D | 1.5 | | pp = 400 | |
| | | D | 2.0 | | pp = 500 | |
| | - trace ironstone gravel below 2.5m | D | 2.5 | | pp = 500 | |
| 3.0 | Bore discontinued at 3.0m<br>- limit of investigation | D | 3.0 | | pp = 400 | |

Dynamic Penetrometer Test (blows per 150mm)



**RIG:** Hyundai 60CR-9 6 tonne excavator **DRILLER:** Quake Excavations **LOGGED:** JHB **CASING:** N/A
**TYPE OF BORING:** 300mm diameter SFA
**WATER OBSERVATIONS:** No free groundwater observed whilst augering
**REMARKS:** Location coordinates are in MGA94 Zone 56.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

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

Douglas Partners
Geotechnics / Environment / Groundwater

# BOREHOLE LOG

**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 8.9 mAHD
**EASTING:** 308986
**NORTHING:** 6245042
**DIP/AZIMUTH:** 90°/--

**BORE No:** 16
**PROJECT No:** 92370.00
**DATE:** 1/10/2019
**SHEET** 1 OF 2

| RL | Depth (m) | Description of Strata | Degree of Weathering | Graphic Log | Rock Strength | Water | Fracture Spacing (m) | Discontinuities | Sampling & In Situ Testing: Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | EW HW MW SW FS FR | | Ex Low, Very Low, Low, Medium, High, Very High, Ex High | | 0.01 0.05 0.10 0.50 1.00 | B - Bedding J - Joint<br>S - Shear F - Fault | | | | |
| | 0.2 | FILL/TOPSOIL: Silty CLAY CL: low plasticity, dark brown, trace rootlets, w~PL | | | | | | Note: Unless otherwise stated, rock is fractured along sub-horizontal, planar, rough or smooth, clean joints or bedding planes | D | | | |
| | 0.7 | FILL/Silty CLAY CI: medium plasticity, grey, w~PL, appears to be typically stiff | | | | | | | | | | |
| 8 | 1 | Silty CLAY CH: high plasticity, grey, with rootlets, mottled red, w<PL, very stiff, alluvial | | | | | | | S/A | 100 | | 4,9,12<br>N = 21 |
| 7 | 2 | | | | | | | | D | | | |
| | | - becoming grey mottled orange, trace ironstone gravel, hard below 2.3m | | | | | | | S/A | 100 | | 8,21,23<br>N = 44 |
| 6 | 3 | | | | | | | | | | | |
| | 3.8 | Clayey SAND SC: well graded, medium grained, sub-rounded, pale grey mottled orange, wet, very dense, alluvial | | | | | | | | | | |
| 5 | 4 | | | | | | | | S/A | 100 | | 19,19,32<br>N = 51 |
| 4 | 5 | - becoming medium dense, trace gravel below 5.2m | | | | | | | S/A | 100 | | 5,9,14<br>N = 23 |
| 3 | 6 | | | | | | | | | | | |
| | | - with sub-rounded gravel below 6.6m | | | | | | | | | | |
| 2 | 7 | - with clay below 7.1m | | | | | | | S/A | 100 | | 6,8,8<br>N = 16 |
| | | - becoming pale grey, trace clay below 7.4m | | | | | | | | | | |
| 1 | 8 | | | | | | | | S/A | 100 | | 10,11,12<br>N = 23 |
| 0 | 9 | | | | | | | | | | | |
| -1 | 9.9 | | | | | | | | | | | |

**RIG:** Scout IV **DRILLER:** Groundtest **LOGGED:** SE/JHB **CASING:** HW to 2.5m; HQ to 14.5m
**TYPE OF BORING:** SFA to 2.5m, rotary drilling to 14.5m, then NMLC coring to 17.66m
**WATER OBSERVATIONS:** No free groundwater observed whilst augering
**REMARKS:** Location coordinates are in MGA94 Zone 56.

**SAMPLING & IN SITU TESTING LEGEND**

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

Douglas Partners
Geotechnics / Environment / Groundwater

DOUGLAS PARTNERS PTY LTD

SCHOOL INFRASTRUCTURE NSW
LIVERPOOL GIRLS & BOYS HIGH SCHOOL

BORE: 16 DEPTH: 14.5 – 17.66m PROJECT: 92370.00 OCTOBER 2019

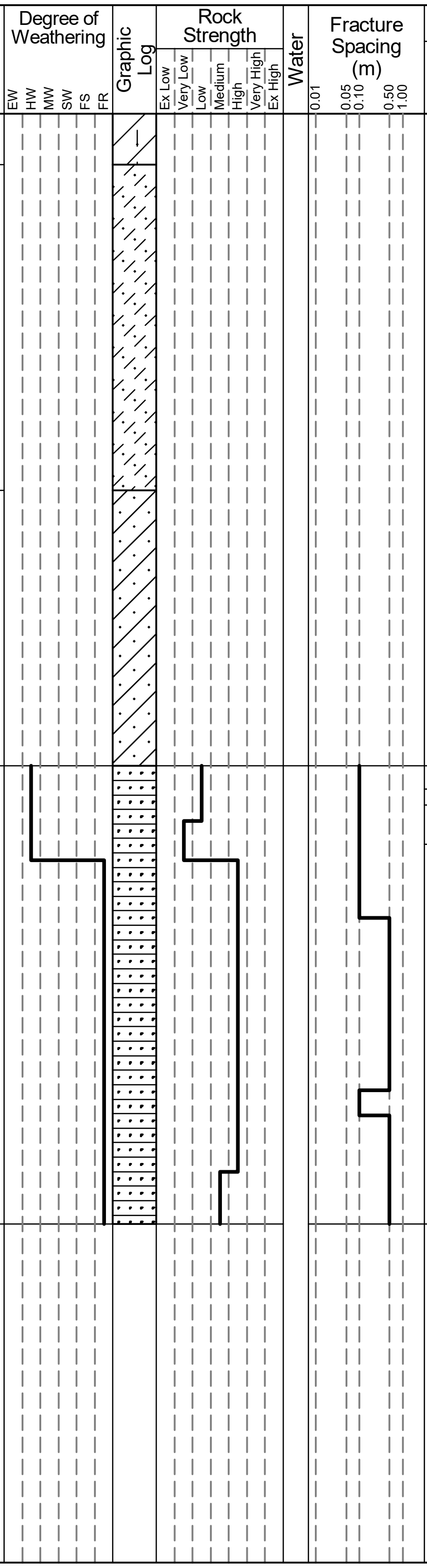
End of Bore at 17.66 m

# BOREHOLE LOG

**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 8.9 mAHD
**EASTING:** 308986
**NORTHING:** 6245042
**DIP/AZIMUTH:** 90°/--

**BORE No:** 16
**PROJECT No:** 92370.00
**DATE:** 1/10/2019
**SHEET** 2 OF 2



| RL | Depth (m) | Description of Strata | Discontinuities<br>B - Bedding J - Joint<br>S - Shear F - Fault | Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|---|
| | | Silty CLAY CL: medium plasticity, grey, w>PL, very stiff, alluvial *(continued)* | | | | | |
| | 10.35 | Clayey SAND SC: well graded, medium grained, sub-rounded, orange brown, with sub-rounded gravel, wet, dense, alluvial | | S/A | 100 | | 2,6,19<br>N = 25 |
| -2 | 11 | | | | | | |
| | | | | S/A | 100 | | 10,13,25<br>N = 38 |
| -3 | 12 | | | | | | |
| | 12.6 | Sandy CLAY CI: medium plasticity, brown, with gravel, trace ironstone gravel, w>PL, stiff, alluvial | | | | | |
| -4 | 13 | | | S/A | 100 | | 3,7,6<br>N = 13 |
| | | - becoming dark brown, with sand below 13.4m | | | | | |
| -5 | 14 | | | | | | |
| | 14.5 | LAMINITE: grey, laminated siltstone and quartz lithic sandstone, very low to low strength, highly weathered, highly fractured, Bringelly Shale | 14.59m: Ds 250mm<br>14.66m: J, sh, pl, ro, clay co<br>14.77m: J, sh, pl, ro, clay co<br>15.04m: B, h, pl, ca inf | C | 100 | 0 | PL(A) = 0.13 |
| -6 | 15 | - becoming medium to high strength, fresh, slightly fractured below 15.15m | | | | | |
| | | | | | | | PL(A) = 1.26 |
| -7 | 16 | | | | | 89 | |
| | | | | | | | PL(A) = 1.52 |
| -8 | 17 | | 16.91m: J, sv, cu, ro, ca co 140mm | | | | PL(A) = 1.7 |
| | | | | C | 100 | | PL(A) = 0.97 |
| | 17.66 | Bore discontinued at 17.66m<br>- limit of investigation | | | | | |
| -9 | 18 | | | | | | |
| -10 | 19 | | | | | | |
| -11 | | | | | | | |

