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Report on
Geotechnical Investigation

Proposed Residential Subdivision
Cessnock Road, Gillieston Heights

Prepared for
Loxford Project Management Pty Ltd

Project 81520.01
February 2022

Douglas Partners
Geotechnics / Environment / Groundwater

## Document History

Document details

| | | | |
|---|---|---|---|
| Project No. | 81520.01 | Document No. | R.001.Rev1 |
| Document title | Report on Geotechnical Investigation<br>Proposed Residential Subdivision | | |
| Site address | Cessnock Road, Gillieston Heights | | |
| Report prepared for | Loxford Project Management Pty Ltd | | |
| File name | 81520.01.R.001.Rev1 | | |

Document status and review

| Status | Prepared by | Reviewed by | Date issued |
|---|---|---|---|
| Revision 0 | Ryan Pankhurst /<br>Julie Wharton | Scott McFarlane | 7 December 2021 |
| Revision 1 | Julie Wharton | Scott McFarlane | 15 February 2022 |
| | | | |
| | | | |

Distribution of copies

| Status | Electronic | Paper | Issued to |
|---|---|---|---|
| Revision 0 | 1 | 0 | Jeffrey Bretag, Loxford Project Management Pty Ltd |
| Revision 1 | 1 | 0 | Jeffrey Bretag, Loxford Project Management Pty Ltd |
| | | | |
| | | | |

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 | | 15 February 2022 |
| Reviewer | | 15 February 2022 |

bsi. ISO 9001 Quality Management
FS 604853

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# Report on Geotechnical Investigation
# Proposed Residential Subdivision
# Cessnock Road, Gillieston Heights

## 1. Introduction

This report presents the results of a geotechnical investigation undertaken for a proposed residential subdivision at Cessnock Road, Gillieston Heights. The work was undertaken for Loxford Project Management Pty Ltd (a McCloy Group company).

The purpose of the investigation was to provide the following:

- Subsurface conditions at the site;
- Preliminary pavement thickness design (internal roads only);
- Geotechnical comment on detention basin construction (material properties, compaction requirements etc);
- Comment on soil salinity;
- Acid sulfate soil assessment;
- Slope stability, particularly north and east of the proposed park;
- Preliminary site classification with regard to foundation soil reactivity (shrink-swell), in accordance with (AS2870, 2011);
- Comment on excavatability.

For purposes of the investigation, the client supplied DP with various drawings by ADW Johnson Pty Ltd (ADWJ). The relevant drawings that have been referred to in the preparation of this report include:

- 'Proposed Subdivision Site Regrade Plan', Project No 240289(1), Drawing Number 501 (CENG), Rev A dated 10.12.2021;
- 'Overall Stage Master Plan", Dwg Ref 240289(1)-DA-006, ver B, dated 28.01.22;

The site has been subject to a previous preliminary geotechnical report by Douglas Partners Pty Ltd (DP), the results of which have been referred to in the preparation of this report (DP, 2015).

The current investigation included the excavation of test pits in areas nominated by the client, laboratory testing of selected samples, engineering analysis and preparation of this report. The details of the field work and laboratory testing are presented in this report, together with comments and recommendations on the items listed above.

## 2. Proposed Development

The proposed development includes a residential subdivision, together with internal roads and construction of detention basins. It is understood that the subdivision will comprise 344 residential lots, three residue lots and seven public reserve lots.

Available information indicates the following:

- Bulk earthworks and benching will occur over the site, with retaining walls of up to 1.5 m height proposed;
- Internal subdivision roads will include:
  - Road MC01 – divided carriageway;
  - Auburn Street and Road MC05 as primary collector roads;
  - All remaining roads as local streets;
- Lot sizes to range from about 450 $m^2$ to about 1029 $m^2$;
- Construction is expected to occur across 17 stages;
- A signalised intersection will be constructed at the subdivision entrance off Cessnock Road, subject to TfNSW approval;
- Water quality / detention basin construction is proposed;
- A District Park will be provided on the topographic highpoint;
- An arterial road will eventually connect to William Tester Drive (to the south) to provide flood-free access to Gillieston Heights.

A preliminary earthworks plan indicates that bulk earthworks will include excavations in the order of up to 4.5 m, and fill of up to about 4 m. It is assumed that material won from excavations will be used in areas of fill.

## 3. Site Description and Regional Geology

### 3.1 Site Description

The site is located west of Cessnock Road, south of Ardennes Circuit, east of the South Maitland Railway, and is located within the suburb of Gillieston Heights in the Maitland City Council local government area. It is understood that the boundary with Cessnock City Council is located just beyond the southern extents of the site.

The site is an irregular shape and covers an area of approximately 50 ha. The indicative site extents are shown below in Figure 1.


**Figure 1: Indicative Site Extents (Red Outline)**

The site generally includes a broadly rolling landscape, predominantly cleared and grassed and used for grazing. Existing development on the site includes a dam in north-east part of the site, powerlines crossing in an approximately east-west direction in the central part of the site, water troughs for livestock, and an unsealed track that provides access from Cessnock Road to a property on the western side of the South Maitland Railway. Existing residential development is located to the north and north-east of the site.

There are two local high points on the site, located in the central eastern part of the site (approximate RL 42 (AHD)), and towards the north-western part of the site (approximate RL 46), with a saddle between the two. The site generally slopes down towards the north, north-west and north-east on the northern side of the high points; and down towards the south / south-west on the southern side of the high points. Slopes in the north-west, south-west and south-east portions of the site were generally in the order of 5° to 10°. Slopes in the north-east portion of the site were in the order of 10° to 15°.

Several gullies / drainage lines were present within and immediately adjacent to the site. A gully in the north-east part of the site drained to the north to the existing dam, and then from the dam down to the north. A creek that drained to the west / north-west was located just beyond the southern extents of the site. Several drainage gullies in the southern part of the site drained to the south, towards the creek. Locally, drainage is towards Swamp Creek, which is located west and north-west of the site.

Scattered stands of mature trees can be found across the site, mainly along drainage features. Rock was observed to be outcropping in several parts of the site, particularly near the high point in the north-western portion, but also in other generally elevated areas.

Figure 2, below, shows an overview of the site with 2 m contours and indicative watercourses / drainage lines overlaid (site extents indicated in red).

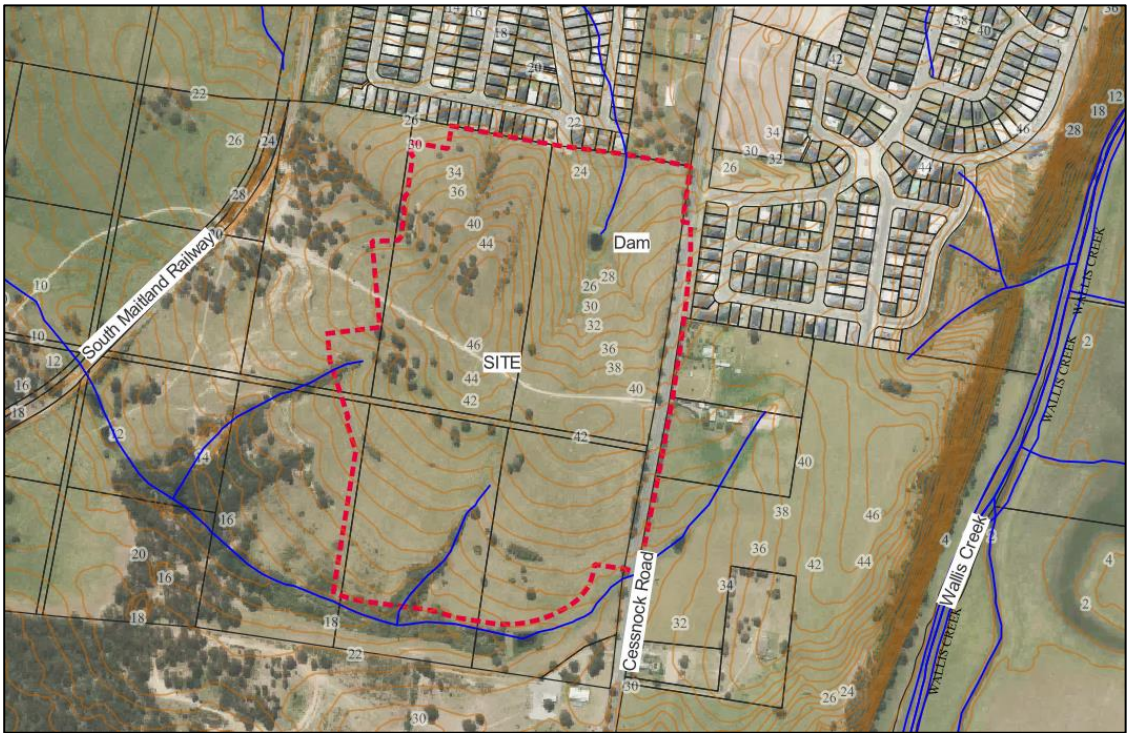


**Figure 2: Topographic and Aerial Image of the Proposed Site with Indicative drainage lines (Site extents in red outline)**

The following photos also show areas of the site at the time of the field work.

**Figure 3: North-east part of the site looking south-west towards the dam and gully line**

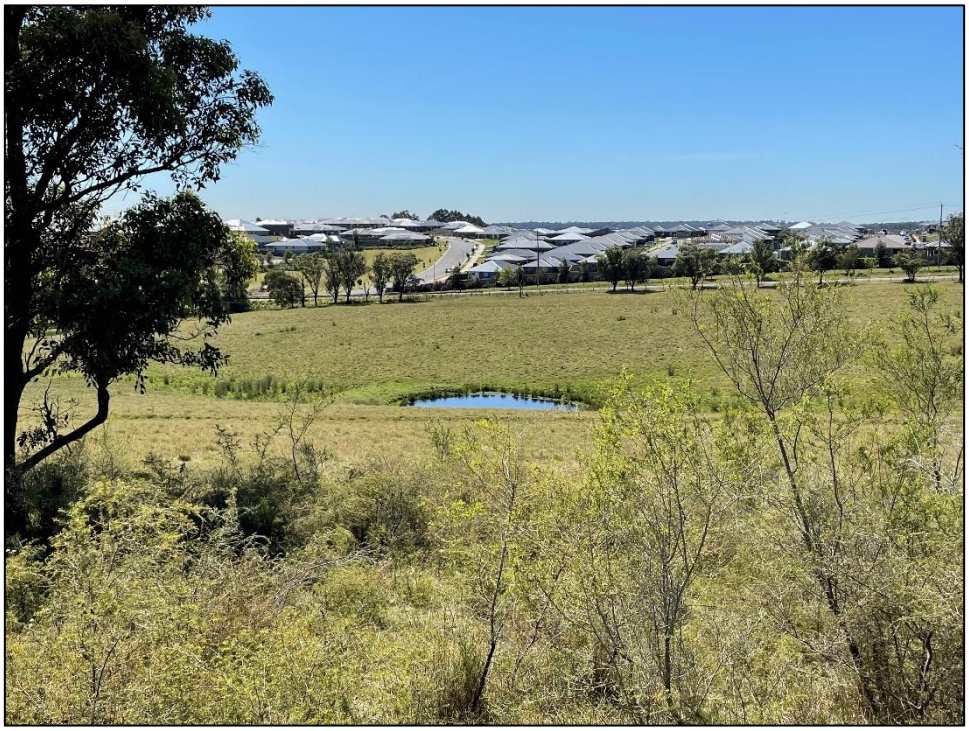

**Figure 4: Looking north-east from high point of site, across dam and towards existing residential development beyond**

**Figure 5: Looking north-west / north from north-west part of site (high point)**

**Figure 6: Looking north-east down slope from high point in north-west part of site, towards neighbouring residential development (note exposed rock)**

**Figure 7: Looking east/south-east from northern part of site**

**Figure 8: Looking south from northern part of site, along slope down from site high point (note exposed rock)**

**Figure 9: Looking north-west from the south-east part of the site (note outcropping rock)**

**Figure 10: Looking south / south-east from central part of site (note outcropping rock)**

**Figure 11: Looking south-west from the south-west part of site (towards creek line)**

## 3.2 Regional Geology

Reference to the NSW Seamless Geology map indicates that the majority of the site is underlain by the Branxton Formation of the Maitland Group of rocks. The Branxton formation typically includes conglomerate, sandstone and siltstone, with conglomerate noted as the dominant lithology within the formation.

The northern half of the western site boundary passes close to, and locally extends into, an area mapped as being underlain by the Greta Coal Measures. The Greta Coal measures are characterised by sandstone, siltstone, claystone, coal, chert and conglomerate, with sandstone noted as the dominant lithology.

Stratigraphically, the Maitland Group overlies the Greta Coal Measures. The Greta Coal Measures can be associated with shallow workings / mining locally, and it is understood that there is evidence of pothole subsidence in general proximity to the western site boundary. The Greta Coal Measures are understood to steeply dip down to the east.

Figure 12, below, shows the indicative outline of the site (red outline) over the geological mapping.

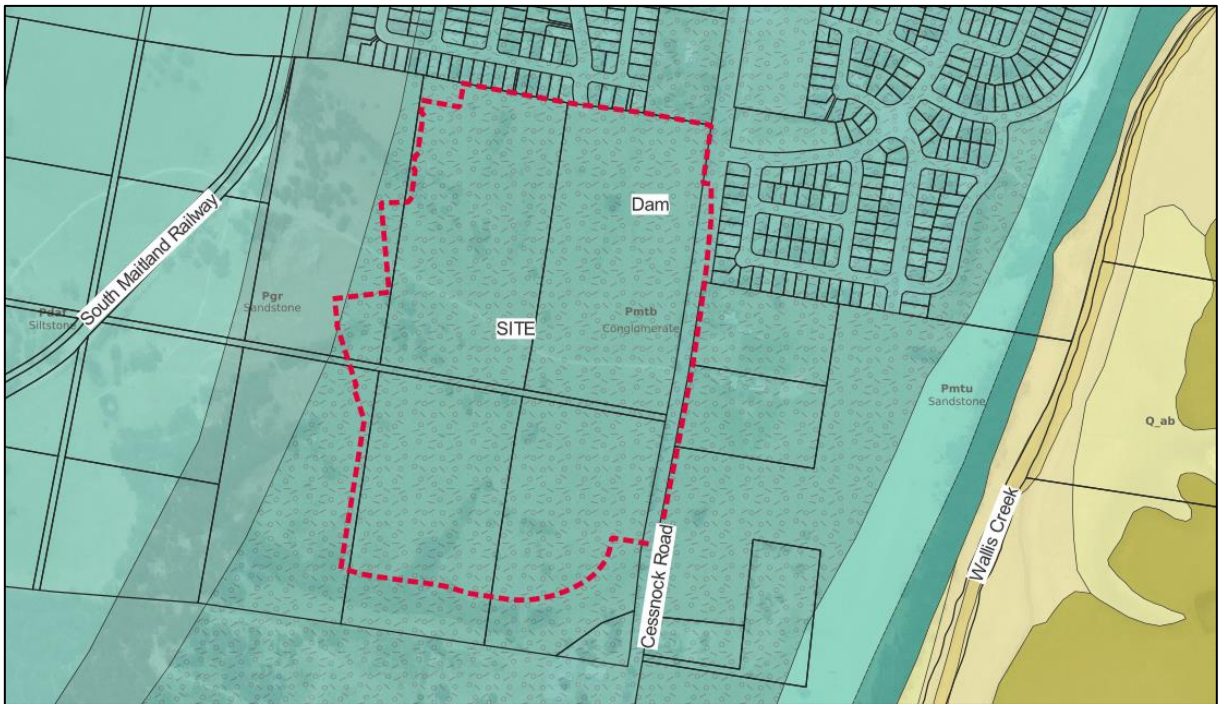


**Figure 12: Indicative site geology (source: NSW Seamless Geology Mapping)**

## 3.3 Salinity Mapping

Reference to the Australian Dryland Salinity mapping indicates that the site is located in an area mapped as having a high hazard or risk of salinity.

Reference to the IGW Water Table Salinity Mapping suggests that the site is located in an area mapped as having relatively saline groundwater.

The NSW Central Resource for Sharing and Enabling Environmental Data (SEED) information system eSPADE shows the results of soils tested at discrete locations in the local area. Figure 13, below, shows an extract from the eSPADE mapping. The green dots are indicative of locations where no salting was evident, whereas the yellow dots are indicative of salting being evident.

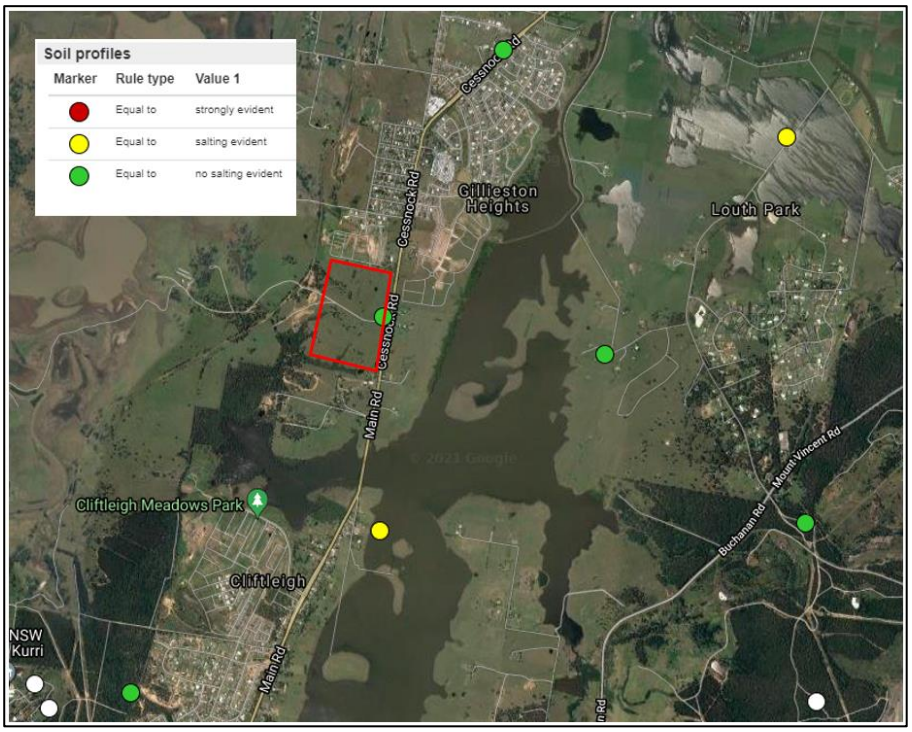


**Figure 13: Extract from eSPADE mapping of salinity potential with approximate site location shown in red outline**

## 3.4 Acid Sulfate Soil

Reference to the NSW acid sulphate soils risk maps indicates that the site is located in an area with no known occurrence of acid sulfate soils.

Acid sulfate soils occur in low lying coastal areas below RL 10 (AHD), but more generally below RL 5. Elevations at this site generally range from about RL18 (northern and southern site limits) to RL 47 (north-western quadrant). Acid sulfate soils do not occur at these elevations.