**RIG:** Scout IV **DRILLER:** Groundtest **LOGGED:** SE/JHB **CASING:** HW to 2.5m; HQ to 14.5m

**TYPE OF BORING:** SFA to 2.5m, rotary drilling to 14.5m, then NMLC coring to 17.66m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering

**REMARKS:** Location coordinates are in MGA94 Zone 56.

**SAMPLING & IN SITU TESTING LEGEND**

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

Douglas Partners
Geotechnics / Environment / Groundwater

# BOREHOLE LOG

**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 9.1 mAHD
**EASTING:** 308908
**NORTHING:** 6245018
**DIP/AZIMUTH:** 90°/--

**BORE No:** 18
**PROJECT No:** 92370.00
**DATE:** 3/10/2019
**SHEET** 1 OF 2

| Depth (m) | Description of Strata | Discontinuities<br>B - Bedding J - Joint<br>S - Shear F - Fault | Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|
| | FILL/TOPSOIL: Silty CLAY CL, low plasticity, dark brown, w~PL | Note: Unless otherwise stated, rock is fractured along sub-horizontal, planar, rough, clean joints or bedding planes | D<br>D | | | |
| 0.3 | FILL/Silty CLAY CI: medium plasticity, brown, trace gravel, w~PL, appears to be typically stiff | | | | | |
| 0.7 | Silty CLAY CH: high plasticity, grey mottled red and orange, w<PL, very stiff, alluvial | | S/A | 100 | | 7,11,14<br>N = 25 |
| | - becoming hard below 2.5m | | S/A | 100 | | 9,13,19<br>N = 32 |
| 3.8 | Clayey SAND SW: well graded, medium grained, sub-rounded, orange brown, moist, dense, alluvial | | S/A | 100 | | 11,16,26<br>N = 42 |
| | - becoming fine grained, pale grey below 5.6m | | S/A | 100 | | 14,19,23<br>N = 42 |
| | - becoming medium dense below 7.0m | | S/A | 100 | | 16,19,18<br>N = 37 |
| | - becoming silty clay below 7.7m | | | | | |
| | - becoming dark grey below 8.55m | | S/A | 100 | | 11,16,19<br>N = 35 |
| 9.2 | Silty CLAY CI: medium plasticity, grey mottled yellow and orange, w>PL, very stiff, alluvial | | | | | |

**RIG:** Scout IV **DRILLER:** Groundtest **LOGGED:** SE/JHB **CASING:** HW to 2.5m; HQ to 11.5m
**TYPE OF BORING:** SFA to 2.5m, wash boring to 10.9m, then NMLC coring to 14.55m
**WATER OBSERVATIONS:** No free groundwater observed whilst augering
**REMARKS:** Location coordinates are in MGA94 Zone 56.

**SAMPLING & IN SITU TESTING LEGEND**

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

**Douglas Partners**
Geotechnics / Environment / Groundwater

DOUGLAS PARTNERS PTY LTD

SCHOOL INFRASTRUCTURE NSW
LIVERPOOL GIRLS & BOYS HIGH SCHOOL

BORE: 18 DEPTH: 11.50 – 14.55m PROJECT: 92370.00 OCTOBER 2019

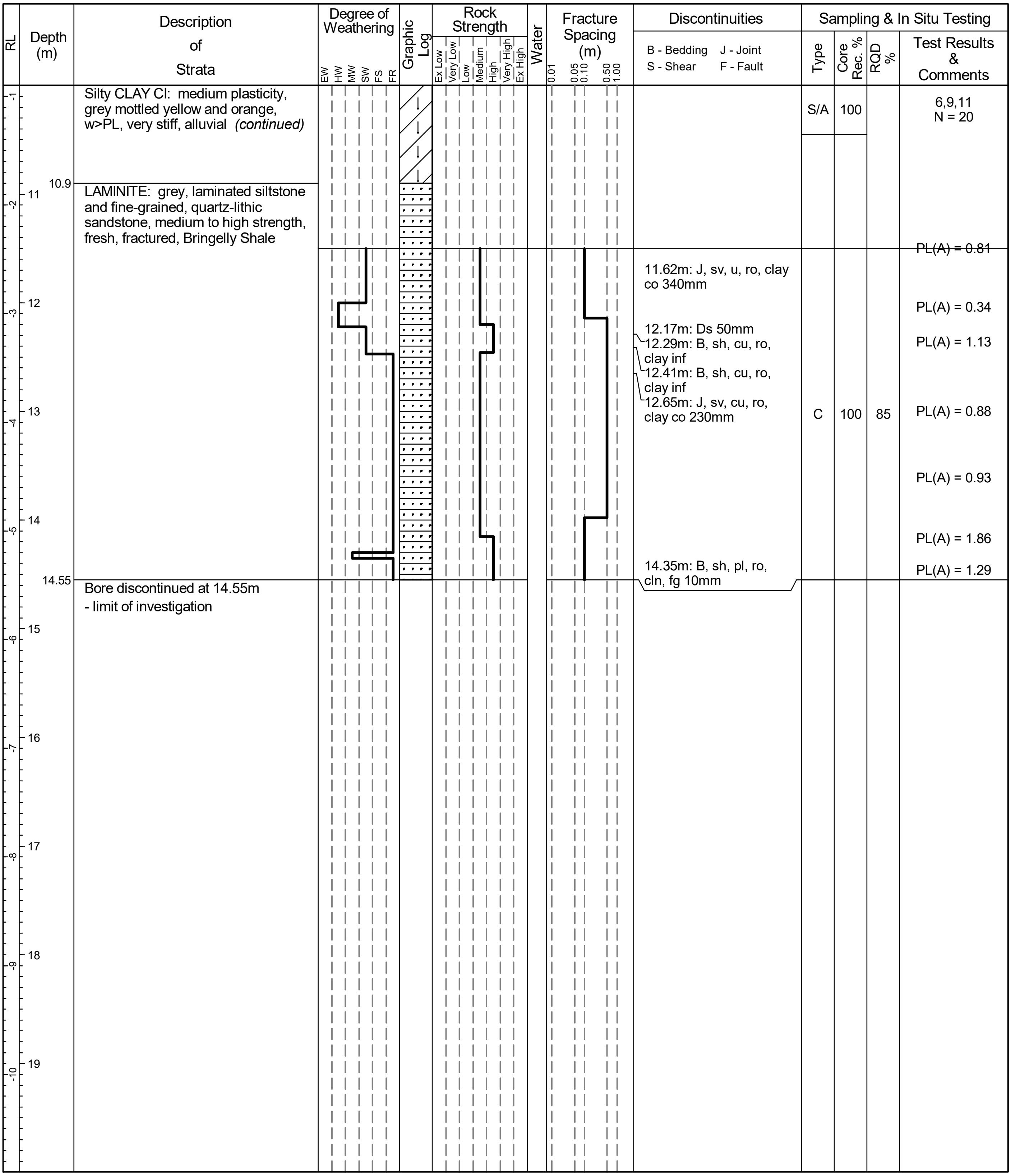
End of Bore at 14.55 m

# BOREHOLE LOG

**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 9.1 mAHD
**EASTING:** 308908
**NORTHING:** 6245018
**DIP/AZIMUTH:** 90°/--

**BORE No:** 18
**PROJECT No:** 92370.00
**DATE:** 3/10/2019
**SHEET** 2 OF 2



| Depth (m) | Description of Strata | Discontinuities<br>B - Bedding J - Joint<br>S - Shear F - Fault | Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|
| | Silty CLAY CI: medium plasticity, grey mottled yellow and orange, w>PL, very stiff, alluvial *(continued)* | | S/A | 100 | | 6,9,11<br>N = 20 |
| 10.9 | LAMINITE: grey, laminated siltstone and fine-grained, quartz-lithic sandstone, medium to high strength, fresh, fractured, Bringelly Shale | | | | | PL(A) = 0.81 |
| | | 11.62m: J, sv, u, ro, clay co 340mm<br>12.17m: Ds 50mm<br>12.29m: B, sh, cu, ro, clay inf<br>12.41m: B, sh, cu, ro, clay inf<br>12.65m: J, sv, cu, ro, clay co 230mm<br>14.35m: B, sh, pl, ro, cln, fg 10mm | C | 100 | 85 | PL(A) = 0.34<br>PL(A) = 1.13<br>PL(A) = 0.88<br>PL(A) = 0.93<br>PL(A) = 1.86<br>PL(A) = 1.29 |
| 14.55 | Bore discontinued at 14.55m<br>- limit of investigation | | | | | |

**RIG:** Scout IV **DRILLER:** Groundtest **LOGGED:** SE/JHB **CASING:** HW to 2.5m; HQ to 11.5m
**TYPE OF BORING:** SFA to 2.5m, wash boring to 10.9m, then NMLC coring to 14.55m
**WATER OBSERVATIONS:** No free groundwater observed whilst augering
**REMARKS:** Location coordinates are in MGA94 Zone 56.