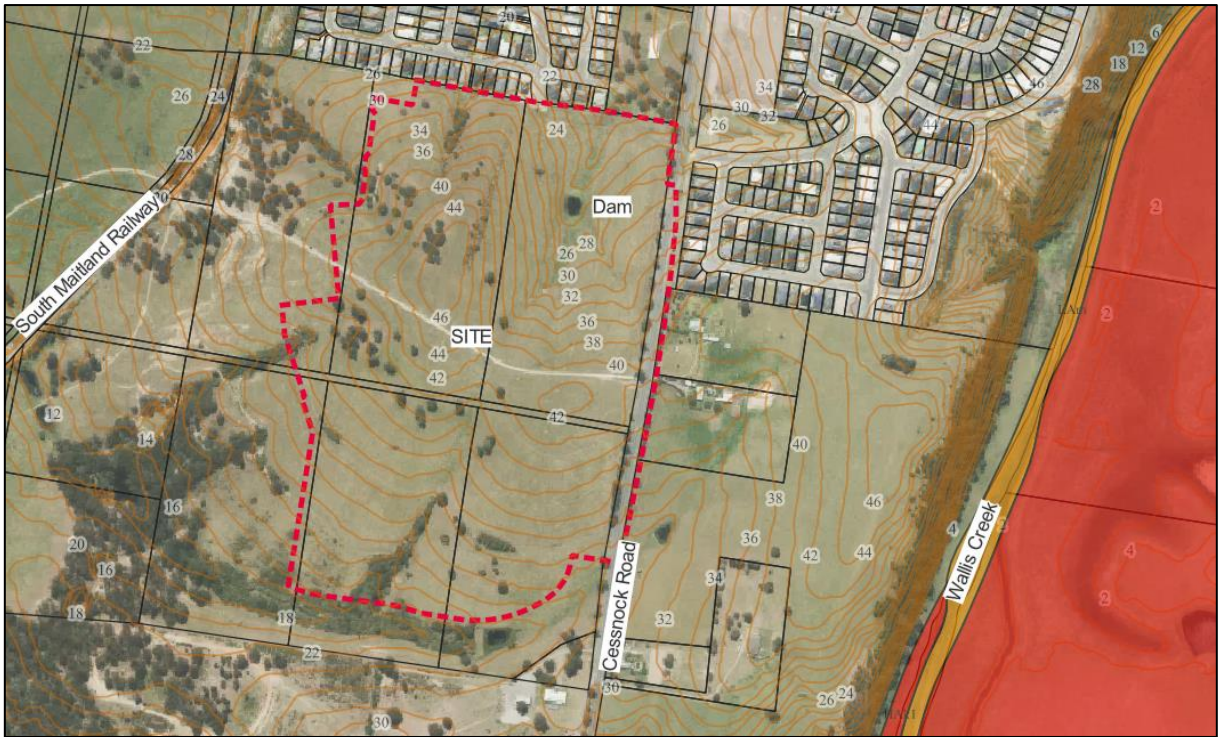


**Figure 14: NSW Acid Sulfate Risk Map with the Site Extents (Red Outline)**

# 4. Field Work

## 4.1 Methods

The field work was undertaken on 19 October 2021 and comprised the excavation of six test pits using a 5 tonne excavator to depths between 0.75 m to 3.0 m (Pits 101 to 106).

The test pits were set out by a geotechnical engineer, generally at locations indicated by the client, but with reference to site access and the location of underground services on site. DP's engineer also logged the subsurface profile in each test pit and took regular samples for laboratory testing and identification purposes. Pocket penetrometer and dynamic penetrometer tests (DPT) were performed at selected depths and locations.

The location and elevation of the test pits were recorded using a differential GPS, which is typically accurate to ±0.1 m, depending on satellite coverage and site condition. The coordinates (MGA/94) and elevations (AHD) of the test locations are shown on the attached test pit logs. It is important to note that DP is not a registered surveyor, hence the coordinates and elevations should be considered approximate only.

The approximate locations of the pits are indicated on attached Drawing 1 in Appendix D.

## 4.2 Results

The subsurface conditions encountered are presented in detail in the test pit logs in Appendix A. These should be read in conjunction with the accompanying notes which explain the descriptive terms and classification methods used in the reports.

In summary, the test pits from the current investigation generally encountered near-surface topsoil and silty sand, over residual silty and sandy clay. Rock, or extremely weathered material, was encountered in each of the test pits, resulting in test pit refusal in four of the six pits. Minor near-surface fill was encountered in Pit 103, which was excavated adjacent to an existing unsealed access road. The conditions in the current test pits were generally consistent with the conditions encountered during the previous investigation at the site (DP, 2015).

The following is a summary of the depth to rock / extremely weathered material in each of the test pits from both the current investigation (Pits 101 to 106), and the previous investigation at the site.

**Table 1: Summary of Field Investigations**

| Location(1) | Surface Level (AHD) | Depth to Top of Extremely Weathered Material(2) (m) | Depth to Top of Rock (m) | Test Pit Refusal Depth (m) |
|---|---|---|---|---|
| 101 | 19.8 | 1.4 | NE to 3.0 | NE to 3.0 |
| 102 | 44.6 | 0.7 | 0.9 | 1.1 |
| 103 | 43.2 | 0.8 | 1.0 | 1.0 |
| 104 | 28.0 | 0.6 | 0.7 | 0.75 |
| 105 | 16.8 | 2.8 | NE to 2.9 | NE to 2.9 |
| 106 | 39.0 | - | 0.6 | 0.8 |
| 1 | 32.0* | - | 0.1 | 1.1 |
| 2 | 38.5* | - | 0.9 | 1.2 |
| 3 | 21.5* | - | 1.2 | 1.55 |
| 4 | 35.5* | - | 0.7 | 1.9 |
| 5 | 31.0* | - | 0.42 | 0.55 |
| 6 | 19.0* | - | 1.0 | NE to 1.9 |
| 7 | 24.0* | - | 0.9 | 1.8 |
| 8 | 26.0* | - | NE to 2.0 | NE to 2.0 |

Notes to Table 1:

Shaded values are from current investigation

* surface level interpolated from contour plan so is approximate

NE – Not Encountered

(1) Pits 1 to 8 excavated using 10 t excavator; Pits 101 to 106 excavated using 5 t excavator

(2) – Changes to the Australian Standard (AS 1726, 2017) since the previous report are such that material previously logged as rock may in some circumstance now be logged as 'extremely weathered material'

Groundwater was not observed in the test pits from either the current or previous investigations during the time they remained open. It should be noted that groundwater levels are affected by factors such as climatic conditions and soil permeability and will therefore vary with time.

## 5. Laboratory Testing

Laboratory testing for the current investigation included the following:

- Three shrink-swell tests on undisturbed samples of clayey soils;
- Four shrink-swell tests on bulk samples compacted and remoulded to replicate earthworks;
- Six standard compaction / California bearing ratio (CBR) tests
- Two linear shrinkage tests;
- Four particle size distribution (PSD) tests / gradings;
- Six Atterberg Limit tests;
- Four Emerson crumb tests for soil dispersion;
- Four soil aggressiveness tests (pH, EC, chlorides and sulfates); and
- Four samples for cation exchange capacity (CEC) and exchangeable sodium percentage (ESP) for indications of soil salinity.

The detailed laboratory test results from the current investigation (Pits 101 to 106) are attached in Appendix B, and are summarised in the following tables. Copies of relevant laboratory test results from the previous investigation (DP, 2015) are attached in Appendix C, and are also summarised in the following tables

**Table 2: Results of CBR and Standard Compaction Testing**

| Test Pit | Depth (m) | Description | FMC (%) | OMC (%) | SMDD (t/m3) | CBR (%) | Swell During Soaking Phase (%) |
|---|---|---|---|---|---|---|---|
| 101 | 0.6 - 0.8 | Silty Clay | 20.4 | 18.0 | 1.73 | 3.0 | 3.0 |
| 102 | 0.3 - 0.5 | Silty Clay | 13.4 | 16.5 | 1.76 | 11 | 1.5 |
| 103 | 0.8 - 1.0 | Sandstone | 8.8 | 12.0 | 1.89 | 35 | -0.5 |
| 104 | 0.2 - 0.4 | Sandy Clay | 24.7 | 23.0 | 1.60 | 3.0 | 3.0 |
| 105 | 0.4 - 0.7 | Silty Sand | 16.3 | 14.0 | 1.74 | 20 | 0.0 |
| 106 | 0.6 - 0.8 | Sandstone | 15.4 | 17.0 | 1.77 | 10 | 0.0 |
| 2 | 0.9 - 1.1 | Siltstone | 8.4 | 11.5 | 1.97 | 25 | 0.1 |
| 5 | 0.2 - 0.42 | Silty clay | 19.0 | 17.0 | 1.77 | 7 | 1.1 |

Notes to table:

FMC - Field Moisture Content

OMC - Optimum Moisture Content (Standard)

SMDD - Maximum Dry Density (Standard)

CBR - Californian Bearing Ratio

**Table 3: Results of Grading Results and Emerson Class No**

| Test Pit | Depth (m) | Description | Percent Fines (%)* | Emerson Class No |
|---|---|---|---|---|
| 101 | 0.6 - 0.8 | Silty Clay | 62 | 3 |
| 102 | 0.3 - 0.5 | Silty Clay | 61 | 5 |
| 104 | 0.2 - 0.4 | Sandy Clay | 68 | 6 |
| 105 | 0.4 - 0.7 | Silty Sand | 28 | 3 |

Notes to table:

* percent fines – percentage of sample finer than 75 μm sieve (ie proportion silt & clay)

**Table 4: Summary of Shrink-swell and Linear Shrinkage Test Results**

| Test Pit | Depth (m) | Description | FMC (%) | LL (%) | PL (%) | PI (%) | LS (%) | Iss (% per ΔpF) - Remoulded | Iss (% per ΔpF) - Undisturbed |
|---|---|---|---|---|---|---|---|---|---|
| 101 | 0.6 – 0.8 | Silty Clay | 22.3 | 46 | 26 | 20 | - | 7.0 | - |
| 101 | 0.6 – 0.8 | Silty Clay | 22.4 | - | - | - | - | - | 3.5 |
| 102 | 0.3 – 0.5 | Silty Clay | 19.5 | 47 | 18 | 29 | - | 3.9 | - |
| 103 | 0.5 – 0.7 | Sandy Clay | 19.9 | - | - | - | - | - | 3.3 |
| 104 | 0.2 – 0.4 | Sandy Clay | 26.7 | 64 | 20 | 44 | - | 5.3 | - |
| 104 | 0.3 – 0.5 | Sandy Clay | 23.6 | - | - | - | - | - | 4.7 |
| 105 | 0.4 – 0.7 | Silty Sand | 16.3 | Not Obtainable | Not Obtainable | Not Obtainable | - | 2.3* | - |
| 105 | 0.7 – 1.0 | Sandy Clay | 15.9 | 33 | 17 | 16 | 7.0 | - | - |
| 106 | 0.4 – 0.6 | Silty Clay | 14.7 | 37 | 19 | 18 | 10.5 | - | - |
| 5 | 0.2 – 0.42 | Silty Clay | 19.0 | 50 | 19 | 31 | - | - | - |
| 5 | 0.3 – 0.42 | Silty Clay | 20.0 | - | - | - | - | - | 3.0 |
| 6A | 0.45 - 0.85 | Silty Clay | 19.8 | 67 | 18 | 49 | - | - | 2.4 |
| 8 | 0.6 – 1.0 | Silty Clay | 20.6 | 74 | 17 | 57 | - | - | 2.9 |

Notes to Table 4:

FMC = Field Moisture Content LL=Liquid Limit PL = Plastic Limit

PI = Plasticity Index LS = Linear Shrinkage from liquid limit condition (Mould length 250mm)

Iss - Shrink/Swell Index

* result is considered high for a silty sand, but may reflect variability within the tested layer / increased clay content

**Table 5: Summary of Soil Aggressiveness Test Results**

| Test Pit | Depth (m) | Description | pH | EC (µS/cm) | Chlorides (mg/kg) | Sulfates (mg/kg) |
|---|---|---|---|---|---|---|
| 102 | 1.0 | Sandstone | 5.4 | 22 | <10 | 20 |
| 103 | 0.9 | Sandy Clay | 5.1 | 48 | 20 | 36 |
| 104 | 0.65 | Sandy Clay | 5.7 | 37 | 23 | 25 |
| 105 | 0.4 | Silty Sand | 6.0 | 10 | <10 | <10 |
| 106 | 0.4 | Silty Clay | 5.5 | 37 | 10 | 21 |

Notes to Table 5:
EC – Electrical Conductivity

**Table 6: Results of CEC and ESP laboratory testing**

| Test Pit | Depth (m) | Description | CEC (meq/100g) | ESP (%) |
|---|---|---|---|---|
| 102 | 1.0 | Sandstone | 1.7 | 8 |
| 103 | 0.9 | Sandy Clay (extremely weathered sandstone) | 3.3 | 7 |
| 104 | 0.65 | Silty Clay (extremely weathered sandstone) | 2.5 | 23 |
| 105 | 0.4 | Silty Sand | <1 | - |
| 106 | 0.4 | Silty Clay | 7.0 | 10 |

# 6. Comments

## 6.1 General

The results of field investigation indicate that the subsurface conditions generally comprise residual silty / sandy clay profile overlying rock at variable depth. Near-surface topsoil and silty sand was encountered at some locations.

Earthworks will include excavations of up to about 4.5 m, and fill of up to about 4 m. Test pit refusal was encountered in a number of the test pits, hence earthworks will need to consider excavation through rock, and appropriate methods to break down excavated particles to render them suitable for use in engineered fill.

High plasticity / reactive clays were encountered in some areas. The process of cutting and filling will affect site classification, hence careful planning of earthworks methods may need to be considered in order to reduce the risk of creating Class E lots (AS 2870, 2011).

Road subgrade conditions are expected to generally range from the natural silty and sandy clay, to rock, to engineered fill. The local clay can at times provide poor subgrade support that can require the inclusion of a select subgrade layer, depending on the material's propensity to swell (with increased moisture), and / or soften if it becomes wet.

Additional comments are presented in the following sections of this report.

## 6.2 Excavatability

It is understood that bulk earthworks will include excavations in a number of areas of the site, with excavations of up to about 5 m depth proposed in northern parts of the site, with the deepest excavations along and to the north of proposed Road MC5, between Auburn Street and Road MC11. Pit 102 was excavated in this vicinity at the client's request. Similarly deep excavations may also be required to the north of Road MC10 as part of detention basin construction.

An additional area of deeper excavation, in the order of about 2 m depth, is proposed in the vicinity of Road MC01, between Auburn Street and Road MC03, just west of Pit 103.
Figure 15, below, shows an extract of the preliminary earthworks plan provided to DP for this project, with areas of excavation shown in red, and areas of fill shown in green.


**Figure 15: Indicative Earthworks plan, with cut shown in red and fill shown in green (Site extents in red outline)**

The results of Pit 102 indicate that appreciable excavation through rock should be expected in this vicinity. Conditions at Pit 102 included very stiff to hard silty clay to 0.7 m, over extremely weathered sandstone (silty clay) to 0.9 m. Sandstone that was estimated to be initially very low to low strength was encountered at 0.9 m, with excavator refusal on probable medium strength sandstone at 1.1 m depth.

The results of Pit 103 indicate that excavation through rock should also be expected in this vicinity. Conditions at Pit 103, which is located to the east of the deeper part of the nearby proposed excavation, included near-surface fill and topsoil over very stiff sandy clay to 0.8 m, over extremely weathered sandstone (sandy clay) to 1.0. Excavator refusal was encountered on rock at 1.0 m depth. In addition to the above observations, rock was observed outcropping at a number of locations throughout the site, further confirming that excavation through bedrock should be expected.

The excavatability of rock is dependent not only on rock strength, but also on the presence, orientation and extent of discontinuities such as jointing and fracturing and other factors. For example, low strength rock with few discontinuities can be more difficult to excavate than highly fractured high strength rock. To better understand excavatability at this site, cored bores will be required to assess rock strength and jointing / fracturing.

Based on local experience, it is anticipated that bulk excavation will involve heavy ripping with large bulldozers, together with hydraulic or pneumatic rock hammers. Rock hammers and/or rock saws could be required for detailed excavation and trimming of batters and footings. This however does not take into consideration productivity rates, and the potential presence of areas of higher strength rock, which could be difficult to excavate using traditional methods, can not be excluded.

Selection of excavation methods and equipment would also need to take into account the particle size distribution of excavated material which is intended for re-use as engineered fill.

To further consider the excavatability of rock, targeted investigation with a drill rig (cored bores) would be required.

## 6.3 Preliminary Site Classification

Site classification of foundation soil reactivity provides an indication of the propensity of the ground surface to move with seasonal variation in moisture. The site classification is based on procedures presented in AS 2870:2011, the typical soil profiles revealed in the test pits, and the results of laboratory testing.

The process of cutting and filling affects the site classification and the estimated characteristic free surface movement ($y_s$) values, and sites which are subject to filling are classified as Class P. However, AS 2870:2011 makes provision for re-classification at the completion of earthworks, provided that the fill is placed and compacted under Level 1 testing and supervision (AS 3798, 2007) to the requirements of engineered / structural fill.

The proposed development of the site will include substantial earthworks, with excavations in the order of up to 4.5 m, and fill of up to about 4 m. The classification of the site in its current condition will be redundant once earthworks is undertaken. Therefore, preliminary site classification to AS2870 will need to consider the proposed earthworks.
With reference to the limited laboratory testing undertaken during the current and previous geotechnical investigations at the site, the following comments are made:

- Shrink-swell tests on remoulded samples for the current scope of work ranged from 2.3% (Pit 105) to 7.0% (Pit 101). The purpose of testing remoulded samples was to replicate earthworks. These results indicate soils that are highly to extremely reactive;
- Shrink-swell tests on undisturbed samples for the current scope of work ranged from 3.3% to 4.7%. These tests on undisturbed samples are indicative of the behaviour of the on-site clayey soils in their natural condition, and also indicate soils that are highly to extremely reactive;
- Shrink-swell tests on undisturbed samples from the previous report (DP, 2015) ranged from 2.4% to 3.0%;
- Two of the six current CBR tests returned swell values of 3%, under a 4.5 kg surcharge. The four other tests had a swell of 1.5% or less. These swell values confirm that there are highly to extremely reactive clays are present in parts of the site.

It is expected that filling of the site will be undertaken using material won from site excavations. It is possible that rock could be exposed in areas where excavations are undertaken.

Therefore, based on the conditions encountered at the site, and the proposed earthworks, site classifications could preliminarily range from Class A (rock sites) up to Class E (extremely reactive sites). Typically, Class A, S, M, H1 and H2 sites enable the use of standard footings from AS2870 in construction. Class E (and Class P) sites require footing design by engineering principles. The risk of post-earthworks classifications of Class E increases when the higher plasticity clay is used as engineered fill in lot areas.

That said, it is possible to reduce the risk of creating Class E site classifications on filled lots, through the implementation of construction controls. This can include:

- Placing high plasticity clays at lower elevations of engineered fill (in areas where deeper fill is proposed);
- Blending high plasticity clays with low reactive materials (eg weathered rock), subject to the ability to adequately blend materials and confirmation testing;
- Using a low reactive material (such as ripped rock which could be sourced from areas of excavation and subject to appropriate mechanical breakdown), in the upper portions of engineered fill in lot areas as a ‘capping layer’.

Additional testing should be considered if a more detailed earthworks strategy is to be adopted to reduce the risk of creating Class E lots.

Classification of residential lots to AS 2870:2011 should be undertaken at the completion of earthworks.

## 6.4 Re-use of Excavated Material

It is expected that the material won during the bulk excavations will be re-used as fill where required on the site. The bulk of the material is anticipated to comprise either silty clay, sandy clay or a range of bedrock materials, but may also include areas of silty and sandy soils. Although not encountered during the current investigation, the proximity of the site to a subcrop of the Greta Coal Measures indicates that there is some (albeit low) potential of encountering weathered coal / carbonaceous soils.

The suitability of the excavated material for re-use as bulk fill is dependent on the particle size achieved during excavation, which is a function of fracture spacing, rock strength and excavation methods.

Provided that a maximum particle size of approximately 150 mm can be achieved by appropriate excavation methods and by mechanical breakdown of rock particles, and the resulting material is well-graded, the majority of the material that is expected to be excavated is considered suitable for use as bulk earthworks fill. Some materials may require blending depending on where they are to be used (eg high plasticity clays). Organic-rich topsoil layers should not be re-used in engineered fill.

As mentioned above, consideration should be given to placing high plasticity / reactive clays towards the base of deeper bulk fill areas. Alternatively, highly reactive clay soils could potentially be blended with less reactive material (eg ripped / processed excavated rock) prior to use in engineered fill. Once details of the proposed earthworks are known, additional targeted investigation may assist in identifying areas where highly reactive clay soils are to be excavated, so that they can be strategically incorporated into areas of bulk fill so as not to adversely affect the resulting site classification (AS 2870:2011) on residential lots.

Excavated materials will need to be moisture conditioned and compacted where they will be placed in engineered fill; refer to Section 6.5 for recommendations for placement and compaction of engineered fill.

Silty soils were encountered in some areas. Silty soils can be difficult to work, particularly when wet. Completely weathered siltstone bedrock can also behave like a silty soil when excavated and worked. If encountered during construction, consideration could be given to blending silty soils that are free of organics with clayey soils or crushed rock prior to using as engineered fill. Where used, silty soils will require tight control of moisture during compaction.

## 6.5 Engineered Fill

The following general procedure is recommended for placement of engineered fill in lot areas and areas of general fill. Recommendations for subgrade are presented in Section 6.9.6:

- Remove topsoil, uncontrolled fill and deleterious materials;
- Test roll the surface in order to determine any soft zones and assess moisture condition. Moisture contents should be in the range OMC -3% (dry) to OMC +1% (wet) where OMC is the optimum content at standard compaction;
- The exposed soils should be left exposed for a minimum of time prior to placement of additional fill to minimise the risk of desiccation cracking (eg clays) or softening from weather exposure;
- Suitable fill should be placed in horizontal layers not exceeding 300 mm loose thickness and compacted to a dry density ratio of at least 98% Standard in lot areas and areas of general fill. An upper compaction limit of 102% Standard should be observed if high plasticity clays are used in engineered fill. Moisture content should be in the range as stated above.

It is noted that the silty soils were encountered in a number of areas across the site. Silty soils can be difficult to work, particularly when wet. If the soils become wet, they should be tyned and allowed to dry. Tight control of moisture will be required during compaction of these soils.

Geotechnical inspections and testing should be performed during construction in accordance with the earthworks standard (AS 3798, 2007).

If any existing on-site dams are to be decommissioned as part of development, significantly wet of optimum soils should be expected. Additional advice should be obtained from this office if in-filled dams will be located in areas where structures and / or roads are to be constructed.

Similarly, existing drainage gullies can be areas where there is a higher risk of wet of optimum soils, and/or deeper organic / silty soil profiles. Depending on conditions at the time of construction, drainage gullies can require additional site preparation such as bridging layers and/or additional subsoil drainage, if they are present in areas of bulk earthworks.

## 6.6 Detention Basins

Detention basins will be constructed as part of the proposed development, however details regarding their configurations were not known at the time of this report. It is assumed that detention basins will generally be constructed through a combination of excavation of the basin area and fill for embankment construction. The current investigation has included only general consideration of the properties of the on-site soils for potential use in detention basin construction. Additional targeted investigation should be undertaken once the location and configuration of detention basins are known.

There are several key geotechnical considerations for typical earth-dam construction such as detention basins that are typical for residential subdivision construction, including those proposed for this site, as follows:

- The propensity of the soils to disperse when in contact with fluid intended to be retained;
- The need for a zoned embankment. A zoned embankment includes several different material zones, each with different functions. A homogeneous embankment comprises a single material type for the whole embankment;

- A zoned earthfill detention basin embankment would typically include a zone of low permeability material, either on the upstream face or as a central core, with the other embankment material often able to comprise a range of earthfill materials from a local borrow area. Zoned embankments generally provide an improved degree of control of internal erosion and piping, and improved control of pore pressure for stability, compared to a homogeneous embankment. A zoned embankment requires a high degree of control over the material quality being used in different areas of the embankment. A zoned embankment is also adopted when there is a limited amount of a particular material type such as the material for the clay core;
- A homogeneous embankment, however, provides no filter control, and seepage at the downstream face / toe is a risk. There is also a poor degree of control of pore pressures for embankment stability. If the consequence of detention basin embankment failure is low, a homogeneous embankment could be considered;
- Inclusion of a keyway beneath the detention basin embankment. This is generally considered an important component of most earthfill water retention structures, with the purpose of the keyway being to create a controlled foundation which interrupts potential seepage paths, and "keys" the embankment into the natural site soils or rock. The keyway should be constructed using a low permeability, non-dispersive soil, similar to that which would be used for clay core / clay liner, and should be included irrespective of whether the embankment is constructed as a zoned or homogeneous embankment;
- The construction of pipes through detention basin embankments. These are areas that provide increased risk of piping and detention basin embankment failure if not properly constructed. This can, at times, include a requirement to concrete-encase pipes through the embankment in combination with a specifically designed filter medium around the pipe backfill zone. The specifications for a filter medium are a function of the characteristics of the 'parent material' from which the embankment has been constructed, and requires targeted geotechnical testing, analysis and design.

If the consequences of detention basin failure could include loss of life and/or damage to property downstream, then the detention basin should be constructed as a zoned embankment, with a clay core and keyway. If the consequences of detention basin failure are insignificant, then a homogeneous embankment could be considered.

It is assumed that the detention basin embankment fill material will be won from on-site excavations. Based on the results of the test pits, the natural site material is anticipated to include high plasticity clay and ripped rock.

The following tables summarise the recommended material property guidelines for a clay core (zoned embankment), keyway and/or homogeneous detention basin embankment.

**Table 7: Recommended Material Properties - Clay Core / Keyway / Homogeneous Embankment**

| Material Property | | Specification |
|---|---|---|
| **Grading** | **Maximum Particle Size** | 50 mm |
| | **% Passing 2.36 mm sieve** | 60% to 100% |
| | **% Passing 75 μm sieve** | >30% |
| **Plasticity** | **Plasticity Index (PI)** | CH-CI-CL clay fines (ie above the 'A-line') |
| **Dispersion** | **Emerson Class** | > 4 |

The following tables summarise the recommended material property guidelines for general shoulder embankment fill if a zoned embankment is constructed.

**Table 8: Recommended Material Properties – General Embankment Shoulder Fill (Zoned Embankment)**

| Material Property | | Specification |
|---|---|---|
| **Grading** | **Maximum Particle Size** | 100 mm |
| | **% Passing 75 μm sieve** | >15% |
| **Plasticity** | **Plasticity Index (PI)** | CH-CI-CL clay fines (ie above the 'A-line') |
| **Dispersion** | **Emerson Class** | > 4 |

It is noted that soils with Emerson Class 1 to 4 need to be treated with extra caution if they are to be used in detention basin embankment construction (Fell, et al., 2005). Dispersive soils are a major contributor to piping failure within embankments when used in embankments which retain water.

Of the materials tested as part of the current assessment:

- Three out of four samples tested for particle size distribution contained more than 30% fines (ie <75 μm), so satisfy the grading requirements for clay core / keyway / homogeneous embankment;
- One sample (Pit 105) did not satisfy the grading requirement for use in clay core / keyway / homogenous embankment, but did satisfy the requirement for consideration in general shoulder fill areas of a zoned embankment;
- Seven out of eight samples tested during the current and previous investigations had an Atterberg limit that placed the result above the 'A-line' for CH-CI-CL fines. One sample however did not, and tested as a silty material (Pit 105);
- The results of the four Emerson class number tests indicated variable dispersion characteristics of the samples tested. Two samples satisfied the dispersion risk criteria, however two samples (Pit 101 and 105) returned results that indicated potential dispersion risk; The risks associated with dispersive soils can be reduced through the addition gypsum. Dispersive soil risks can also, in part, be managed through construction controls such as tight control of compaction and moisture, as well as the provision of appropriate erosion controls, and consideration of where the material is to be used in the embankment.

Therefore, it is considered that the on-site clayey soils are likely to be considered suitable for use in detention basin embankment construction, subject to addressing the issue of soil dispersion. Additional targeted testing will be required to confirm the need or otherwise for treatment of the soils for dispersion.

Topsoil and organic-rich soils are not suitable for use in the embankment. Weathered rock excavated from the site, that has been subjected to mechanical breakdown to satisfy the maximum particle size requirements, is expected to be suitable for use in shoulder zone embankment fill if a zoned embankment is constructed.

Once the proposed detention basin configurations are known, geotechnical comments regarding proposed batter slopes should be reviewed.

It is recommended that exposed batter slopes be protected against erosion by topsoiling and grassing.

In areas where high water velocities are expected (ie around filling points) erosion resistance measures other than grassing may be required, eg rip rap material, grasses grown with a stabilised mesh or reinforcing blanket.

Detention basin fill embankment heights are not known but are assumed to be less than 3 m vertical height. It is also assumed that excavations will be in the order of 2 m depth or less. If the proposed geometry exceeds either of these values, the recommendations below should be reviewed and revised if necessary.

The following general procedure should be considered detention basin construction:

- Preparation for the basin should include removal of the surface vegetation, uncontrolled fill and topsoil from the area of the proposed basin;
- Excavate to design depth. The embankment foundation should be excavated an additional 0.5 m depth (subject to geotechnical inspection, ie below any shrinkage cracks) along the embankment alignment to provide a key and help restrict seepage. The keyway excavation should be battered no steeper than 45° (1H:1V);
- Exposed clay should be tyned to at least 200 mm depth and re-compacted to at least 95% dry density ratio standard at a moisture content within the range OMC to OMC +3% (wet). Where bedrock is encountered at the base and on the batters of the basin, the rock should be tyned and re-compacted for at least 200 mm depth;
- Clay should not be allowed to dry and crack before placement of fill. If desiccation cracking occurs, the clay should be tyned, moisture conditioned and re-compacted;
- The foundation key material should be placed in 250 mm loose thickness horizontal layers to the same density and moisture content as described above;
- The embankment crest and batters should be protected against erosion by grass cover or other suitable methods;

- If the basin will include an emergency spillway or similar, it is recommended that adequate measures be designed and constructed to minimise erosion and scour of the embankment. The integrity of the embankment should be maintained in the event that the spillway is overtopped;
- If rock is exposed in the base of the basin, a clay layer of approximately 300 mm thickness may need to be placed and compacted;
- Detention basin batters should generally be no steeper than about 3H:1V without additional geotechnical assessment.

Care will be required when constructing the embankments to ensure adequate compaction is achieved and good bonding between fill layers, and also between embankment fill and natural ground. Where fill is to be placed on natural slopes, benching into the existing slope will be required to allow horizontal layers to be placed and compacted. It is also recommended that the embankment fill be placed and compacted beyond the final slope line, and then trimmed back to the design slope line. Poor compaction of fill to the full extent of the embankment presents an increased risk of slope instability, particularly if the slope becomes wet.

It is important that the embankment key and foundation are constructed in 'dry' conditions. Temporary cut-off drains or similar may need to be installed ahead of construction of the embankment to divert any surface water run on away from the embankment foundation prior to construction. If the embankment foundation is saturated, it will not be possible to achieve compaction of the embankment foundation.

Detention basin embankments should be constructed under Level 1 earthworks supervision (AS 3798, 2007).

## 6.7 Batter Slopes

While the proposed bulk earthworks will include excavations of up to 4.5 m depth, and fill of up to 4.0 m depth, the height of permanent batter slopes is not known at this time. It is assumed that permanent batters are unlikely to exceed 3 m vertical height. Additional / targeted geotechnical investigation may be required for taller batters. The following permanent batters are recommended:

**Table 9: Recommended Permanent Batter Slopes**

| Strata | Maximum Slope (H:V) |
|---|---|
| Engineered fill | 2:1[1] |
| Very stiff to hard clay [2] and extremely low to very low strength rock | 2:1[1] |
| Low strength rock | 1:1[3] |
| Medium to high strength rock | 0.25:1[3] |

Notes to Table 9:

[1] But flatter if vegetation or maintenance required – 3:1

[2] Very stiff to hard clays are often fissured. Flatter slopes may be necessary in such clays and measures such as topsoiling and vegetation may be necessary to resist erosion

[3] Subject to geotechnical inspection during construction; dependent on jointing

Locally steeper temporary batters may be appropriate during construction, in areas that are remote from services, site boundaries etc. If steeper batters are required for consideration during construction, please contact this office for additional advice with respect to the proposed batter configuration.

Slopes should not exceed 3 m in vertical height without incorporating intermediate benches. Benches should be a suitable width to allow access for equipment for future maintenance.

Rock cuttings should be inspected by a suitably qualified engineering geologist / geotechnical engineer, during excavation / trimming, to confirm the above batter slopes and identify the need or otherwise for bolting or other support measures.

All batter slopes should be protected from erosion. Surface water should be diverted away from slopes by installation of a dish drain at the crest of slopes.

## 6.8 Slope Stability

The majority of the project area is typically characterised by gently undulating topography with some localised steeper slopes along gully lines.

With reference to the available information, and the site walkover, there were no signs of deep-seated slope instability within the observed portions of the site at the time of the assessment. Based on the site observations and topographical / geological information for the project area, the majority of the site is considered to have a low risk of slope instability.

That said, it is understood that the steeper areas of the site will be modified during bulk earthworks through cut and fill operations.

Provided that the above recommendations regarding permanent batter slopes are followed, and the recommendations for the placement and compaction of engineered fill, along with good construction practice are followed, it is anticipated that the completed development will also have a relatively low risk of slope instability.

In areas where the permanent batter slopes cannot be accommodated, retaining walls may need to be considered. Geotechnical parameters for retaining wall design can be provided at the detailed design stage of the project. Retaining walls that exceed 1 m vertical height, or which will support footings or other structural loads should be engineer-designed for appropriate earth pressures.

No assessment of the integrity of existing dam embankments has been undertaken.

Stormwater should be discharged to the street drainage system or to an on-site system designed to minimise erosion. The heavy clay soils of the project area are not suitable for on-site stormwater infiltration.

## 6.9 Pavements

### 6.9.1 Overview

Preliminary pavement thickness design for internal roads has been undertaken with reference to the results of the limited geotechnical testing, on the assumption that more detailed and targeted testing will be undertaken during the detailed design stage of the project.

It is anticipated that Transport for NSW (TfNSW) will likely be a consent authority for any pavement upgrade requirements to Cessnock Road, and/or the intersection with the subdivision entry, if it will be a signalised intersection. TfNSW pavement requirements can often include deep-lift asphalt and stabilised pavement layers, together with select material zones and drainage layers if rock is present at subgrade level.

A separate targeted geotechnical investigation would be required if pavement thickness design is to satisfy TfNSW requirements.

### 6.9.2 Subgrade

The results of the limited field investigation suggest that subgrade conditions are likely to comprise the on-site natural clay soils, engineered fill and/or rock.

The results of laboratory testing generally indicated CBR values in the range 3.0% to 11% for the on-site silty and sandy clay; and in the range 10% to 35% for samples of rock which were able to be tested. A sample of silty sand (weathered sandstone) returned a result of 20%.

Two samples of silty and sandy clay returned swell values of 3% during the soaking phase of the test. The Atterberg limits tests also suggest that some of the natural site clays are considered highly plastic. Based on classification methods presented in Austroads (Austroads, 2019), the results of laboratory testing, some of the on-site natural clay soils are considered to have a high to very high expansive nature with respect to potential subgrade performance.

Based on the results of laboratory testing, together with recent experience with Maitland City Council (MCC), there is a possibility that a select subgrade may be required in some areas, if high plasticity and high swelling natural site clays are present at subgrade level (eg samples collected from Pits 101 and 104). Additional testing during the detailed design stage of the work will assist in assessing the need or otherwise for a select subgrade to manage the risk of potentially expansive soils at subgrade level. For example, where rock / weathered rock is present at subgrade level, or where low to non-expansive soils (natural or engineered fill) are present at subgrade level, and for a sufficient depth below top of subgrade, a select subgrade is not expected to be required for management of expansive soils.

Where a select subgrade is required to provide capping over high to very high expansive soils, it should generally comprise a low-permeability material layer that is at least 200 mm thick. . If a select subgrade is required to bridge over wet of optimum / yielding subgrades soils, or if soils with a CBR of less than 3% are encountered, the select layer will need to be thicker (eg approximately 300 mm to 500 mm, depending on conditions at the time of construction).

For the purpose of this preliminary pavement thickness design, and based on previous experience and the provisions of Austroads (Austroads, 2019), the following subgrade CBR values have been considered:

- Clay / Engineered Fill – 3%
- Weathered Rock – 8%

### 6.9.3 Design Traffic Loading

Details regarding the proposed traffic loadings for each internal subdivision road are not known at this time, however a range of traffic loadings have been considered, based on the provisions of Maitland City Council's Manual of Engineering Standards (MCC, 2014), as follows.

**Table 10: Indicative Design Traffic Loadings from MOES (MCC, 2014)**

| Road Type (MCC, 2014) | Max No Lots | Design Traffic (ESA) |
|---|---|---|
| Local - Secondary | 50 | $2 \times 10^5$ |
| Local – Primary | 100 | $5 \times 10^5$ |
| Collector – Secondary | 200 | $1 \times 10^6$ |
| Collector – Primary | 300 | $1.5 \times 10^6$ |
| Distributor – Secondary | 400 | $2 \times 10^6$ |
| Distributor – Primary | 500 | $5 \times 10^6$ |
| School Bus / Public Route | - | $2 / 5 \times 10^6$ |

Additional traffic configurations could be considered, depending on how many lots will be serviced by each road. For the purpose of this preliminary report, traffic loadings for roads that service less than 50 lots or more than 500 lots have not been considered. Council will need to confirm appropriate design traffic loadings for bus routes or other significant thoroughfares. Alternatively, if a traffic study has been undertaken for any of the proposed roads, then a design traffic loading can be estimated if the traffic study has reported parameters such as the annual average daily traffic, percent heavy vehicles and growth rate.

If the development will include roads that will be designated 'sub-arterial' ($1 \times 10^7$ ESA), these roads will require specific considerations using mechanistic analysis methods and will likely need to consider use of a heavily bound rather than flexible pavement.

If roundabouts are proposed, design traffic loadings will need to be modified to account for the forces associated with the nature of turning vehicles. Roundabouts would also likely need to consider rigid / concrete pavement thickness.

It is important that the pavement areas are carefully considered and separated into those areas likely to see truck traffic and those that are unlikely to see truck traffic. If trucks are allowed to traffic pavement areas which have been designated for car traffic, there is a risk of reduced design life and pavement damage.

The above traffic loadings should be reviewed as more detailed information on traffic loading becomes available. In particular, the likely number and types of trucks should be confirmed to assess the suitability of the suggested pavement thickness.

### 6.9.4 Preliminary Pavement Thickness Design

Council's Manual of Engineering Standards (MCC, 2014) indicates that the following is required in regard to the design of flexible pavements:

**Table 11: MCC Flexible Pavement Requirements**

| Parameter / Material | MCC Requirement |
|---|---|
| Minimum Pavement Thickness | 300 mm |
| Minimum Basecourse Thickness | 100 mm |
| Minimum Subbase Thickness | 125 mm[1] |
| Wearing Course Thickness | 30 mm (asphalt) |

Notes to Table 11:

1 - A combined basecourse / subbase single layer can be considered if a geotechnical report nominates materials and compaction methods

Based on the procedures presented in Austroads (Austroads, 2019), the preliminary pavement thickness designs for the indicative traffic loadings above are as presented in Table 12 below.

**Table 12: Preliminary Pavement Thickness Designs**

| Subgrade CBR | Indicative Road Type | Design Traffic Loading (ESA) | Minimum Layer Thickness (mm) | | | Minimum Total Thickness[3] (mm) |
|---|---|---|---|---|---|---|
| | | | Wearing Course* | Basecourse | Subbase | |
| ≥ 3% | Local - Secondary | 2 x $10^5$ | 30[1] | 110 | 290 | 430 |
| | Local – Primary | 5 x $10^5$ | 40[2] | 130 | 310 | 480 |
| | Collector – Secondary | 1 x $10^6$ | 40[2] | 140 | 340 | 520 |
| | Collector – Primary | 1.5 x $10^6$ | 40[2] | 140 | 360 | 540 |
| | Distributor – Secondary[4] | 2 x $10^6$ | 40[2] | 150 | 370 | 560 |
| | Distributor – Primary[4] | 5 x $10^6$ | 50[2] | 160 | 400 | 610 |
| ≥ 8% | Local - Secondary | 2 x $10^5$ | 30[1] | 110 | 160[5] | 300 |
| | | | | 270 | - | |
| | Local – Primary | 5 x $10^5$ | 40[2] | 130 | 130[5] | 300 |
| | | | | 260 | - | |
| | Collector – Secondary | 1 x $10^6$ | 40[2] | 140 | 120[5] | 300 |
| | | | | 260 | - | |
| | Collector – Primary | 1.5 x $10^6$ | 40[2] | 140 | 130[5] | 310 |
| | | | | 270 | - | |
| | Distributor – Secondary[4] | 2 x $10^6$ | 40[2] | 150 | 130[5] | 320 |
| | | | | 280 | - | |
| | Distributor – Primary[4] | 5 x $10^6$ | 50[2] | 160 | 140[5] | 350 |

Notes to Table 12:

* a 7 mm to 10 mm prime seal should be placed over the basecourse prior to asphalting

1 – AC 14 or equivalent

2 – AC 10 or equivalent

3 – Does not include select subgrade which could be required in areas of high to very high expansive soils, or soils with CBR<3%

4 – could also include bus routes, subject to confirmation from Council

5 – refer additional comments regarding changes to base and subbase thickness for practical considerations

It is noted that there may be 'constructability minimum values' which apply in relation to minimum thickness of subbase under kerb, and minimum thickness of basecourse to match with kerb height. It is understood that these minimum values can vary depending on the type of kerb being used and on Council's requirements. The pavement thicknesses above are minimum values. The minimum basecourse thickness can be increased, if it assists with the practical aspects of construction. It is possible to then decrease the subbase thickness, but the overall minimum total pavement thickness must be observed and provided the subbase does not reduce to less than 150 mm. It is also possible to increase the minimum subbase thickness if practical considerations govern.