**SAMPLING & IN SITU TESTING LEGEND**

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

Douglas Partners
Geotechnics / Environment / Groundwater

# BOREHOLE LOG

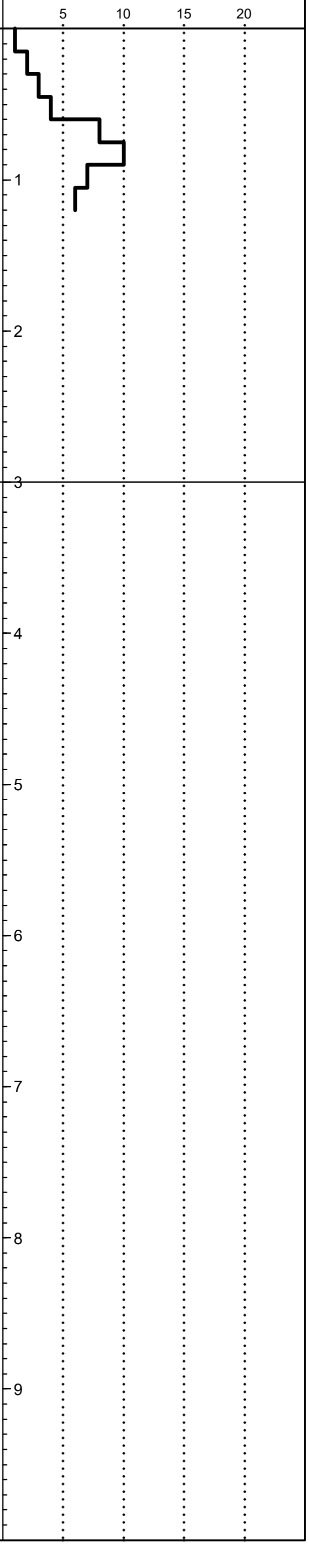
**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 8.9 mAHD
**EASTING:** 308962
**NORTHING:** 6244986
**DIP/AZIMUTH:** 90°/--

**BORE No:** 21
**PROJECT No:** 92370.00
**DATE:** 1/10/2019
**SHEET** 1 OF 1

| Depth (m) | Description of Strata | Type | Depth | Sample | Results & Comments | Water |
|---|---|---|---|---|---|---|
| 0.2 | FILL/TOPSOIL: Clayey SILT ML, low plasticity, dark brown, moist | | | | | |
| 0.4 | FILL/Silty CLAY CI: medium plasticity, grey, w~PL, appears to be typically stiff | D | 0.5 | | | |
| | Silty CLAY CH: high plasticity, brown, w~PL, very stiff, alluvial | D | 1.0 | | | |
| | - becoming grey, red and brown below 0.8m | | | | | |
| | - becoming hard below 1.5m | D | 1.5 | | pp = 400 | |
| | | D | 2.0 | | pp = 500-600 | |
| | - becoming brown and grey, trace ironstone gravel below 2.3m | D | 2.5 | | pp = 500 | |
| 2.8 | - with sand below 2.7m | | | | | |
| 3.0 | Clayey SAND SP: poorly graded, grey and brown, moist, appears to be typically medium dense, alluvial | D | 3.0 | | | |
| | Bore discontinued at 3.0m<br>- limit of investigation | | | | | |

Dynamic Penetrometer Test
(blows per 150mm)



**RIG:** Hyundai 60CR-9 6 tonne excavator **DRILLER:** Quake Excavations **LOGGED:** JHB **CASING:** N/A
**TYPE OF BORING:** 300mm diameter SFA
**WATER OBSERVATIONS:** No free groundwater observed whilst augering
**REMARKS:** Location coordinates are in MGA94 Zone 56.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

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

Douglas Partners
Geotechnics / Environment / Groundwater

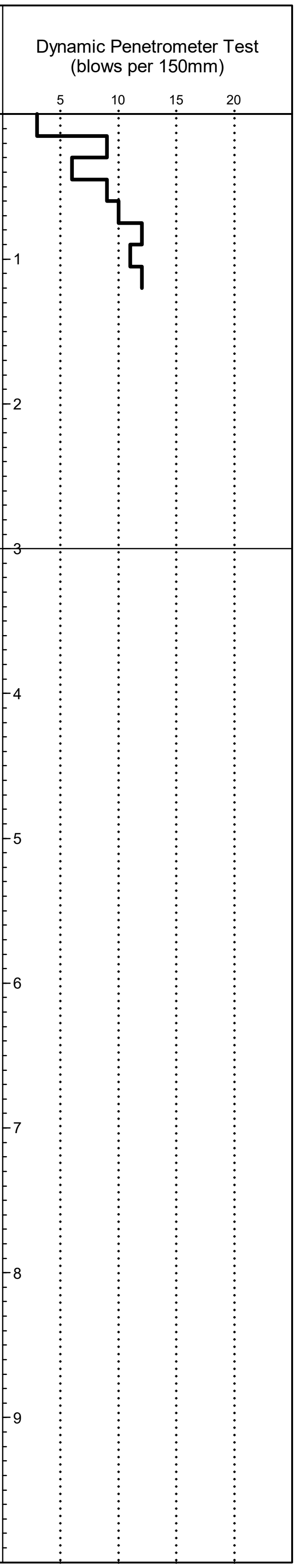
# BOREHOLE LOG

**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 9.1 mAHD
**EASTING:** 308937
**NORTHING:** 6244941
**DIP/AZIMUTH:** 90°/--

**BORE No:** 24
**PROJECT No:** 92370.00
**DATE:** 1/10/2019
**SHEET** 1 OF 1

| Depth (m) | Description of Strata | Type | Depth | Sample | Results & Comments | Water |
|---|---|---|---|---|---|---|
| 0.2 | FILL/TOPSOIL: Silty CLAY CL, low plasticity, brown, w~PL | D | 0.2 | | | |
| 0.5 | FILL/Silty CLAY CL: low plasticity, brown and black, with ash, w<PL, appears to be typically very stiff | | | | | |
| | Silty CLAY CH: high plasticity, brown, w~PL, very stiff, alluvial | D | 1.0 | | | |
| | | D | 1.5 | | pp = 400-500 | |
| | | D | 2.0 | | pp = 500 | |
| | - becoming grey, red and brown, hard below 2.5m | D | 2.5 | | pp = 500 | |
| 3.0 | Bore discontinued at 3.0m<br>- limit of investigation | D | 3.0 | | pp = 400 | |



**RIG:** Hyundai 60CR-9 6 tonne excavator **DRILLER:** Quake Excavations **LOGGED:** JHB **CASING:** N/A
**TYPE OF BORING:** 300mm diameter SFA
**WATER OBSERVATIONS:** No free groundwater observed whilst augering
**REMARKS:** Location coordinates are in MGA94 Zone 56.