Any changes in overall pavement thickness between adjoining sections of road should be transitioned and not abruptly stepped.

The pavement thicknesses presented above are dependent on the provision and maintenance of adequate surface and subsurface drainage.

### 6.9.5 Material Quality and Compaction Requirements

Recommended pavement material quality and compaction requirements are presented in Table 13 below.

**Table 13: Material Quality and Compaction Requirements**

| Pavement Layer | Material Quality | Compaction |
|---|---|---|
| Basecourse | CBR > 80%, PI ≤ 6%, Grading in accordance with MoES (MCC, 2014) | Compact to at least 98% dry density ratio Modified (AS 1289.5.2.1) |
| Subbase | CBR > 30%, PI ≤ 12%, Grading in accordance with MoES (MCC, 2014) | Compact to at least 95% dry density ratio Modified (AS 1289.5.2.1) |
| Select Subgrade | CBR ≥ 15% | Compact to at least 100% dry density ratio Standard (AS 1289.5.1.1) |
| Subgrade | CBR ≥ 3% (Clay / Engineered Fill)<br>CBR ≥ 8% (Weathered / Ripped Rock) | Compact to at least 100% dry density ratio Standard (AS 1289.5.1.1) |

### 6.9.6 Subgrade Preparation

The following procedure is recommended for preparation of the pavement subgrade:

- Excavate to design subgrade level;
- Remove any additional topsoil or deleterious materials;

- Test roll the surface in order to determine any soft zones and assess moisture condition. Moisture contents should be in the range OMC -3% (dry) to OMC where OMC is the optimum content at standard compaction. Some of the tested samples were outside this range during field work. Moisture conditioning may be required if similar moisture conditions are encountered during construction;
- If rock is encountered at subgrade level, it should be ripped to a depth of at least 100 mm and recompacted prior to placement of pavement layers;
- Compact the tyned natural subgrade to a minimum dry density ratio of 100% Standard. The compacted clay subgrade should be left exposed for a minimum of time prior to placement of pavement layers, to minimise the occurrence of desiccation cracking and/or softening due to weather exposure.

There is a risk of wet of optimum subgrade and other deleterious materials in areas where existing dams are to be decommissioned, and in drainage gully areas.

Geotechnical inspections and testing should be performed during construction in accordance with the earthworks standard (AS 3798, 2007).

## 6.10 Soil Aggressiveness

The results of laboratory testing of soil samples collected during field work have been compared to the exposure classifications for steel and concrete as outlined in the piling standard (AS2159, 2009). The following table summarises the exposure classifications for each of the samples tested.

**Table 14: Soil Aggressiveness Exposure Classification (AS2159, 2009)**

| Bore | Depth (m) | Description | Exposure Classification for Concrete (AS2159, 2009) | Exposure Classification for Steel (AS2159, 2009) |
|---|---|---|---|---|
| 102 | 1.0 | Sandstone | Mild | Non-aggressive |
| 103 | 0.9 | Sandy Clay | Mild | Non-aggressive |
| 104 | 0.65 | Sandy Clay | Non-aggressive | Non-aggressive |
| 105 | 0.4 | Silty Sand | Non-aggressive | Non-aggressive |
| 106 | 0.4 | Silty Clay | Mild | Non-aggressive |

## 6.11 Soil Salinity

Laboratory testing was undertaken on select samples to measure various parameters for preliminary consideration of soil salinity. Detailed results are attached in Appendix B, and are summarised in Section 5.

Soil EC results have been multiplied by an appropriate soil texture factor (DLWC, 2002) to give the extract electrical conductivity ($EC_e$) to assess soil salinity. Review of the ESP results provides an indication of soil sodicity, which is a measure of the presence of a high proportion of sodium ions relative to other cations, and is another indicator of soil salinity.

The results of the assessment of the laboratory test results are shown in Table 15 and Table 16, below.

**Table 15: Assessment of Soil Salinity Class (DLWC, 2002)**

| Test Pit | Depth (m) | Description | Indicative Texture | EC (µS/cm) | EC (dS/m) | Multiplication Factor | ECe (dS/m) | Salinity Class |
|---|---|---|---|---|---|---|---|---|
| 102 | 1.0 | Weathered Sandstone | Light Medium Clay | 22 | 0.022 | 8 | 0.176 | Non-Saline |
| 103 | 0.9 | Sandy Clay (extremely weathered sandstone) | Medium Clay | 48 | 0.048 | 7 | 0.336 | Non-Saline |
| 104 | 0.65 | Silty Clay | Medium to Heavy Clay | 37 | 0.037 | 6 | 0.222 | Non-Saline |
| 105 | 0.4 | Silty Sand | Sandy loam | 10 | 0.01 | 14 | 0.14 | Non-Saline |
| 106 | 0.4 | Silty Clay | Medium Clay | 37 | 0.037 | 7 | 0.259 | Non-Saline |

**Table 16: Assessment of Soil Sodicity (DLWC, 2002)**

| Test Pit | Depth (m) | Description | ESP (%) | Sodicity[1] |
|---|---|---|---|---|
| 102 | 1.0 | Sandstone | 8 | Sodic |
| 103 | 0.9 | Sandy Clay (extremely weathered sandstone) | 7 | Sodic |
| 104 | 0.65 | Silty Clay (extremely weathered sandstone) | 23 | Highly Sodic |
| 106 | 0.4 | Silty Clay | 10 | Sodic |

Notes to Table 16:

[1] – Based on classification rating in DLWC (2002)

Based on the results of the limited laboratory testing, the tested soils are generally considered to be non-saline, however the tested soils were indicative of sodic to highly sodic soils. As discussed in Section 6.10, above, some soils were also considered to be mildly aggressive towards buried concrete.

Due to the limited nature of the soil salinity testing, it is possible that soils with a different (higher) salinity potential than those that were tested could be present on the site.

As a minimum, future residential design and construction should be undertaken with reference to good practices as detailed in published guidelines (DLWC, 2002) to minimise the potential for saline impact to occur. Typical construction practices include:

- Correctly installing a damp proof course within each structure;
- Providing adequate floor ventilation beneath the building for houses on bearers and joists;
- Minimum disruption to natural water courses (surface and subsurface) to reduce the potential for waters to come in contact with structures (ie minimising cut and fill where possible);
- Maintaining good drainage and minimising excessive infiltration;
- Ensuring that paths which are provided around houses slope away from the building;
- Careful design of landscaping and landscaping watering methods;
- Adequate drainage behind retaining walls;
- Regular monitoring of pipes, pools etc for leaks.

Most of these features are consistent with the guidelines in the standard for residential slabs and footings (AS 2870, 2011).

For the construction of roads, consideration should be given to:

- Minimise ponding of water and the concentration of surface run-off on shoulders and adjacent drains;
- Careful selection of construction materials to minimise salt content and maximise compaction and impermeability.

## 7. References

AS 1726. (2017). *Geotechnical Site Investigations.* Standards Australia.

AS 2870. (2011). *Residential Slabs and Footings.* Standards Australia.

AS 3798. (2007). *Guidelines on Earthworks for Commercial and Residential Developments.* Standards Australia.

AS2159. (2009). *Piling – Design and Installation.* Standards Australia.

AS2870. (2011). *AS 2870-2011 Residential Slabs and Footings.* Standards Australia.

Austroads. (2019). *Guide to Pavement Technology Part 2: Pavement Structural Design.* Publication No. AGPT02-17: Austroads Ltd.

DLWC. (2002). *Site Investigations for Urban Salinity.* Department of Land and Water Conservation.

DP. (2015). *Report on Preliminary Geotechnical Assessment, Proposed Residential Rezoning, Hydro Aluminium Kurri Kurri, Gillieston Heights Portion.* Report No 81520.00.R.001.Rev1, dated 23 March 2015: Douglas Partners Pty Ltd.

Fell, R., MacGregor, P., Stapleton, D., & Bell, G. (2005). *Geotechnical Engineering of Dams.* AA Balkema.

MCC. (2014). *Manual of Engineering Standards.* Maitland City Council.

## 8. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Cessnock Road, Gillieston Heights with reference to DP's proposal dated 29 September 2021 and acceptance received from Loxford Project Management Pty Ltd (a McCloy Group company) dated 1 October 2021. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Loxford Project Management Pty Ltd for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

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

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

The assessment of atypical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

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.

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

**Douglas Partners Pty Ltd**

# Appendix A

About this Report
Terminology, Symbols and Abbreviations
Soil Descriptions
Rock Descriptions
Sampling, Testing and Excavation Methodology
Test Pit Logs (Pits 101 to 106)

# About this Report

August 2020

## Introduction

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

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

## Copyright



## Borehole and Test Pit Logs

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

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

## Groundwater

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

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

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

## Reports

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

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

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

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

continued next page

## 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.

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## Introduction to Terminology, Symbols and Abbreviations

Douglas Partners' reports, investigation logs, and other correspondence may use terminology which has quantitative or qualitative connotations. To remove ambiguity or uncertainty surrounding the use of such terms, the following sets of notes pages may be attached Douglas Partners' reports, depending on the work performed and conditions encountered:

- Soil Descriptions;
- Rock Descriptions; and
- Sampling, insitu testing, and drilling methodologies

In addition to these pages, the following notes generally apply to most documents.

### *Abbreviation Codes*

Site conditions may also be presented in a number of different formats, such as investigation logs, field mapping, or as a written summary. In some of these formats textual or symbolic terminology may be presented using textual abbreviation codes or graphic symbols, and, where commonly used, these are listed alongside the terminology definition. For ease of identification in these note pages, textual codes are presented in these notes in the following style `XW`. Code usage conforms with the following guidelines:

- Textual codes are case insensitive, although herein they are generally presented in upper case; and
- Textual codes are contextual (i.e. the same or similar combinations of characters may be used in different contexts with different meanings (for example `PL` is used for plastic limit in the context of soil moisture condition, as well as in `PL(A)` for point load test result in the testing results column)).

### *Data Integrity Codes*

Subsurface investigation data recorded by Douglas Partners is generally managed in a highly structured database environment, where records "span" between a top and bottom depth interval. Depth interval "gaps" between records are considered to introduce ambiguity, and, where appropriate, our practice guidelines may require contiguous data sets. Recording meaningful data is not always appropriate (for example assigning a "strength" to a concrete pavement) and the following codes may be used to maintain contiguity in such circumstances.

| Term | Description | Abbreviation Code |
|---|---|---|
| Core loss | No core recovery | KL |
| Unknown | Information was not available to allow classification of the property. For example, when auguring in loose, saturated sand auger cuttings may not be returned. | UK |
| No data | Information required to allow classification of the property was not available. For example if drilling is commenced from the base of a hole predrilled by others | ND |
| Not Applicable | Derivation of the properties not appropriate or beyond the scope of the investigation. For example providing a description of the strength of a concrete pavement | NA |

### *Graphic Symbols*

Douglas Partners' logs contain a "graphic" column which provides a pictorial representation of the basic composition of the material. The symbols used are directly representing the material name stated in the adjacent "Description of Strata" column, and as such no specific graphic symbology legend has been provided in these notes.

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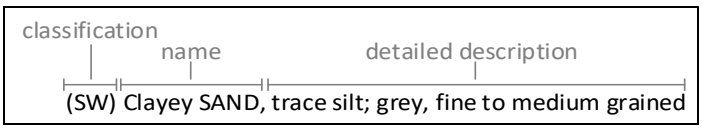
## Introduction

All materials which are not considered to be "in-situ rock" are described in general accordance with the soil description model of AS 1726-2017 Part 6.1.3, and can be broken down into the following description structure:




The "classification" comprises a two character "group symbol" providing a general summary of dominant soil characteristics. The "name" summarises the particle sizes within the soil which most influence it's behaviour. The detailed description presents more information about the soil's composition, condition, structure, and origin.

Classification, naming and description of soils requires the relative proportion of particles of different sizes within the whole soil mixture to be considered.

### *Particle size designation and Behaviour Model*

Solid particles within a soil are differentiated on the basis of size.

The engineering behaviour properties of a soil can subsequently be modelled to be either "fine grained" (also known as "cohesive" behaviour) or "coarse grained" ("non cohesive" behaviour), depending on the relative proportion of fine or coarse fractions in the soil mixture.

| Particle Size Fraction | Particle Size (mm) | Behaviour Model | |
|---|---|---|---|
| | | Behaviour | Approximate Dry Mass |
| Boulder | >200 | Excluded from particle behaviour model as "oversize" | |
| Cobble | 63 - 200 | | |
| Gravel[1] | 2.36 - 63 | Coarse | >65% |
| Sand[1] | 0.075 - 2.36 | | |
| Silt | 0.002 - 0.075 | Fine | >35% |
| Clay | <0.002 | | |

[1] – refer grain size subdivision descriptions below

The behaviour model boundaries defined above are not precise, and the material behaviour should be assumed from the name given to the material (which considers the particle fraction which dominates the behaviour, refer "component proportions" below), rather than strict observance of the proportions of particle sizes. For example, if a material is named a "Sandy CLAY", this is indicative that the material exhibits fine grained behaviour, even if the dry mass of coarse grained material may exceed 65%.

### *Component proportions*

The relative proportion of the dry mass of each particle size fraction is assessed to be a "primary", "secondary", or "minor" component of the soil mixture, depending on it's influence over the soils behaviour.

| Component Proportion Designation | Definition[1] | Relative Proportion | |
|---|---|---|---|
| | | In Fine Grained Soil | In Coarse Grained Soil |
| Primary | The component (particle size designation, refer above) which dominates the engineering behaviour of the soil | The clay/silt component with the greater proportion | The sand/gravel component with the greater proportion |
| Secondary | Any component which is not the primary, but is significant to the engineering properties of the soil | Any component with greater than 30% proportion | Any granular component with greater than 30%; or<br>Any fine component with greater than 12% |
| Minor[2] | Present in the soil, but not significant to it's engineering properties | All other components | All other components |

[1] – As defined in AS1726-2017 6.1.4.4

[2] – in the detailed material description, minor components are split into two further sub categories. Refer "identification of minor components" below

### *Composite Materials*

In certain situations a lithology description may describe more than one material, for example, collectively describing a layer of interbedded sand and clay. In such a scenario, the two materials would be described independently, with the names preceded or followed by a statement describing the arrangement by which the materials co-exist. For example "INTERBEDDED Silty CLAY AND SAND".

## Classification

The soil classification comprises a two character group symbol. The first symbol identifies the primary component. The second symbol identifies either the grading or presence of fines in a coarse grained soil, or the plasticity in a fine grained soil. Refer AS1726-2017 6.1.6 for further clarification.

## Soil Name

For most soils the name is derived with the primary component included as the noun (in upper case), preceded by any secondary components stated in an adjective form. In this way the soil name also describes the general composition and indicates the dominant behaviour of the material.

| Component[1] | Prominence in Soil Name |
|---|---|
| Primary | Noun (eg "CLAY") |
| Secondary | Adjective modifier (eg "Sandy") |
| Minor | No influence |

[1] – for determination of component proportions, refer component proportions on previous page

For materials which cannot be disaggregated, or which are not comprised of rock or mineral fragments, the names "ORGANIC MATTER" or "ARTIFICIAL MATERIAL" may be used, in accordance with AS1726-2017 Table 14.

Commercial or colloquial names are not used for the soil name where a component derived name is possible (for example "Gravelly SAND" rather than "CRACKER DUST").

## Identification of minor components

Minor components are identified in the soil description immediately following the soil name. The minor component fraction is usually preceded with a term indicating the relative proportion of the component.

| Minor Component Proportion Term | Relative Proportion | |
|---|---|---|
| | In Fine Grained Soil | In Coarse Grained Soil |
| With | All fractions: 15-30% | clay/silt: 5-12%<br>sand/gravel: 15-30% |
| Trace | All fractions: 0-15% | clay/silt: 0-5%<br>sand/gravel: 0-15% |

## Soil Composition

Plasticity

| Descriptive Term | Laboratory liquid limit range | |
|---|---|---|
| | Silt | Clay |
| Non-plastic materials | Not applicable | Not applicable |
| Low plasticity | ≤50 | ≤35 |
| Medium plasticity | Not applicable | >35 and ≤50 |
| High plasticity | >50 | >50 |

Note, Plasticity descriptions generally describe the plasticity behaviour of the whole of the fine grained soil, not individual fine grained fractions.

Grain Size

| Type | | Particle size (mm) |
|---|---|---|
| Gravel | Coarse | 19 - 63 |
| | Medium | 6.7 - 19 |
| | Fine | 2.36 – 6.7 |
| Sand | Coarse | 0.6 - 2.36 |
| | Medium | 0.21 - 0.6 |
| | Fine | 0.075 - 0.21 |

Grading

| Grading Term | Particle size (mm) |
|---|---|
| Well | A good representation of all particle sizes |
| Poorly | An excess or deficiency of particular sizes within the specified range |
| Uniformly | Essentially of one size |
| Gap | A deficiency of a particular particle size with the range |

Note, AS1726-2017 provides terminology for additional attributes not listed here.

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## Soil Condition

*Moisture*

The moisture condition of soils is assessed relative to the plastic limit for fine grained soils, while for coarse grained soils it is assessed based on the appearance and feel of the material. The moisture condition of a material is considered to be independent of stratigraphy (although commonly these are related), and this data is presented in its own column on logs.

| Applicability | Term | Tactile Assessment | Abbreviation code |
|---|---|---|---|
| Fine | Dry of plastic limit | Hard and friable or powdery | <PL |
| | Near plastic limit | Can be moulded | ≈PL |
| | Wet of plastic limit | Water residue remains on hands when handling | >PL |
| | Near liquid limit | "oozes" when agitated | ≈LL |
| | Wet of liquid limit | "oozes" | >LL |
| Coarse | Dry | Non-cohesive and free running | D |
| | Moist | Feels cool, darkened in colour, particles may stick together | M |
| | Wet | Feels cool, darkened in colour, particles may stick together, free water forms when handling | W |

The abbreviation code NDF, meaning "not-assessable due to drilling fluid use" may also be used.

Note, observations relating to free ground water or drilling fluids are provided independent of soil moisture condition.

*Consistency/Density/Compaction/Cementation/Extremely Weathered Rock*

These concepts give an indication of how the material may respond to applied forces (when considered in conjunction with other attributes of the soil). This behaviour can vary independent of the composition of the material, and on logs these are described in an independent column and are generally mutually exclusive (i.e it is inappropriate to describe both consistency and compaction at the same time). The method by which the behaviour is described depends on the behaviour model and other characteristics of the soil as follows:

- In fine grained soils, the "consistency" describes the ease with which the soil can be remoulded, and is generally correlated against the materials undrained shear strength;
- In granular materials, the relative density describes how tightly packed the particles are, and is generally correlated against the density index;
- In anthropogenically modified materials the compaction of the material is described qualitatively;
- In cemented soils (both natural and anthropogenic), the cemented "strength" is described qualitatively, relative to the difficulty with which the material is disaggregated; and
- In soils of extremely weathered rock origin, the engineering behaviour may be governed by relic rock features, and expected behaviour needs to be assessed based the overall material description

Quantitative engineering performance of these materials may be determined by laboratory testing, or estimated by correlated field tests (for example penetration or shear vane testing), or by tactile methods, as appropriate.