☐ Sand Penetrometer AS1289.6.3.3
☒ Cone Penetrometer AS1289.6.3.2

**SAMPLING & IN SITU TESTING LEGEND**

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

Douglas Partners
Geotechnics / Environment / Groundwater

# BOREHOLE LOG

**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 9.3 mAHD
**EASTING:** 308922
**NORTHING:** 6244899
**DIP/AZIMUTH:** 90°/--

**BORE No:** 27
**PROJECT No:** 92370.00
**DATE:** 3/10/2019
**SHEET** 1 OF 2

| Depth (m) | Description of Strata | Water | Sampling Type | Core Rec. % | Test Results & Comments |
|---|---|---|---|---|---|
| 0.1 | FILL/TOPSOIL: Silty CLAY CL, low plasticity, dark brown, with rootlets, w<PL | | D | | |
| 0.4 | FILL/Silty CLAY CI: medium plasticity, brown, trace gravel, w~PL, appears to be typically stiff | | D | | |
| | | | D | | |
| | Silty CLAY CH: high plasticity, pale grey mottled red and yellow, w>PL, stiff, alluvial<br>- becoming w~PL below 0.7m | | S/A | 100 | 4,4,4<br>N = 8 |
| | - trace ironstone gravel below 2.5m | | S/A | 100 | 10,14,12<br>N = 26 |
| 3.7 | Clayey SAND SC: well graded, fine grained, sub-rounded, pale grey mottled red brown, moist, medium dense, alluvial | | S/A | 100 | 8,12,14<br>N = 26 |
| | | | S/A | 100 | 10,13,15<br>N = 28 |
| 6.9 | Sandy CLAY CI: low plasticity, pale grey mottled orange, w~PL, very stiff, alluvial<br>- trace ironstone gravel below 7.2m | | V | 100 | 7,11,16<br>N = 27 |
| | | ▼ 20-11-19 | | | |
| | | | S/A | 100 | 6,11,14<br>N = 25 |

**RIG:** Scout IV **DRILLER:** Groundtest **LOGGED:** SE/JHB **CASING:** HW to 2.5m; HQ to 14.7m
**TYPE OF BORING:** SFA to 2.5m, rotary drilling to 14.7m, then NMLC coring to 18.08m
**WATER OBSERVATIONS:** No free groundwater observed whilst augering
**REMARKS:** Location coordinates are in MGA94 Zone 56. Well installed: 0 - 0.1 gatic cover; 0.1 - 8.58m backfill; 8.58 - 9.08m bentonite; 9.08 - 18.08m gravel;
0 - 9.08m casing; 9.08 - 18.08m screen

**SAMPLING & IN SITU TESTING LEGEND**

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

Douglas Partners
Geotechnics / Environment / Groundwater

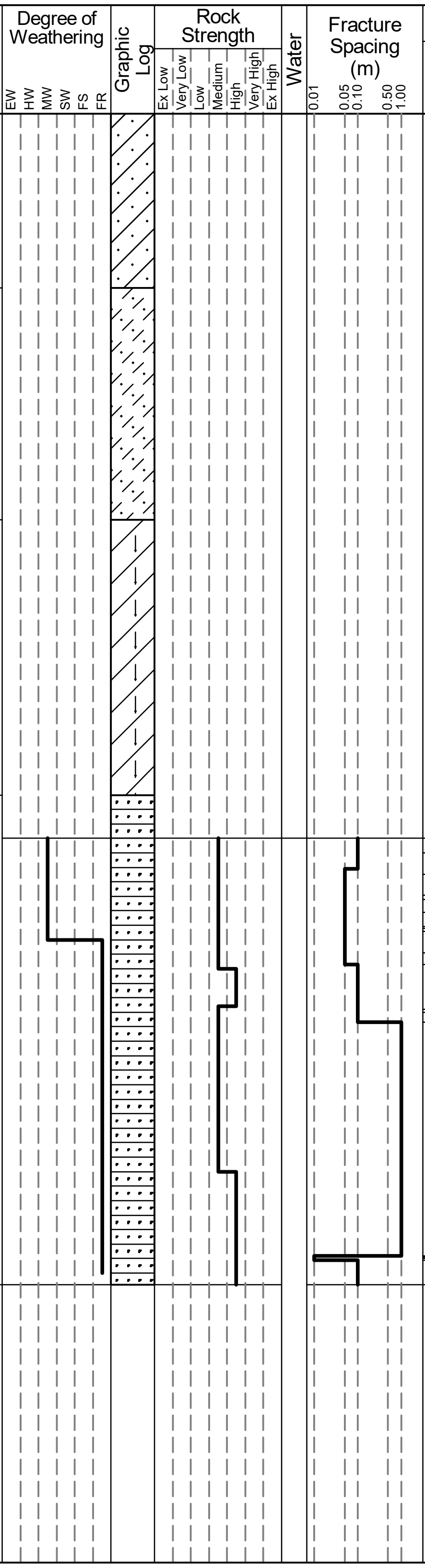
# BOREHOLE LOG

**CLIENT:** School Infrastructure NSW
**PROJECT:** Liverpool Boys & Girls High School
**LOCATION:** Forbes Street, Liverpool, NSW

**SURFACE LEVEL:** 9.3 mAHD
**EASTING:** 308922
**NORTHING:** 6244899
**DIP/AZIMUTH:** 90°/--

**BORE No:** 27
**PROJECT No:** 92370.00
**DATE:** 3/10/2019
**SHEET** 2 OF 2

| Depth (m) | Description of Strata | Discontinuities<br>B - Bedding J - Joint<br>S - Shear F - Fault | Type | Core Rec. % | RQD % | Test Results & Comments |
|---|---|---|---|---|---|---|
| | Sandy CLAY CI: low plasticity, pale grey mottled orange, w~PL, very stiff, alluvial *(continued)* | | S/A | 100 | | 5,7,8<br>N = 15 |
| 11.2 | Clayey SAND SC: well graded, medium grained, sub-rounded, brown, with gravel, wet, dense, alluvial | | S/A | 100 | | 14,27,18<br>N = 45 |
| 12.8 | Silty CLAY CI: low plasticity, dark brown grey, trace sand, w>PL, stiff, alluvial<br>- with sand below 13.2m | | S/A | 100 | | 6,8,6<br>N = 14 |
| | - with sub-rounded gravel below 14.4m | | S/A | 100 | | 27,20/50mm,-<br>refusal |
| 14.7 | LAMINITE: grey, laminated, siltstone and fine-grained, quartz-lithic sandstone, medium to high strength, moderately weathered, slightly fractured, Bringelly Shale<br>- becoming fresh below 15.7m | 15m: Cs 140mm<br>15.1m: B, h, pl, ro, clay co<br>15.25m: B, h, pl, ro, clay co<br>15.39m: B, h, pl, ro, clay co<br>15.42m: B, h, pl, ro, clay co<br>15.51m: B, h, cu, ro, clay co<br>15.61m: B, h, pl, ro, clay inf<br>15.62m: B, h, pl, ro, clay inf<br>15.64m: B, h, pl, ro, clay nf<br>15.79m: J, h, cu, ro, clay co<br>15.87m: J, h, pl, ro, clay inf<br>16.18m: J, sh, cu, ro, clay inf<br>16.2m: J, sh, cu, ro, clay co<br>16.27m: B, h, pl, ro, clay inf<br>17.88m: v, sh, ca 1mm<br>17.89m: v, sh, ca 1mm<br>17.9m: v, sh, ca 1mm<br>17.91m: J, sv, pl, ro, clay co 170mm | C | 100 | 81 | PL(A) = 0.49<br>PL(A) = 0.65<br>PL(A) = 1.51<br>PL(A) = 0.76<br>PL(A) = 1.14<br>PL(A) = 1.31 |
| 18.08 | Bore discontinued at 18.08m<br>- limit of investigation | | | | | |



RL: -1, -2, -3, -4, -5, -6, -7, -8, -9, -10
Depth: 11, 12, 13, 14, 15, 16, 17, 18, 19

**RIG:** Scout IV **DRILLER:** Groundtest **LOGGED:** SE/JHB **CASING:** HW to 2.5m; HQ to 14.7m

**TYPE OF BORING:** SFA to 2.5m, rotary drilling to 14.7m, then NMLC coring to 18.08m

**WATER OBSERVATIONS:** No free groundwater observed whilst augering

**REMARKS:** Location coordinates are in MGA94 Zone 56. Well installed: 0 - 0.1 gatic cover; 0.1 - 8.58m backfill; 8.58 - 9.08m bentonite; 9.08 - 18.08m gravel;
0 - 9.08m casing; 9.08 - 18.08m screen