Consistency (fine grained soils)

| Consistency Term | Tactile Assessment | Undrained Shear Strength (kPa) | Abbreviation Code |
|---|---|---|---|
| Very soft | Extrudes between fingers when squeezed | <12 | VS |
| Soft | Mouldable with light finger pressure | >12 - ≤25 | S |
| Firm | Mouldable with strong finger pressure | >25 - ≤50 | F |
| Stiff | Cannot be moulded by fingers | >50 - ≤100 | ST |
| Very stiff | Indented by thumbnail | >100 - ≤200 | VST |
| Hard | Indented by thumbnail with difficulty | >200 | H |
| Friable | Easily crumbled or broken into small pieces by hand | - | FR |

Relative Density (coarse grained soils)

Tactile assessment of relative density is difficult, and generally requires penetration testing, hence a tactile assessment guide is not provided.

| Relative Density Term | Density Index | Abbreviation Code |
|---|---|---|
| Very loose | <15 | VL |
| Loose | >15-≤35 | L |
| Medium dense | >35-≤65 | MD |
| Dense | >65-≤85 | D |
| Very dense | >85 | VD |

Compaction (anthropogenically modified soil)

| Compaction Term | Abbreviation Code |
|---|---|
| Well compacted | WC |
| Poorly compacted | PC |
| Moderately compacted | MC |
| Variably compacted | VC |

Cementation (natural and anthropogenic)

| Cementation Term | Abbreviation Code |
|---|---|
| Moderately cemented | MCE |
| Weakly cemented | WKCE |
| Cemented | CE |
| Strongly bound | SB |
| Weakly bound | WB |
| Unbound | UB |

*Extremely Weathered Rock*

AS1726-2017 considers weathered rock material to be soil if the unconfined compressive strength is less than 0.6 MPa (i.e. very low strength rock). These materials may be identified as "extremely weathered rock" in reports and by the abbreviation code XWR on log sheets. This identification is not correlated to any specific qualitative or quantitative behaviour, and the engineering properties of this material must therefore be assessed according to engineering principles with reference to any relic rock structure, fabric, or texture described in the description.

**Soil Origin**

| Term | Description | Abbreviation Code |
|---|---|---|
| Residual | Derived from in-situ weathering of the underlying rock | RES |
| Extremely weathered material | Formed from in-situ weathering of geological formations. Has strength of less than 'very low' as per as1726 but retains the structure or fabric of the parent rock. | XWM |
| Alluvial | Deposited by streams and rivers | ALV |
| Estuarine | Deposited in coastal estuaries | EST |
| Marine | Deposited in a marine environment | MAR |
| Lacustrine | Deposited in freshwater lakes | LCS |
| Aeolian | Carried and deposited by wind | AEO |
| Colluvial | Soil and rock debris transported down slopes by gravity | COL |
| Topsoil | Mantle of surface soil, often with high levels of organic material | TOP |
| Fill | Any material which has been moved by man | FILL |
| Littoral | Deposited on the lake or sea shore | LIT |
| Unidentifiable | Not able to be identified | UID |

**Cobbles and Boulders**

The presence of particles considered to be "oversize" may be described using one of the following strategies:

- Oversize encountered in a minor proportion (when considered relative to the wider area) are noted in the soil description; or
- Where a significant proportion of oversize is encountered, the cobbles/boulders are described independent of the soil description, in a similar manner to composite soils (described above) but qualified with "MIXTURE OF".

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## Rock Strength

Rock strength is defined by the unconfined compressive strength and it 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 Point Load Strength Index $I_{s(50)}$ is commonly used to provide an estimate of the rock strength and site specific correlations should be developed to allow UCS values to be determined. The point load strength test procedure is described by Australian Standard AS4133.4.1-2007. The terms used to describe rock strength are as follows:

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

[1] Assumes a ratio of 20:1 for UCS to $I_{s(50)}$. It should be noted that the UCS to $I_{s(50)}$ ratio varies significantly for different rock types and specific ratios may be required for each site.

On investigation logs only, the following data contiguity codes may be in rock strength tables for layers or seams of material "within rock", but for which the equivalent UCS strength is less than 0.6 MPa.

| Scenario | Abbreviation Code |
|---|---|
| The material encountered has an equivalent UCS strength of less than 0.6 MPa, and therefore is considered to be soil (as per Note 1 of Table 20 of AS 1726-2017). The properties of the material encountered over this interval are described in the "Description of Strata" and soil properties columns. | SOIL |
| The material encountered has an equivalent UCS strength of less than 0.6 MPa, and therefore is considered to be soil (as per Note 1 of Table 20 of AS 1726-2017). The prominence of the material is such that it can be considered to be a seam (as defined in Table 22 of AS1726-2017) and the properties of the material are described in the defect column. | SEAM |

## Degree of Weathering

The degree of weathering of rock is classified as follows:

| Weathering Term | Description | Abbreviation Code |
|---|---|---|
| Residual Soil[1,2] | Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported. | RS |
| Extremely weathered[1,2] | Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible | XW |
| Highly weathered | The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores. | HW |
| Moderately weathered | The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock. | MW |
| Slightly weathered | Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock. | SW |
| Fresh | No signs of decomposition or staining. | FR |
| Note: If HW and MW cannot be differentiated use DW (see below) | | |
| Distinctly weathered | Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching or may be decreased due to deposition of weathered products in pores. | DW |

[1] – AS1726-2017 6.1.9 provides similar definitions for "residual soil" and "extremely weathered material" as soil origins. Generally, the soil origin terms would be used above the depth at which very low strength or stronger rock material is first encountered, while both soil origin and weathering should may be stated for soil encountered below the first contact with rock material, where appropriate.

[2] –The parent rock type, of which the residual/extremely weathered material is a derivative, will be stated in the description (where discernible).

## Degree of Alteration

The degree of alteration of the rock material (physical or chemical changes caused by hot gasses or liquids at depth) is classified as follows:

| Term | Description | Abbreviation Code |
|---|---|---|
| Extremely altered | Material is altered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible. | XA |
| Highly altered | The whole of the rock material is discoloured, usually by staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is changed by alteration. Some primary minerals are altered to clay minerals. Porosity may be increased by leaching, or may be decreased due to precipitation of secondary materials in pores. | HA |
| Moderately altered | The whole of the rock material is discoloured, usually by staining or bleaching to the extent that the colour of the original rock is not recognisable but shows little or no change of strength from fresh rock. | MA |
| Slightly altered | Rock is slightly discoloured but shows little or no change of strength from fresh rock | SA |
| Note: If HA and MA cannot be differentiated use DA (see below ) | | |
| Distinctly altered | Rock strength usually changed by alteration. The rock may be highly discoloured, usually by staining or bleaching. Porosity may be increased by leaching, or may be decreased due to precipitation of secondary minerals in pores. | DA |

## Degree of Fracturing

The following descriptive classification apply to the spacing of natural occurring fractures in the rock mass. It includes bedding plane partings, joints and other defects, but excludes drilling breaks. These terms are generally not required on investigation logs where fracture spacing is presented as a histogram, and where used are presented in an unabbreviated format.

| Term | Description |
|---|---|
| Fragmented | Fragments of <20 mm |
| Highly Fractured | Core lengths of 20-40 mm with occasional fragments |
| Fractured | Core lengths of 30-100 mm with occasional shorter and longer sections |
| Slightly Fractured | Core lengths of 300 mm or longer with occasional sections of 100-300 mm |
| Unbroken | Core contains very few fractures |

## 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 stronger. 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

These terms may be used to describe the spacing of bedding partings in sedimentary rocks. Where used, these terms are generally presented in an unabbreviated format

| 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 |

## Defect Descriptions

*Defect Type*

| Term | Abbreviation Code |
|---|---|
| Bedding plane | B |
| Clay seam | CS |
| Cleavage | CV |
| Crushed zone | CZ |
| Decomposed seam | DS |
| Fault | F |
| Joint | J |
| Lamination | LAM |
| Parting | PT |
| Sheared zone | SZ |
| Vein | VN |
| Drilling/handling break | DB , HB |
| Fracture | FCT |

*Rock Defect Orientation*

| Term | Abbreviation Code |
|---|---|
| Horizontal | H |
| Vertical | V |
| Sub-horizontal | SH |
| Sub-vertical | SV |

*Rock Defect Coating*

| Term | Abbreviation Code |
|---|---|
| Clean | CLN |
| Coating | CO |
| Healed | HE |
| Infilled | INF |
| Stained | STN |
| Tight | TI |
| Veneer | VEN |

*Rock Defect Infill*

| Term | Abbreviation Code |
|---|---|
| Calcite | CA |
| Carbonaceous | CBS |
| Clay | CLY |
| Iron oxide | FE |
| Manganese | MN |
| Silty | SLT |

intentionally blank

*Rock Defect Shape/Planarity*

| Term | Abbreviation Code |
|---|---|
| Curved | CU |
| Irregular | IR |
| Planar | PL |
| Stepped | ST |
| Undulating | UN |

*Rock Defect Roughness*

| Term | Abbreviation Code |
|---|---|
| Polished | PO |
| Rough | RO |
| Slickensided | SL |
| Smooth | SM |
| Very rough | VR |

*Other Rock Defect Attributes*

| Term | Abbreviation Code |
|---|---|
| Fragmented | FG |
| Band | BND |
| Quartz | QTZ |

*Defect Orientation*

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

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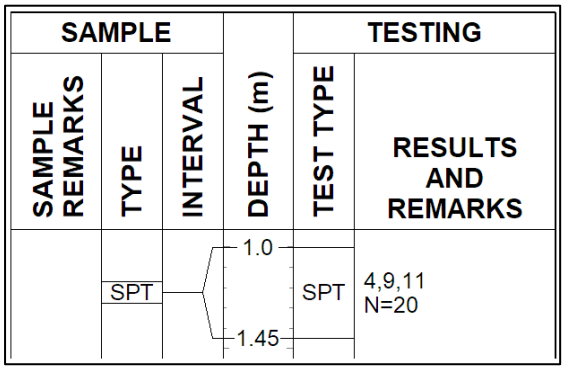
# Sampling, Testing and Excavation Methodology

Terminology
Symbols
Abbreviations

August 2020

## Sampling and Testing

A record of samples retained and field testing performed is usually shown on a Douglas Partners' log with samples appearing to the left of a depth scale, and selected field and laboratory testing (including results, where relevant) appearing to the right of the scale, as illustrated below:




### *Sampling*

The type or intended purpose for which a sample was taken is indicated by the following abbreviation codes.

| Sample Type | Code |
|---|---|
| Auger sample | A |
| Acid sulfate sample | ASS |
| Bulk sample | B |
| Core sample | C |
| Disturbed sample | D |
| Sample from SPT test | SPT |
| Environmental sample | E |
| Gas sample | G |
| Jar sample | J |
| Undisturbed tube sample | U[1] |
| Water sample | W |
| Piston sample | P |
| Core sample for unconfined compressive strength testing | UCS |

[1] – numeric suffixes indicate tube diameter/width in mm

The above codes only indicate that a sample was retained, and not that testing was scheduled or performed.

### *Field and Laboratory Testing*

A record that field and laboratory testing was performed is indicated by the following abbreviation codes.

| Test Type | Code |
|---|---|
| Pocket penetrometer (kpa) | PP |
| Photo ionisation detector | PID |
| Standard Penetration Test | SPT |
| Shear vane (kpa) | V |
| Unconfined compressive strength, (MPa) | UCS |
| Point load test, axial (A), diametric (D), irregular (I) | PLT(_) |

### *Field and laboratory testing (continued)*

| Test Type | Code |
|---|---|
| Dynamic cone penetrometer, followed by blow count penetration increment in mm (cone tip, generally in accordance with AS1289.6.3.2) | DCP/150 |
| Perth sand penetrometer, followed by blow count penetration increment in mm (flat tip, generally in accordance with AS1289.6.3.3) | PSP/150 |

## Groundwater Observations

| | |
|---|---|
| ▷ | seepage/inflow |
| ▽ | standing or observed water level |
| NFGWO | no free groundwater observed |
| OBS | Observations obscured by drilling fluids |

## Drilling or Excavation Methods/Tools

The drilling/excavation methods used to perform the investigation may be shown either in a dedicated column down the left hand edge of the log, or stated in the log footer. In some circumstances abbreviation codes may be used.

| Method | Abbreviation Code |
|---|---|
| Excavator/backhoe bucket | B[1] |
| Toothed bucket | TB[1] |
| Mud/blade bucket | MB[1] |
| Ripping tyne/ripper | RT |
| Rock breaker/hydraulic hammer | RB |
| Hand auger | HA[1] |
| NMLC series coring | NMLC |
| HMLC series coring | HMLC |
| NQ coring | NQ |
| HQ coring | HQ |
| PQ coring | PQ |
| Push tube | PT [1] |
| Rock roller | RR[1] |
| Solid flight auger. Suffixes (TC) and (V) indicate tungsten carbide or v-shaped tip respectively | SFA[1] |
| Sonic drilling | SON[1] |
| Vibrocore | VC[1] |
| Wash bore (unspecified bit type) | WB[1] |
| Existing exposure | X |
| Hand tools (unspecified) | HT |
| Predrilled | PD |
| Specialised bit (refer report) | SPEC[1] |
| Diatube | DT[1] |
| Hollow flight auger | HFA[1] |
| Vacuum excavation | VE |

[1] – numeric suffixes indicate tool diameter/width in mm

# TEST PIT LOG

**CLIENT:** Loxford Project Management Pty Ltd
**PROJECT:** Proposed Residential Subdivision
**LOCATION:** Cessnock Road, Gillieston Heights

**SURFACE LEVEL:** 19.8 AHD
**COORDINATE** **E:**361871 **N:** 6373233
**DATUM/GRID:** MGA94 Zone 56

**LOCATION ID:** 101
**PROJECT No:** 81520.01
**DATE:** 19/10/21
**SHEET:** 1 of 1

| GROUNDWATER | RL (m) | DEPTH (m) | DESCRIPTION OF STRATA | GRAPHIC | ORIGIN(#) | CONSIS.(*) / DENSITY.(*) | MOISTURE | REMARKS | SAMPLE TYPE | SAMPLE INTERVAL | DEPTH (m) | TESTING AND REMARKS: TEST TYPE | RESULTS AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19/10/21, No free groundwater observed | 19 | 0.0 | TOPSOIL/ (SM) Silty SAND; dark brown; fine; trace rootlets | | TOP | NA | M | | | | | | |
| | | 0.3 | (SM) Silty SAND; yellow brown; fine; trace charcoal | | ALV | L | M | | D, E | | 0.4 | | |
| | | 0.6 | (CI) Silty CLAY, with sand; brown mottled red; clay fraction medium plasticity; sand fraction fine to medium | | | ST | | | B, U50, D, E | | 0.6<br>0.7<br>0.8 | DCP/150<br>PP<br>PP | 150<br>290-310 |
| | 18 | 1 | | | RES | VST | <PL | | | | 1 | PP | 200 |
| | | 1.4 | (CL) Sandy CLAY; grey mottled yellow; sand fraction fine to medium; extremely weathered sandstone with pockets of clay, slightly cemented | | | | | | D | | 1.5 | PP | >400 |
| | 17 | 2 | | | XWM | H | <PL | | | | 2 | | |
| | | | | | | | | | D | | 2.4 | PP | >400 |
| | 16 | 3.0 | Test pit discontinued at 3.00m depth<br>Limit of investigation | | | | | | | | 3 | | |
| | 15 | 4 | | | | | | | | | 4 | | |

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

**PLANT:** 5T Kobelco Excavator
**OPERATOR:** Precision Piering (Francis)
**LOGGED:** Pankhurst
**METHOD:** 400mm bucket with teeth
**REMARKS:** Co-ordinates obtained using DGPS, typical accuracy +/-0.1m depending on satellite coverage and site condition

EXPORTED 07/12/21 14:23. TEMPLATE ID: DP_101.02.00_SOILLOG

# TEST PIT LOG

**CLIENT:** Loxford Project Management Pty Ltd
**PROJECT:** Proposed Residential Subdivision
**LOCATION:** Cessnock Road, Gillieston Heights

**SURFACE LEVEL:** 44.6 AHD
**COORDINATE** **E:**361703.5 **N:** 6373120.1
**DATUM/GRID:** MGA94 Zone 56

**LOCATION ID:** 102
**PROJECT No:** 81520.01
**DATE:** 19/10/21
**SHEET:** 1 of 1

| CONDITIONS ENCOUNTERED | | | | | | | | | SAMPLE | | | | TESTING AND REMARKS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GROUNDWATER | RL (m) | DEPTH (m) | DESCRIPTION OF STRATA | ROCK WEATHERING (where encountered) / ROCK STRENGTH | GRAPHIC | ORIGIN(#) | CONSIS.(*) / DENSITY.(*) | MOISTURE | REMARKS | TYPE | INTERVAL | DEPTH (m) | TEST TYPE | RESULTS AND REMARKS |
| 19/10/21, No free groundwater observed | 44 | 0.0 | TOPSOIL/ (SM) Silty SAND; dark brown; trace rootlets | | | TOP | NA | M | | | | 0.3 | DCP/150 | 5 10 15 |
| | | 0.1 | (Cl) Silty CLAY, sand; orange grey; clay fraction medium plasticity; sand fraction fine | | | RES | VST | <PL | | B D E U50 | | 0.4 | PP | >400 |
| | | | | | | | | | | | | 0.5 | | |
| | | 0.7 | | | | | H | | | | | 0.6 | PP | >400 |
| | | | (Cl) Silty CLAY; pale grey; extremely weathered sandstone | | | XWM | H | <PL | | | | | PP | >400 |
| | | 0.9 | | | | | | | | | | 0.9 | | |
| | | 1 | SANDSTONE; pale grey; medium strength, moderately weathered | VLtoL | | | | D | | B D E | | 1.0 | | 25/100mm 25 |
| | | 1.1 | Test pit discontinued at 1.10m depth refusal on medium strength sandstone | | | | | | | | | 1.1 | | |
| | 43 | 2 | | | | | | | | | | 2 | | |
| | 42 | 3 | | | | | | | | | | 3 | | |
| | 41 | 4 | | | | | | | | | | 4 | | |
| | 40 | | | | | | | | | | | | | |

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

**PLANT:** 5T Kobelco Excavator
**OPERATOR:** Precision Piering (Francis)
**LOGGED:** Pankhurst
**METHOD:** 400mm bucket with teeth
**REMARKS:** Co-ordinates obtained using DGPS, typical accuracy +/-0.1m depending on satellite coverage and site condition

EXPORTED 07/12/21 14:23. TEMPLATE ID: DP_101.02.00_SOILLOG

# TEST PIT LOG

**CLIENT:** Loxford Project Management Pty Ltd
**PROJECT:** Proposed Residential Subdivision
**LOCATION:** Cessnock Road, Gillieston Heights

**SURFACE LEVEL:** 43.2 AHD
**COORDINATE E:**361694.3 **N:** 6372964.2
**DATUM/GRID:** MGA94 Zone 56

**LOCATION ID:** 103
**PROJECT No:** 81520.01
**DATE:** 19/10/21
**SHEET:** 1 of 1

| GROUNDWATER | RL (m) | DEPTH (m) | DESCRIPTION OF STRATA | GRAPHIC | ORIGIN(#) | CONSIS.(*) DENSITY.(*) | MOISTURE | REMARKS | SAMPLE TYPE | SAMPLE INTERVAL | DEPTH (m) | TESTING AND REMARKS: TEST TYPE | RESULTS AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19/10/21, No free groundwater observed | 43 | 0.0 | FILL/ (SM) Silty SAND; brown; fine; fill from road cutting | | FILL | NA | M | | | | | | |
| | | 0.1 | TOPSOIL/ (SM) Silty SAND; brown; trace rootlet | | TOP | NA | M | | | | | | |
| | | 0.3 | (CI) Sandy CLAY, trace gravel; red mottled grey; clay fraction medium plasticity; sand fraction fine; gravel fraction fine to medium, sub-angular | | RES | VST | <PL | | D<br>E<br>U50 | | 0.5<br>0.7 | PP<br>PP | DCP/150<br>200-250<br>310->400 |
| | | 0.8 | (CL) Sandy CLAY; red mottled grey; low plasticity; extremely weathered sandstone with low strength sandstone cobbles | | XWM | H | <PL | | B<br>D<br>E | | 0.8<br>0.9<br>1.0 | | |
| | | 1.0 | Test pit discontinued at 1.00m depth refusal on rock | | | | | | | | | | |
| | 42 | 2 | | | | | | | | | 2 | | |
| | 41 | | | | | | | | | | | | |
| | 40 | 3 | | | | | | | | | 3 | | |
| | 39 | 4 | | | | | | | | | 4 | | |

5 10 15
25/30mm mm 25

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

**PLANT:** 5T Kobelco Excavator
**OPERATOR:** Precision Piering (Francis)
**LOGGED:** Pankhurst

**METHOD:** 400mm bucket with teeth

**REMARKS:** Rock depth varies from 0.5m to 1.0m depth along length of pit. Co-ordinates obtained using DGPS, typical accuracy +/-0.1m depending on satellite coverage and site condition