**SAMPLING & IN SITU TESTING LEGEND**

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

Douglas Partners
Geotechnics / Environment / Groundwater

DOUGLAS PARTNERS PTY LTD

SCHOOL INFRASTRUCTURE NSW
LIVERPOOL GIRLS & BOYS HIGH SCHOOL

BORE: 27 DEPTH: 15.0 – 18.08m PROJECT: 92370.00 OCTOBER 2019

End of Bore at 18.08 m

Photo 1 - Borehole 13

Photo 2 - Borehole 15

| | | | | |
|---|---|---|---|---|
| **Douglas Partners**<br>Geotechnics / Environment / Groundwater | CLIENT: School Infrastructure NSW | | Site Photographs | PROJECT No: 92370.00 |
| | OFFICE: Macarthur | PREPARED BY: JHB | Liverpool Boys and Girls High Schools | PLATE No: 1 |
| | SCALE: NTS | DATE: Oct 2019 | Forbs Street, Liverpool | REVISION: 0 |

Photo 3 - Borehole 21

| | | | | |
|---|---|---|---|---|
| **Douglas Partners**<br>Geotechnics / Environment / Groundwater | CLIENT: School Infrastructure NSW | | Site Photographs | PROJECT No: 92370.00 |
| | OFFICE: Macarthur | PREPARED BY: JHB | Liverpool Boys and Girls High Schools | PLATE No: 2 |
| | SCALE: NTS | DATE: Oct 2019 | Forbs Street, Liverpool | REVISION: 0 |

**Douglas Partners**
*Geotechnics | Environment | Groundwater*

TITLE: **Borehole Location Plan**
**Proposed Liverpool Primary School**
**Lachlan and Forbes St, Liverpool**

CLIENT: School Infrastructure NSW
PROJECT No.: 92370.01
SCALE: As shown
DRAWING No: 1
OFFICE: Macarthur
DRAWN BY: JHB/ABB
DATE: 06.12.2019
REVISION: 1

# Appendix B

## Results of Laboratory Testing

# Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
Fax: (02) 4646 1886
Email: john.purcell@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

J.T. Purcell

Approved Signatory: John Purcell
Lab technician
NATA Accredited Laboratory Number: 828

**Report Number:** **92370.00-1**
**Issue Number:** 1
**Date Issued:** 25/10/2019
**Client:** School Infrastructure NSW
Level 8, SYDNEY NSW 2000
**Contact:** Jester Magpayo
**Project Number:** 92370.00
**Project Name:** Liverpool Girls & Boys High School
**Project Location:** Forbes Street, Liverpool
**Work Request:** 1502
**Sample Number:** MA-1502B
**Date Sampled:** 01/10/2019
**Dates Tested:** 17/10/2019 - 22/10/2019
**Sampling Method:** Sampled by Engineering Department
*The results apply to the sample as received*
**Remarks:** Field moisture content = 22.1%
**Sample Location:** **BH 4 (1.0m - 1.45m)**
**Material:** SILTY CLAY - grey, red & brown silty clay

| Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) | | Min | Max |
|---|---|---|---|
| Sample History | Air Dried | | |
| Preparation Method | Dry Sieve | | |
| Liquid Limit (%) | 63 | | |
| Plastic Limit (%) | 17 | | |
| **Plasticity Index (%)** | **46** | | |

| Linear Shrinkage (AS1289 3.4.1) | | Min | Max |
|---|---|---|---|
| Linear Shrinkage (%) | 13.0 | | |
| Cracking Crumbling Curling | Curling | | |

*This document shall not be reproduced except in full without approval of the laboratory.*
*Results relate only to the items tested/sampled.*

# Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
Fax: (02) 4646 1886
Email: john.purcell@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

J.T. Purcell

Approved Signatory: John Purcell
Lab technician
NATA Accredited Laboratory Number: 828

**Report Number:** **92370.00-1**
**Issue Number:** 1
**Date Issued:** 25/10/2019
**Client:** School Infrastructure NSW
Level 8, SYDNEY NSW 2000
**Contact:** Jester Magpayo
**Project Number:** 92370.00
**Project Name:** Liverpool Girls & Boys High School
**Project Location:** Forbes Street, Liverpool
**Work Request:** 1502
**Sample Number:** MA-1502C
**Date Sampled:** 01/10/2019
**Dates Tested:** 17/10/2019 - 24/10/2019
**Sampling Method:** Sampled by Engineering Department
*The results apply to the sample as received*
**Remarks:** Field moisture content = 16.6%
**Sample Location:** **BH 6 (1.0m - 1.45m)**
**Material:** SILTY CLAY - grey & orange silty clay

| Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) | | Min | Max |
|---|---|---|---|
| Sample History | Air Dried | | |
| Preparation Method | Dry Sieve | | |
| Liquid Limit (%) | 66 | | |
| Plastic Limit (%) | 18 | | |
| **Plasticity Index (%)** | **48** | | |

| Linear Shrinkage (AS1289 3.4.1) | | Min | Max |
|---|---|---|---|
| Linear Shrinkage (%) | 17.0 | | |
| Cracking Crumbling Curling | Curling | | |

# Material Test Report

Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
Fax: (02) 4646 1886
Email: john.purcell@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

J. T. Purcell

Approved Signatory: John Purcell
Lab technician
NATA Accredited Laboratory Number: 828

**Report Number:** **92370.00-1**
**Issue Number:** 1
**Date Issued:** 25/10/2019
**Client:** School Infrastructure NSW
Level 8, SYDNEY NSW 2000
**Contact:** Jester Magpayo
**Project Number:** 92370.00
**Project Name:** Liverpool Girls & Boys High School
**Project Location:** Forbes Street, Liverpool
**Work Request:** 1502
**Sample Number:** MA-1502D
**Date Sampled:** 01/10/2019
**Dates Tested:** 17/10/2019 - 24/10/2019
**Sampling Method:** Sampled by Engineering Department
*The results apply to the sample as received*
**Remarks:** Field moisture content = 22.0%
**Sample Location:** **BH 10 (0.5m)**
**Material:** FILL - red brown silty clay fill

| Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) | | Min | Max |
|---|---|---|---|
| Sample History | Oven Dried | | |
| Preparation Method | Dry Sieve | | |
| Liquid Limit (%) | 53 | | |
| Plastic Limit (%) | 20 | | |
| **Plasticity Index (%)** | **33** | | |

| Linear Shrinkage (AS1289 3.4.1) | | Min | Max |
|---|---|---|---|
| Linear Shrinkage (%) | 14.5 | | |
| Cracking Crumbling Curling | None | | |

# Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
Fax: (02) 4646 1886
Email: john.purcell@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

J. T. Purcell

Approved Signatory: John Purcell
Lab technician
NATA Accredited Laboratory Number: 828

**Report Number:** **92370.00-1**
**Issue Number:** 1
**Date Issued:** 25/10/2019
**Client:** School Infrastructure NSW
Level 8, SYDNEY NSW 2000
**Contact:** Jester Magpayo
**Project Number:** 92370.00
**Project Name:** Liverpool Girls & Boys High School
**Project Location:** Forbes Street, Liverpool
**Work Request:** 1502
**Sample Number:** MA-1502G
**Date Sampled:** 01/10/2019
**Dates Tested:** 17/10/2019 - 23/10/2019
**Remarks:** Field moisture content = 18.4%
**Sample Location:** **BH 16 (1.0m - 1.45m)**
**Material:** SILTY CLAY - grey & red silty clay

| Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) | | Min | Max |
|---|---|---|---|
| Sample History | Oven Dried | | |
| Preparation Method | Dry Sieve | | |
| Liquid Limit (%) | 61 | | |
| Plastic Limit (%) | 17 | | |
| **Plasticity Index (%)** | **44** | | |

| Linear Shrinkage (AS1289 3.4.1) | | Min | Max |
|---|---|---|---|
| Linear Shrinkage (%) | 15.5 | | |
| Cracking Crumbling Curling | Curling | | |

# Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
Fax: (02) 4646 1886
Email: john.purcell@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

J. T. Purcell

Approved Signatory: John Purcell
Lab technician

NATA Accredited Laboratory Number: 828

**Report Number:** **92370.00-1**
**Issue Number:** 1
**Date Issued:** 25/10/2019
**Client:** School Infrastructure NSW
Level 8, SYDNEY NSW 2000
**Contact:** Jester Magpayo
**Project Number:** 92370.00
**Project Name:** Liverpool Girls & Boys High School
**Project Location:** Forbes Street, Liverpool
**Work Request:** 1502
**Sample Number:** MA-1502J
**Date Sampled:** 01/10/2019
**Dates Tested:** 17/10/2019 - 24/10/2019
**Sampling Method:** Sampled by Engineering Department
*The results apply to the sample as received*
**Remarks:** Field moisture content = 22.1%
**Sample Location:** **BH 24 (1.0m)**
**Material:** SILTY CLAY - brown silty clay

| Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) | | Min | Max |
|---|---|---|---|
| Sample History | Oven Dried | | |
| Preparation Method | Dry Sieve | | |
| Liquid Limit (%) | 68 | | |
| Plastic Limit (%) | 20 | | |
| **Plasticity Index (%)** | **48** | | |

| Linear Shrinkage (AS1289 3.4.1) | | Min | Max |
|---|---|---|---|
| Linear Shrinkage (%) | 16.0 | | |
| Cracking Crumbling Curling | Curling | | |

# Material Test Report

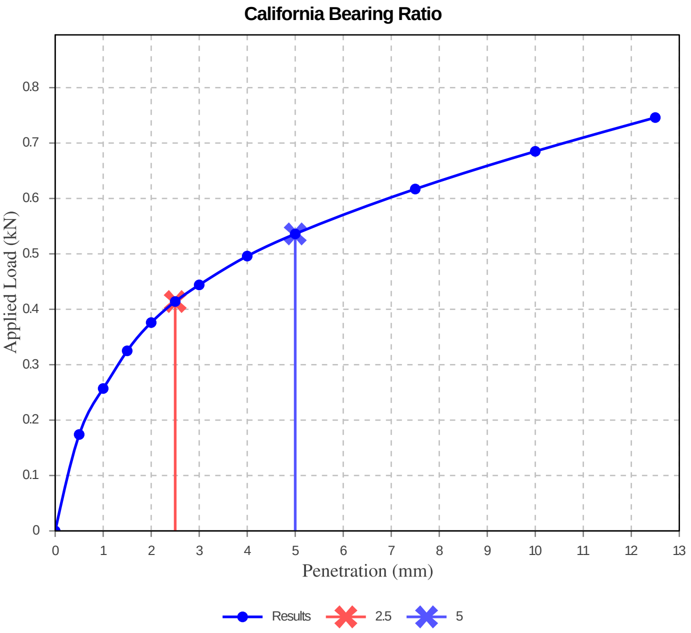
Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
Fax: (02) 4646 1886
Email: ramon.arancibia@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Ramon Arancibia
Assistant Laboratory Manager
NATA Accredited Laboratory Number: 828

**Report Number:** **92370.00-2**
**Issue Number:** 2 - *This version supersedes all previous issues*
**Reissue Reason:** *Name ammended, added missing data and corrected depth*
**Date Issued:** 21/11/2019
**Client:** School Infrastructure NSW
Level 8, SYDNEY NSW 2000
**Contact:** Jester Magpayo
**Project Number:** 92370.00
**Project Name:** Liverpool Boys & Girls High School
**Project Location:** Forbes Street, Liverpool
**Work Request:** 1524
**Sample Number:** MA-1524A
**Date Sampled:** 21/10/2019
**Dates Tested:** 21/10/2019 - 01/11/2019
**Sample Location:** **Composite 1 - BH11.15,16,18,21,24,27 (0.5 - 1.5m)**
**Material:** SILTY CLAY - grey red and brown

| California Bearing Ratio (AS 1289 6.1.1 & 2.1.1) | | Min | Max |
|---|---|---|---|
| CBR taken at | 2.5 mm | | |
| CBR % | **3.0** | | |
| Method of Compactive Effort | Standard | | |
| Method used to Determine MDD | AS 1289 5.1.1 & 2.1.1 | | |
| Method used to Determine Plasticity | Visual Assessment | | |
| Maximum Dry Density (t/m$^3$) | 1.62 | | |
| Optimum Moisture Content (%) | 23.0 | | |
| Laboratory Density Ratio (%) | 100.0 | | |
| Laboratory Moisture Ratio (%) | 100.0 | | |
| Dry Density after Soaking (t/m$^3$) | 1.61 | | |
| Field Moisture Content (%) | 21.1 | | |
| Moisture Content at Placement (%) | 23.2 | | |
| Moisture Content Top 30mm (%) | 27.4 | | |
| Moisture Content Rest of Sample (%) | 24.0 | | |
| Mass Surcharge (kg) | 4.5 | | |
| Soaking Period (days) | 4 | | |
| Curing Hours | 48 | | |
| Swell (%) | 1.0 | | |
| Oversize Material (mm) | 19 | | |
| Oversize Material Included | Excluded | | |
| Oversize Material (%) | | | |



# Material Test Report

**Douglas Partners**
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
Fax: (02) 4646 1886
Email: ramon.arancibia@douglaspartners.com.au

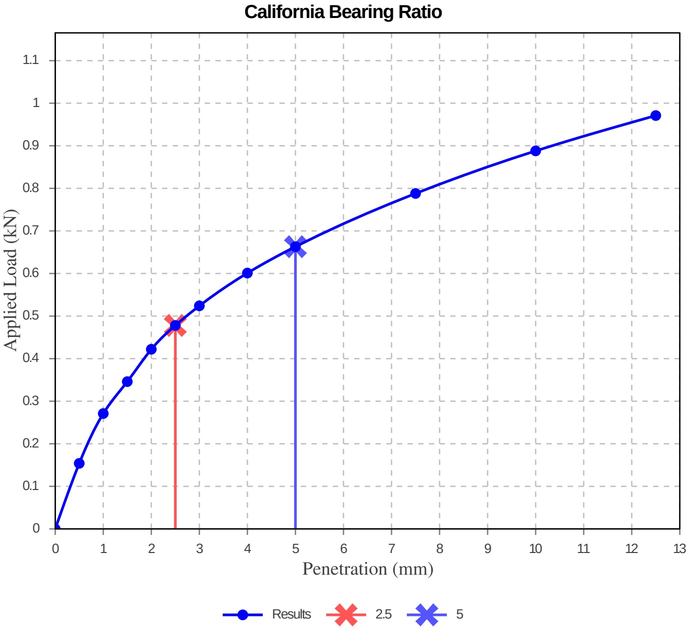
Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Ramon Arancibia
Assistant Laboratory Manager
NATA Accredited Laboratory Number: 828

**Report Number:** **92370.00-2**
**Issue Number:** 2 - *This version supersedes all previous issues*
**Reissue Reason:** *Name ammended, added missing data and corrected depth*
**Date Issued:** 21/11/2019
**Client:** School Infrastructure NSW
Level 8, SYDNEY NSW 2000
**Contact:** Jester Magpayo
**Project Number:** 92370.00
**Project Name:** Liverpool Boys & Girls High School
**Project Location:** Forbes Street, Liverpool
**Work Request:** 1524
**Sample Number:** MA-1524B
**Date Sampled:** 01/10/2019
**Dates Tested:** 21/10/2019 - 01/11/2019
**Sample Location:** **Composite 2 BH1,2,3,4,5,7,8,9,10,14 (0.5 - 1.5m)**
**Material:** SILTY CLAY _ grey, red and brown

| California Bearing Ratio (AS 1289 6.1.1 & 2.1.1) | | Min | Max |
|---|---|---|---|
| CBR taken at | 2.5 mm | | |
| CBR % | **3.5** | | |
| Method of Compactive Effort | Standard | | |
| Method used to Determine MDD | AS 1289 5.1.1 & 2.1.1 | | |
| Method used to Determine Plasticity | Visual Assessment | | |
| Maximum Dry Density (t/m$^3$) | 1.64 | | |
| Optimum Moisture Content (%) | 22.5 | | |
| Laboratory Density Ratio (%) | 100.0 | | |
| Laboratory Moisture Ratio (%) | 100.0 | | |
| Dry Density after Soaking (t/m$^3$) | 1.62 | | |
| Field Moisture Content (%) | 22.3 | | |
| Moisture Content at Placement (%) | 22.3 | | |
| Moisture Content Top 30mm (%) | 27.0 | | |
| Moisture Content Rest of Sample (%) | 24.5 | | |
| Mass Surcharge (kg) | 4.5 | | |
| Soaking Period (days) | 4 | | |
| Curing Hours | 96 | | |
| Swell (%) | 1.0 | | |
| Oversize Material (mm) | 19 | | |
| Oversize Material Included | Excluded | | |
| Oversize Material (%) | | | |