# TEST PIT LOG

**CLIENT:** Loxford Project Management Pty Ltd
**PROJECT:** Proposed Residential Subdivision
**LOCATION:** Cessnock Road, Gillieston Heights

**SURFACE LEVEL:** 28 AHD
**COORDINATE** **E:**361904.4 **N:** 6372971.6
**DATUM/GRID:** MGA94 Zone 56

**LOCATION ID:** 104
**PROJECT No:** 81520.01
**DATE:** 19/10/21
**SHEET:** 1 of 1

| GROUNDWATER | RL (m) | DEPTH (m) | DESCRIPTION OF STRATA | GRAPHIC | ORIGIN(#) | CONSIS.(*) | DENSITY.(*) | MOISTURE | REMARKS | TYPE | INTERVAL | DEPTH (m) | TEST TYPE | RESULTS AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No free groundwater observed | 28 | 0.0 | TOPSOIL/ (ML) Sandy SILT; dark brown; low plasticity | | TOP | NA | | M | | | | | | |
| | | 0.1 | (CI) Sandy CLAY; orange brown mottled red; clay fraction medium plasticity; sand fraction fine to medium | | RES | ST | | <PL | | B<br>U50<br>D<br>E | | 0.2<br>0.3<br>0.4<br>0.5 | DCP 150<br>PP | 120-190<br>170-210 |
| | | 0.6 | (CI) Silty CLAY, trace gravel; grey mottled orange brown; clay fraction medium to high plasticity; gravel fraction fine, sub-angular; extremely weathered sandstone | | XWM | VST | | <PL | | B<br>D<br>E<br>D | | 0.6<br>0.65<br>0.7<br>0.75 | PP<br>PP | 310->400<br>250 |
| 19/10/21, | 27 | 0.7<br>0.75<br>1 | SILTSTONE; grey; low strength, moderately weathered | | | | | D | | | | 1 | | |
| | | | Test pit discontinued at 0.75m depth refusal on medium strength siltstone | | | | | | | | | | | |
| | 26 | 2 | | | | | | | | | | 2 | | |
| | 25 | 3 | | | | | | | | | | 3 | | |
| | 24 | 4 | | | | | | | | | | 4 | | |

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

**PLANT:** 5T Kobelco Excavator
**OPERATOR:** Precision Piering (Francis)
**LOGGED:** Pankhurst

**METHOD:** 400mm bucket with teeth

**REMARKS:** Rock depth varies from 0.6m to 0.9m along length of test pit. Co-ordinates obtained using DGPS, typical accuracy +/-0.1m depending on satellite coverage and site condition

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# TEST PIT LOG

**CLIENT:** Loxford Project Management Pty Ltd
**PROJECT:** Proposed Residential Subdivision
**LOCATION:** Cessnock Road, Gillieston Heights

**SURFACE LEVEL:** 16.8 AHD
**COORDINATE** **E:**361364.4 **N:** 6372667.5
**DATUM/GRID:** MGA94 Zone 56

**LOCATION ID:** 105
**PROJECT No:** 81520.01
**DATE:** 19/10/21
**SHEET:** 1 of 1

| GROUNDWATER | RL (m) | DEPTH (m) | DESCRIPTION OF STRATA | GRAPHIC | ORIGIN(#) | CONSIS.(*) DENSITY.(*) | MOISTURE | REMARKS | TYPE | INTERVAL | DEPTH (m) | TEST TYPE | RESULTS AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19/10/21, No free groundwater observed | 16.8 | 0.0 | TOPSOIL/ (SM) Silty SAND; dark brown; trace rootlets | | TOP | NA | M | | | | 0.0 | | |
| | | 0.1 | (SM) Silty SAND; grey brown; trace rootlets | | ALV | L TO MD | M | | D<br>E<br>B | | 0.4 | | |
| | 16 | 0.7 | (Cl) Sandy CLAY; orange brown mottled grey; clay fraction medium to high plasticity; sand fraction fine to medium | | RES | ST | <PL | | D<br>E<br>U50 | | 0.7<br>0.8<br>1.0 | DCP/150<br>PP<br>PP | 140<br>290-310<br>25/130mm |
| | 1 | | | | | | | | B | | 1.3<br>1.6 | PP | 150 |
| | 15 | | | | | | | | D<br>E | | 1.8 | PP | 150 |
| | | 2.0 | (CL) Sandy CLAY; grey; clay fraction low plasticity; sand fraction fine to medium | | RES | ST | <PL | | D | | 2.3 | PP | 190-200 |
| | 14 | | 2.8m: possible extremely weathered sandstone | | | H | | | D | | 2.8 | PP | >400 |
| | | 2.9 | Test pit discontinued at 2.90m depth<br>Limit of investigation | | | | | | | | | | |
| | 13 | 3 | | | | | | | | | 3 | | |
| | | 4 | | | | | | | | | 4 | | |
| | 12 | | | | | | | | | | | | |

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

**PLANT:** 5T Kobelco Excavator
**OPERATOR:** Precision Piering (Francis)
**LOGGED:** Pankhurst
**METHOD:** 400mm bucket with teeth
**REMARKS:** Co-ordinates obtained using DGPS, typical accuracy +/-0.1m depending on satellite coverage and site condition

EXPORTED 07/12/21 14:23. TEMPLATE ID: DP_101.02.00_SOILLOG

# TEST PIT LOG

**CLIENT:** Loxford Project Management Pty Ltd
**PROJECT:** Proposed Residential Subdivision
**LOCATION:** Cessnock Road, Gillieston Heights

**SURFACE LEVEL:** 39 AHD
**COORDINATE** **E:**361919.9 **N:** 6372930.4
**DATUM/GRID:** MGA94 Zone 56

**LOCATION ID:** 106
**PROJECT No:** 81520.01
**DATE:** 19/10/21
**SHEET:** 1 of 1

| GROUNDWATER | RL (m) | DEPTH (m) | DESCRIPTION OF STRATA | ROCK WEATHERING (where encountered) / ROCK STRENGTH | GRAPHIC | ORIGIN(#) | CONSIS.(*) / DENSITY.(*) | MOISTURE | REMARKS | SAMPLE TYPE | SAMPLE INTERVAL | DEPTH (m) | TESTING AND REMARKS: TEST TYPE | RESULTS AND REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19/10/21, No free groundwater observed | | 0.0 | TOPSOIL/ (ML) Sandy SILT; dark brown; silt fraction low plasticity; sand fraction fine; trace rootlets | | | TOP | NA | <PL | | | | | | |
| | | 0.2 | (CI) Silty CLAY, with sand, trace gravel; red brown mottled grey; clay fraction medium plasticity; sand fraction fine to medium; gravel fraction medium, angular to sub-angular | | | RES | ST TO VST | <PL | | D | | 0.4 | PP | 90 |
| | | | | | | | | | | U50 | | | PP | 80-90 |
| | | 0.6 | SANDSTONE; grey mottled yellow | HW / VLtoL | | | | M | | B | | 0.6 | PP | >400 |
| | | | | | | | | | | D | | 0.7 | PP | >400 |
| | | 0.8 | Test pit discontinued at 0.80m depth refusal on medium strength sandstone | | | | | | | | | 0.8 | | |
| | 38 | 1 | | | | | | | | | | 1 | | |
| | 37 | 2 | | | | | | | | | | 2 | | |
| | 36 | 3 | | | | | | | | | | 3 | | |
| | 35 | 4 | | | | | | | | | | 4 | | |

DCP/150: 5, 10, 15; 25/20mm; 25

NOTES: (#)Soil origin is "probable" unless otherwise stated. (*)Consistency/Relative density shading is for visual reference only - no correlation between cohesive and granular materials is implied.

**PLANT:** 5T Kobelco Excavator
**OPERATOR:** Precision Piering (Francis)
**LOGGED:** Pankhurst

**METHOD:** 400mm bucket with teeth

**REMARKS:** Rock varies from 0.6 to 0.8. Co-ordinates obtained using DGPS, typical accuracy +/-0.1m depending on satellite coverage and site condition

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# Appendix B

Laboratory Test Results

# Material Test Report

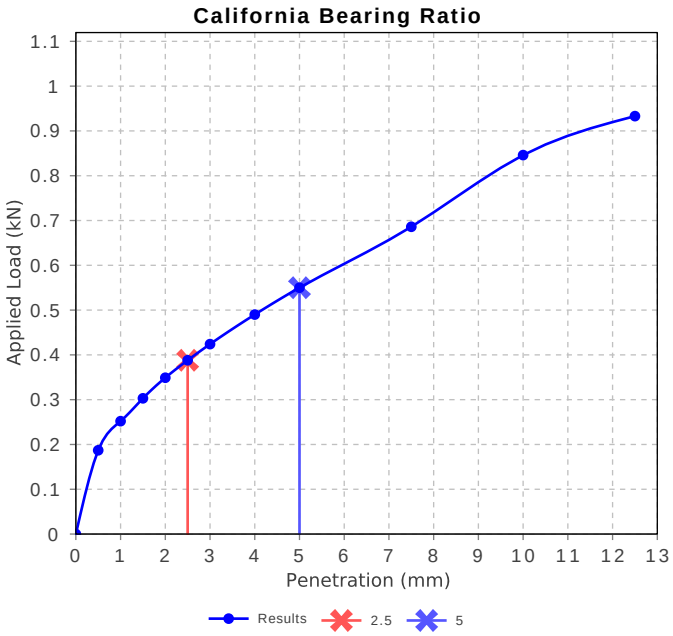
Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Newcastle Laboratory
15 Callistemon Close Warabrook Newcastle NSW 2310
Phone: (02) 4960 9600
Email: Peter.Gorseski@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Peter Gorseski
Laboratory Manager
Laboratory Accreditation Number: 828

| | |
|---|---|
| **Report Number:** | **81520.01-1** |
| **Issue Number:** | 4 - *This version supersedes all previous issues* |
| **Reissue Reason:** | *Updated Sample description* |
| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty |
| | Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685A |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 09/11/2021 |
| **Sampling Method:** | Sampled by Douglas Partners |
| | *The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **101, Depth: 0.6-0.8m** |
| **Material:** | Silty Clay |

| 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 | AS1289 3.1.2 | | |
| Maximum Dry Density (t/m$^3$) | 1.73 | | |
| Optimum Moisture Content (%) | 18.0 | | |
| Laboratory Density Ratio (%) | 102.0 | | |
| Laboratory Moisture Ratio (%) | 84.5 | | |
| Dry Density after Soaking (t/m$^3$) | 1.71 | | |
| Field Moisture Content (%) | 20.4 | | |
| Moisture Content at Placement (%) | 15.2 | | |
| Moisture Content Top 30mm (%) | 24.7 | | |
| Moisture Content Rest of Sample (%) | 19.6 | | |
| Mass Surcharge (kg) | 4.5 | | |
| Soaking Period (days) | 4 | | |
| Curing Hours | 220.2 | | |
| Swell (%) | 3.0 | | |
| Oversize Material (mm) | 19 | | |
| Oversize Material Included | Excluded | | |
| Oversize Material (%) | 0.0 | | |




| Emerson Class Number of a Soil (AS 1289 3.8.1) | | Min | Max |
|---|---|---|---|
| Emerson Class | **3** | | |
| Soil Description | Silty Clay | | |
| Nature of Water | Distilled | | |
| Temperature of Water ($^o$C) | 20 | | |

| Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) | | Min | Max |
|---|---|---|---|
| Sample History | Oven Dried | | |
| Preparation Method | Dry Sieve | | |
| Liquid Limit (%) | 46 | | |
| Plastic Limit (%) | 26 | | |
| **Plasticity Index (%)** | **20** | | |

# Material Test Report

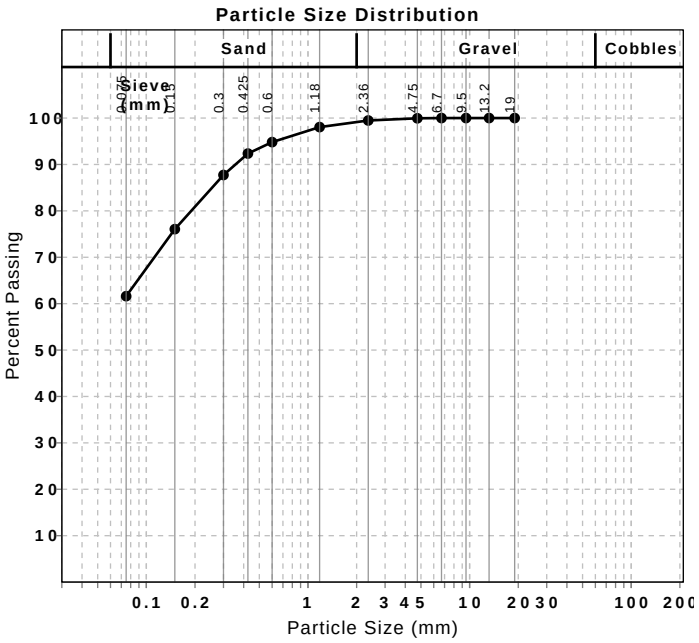
Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Newcastle Laboratory
15 Callistemon Close Warabrook Newcastle NSW 2310
Phone: (02) 4960 9600
Email: Peter.Gorseski@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Peter Gorseski
Laboratory Manager
Laboratory Accreditation Number: 828

| | |
|---|---|
| **Report Number:** | **81520.01-1** |
| **Issue Number:** | 4 - *This version supersedes all previous issues* |
| **Reissue Reason:** | *Updated Sample description* |
| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty<br>Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685A |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 09/11/2021 |
| **Sampling Method:** | Sampled by Douglas Partners<br>*The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **101, Depth: 0.6-0.8m** |
| **Material:** | Silty Clay |

| Particle Size Distribution (AS1289 3.6.1) | | | |
|---|---|---|---|
| Sieve | Passed % | Passing Limits | |
| 19 mm | **100** | | |
| 13.2 mm | **100** | | |
| 9.5 mm | **100** | | |
| 6.7 mm | **100** | | |
| 4.75 mm | **100** | | |
| 2.36 mm | **99** | | |
| 1.18 mm | **98** | | |
| 0.6 mm | **95** | | |
| 0.425 mm | **92** | | |
| 0.3 mm | **88** | | |
| 0.15 mm | **76** | | |
| 0.075 mm | **62** | | |



# Material Test Report

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Accredited for compliance with ISO/IEC 17025 - Testing

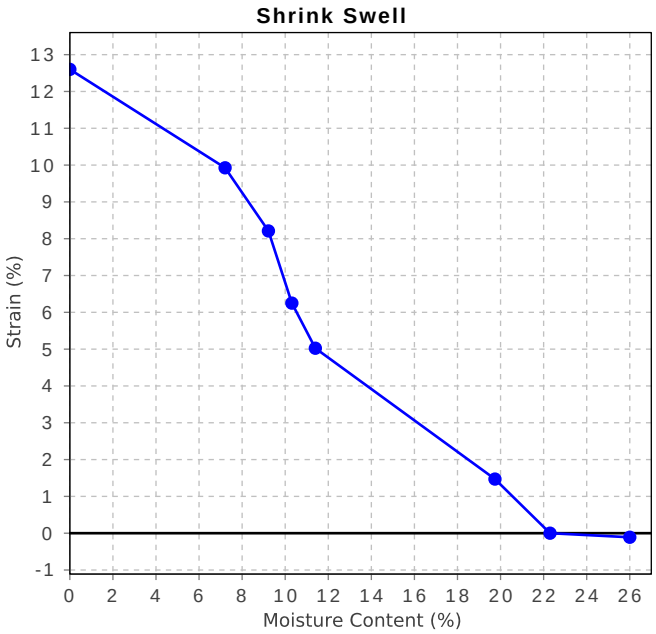
Approved Signatory: Peter Gorseski
Laboratory Manager
Laboratory Accreditation Number: 828

| | |
|---|---|
| **Report Number:** | **81520.01-1** |
| **Issue Number:** | 4 - *This version supersedes all previous issues* |
| **Reissue Reason:** | *Updated Sample description* |
| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty |
| | Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685A |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 28/10/2021 |
| **Sampling Method:** | Sampled by Douglas Partners |
| | *The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **101, Depth: 0.6-0.8m** |
| **Material:** | Silty Clay |

| Shrink Swell Index (AS 1289 7.1.1 & 2.1.1) | |
|---|---|
| **Iss (%)** | **7.0** |
| Visual Description | Silty Clay |
| * Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction. | |
| Remoulded SH/SW | |

| Core Shrinkage Test | |
|---|---|
| **Shrinkage Strain - Oven Dried (%)** | **12.6** |
| Estimated % by volume of significant inert inclusions | 0 |
| Cracking | Slightly Cracked |
| Crumbling | No |
| Moisture Content (%) | 22.3 |

| Swell Test | |
|---|---|
| Initial Pocket Penetrometer (kPa) | 220 |
| Final Pocket Penetrometer (kPa) | 200 |
| Initial Moisture Content (%) | 20.2 |
| Final Moisture Content (%) | 26.0 |
| **Swell (%)** | **0.1** |
| * NATA Accreditation does not cover the performance of pocket penetrometer readings. | |



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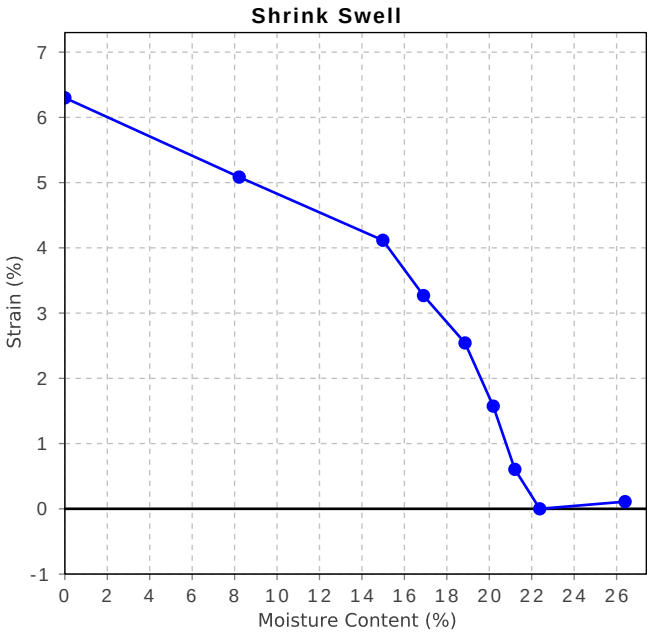
| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty |
| | Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685B |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 26/10/2021 |
| **Sampling Method:** | Sampled by Douglas Partners |
| | *The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **101, Depth: 0.6-0.8m** |
| **Material:** | Silty Clay |

| Shrink Swell Index (AS 1289 7.1.1 & 2.1.1) | |
|---|---|
| **Iss (%)** | **3.5** |
| Visual Description | Silty Clay |
| * Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction. | |

| Core Shrinkage Test | |
|---|---|
| **Shrinkage Strain - Oven Dried (%)** | **6.3** |
| Estimated % by volume of significant inert inclusions | 0 |
| Cracking | Uncracked |
| Crumbling | No |
| Moisture Content (%) | 22.4 |

| Swell Test | |
|---|---|
| Initial Pocket Penetrometer (kPa) | 550 |
| Final Pocket Penetrometer (kPa) | 375 |
| Initial Moisture Content (%) | 22.4 |
| Final Moisture Content (%) | 26.4 |
| **Swell (%)** | **-0.1** |
| * NATA Accreditation does not cover the performance of pocket penetrometer readings. | |