# Material Test Report

**Report Number:** **92370.00-2**
**Issue Number:** 2 - *This version supersedes all previous issues*
**Reissue Reason:** *Name ammended, added missing data and corrected depth*
**Date Issued:** 21/11/2019
**Client:** School Infrastructure NSW
Level 8, SYDNEY NSW 2000
**Contact:** Jester Magpayo
**Project Number:** 92370.00
**Project Name:** Liverpool Boys & Girls High School
**Project Location:** Forbes Street, Liverpool
**Work Request:** 1524
**Dates Tested:** 21/10/2019 - 21/10/2019

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Macarthur Laboratory
18 Waler Crescent Smeaton Grange NSW 2567
Phone: (02) 4647 0075
Fax: (02) 4646 1886
Email: ramon.arancibia@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Ramon Arancibia
Assistant Laboratory Manager
NATA Accredited Laboratory Number: 828

## Moisture Content AS 1289 2.1.1

| Sample Number | Sample Location | Moisture Content (%) | Material |
|---|---|---|---|
| MA-1524C | 1 (0.5 - 0.5m) | 19.7 % | FILLING - brown silty clay |
| MA-1524D | 1 (2.5 -2.95m) | 7.0 % | SITLY CLAY - grey, red and brown |
| MA-1524E | 2 (1.0 - 1.0m) | 19.1 % | FILLING - brown silty clay |
| MA-1524F | 2 (2.5 - 2.5m) | 21.0 % | SILTY CLAY - brown and red |
| MA-1524G | 3 (0.5 - 0.5m) | 22.1 % | SILTY CLAY - brown and grey |
| MA-1524H | 3 (2.5 - 2.5m) | 17.8 % | SILTY CLAY - brown and red |
| MA-1524I | 4 (0.3 - 0.3m) | 20.2 % | FILLING - brown silty clay |
| MA-1524J | 4 (2.5 - 2.5m) | 17.4 % | SILTY CLAY - grey, red and brown |
| MA-1524K | 5 (1.0 - 1.0m) | 31.5 % | SILTY CLAY - grey , red and brown |
| MA-1524L | 5 (3.0 - 3.0m) | 21.3 % | SILTY CLAY - red and grey |
| MA-1524M | 6 (2.5 - 2.95m) | 10.9 % | SILTY CLAY - red and orange |
| MA-1524N | 7 (0.3 - 0.3m) | 18.7 % | FILL/SAND - brown |
| MA-1524O | 9 (1.0-1.0m) | 23.0 % | SILTY CLAY - grey, red and brown |
| MA-1524P | 9 (3.0 - 3.0m) | 17.1 % | SILTY CLAY - grey and brown |
| MA-1524Q | 10 (1.0 - 1.0m) | 27.2 % | SILTY CLAY - grey , red and brown |
| MA-1524R | 11 (3.0 - 3.0m) | 12.7 % | SILTY CLAY - pale brown and grey |
| MA-1524S | 12 (0.5 - 0.5m) | 13.8 % | Fill/Silty CLAY - brown and red |
| MA-1524T | 12 (2.5 - 2.8m) | 16.9 % | SILTY CLAY - grey , red and brown |
| MA-1524U | 13 (3.0 - 3.0m) | 20.0 % | SAND - grey and brown |
| MA-1524V | 14 (0.5 - 0.5m) | 17.4 % | SILTY CLAY - grey , red and brown |
| MA-1524W | 14 (3.0 - 3.0m) | 12.6 % | SAND - white and brown |
| MA-1524X | 15 (0.5 - 0.5m) | 3.4 % | FILL/Silty CLAY - pale grey |
| MA-1524Y | 15 (2.5 -2.5m) | 12.7 % | SILTY CLAY - grey , red and brown |
| MA-1524Z | 16 (2.5 - 2.95m) | 11.9 % | SILTY CLAY - grey , red and brown |
| MA-1524AA | 17 (0.5 - 0.5m) | 24.9 % | FILL/Silty CLAY - red |
| MA-1524AB | 17 (3.0 - 3.0m) | 6.5 % | SILTY CLAY - grey , red and brown |
| MA-1524AC | 18 (2.5 - 2.95m) | 9.1 % | SILTY CLAY - grey , red and brown |
| MA-1524AD | 20 (2.5 - 2.95m) | 20.2 % | Clayey SAND - grey and brown |
| MA-1524AE | 20 (6.9 - 7.35m) | 16.9 % | SAND - grey and brown |
| MA-1524AF | 21 (0.5 - 0.5m) | 23.1 % | Silty CLAY - brown |
| MA-1524AG | 21 (3.0- 3.0m) | 6.3 % | Clayey SAND - grey and brown |
| MA-1524AH | 22 (3.0 - 3.0m) | 15.7 % | SILTY CLAY - grey , red and brown |
| MA-1524AI | 23 (3.0 - 3.0m) | 14.5 % | SILTY CLAY - grey and brown |
| MA-1524AJ | 24 (0.2 - 0.2m) | 13.7 % | FILL/Silty CLAY - brown and grey |
| MA-1524AK | 24 (3.0 - 3.0m) | 18.1 % | SILTY CLAY - grey , red and brown |

| Sample Number | Sample Location | Moisture Content (%) | Material |
|---|---|---|---|
| MA-1524AL | 25 (1.0 - 1.45m) | 16.5 % | Silty CLAY - brown |
| MA-1524AM | 25 (2.5 - 2.95m) | 18.3 % | SILTY CLAY - grey , red and brown |
| MA-1524AN | 26 (2.5 -2.95m) | 15.6 % | SILTY CLAY - grey , red and brown |
| MA-1524AO | 27 (0.7 - 0.7m) | 26.5 % | Silty CLAY - pale brown |
| MA-1524AP | 27 (4.0- 4.45m) | 11.9 % | Silty CLAY - pale brown |

**Envirolab Services Pty Ltd**
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200   fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

# CERTIFICATE OF ANALYSIS 228741

## Client Details

| | |
|---|---|
| **Client** | Douglas Partners Pty Ltd Smeaton Grange |
| **Attention** | Joel Brauer, Konrad Schultz |
| **Address** | 18 Waler Crescent, Smeaton Grange, NSW, 2567 |

## Sample Details

| | |
|---|---|
| **Your Reference** | **92370.00, Liverpool Boys & Girls High School** |
| **Number of Samples** | 20 Soil |
| **Date samples received** | 18/10/2019 |
| **Date completed instructions received** | 18/10/2019 |

## Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

**Please refer to the last page of this report for any comments relating to the results.**

## Report Details

| | |
|---|---|
| **Date results requested by** | 25/10/2019 |
| **Date of Issue** | 25/10/2019 |

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

**Results Approved By**
Nick Sarlamis, Inorganics Supervisor
Priya Samarawickrama, Senior Chemist

**Authorised By**

Nancy Zhang, Laboratory Manager

| Misc Inorg - Soil | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 228741-1 | 228741-2 | 228741-3 | 228741-4 | 228741-7 |
| Your Reference | UNITS | 4 | 4 | 6 | 6 | 7 |
| Depth | | 4.0-4.45 | 8.5-8.95 | 1.0-1.45 | 4.0-4.45 | 0.5-1.0 |
| Date Sampled | | 02/10/2019 | 02/10/2019 | 01/10/2019 | 01/10/2019 | 01/10/2019 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 22/10/2019 | 22/10/2019 | 22/10/2019 | 22/10/2019 | 22/10/2019 |
| Date analysed | - | 22/10/2019 | 22/10/2019 | 22/10/2019 | 22/10/2019 | 22/10/2019 |
| pH 1:5 soil:water | pH Units | 5.5 | 8.0 | 5.3 | 7.8 | 5.4 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 800 | 740 | 130 | 150 | 60 |
| Chloride, Cl 1:5 soil:water | mg/kg | 1,100 | 1,000 | 45 | 170 | 25 |
| Sulphate, SO4 1:5 soil:water | mg/kg | 200 | 110 | 150 | 43 | 59 |

| Misc Inorg - Soil | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 228741-8 | 228741-9 | 228741-10 | 228741-13 | 228741-17 |
| Your Reference | UNITS | 7 | 18 | 18 | 26 | 27 |
| Depth | | 2.5-2.65 | 1.0-1.45 | 4.0-4.45 | 1.0-1.45 | 2.5-2.95 |
| Date Sampled | | 01/10/2019 | 03/10/2019 | 03/10/2019 | 04/10/2019 | 03/10/2019 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 22/10/2019 | 22/10/2019 | 22/10/2019 | 22/10/2019 | 22/10/2019 |
| Date analysed | - | 22/10/2019 | 22/10/2019 | 22/10/2019 | 22/10/2019 | 22/10/2019 |
| pH 1:5 soil:water | pH Units | 6.1 | 4.9 | 5.9 | 5.2 | 5.1 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 22 | 260 | 38 | 230 | 630 |
| Chloride, Cl 1:5 soil:water | mg/kg | <10 | 230 | 20 | 120 | 910 |
| Sulphate, SO4 1:5 soil:water | mg/kg | 10 | 170 | 27 | 300 | 92 |

**sPOCAS field test**

| Our Reference | | 228741-1 | 228741-2 | 228741-3 | 228741-4 | 228741-5 |
|---|---|---|---|---|---|---|
| Your Reference | UNITS | 4 | 4 | 6 | 6 | 6 |
| Depth | | 4.0-4.45 | 8.5-8.95 | 1.0-1.45 | 4.0-4.45 | 7.0-7.45 |
| Date Sampled | | 02/10/2019 | 02/10/2019 | 01/10/2019 | 01/10/2019 | 01/10/2019 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 24/10/2019 | 24/10/2019 | 24/10/2019 | 24/10/2019 | 24/10/2019 |
| Date analysed | - | 24/10/2019 | 24/10/2019 | 24/10/2019 | 24/10/2019 | 24/10/2019 |
| pH$_{F}$ (field pH test)* | pH Units | 5.3 | 7.5 | 5.4 | 7.3 | 6.5 |
| pH$_{FOX}$ (field peroxide test)* | pH Units | 4.3 | 7.6 | 4.0 | 5.9 | 6.1 |
| Reaction Rate* | - | Slight | Slight | Moderate | Slight | Slight |

**sPOCAS field test**

| Our Reference | | 228741-6 | 228741-9 | 228741-10 | 228741-11 | 228741-12 |
|---|---|---|---|---|---|---|
| Your Reference | UNITS | 6 | 18 | 18 | 18 | 18 |
| Depth | | 10.0-10.45 | 1.0-1.45 | 4.0-4.45 | 7.0-7.45 | 10.0-10.45 |
| Date Sampled | | 01/10/2019 | 03/10/2019 | 03/10/2019 | 03/10/2019 | 03/10/2019 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 24/10/2019 | 24/10/2019 | 24/10/2019 | 24/10/2019 | 24/10/2019 |
| Date analysed | - | 24/10/2019 | 24/10/2019 | 24/10/2019 | 24/10/2019 | 24/10/2019 |
| pH$_{F}$ (field pH test)* | pH Units | 7.0 | 5.0 | 6.0 | 7.5 | 7.3 |
| pH$_{FOX}$ (field peroxide test)* | pH Units | 5.8 | 3.7 | 5.7 | 6.1 | 7.1 |
| Reaction Rate* | - | Slight | Slight | Slight | Slight | Slight |

**sPOCAS field test**

| Our Reference | | 228741-13 | 228741-14 | 228741-15 | 228741-16 | 228741-17 |
|---|---|---|---|---|---|---|
| Your Reference | UNITS | 26 | 26 | 26 | 27 | 27 |
| Depth | | 1.0-1.45 | 5.5-5.95 | 10.0-10.43 | 0.4 | 2.5-2.95 |
| Date Sampled | | 04/10/2019 | 04/10/2019 | 04/10/2019 | 03/10/2019 | 03/10/2019 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date prepared | - | 24/10/2019 | 24/10/2019 | 24/10/2019 | 24/10/2019 | 24/10/2019 |
| Date analysed | - | 24/10/2019 | 24/10/2019 | 24/10/2019 | 24/10/2019 | 24/10/2019 |
| pH$_{F}$ (field pH test)* | pH Units | 5.3 | 6.6 | 8.4 | 7.6 | 5.6 |
| pH$_{FOX}$ (field peroxide test)* | pH Units | 3.9 | 5.2 | 7.5 | 4.2 | 4.0 |
| Reaction Rate* | - | Slight | Slight | Slight | Slight | Slight |

| sPOCAS field test | | | | |
|---|---|---|---|---|
| Our Reference | | 228741-18 | 228741-19 | 228741-20 |
| Your Reference | UNITS | 27 | 27 | 27 |
| Depth | | 7.0-7.45 | 11.5-11.95 | 14.5-14.95 |
| Date Sampled | | 03/10/2019 | 03/10/2019 | 03/10/2019 |
| Type of sample | | Soil | Soil | Soil |
| Date prepared | - | 24/10/2019 | 24/10/2019 | 24/10/2019 |
| Date analysed | - | 24/10/2019 | 24/10/2019 | 24/10/2019 |
| $pH_F$ (field pH test)* | pH Units | 6.9 | 6.9 | 7.6 |
| $pH_{FOX}$ (field peroxide test)* | pH Units | 6.6 | 6.6 | 4.4 |
| Reaction Rate* | - | Slight | Slight | Slight |

| Method ID | Methodology Summary |
|---|---|
| **Inorg-001** | pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times. |
| **Inorg-002** | Conductivity and Salinity - measured using a conductivity cell at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons. |
| **Inorg-063** | pH- measured using pH meter and electrode. Soil is oxidised with Hydrogen Peroxide or extracted with water. Based on section H, Acid Sulfate Soils Laboratory Methods Guidelines, Version 2.1 - June 2004. To ensure accurate results these tests are recommended to be done in the field as pH may change with time thus these results may not be representative of true field conditions. |
| **Inorg-081** | Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis.<br>Alternatively determined by colourimetry/turbidity using Discrete Analyser. |

| QUALITY CONTROL: Misc Inorg - Soil | | | | | Duplicate | | | | Spike Recovery % | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Description | Units | PQL | Method | Blank | # | Base | Dup. | RPD | LCS-1 | 228741-2 |
| Date prepared | - | | | 22/10/2019 | 1 | 22/10/2019 | 22/10/2019 | | 22/10/2019 | 22/10/2019 |
| Date analysed | - | | | 22/10/2019 | 1 | 22/10/2019 | 22/10/2019 | | 22/10/2019 | 22/10/2019 |
| pH 1:5 soil:water | pH Units | | Inorg-001 | [NT] | 1 | 5.5 | 5.5 | 0 | 102 | [NT] |
| Electrical Conductivity 1:5 soil:water | µS/cm | 1 | Inorg-002 | <1 | 1 | 800 | 770 | 4 | 97 | [NT] |
| Chloride, Cl 1:5 soil:water | mg/kg | 10 | Inorg-081 | <10 | 1 | 1100 | 1000 | 10 | 99 | # |
| Sulphate, SO4 1:5 soil:water | mg/kg | 10 | Inorg-081 | <10 | 1 | 200 | 220 | 10 | 114 | # |

| Result Definitions | |
|---|---|
| **NT** | Not tested |
| **NA** | Test not required |
| **INS** | Insufficient sample for this test |
| **PQL** | Practical Quantitation Limit |
| **<** | Less than |
| **>** | Greater than |
| **RPD** | Relative Percent Difference |
| **LCS** | Laboratory Control Sample |
| **NS** | Not specified |
| **NEPM** | National Environmental Protection Measure |
| **NR** | Not Reported |

| Quality Control Definitions | |
|---|---|
| **Blank** | This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples. |
| **Duplicate** | This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable. |
| **Matrix Spike** | A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist. |
| **LCS (Laboratory Control Sample)** | This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample. |
| **Surrogate Spike** | Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples. |

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

## Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

## Report Comments

MISC_INORG_DRY: CHLORIDE # Percent recovery is not possible to report due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.

MISC_INORG_DRY: SULPHATE ## Poor spike recovery was obtained for this sample. This is due to matrix interferences. However, an acceptable recovery was obtained for the LCS.