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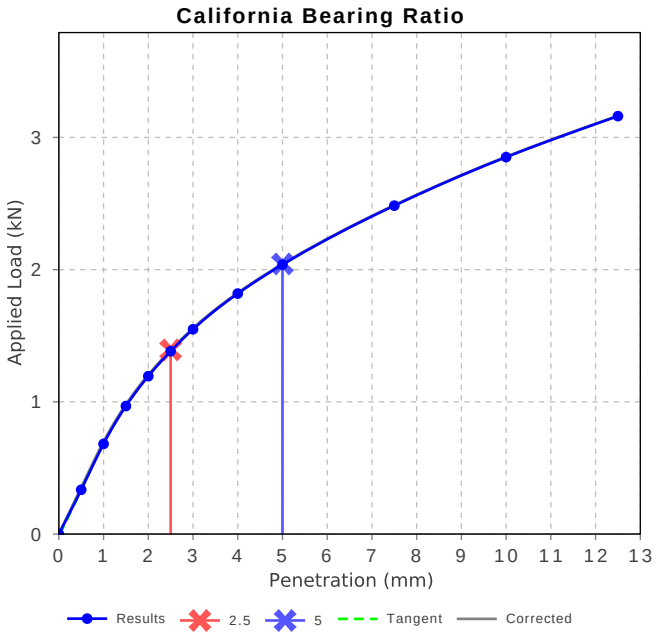
| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty |
| | Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685C |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 09/11/2021 |
| **Sampling Method:** | Sampled by Douglas Partners |
| | *The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **102, Depth: 0.3-0.5m** |
| **Material:** | Silty Clay |

| California Bearing Ratio (AS 1289 6.1.1 & 2.1.1) | | Min | Max |
|---|---|---|---|
| CBR taken at | 2.5 mm | | |
| CBR % | **11** | | |
| Method of Compactive Effort | Standard | | |
| Method used to Determine MDD | AS 1289 5.1.1 & 2.1.1 | | |
| Method used to Determine Plasticity | AS1289 3.1.2 | | |
| Maximum Dry Density (t/m$^3$) | 1.76 | | |
| Optimum Moisture Content (%) | 16.5 | | |
| Laboratory Density Ratio (%) | 101.0 | | |
| Laboratory Moisture Ratio (%) | 92.0 | | |
| Dry Density after Soaking (t/m$^3$) | 1.75 | | |
| Field Moisture Content (%) | 13.4 | | |
| Moisture Content at Placement (%) | 15.0 | | |
| Moisture Content Top 30mm (%) | 20.9 | | |
| Moisture Content Rest of Sample (%) | 18.2 | | |
| Mass Surcharge (kg) | 4.5 | | |
| Soaking Period (days) | 4 | | |
| Curing Hours | 290.7 | | |
| Swell (%) | 1.5 | | |
| Oversize Material (mm) | 19 | | |
| Oversize Material Included | Excluded | | |
| Oversize Material (%) | 0.0 | | |




| Emerson Class Number of a Soil (AS 1289 3.8.1) | | Min | Max |
|---|---|---|---|
| Emerson Class | **5** | | |
| Soil Description | Silty Clay | | |
| Nature of Water | Distilled | | |
| Temperature of Water ($^o$C) | 20 | | |

| Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) | | Min | Max |
|---|---|---|---|
| Sample History | Oven Dried | | |
| Preparation Method | Dry Sieve | | |
| Liquid Limit (%) | 47 | | |
| Plastic Limit (%) | 18 | | |
| **Plasticity Index (%)** | **29** | | |

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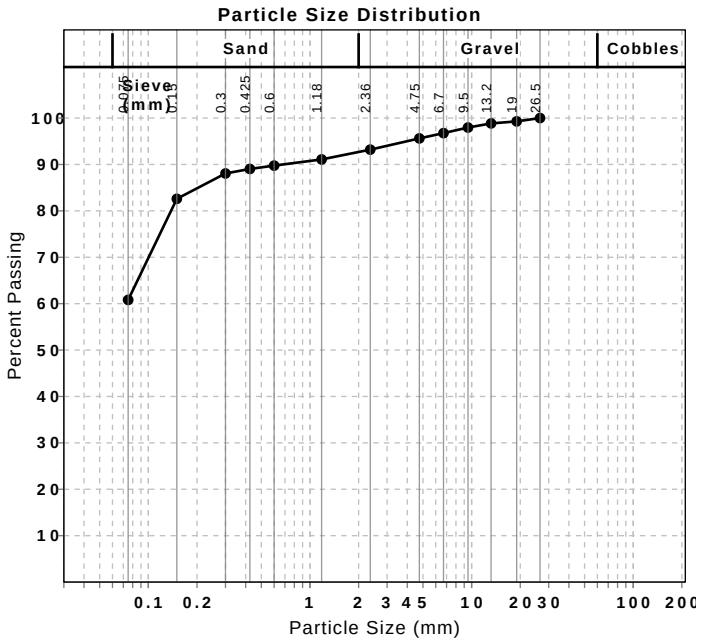
| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty<br>Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685C |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 09/11/2021 |
| **Sampling Method:** | Sampled by Douglas Partners<br>*The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **102, Depth: 0.3-0.5m** |
| **Material:** | Silty Clay |

| Particle Size Distribution (AS1289 3.6.1) | | | |
|---|---|---|---|
| Sieve | Passed % | Passing Limits | |
| 26.5 mm | **100** | | |
| 19 mm | **99** | | |
| 13.2 mm | **99** | | |
| 9.5 mm | **98** | | |
| 6.7 mm | **97** | | |
| 4.75 mm | **96** | | |
| 2.36 mm | **93** | | |
| 1.18 mm | **91** | | |
| 0.6 mm | **90** | | |
| 0.425 mm | **89** | | |
| 0.3 mm | **88** | | |
| 0.15 mm | **83** | | |
| 0.075 mm | **61** | | |



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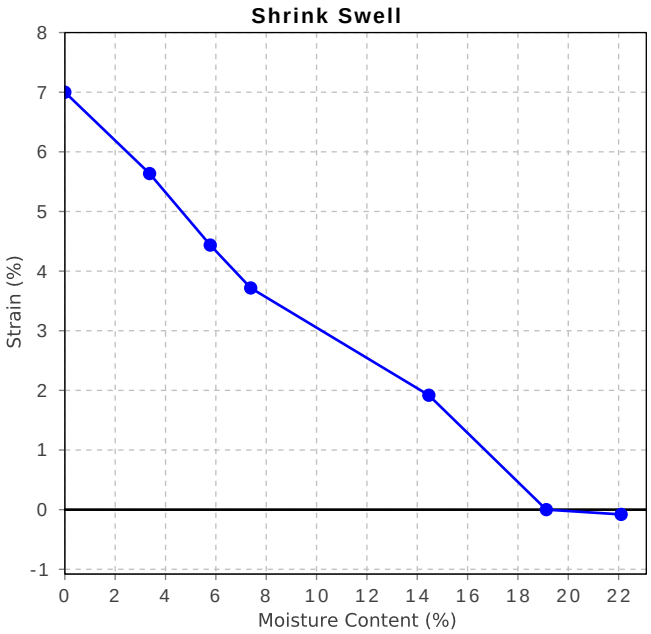
| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty |
| | Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685C |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 28/10/2021 |
| **Sampling Method:** | Sampled by Douglas Partners |
| | *The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **102, Depth: 0.3-0.5m** |
| **Material:** | Silty Clay |

| Shrink Swell Index (AS 1289 7.1.1 & 2.1.1) | |
|---|---|
| **Iss (%)** | **3.9** |
| Visual Description | Silty Clay |
| * Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction. | |
| Remoulded SH/SW | |

| Core Shrinkage Test | |
|---|---|
| **Shrinkage Strain - Oven Dried (%)** | **7.0** |
| Estimated % by volume of significant inert inclusions | 5 |
| Cracking | Slightly Cracked |
| Crumbling | No |
| Moisture Content (%) | 19.1 |

| Swell Test | |
|---|---|
| Initial Pocket Penetrometer (kPa) | 260 |
| Final Pocket Penetrometer (kPa) | 240 |
| Initial Moisture Content (%) | 19.5 |
| Final Moisture Content (%) | 22.1 |
| **Swell (%)** | **0.1** |
| * NATA Accreditation does not cover the performance of pocket penetrometer readings. | |



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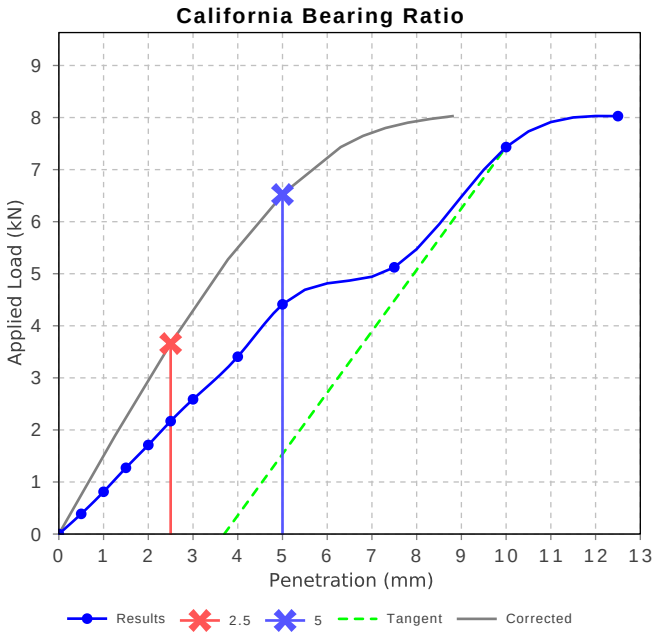
| **Issue Number:** | 4 - *This version supersedes all previous issues* |
| **Reissue Reason:** | *Updated Sample description* |
| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty<br>Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685D |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 08/11/2021 |
| **Sampling Method:** | Sampled by Douglas Partners<br>*The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **103, Depth: 0.8-1.0m** |
| **Material:** | Sandstone |

| California Bearing Ratio (AS 1289 6.1.1 & 2.1.1) | | Min | Max |
|---|---|---|---|
| CBR taken at | 5 mm | | |
| CBR % | **35** | | |
| 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$^3$) | 1.89 | | |
| Optimum Moisture Content (%) | 12.0 | | |
| Laboratory Density Ratio (%) | 100.5 | | |
| Laboratory Moisture Ratio (%) | 94.0 | | |
| Dry Density after Soaking (t/m$^3$) | 1.91 | | |
| Field Moisture Content (%) | 8.8 | | |
| Moisture Content at Placement (%) | 11.2 | | |
| Moisture Content Top 30mm (%) | 12.2 | | |
| Moisture Content Rest of Sample (%) | 12.6 | | |
| Mass Surcharge (kg) | 4.5 | | |
| Soaking Period (days) | 4 | | |
| Curing Hours | 332.7 | | |
| Swell (%) | -0.5 | | |
| Oversize Material (mm) | 19 | | |
| Oversize Material Included | Excluded | | |
| Oversize Material (%) | 16.3 | | |



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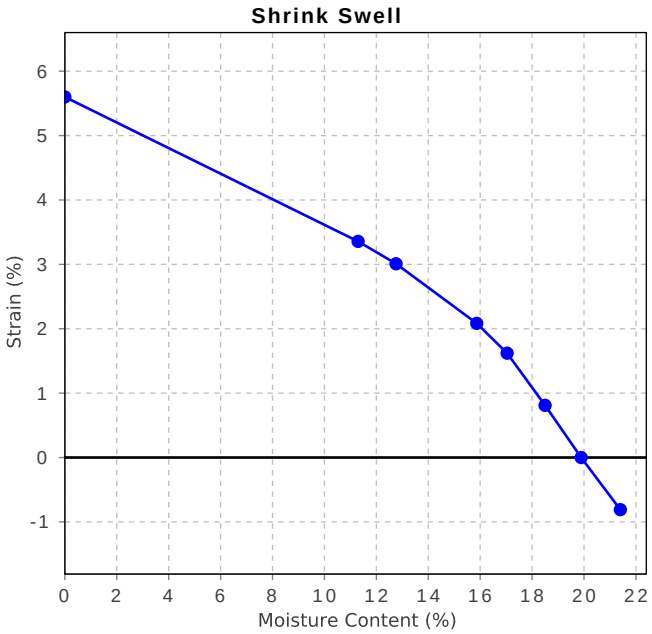
| | Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685E |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 26/10/2021 |
| **Sampling Method:** | Sampled by Douglas Partners |
| | *The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **103, Depth: 0.5-0.7m** |
| **Material:** | Sandy Clay |

| Shrink Swell Index (AS 1289 7.1.1 & 2.1.1) | |
|---|---|
| **Iss (%)** | **3.3** |
| Visual Description | Sandy Clay |
| * Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction. | |

| Core Shrinkage Test | |
|---|---|
| **Shrinkage Strain - Oven Dried (%)** | **5.6** |
| Estimated % by volume of significant inert inclusions | 0 |
| Cracking | Moderately Cracked |
| Crumbling | No |
| Moisture Content (%) | 19.9 |

| Swell Test | |
|---|---|
| Initial Pocket Penetrometer (kPa) | 550 |
| Final Pocket Penetrometer (kPa) | 500 |
| Initial Moisture Content (%) | 19.6 |
| Final Moisture Content (%) | 21.4 |
| **Swell (%)** | **0.8** |
| * NATA Accreditation does not cover the performance of pocket penetrometer readings. | |



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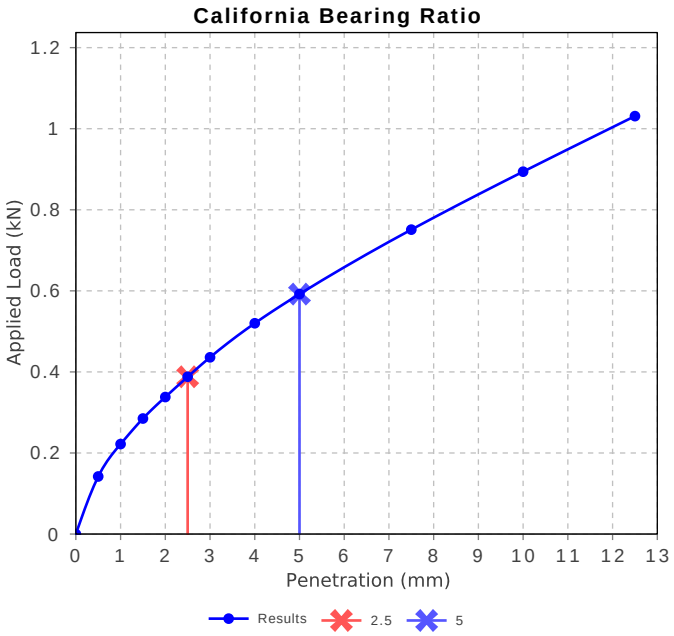
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685F |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 09/11/2021 |
| **Sampling Method:** | Sampled by Douglas Partners |
| | *The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **104, Depth: 0.2-0.4m** |
| **Material:** | Sandy Clay |

| California Bearing Ratio (AS 1289 6.1.1 & 2.1.1) | | Min | Max |
|---|---|---|---|
| CBR taken at | 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 | AS1289 3.1.2 | | |
| Maximum Dry Density (t/m$^3$) | 1.60 | | |
| Optimum Moisture Content (%) | 23.0 | | |
| Laboratory Density Ratio (%) | 100.0 | | |
| Laboratory Moisture Ratio (%) | 100.0 | | |
| Dry Density after Soaking (t/m$^3$) | 1.56 | | |
| Field Moisture Content (%) | 24.7 | | |
| Moisture Content at Placement (%) | 23.0 | | |
| Moisture Content Top 30mm (%) | 27.2 | | |
| Moisture Content Rest of Sample (%) | 25.9 | | |
| Mass Surcharge (kg) | 4.5 | | |
| Soaking Period (days) | 4 | | |
| Curing Hours | 221.3 | | |
| Swell (%) | 3.0 | | |
| Oversize Material (mm) | 19 | | |
| Oversize Material Included | Excluded | | |
| Oversize Material (%) | 0.0 | | |




| Emerson Class Number of a Soil (AS 1289 3.8.1) | | Min | Max |
|---|---|---|---|
| Emerson Class | **6** | | |
| Soil Description | Sandy Clay | | |
| Nature of Water | Distilled | | |
| Temperature of Water ($^o$C) | 20 | | |

| Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) | | Min | Max |
|---|---|---|---|
| Sample History | Oven Dried | | |
| Preparation Method | Dry Sieve | | |
| Liquid Limit (%) | 64 | | |
| Plastic Limit (%) | 20 | | |
| **Plasticity Index (%)** | **44** | | |

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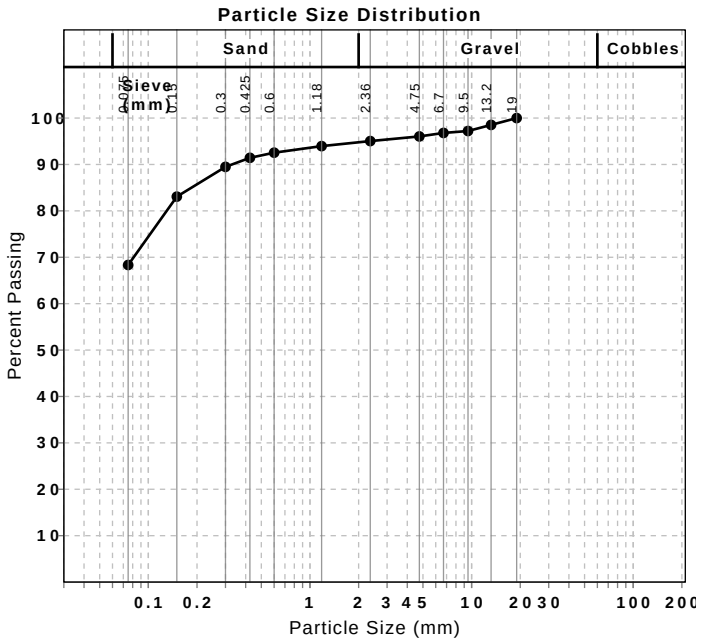
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685F |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 09/11/2021 |
| **Sampling Method:** | Sampled by Douglas Partners<br>*The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **104, Depth: 0.2-0.4m** |
| **Material:** | Sandy Clay |

| Particle Size Distribution (AS1289 3.6.1) | | | |
|---|---|---|---|
| Sieve | Passed % | Passing Limits | |
| 19 mm | **100** | | |
| 13.2 mm | **99** | | |
| 9.5 mm | **97** | | |
| 6.7 mm | **97** | | |
| 4.75 mm | **96** | | |
| 2.36 mm | **95** | | |
| 1.18 mm | **94** | | |
| 0.6 mm | **93** | | |
| 0.425 mm | **91** | | |
| 0.3 mm | **89** | | |
| 0.15 mm | **83** | | |
| 0.075 mm | **68** | | |



# Material Test Report

Douglas Partners
Geotechnics / Environment / Groundwater
Douglas Partners Pty Ltd
Newcastle Laboratory
15 Callistemon Close Warabrook Newcastle NSW 2310
Phone: (02) 4960 9600
Email: Peter.Gorseski@douglaspartners.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

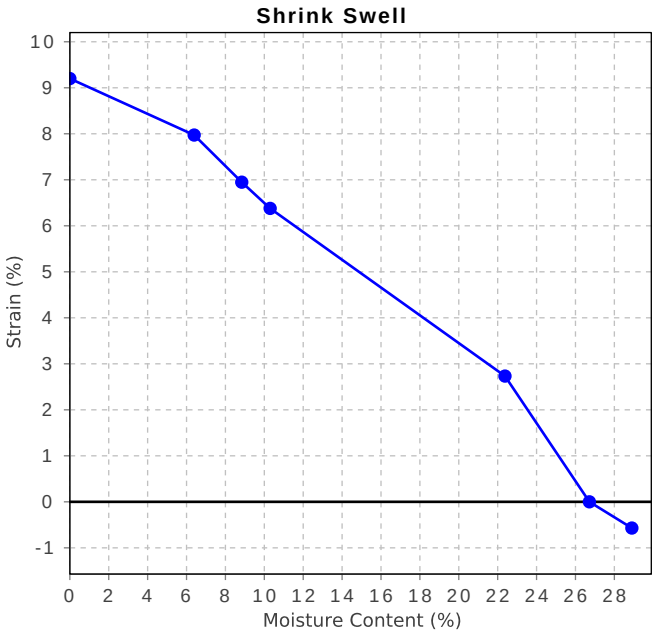
Approved Signatory: Peter Gorseski
Laboratory Manager
Laboratory Accreditation Number: 828

| | |
|---|---|
| **Report Number:** | **81520.01-1** |
| **Issue Number:** | 4 - *This version supersedes all previous issues* |
| **Reissue Reason:** | *Updated Sample description* |
| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty |
| | Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685F |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 27/10/2021 |
| **Sampling Method:** | Sampled by Douglas Partners |
| | *The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **104, Depth: 0.2-0.4m** |
| **Material:** | Sandy Clay |

| Shrink Swell Index (AS 1289 7.1.1 & 2.1.1) | |
|---|---|
| **Iss (%)** | **5.3** |
| Visual Description | Sandy Clay |
| * Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction. | |
| Remoulded SH/SW | |

| Core Shrinkage Test | |
|---|---|
| **Shrinkage Strain - Oven Dried (%)** | **9.2** |
| Estimated % by volume of significant inert inclusions | 0 |
| Cracking | Uncracked |
| Crumbling | No |
| Moisture Content (%) | 26.7 |

| Swell Test | |
|---|---|
| Initial Pocket Penetrometer (kPa) | 300 |
| Final Pocket Penetrometer (kPa) | 250 |
| Initial Moisture Content (%) | 26.1 |
| Final Moisture Content (%) | 28.9 |
| **Swell (%)** | **0.6** |
| * NATA Accreditation does not cover the performance of pocket penetrometer readings. | |



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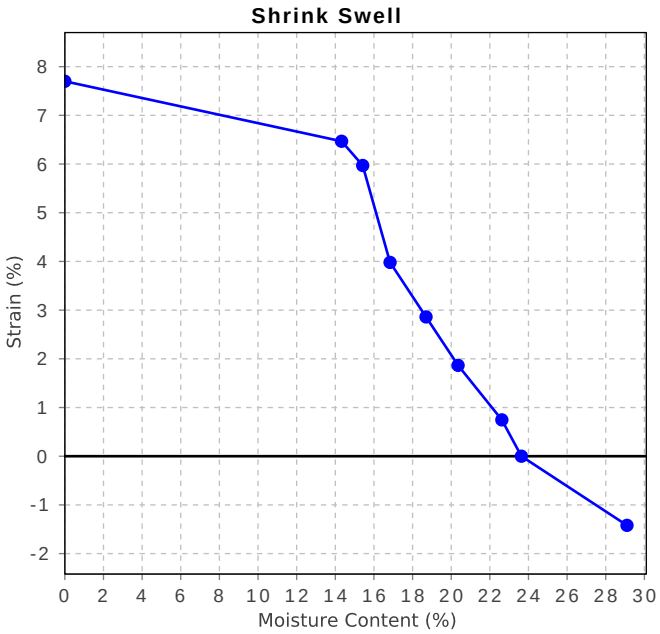
| **Issue Number:** | 4 - *This version supersedes all previous issues* |
| **Reissue Reason:** | *Updated Sample description* |
| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty<br>Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685G |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 26/10/2021 |
| **Sampling Method:** | Sampled by Douglas Partners<br>*The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **104, Depth: 0.3-0.5m** |
| **Material:** | Sandy Clay |

| Shrink Swell Index (AS 1289 7.1.1 & 2.1.1) | |
|---|---|
| **Iss (%)** | **4.7** |
| Visual Description | Sandy Clay |
| * Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction. | |

| Core Shrinkage Test | |
|---|---|
| **Shrinkage Strain - Oven Dried (%)** | **7.7** |
| Estimated % by volume of significant inert inclusions | 0 |
| Cracking | Slightly Cracked |
| Crumbling | No |
| Moisture Content (%) | 23.6 |

| Swell Test | |
|---|---|
| Initial Pocket Penetrometer (kPa) | 400 |
| Final Pocket Penetrometer (kPa) | 300 |
| Initial Moisture Content (%) | 23.2 |
| Final Moisture Content (%) | 29.1 |
| **Swell (%)** | **1.4** |
| * NATA Accreditation does not cover the performance of pocket penetrometer readings. | |



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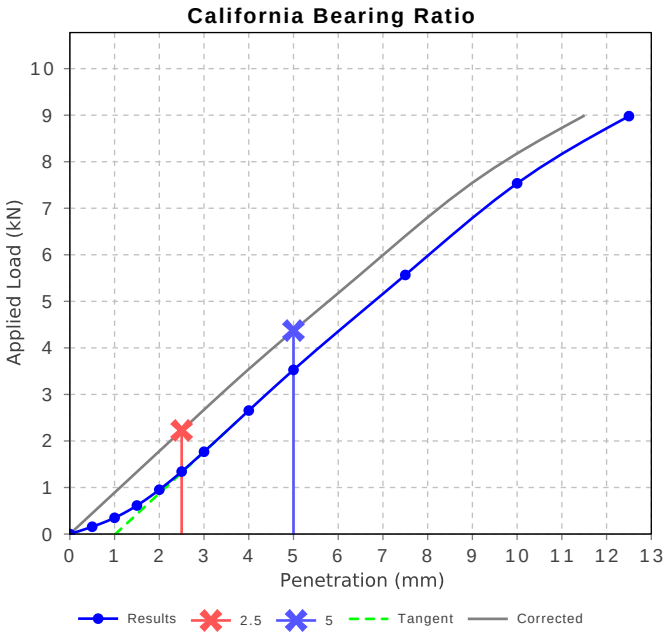
| **Report Number:** | **81520.01-1** |
| **Issue Number:** | 4 - *This version supersedes all previous issues* |
| **Reissue Reason:** | *Updated Sample description* |
| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty |
| | Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685H |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 09/11/2021 |
| **Sampling Method:** | Sampled by Douglas Partners |
| | *The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **105, Depth: 0.4-0.7m** |
| **Material:** | Silty Sand |

| California Bearing Ratio (AS 1289 6.1.1 & 2.1.1) | | Min | Max |
|---|---|---|---|
| CBR taken at | 5 mm | | |
| CBR % | **20** | | |
| 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$^3$) | 1.74 | | |
| Optimum Moisture Content (%) | 14.0 | | |
| Laboratory Density Ratio (%) | 99.5 | | |
| Laboratory Moisture Ratio (%) | 98.5 | | |
| Dry Density after Soaking (t/m$^3$) | 1.74 | | |
| Field Moisture Content (%) | 16.3 | | |
| Moisture Content at Placement (%) | 13.6 | | |
| Moisture Content Top 30mm (%) | 14.9 | | |
| Moisture Content Rest of Sample (%) | 11.9 | | |
| Mass Surcharge (kg) | 4.5 | | |
| Soaking Period (days) | 4 | | |
| Curing Hours | 163.4 | | |
| Swell (%) | 0.0 | | |
| Oversize Material (mm) | 19 | | |
| Oversize Material Included | Excluded | | |
| Oversize Material (%) | 0.0 | | |




| Emerson Class Number of a Soil (AS 1289 3.8.1) | | Min | Max |
|---|---|---|---|
| Emerson Class | **3** | | |
| Soil Description | Silty Sand | | |
| Nature of Water | Distilled | | |
| Temperature of Water ($^o$C) | 20 | | |

| Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) | | Min | Max |
|---|---|---|---|
| Sample History | Oven Dried | | |
| Preparation Method | Dry Sieve | | |
| Liquid Limit (%) | Not Obtainable | | |
| Plastic Limit (%) | Not Obtainable | | |
| **Plasticity Index (%)** | **Non Plastic** | | |

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Laboratory Manager
Laboratory Accreditation Number: 828

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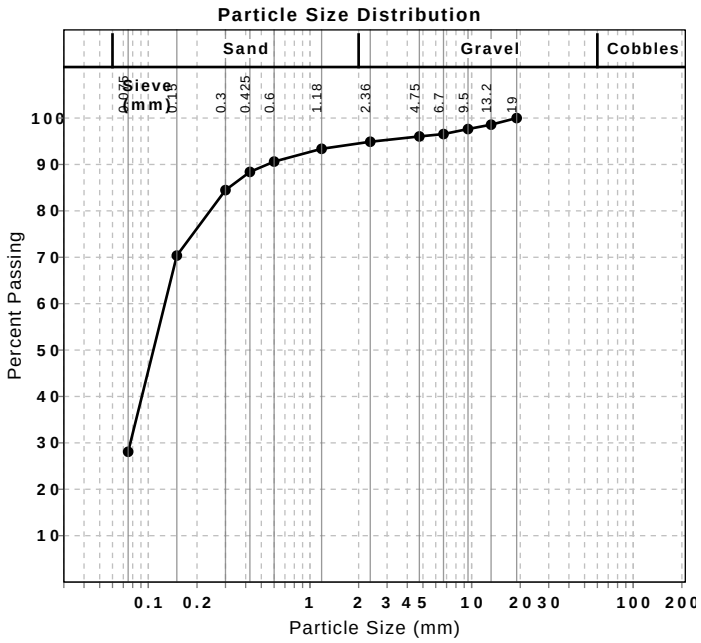
|---|---|
| **Report Number:** | **81520.01-1** |
| **Issue Number:** | 4 - *This version supersedes all previous issues* |
| **Reissue Reason:** | *Updated Sample description* |
| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty<br>Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685H |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 09/11/2021 |
| **Sampling Method:** | Sampled by Douglas Partners<br>*The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **105, Depth: 0.4-0.7m** |
| **Material:** | Silty Sand |

| Particle Size Distribution (AS1289 3.6.1) | | | |
|---|---|---|---|
| Sieve | Passed % | Passing Limits | |
| 19 mm | **100** | | |
| 13.2 mm | **99** | | |
| 9.5 mm | **98** | | |
| 6.7 mm | **97** | | |
| 4.75 mm | **96** | | |
| 2.36 mm | **95** | | |
| 1.18 mm | **93** | | |
| 0.6 mm | **91** | | |
| 0.425 mm | **88** | | |
| 0.3 mm | **84** | | |
| 0.15 mm | **70** | | |
| 0.075 mm | **28** | | |



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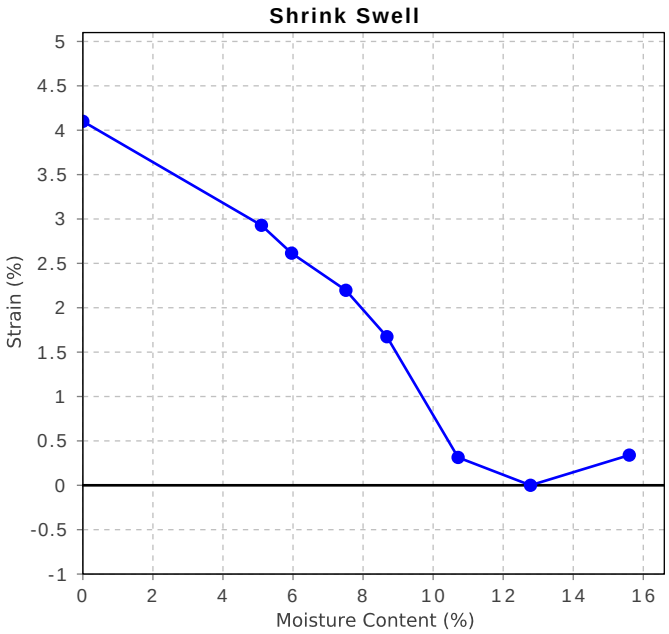
| **Issue Number:** | 4 - *This version supersedes all previous issues* |
| **Reissue Reason:** | *Updated Sample description* |
| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty |
| | Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685H |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 05/11/2021 |
| **Sampling Method:** | Sampled by Douglas Partners |
| | *The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **105, Depth: 0.4-0.7m** |
| **Material:** | Silty Sand |

| Shrink Swell Index (AS 1289 7.1.1 & 2.1.1) | |
|---|---|
| **Iss (%)** | **2.3** |
| Visual Description | Silty Sand |
| * Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction. | |
| Remoulded SH/SW | |

| Core Shrinkage Test | |
|---|---|
| **Shrinkage Strain - Oven Dried (%)** | **4.1** |
| Estimated % by volume of significant inert inclusions | 0 |
| Cracking | Slightly Cracked |
| Crumbling | No |
| Moisture Content (%) | 12.8 |

| Swell Test | |
|---|---|
| Initial Pocket Penetrometer (kPa) | 250 |
| Final Pocket Penetrometer (kPa) | 170 |
| Initial Moisture Content (%) | 12.6 |
| Final Moisture Content (%) | 15.6 |
| **Swell (%)** | **-0.3** |
| * NATA Accreditation does not cover the performance of pocket penetrometer readings. | |



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| | |
|---|---|
| **Report Number:** | **81520.01-1** |
| **Issue Number:** | 4 - *This version supersedes all previous issues* |
| **Reissue Reason:** | *Updated Sample description* |
| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty |
| | Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685I |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 09/11/2021 |
| **Sampling Method:** | Sampled by Douglas Partners |
| | *The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **105 , Depth: 0.7-1.0m** |
| **Material:** | Sandy Clay |

| Moisture Content (AS 1289 2.1.1) | |
|---|---|
| Moisture Content (%) | 15.9 |

| Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) | | Min | Max |
|---|---|---|---|
| Sample History | Oven Dried | | |
| Preparation Method | Dry Sieve | | |
| Liquid Limit (%) | 33 | | |
| Plastic Limit (%) | 17 | | |
| **Plasticity Index (%)** | **16** | | |

| Linear Shrinkage (AS1289 3.4.1) | | Min | Max |
|---|---|---|---|
| Moisture Condition Determined By | AS 1289.3.1.2 | | |
| Linear Shrinkage (%) | 7.0 | | |
| Cracking Crumbling Curling | Cracking | | |

# Material Test Report

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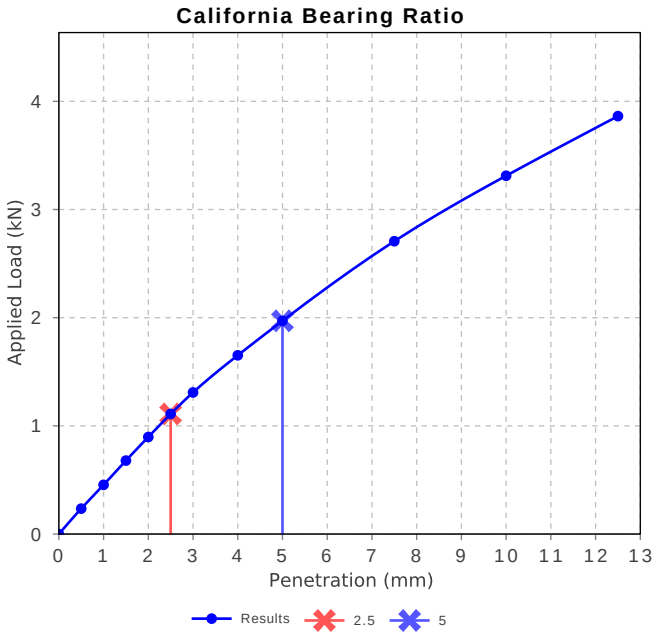
| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty<br>Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685J |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 08/11/2021 |
| **Sampling Method:** | Sampled by Douglas Partners<br>*The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **106, Depth: 0.6-0.8m** |
| **Material:** | Sandstone |

| California Bearing Ratio (AS 1289 6.1.1 & 2.1.1) | | Min | Max |
|---|---|---|---|
| CBR taken at | 5 mm | | |
| CBR % | **10** | | |
| 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$^3$) | 1.77 | | |
| Optimum Moisture Content (%) | 17.0 | | |
| Laboratory Density Ratio (%) | 101.5 | | |
| Laboratory Moisture Ratio (%) | 94.0 | | |
| Dry Density after Soaking (t/m$^3$) | 1.80 | | |
| Field Moisture Content (%) | 15.4 | | |
| Moisture Content at Placement (%) | 15.8 | | |
| Moisture Content Top 30mm (%) | 18.2 | | |
| Moisture Content Rest of Sample (%) | 18.0 | | |
| Mass Surcharge (kg) | 4.5 | | |
| Soaking Period (days) | 4 | | |
| Curing Hours | 77.5 | | |
| Swell (%) | 0.0 | | |
| Oversize Material (mm) | 19 | | |
| Oversize Material Included | Excluded | | |
| Oversize Material (%) | 35.4 | | |



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| **Date Issued:** | 07/12/2021 |
| **Client:** | Loxford Project Management Pty |
| | Suite 2, Ground Floor, Newcastle NSW 2300 |
| **Project Number:** | 81520.01 |
| **Project Name:** | Proposed Residential Subdivision |
| **Project Location:** | Cessnock Road, Gillieston Heights NSW |
| **Work Request:** | 7685 |
| **Sample Number:** | NC-7685K |
| **Date Sampled:** | 19/10/2021 |
| **Dates Tested:** | 22/10/2021 - 09/11/2021 |
| **Sampling Method:** | Sampled by Douglas Partners |
| | *The results apply to the sample as received* |
| **Preparation Method:** | AS 1289.1.1 - Sampling and preparation of soils |
| **Sample Location:** | **106 , Depth: 0.4-0.6m** |
| **Material:** | Silty Clay |

| Moisture Content (AS 1289 2.1.1) | |
|---|---|
| Moisture Content (%) | 14.7 |

| Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1) | | Min | Max |
|---|---|---|---|
| Sample History | Oven Dried | | |
| Preparation Method | Dry Sieve | | |
| Liquid Limit (%) | 37 | | |
| Plastic Limit (%) | 19 | | |
| **Plasticity Index (%)** | **18** | | |

| Linear Shrinkage (AS1289 3.4.1) | | Min | Max |
|---|---|---|---|
| Moisture Condition Determined By | AS 1289.3.1.2 | | |
| Linear Shrinkage (%) | 10.5 | | |
| Cracking Crumbling Curling | None | | |

**Envirolab Services Pty Ltd**
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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 280819

## Client Details

| | |
|---|---|
| **Client** | Douglas Partners Newcastle |
| **Attention** | Julie Wharton |
| **Address** | Box 324 Hunter Region Mail Centre, Newcastle, NSW, 2310 |

## Sample Details

| | |
|---|---|
| **Your Reference** | **81520.01, Gillieston Heights** |
| **Number of Samples** | 5 Soil |
| **Date samples received** | 21/10/2021 |
| **Date completed instructions received** | 21/10/2021 |

## 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** | 28/10/2021 |
| **Date of Issue** | 28/10/2021 |

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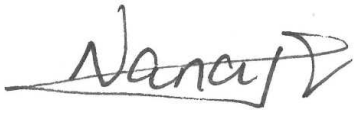
**Results Approved By**
Hannah Nguyen, Metals Supervisor
Priya Samarawickrama, Senior Chemist

**Authorised By**



Nancy Zhang, Laboratory Manager

| Soil Aggressivity | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 280819-1 | 280819-2 | 280819-3 | 280819-4 | 280819-5 |
| Your Reference | UNITS | 102 | 103 | 104 | 105 | 106 |
| Depth | | 1.0 | 0.9 | 0.65 | 0.4 | 0.4 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date Sampled | | 22/10/2021 | 24/10/2021 | 26/10/2021 | 27/10/2021 | 30/10/2021 |
| pH 1:5 soil:water | pH Units | 5.4 | 5.1 | 5.7 | 6.0 | 5.5 |
| Electrical Conductivity 1:5 soil:water | µS/cm | 22 | 48 | 37 | 10 | 37 |
| Chloride, Cl 1:5 soil:water | mg/kg | <10 | 20 | 23 | <10 | 10 |
| Sulphate, SO4 1:5 soil:water | mg/kg | 20 | 36 | 25 | <10 | 21 |

| ESP/CEC | | | | | | |
|---|---|---|---|---|---|---|
| Our Reference | | 280819-1 | 280819-2 | 280819-3 | 280819-4 | 280819-5 |
| Your Reference | UNITS | 102 | 103 | 104 | 105 | 106 |
| Depth | | 1.0 | 0.9 | 0.65 | 0.4 | 0.4 |
| Type of sample | | Soil | Soil | Soil | Soil | Soil |
| Date Sampled | | 22/10/2021 | 24/10/2021 | 26/10/2021 | 27/10/2021 | 30/10/2021 |
| Date prepared | - | 28/10/2021 | 28/10/2021 | 28/10/2021 | 28/10/2021 | 28/10/2021 |
| Date analysed | - | 28/10/2021 | 28/10/2021 | 28/10/2021 | 28/10/2021 | 28/10/2021 |
| Exchangeable Ca | meq/100g | <0.1 | <0.1 | <0.1 | <0.1 | 0.3 |
| Exchangeable K | meq/100g | 0.1 | 0.2 | 0.1 | <0.1 | 0.4 |
| Exchangeable Mg | meq/100g | 1.4 | 2.9 | 1.8 | 0.2 | 5.6 |
| Exchangeable Na | meq/100g | 0.1 | 0.2 | 0.6 | <0.1 | 0.7 |
| Cation Exchange Capacity | meq/100g | 1.7 | 3.3 | 2.5 | <1 | 7.0 |
| ESP | % | 8 | 7 | 23 | [NT] | 10 |

| 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-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. |
| **Metals-020** | Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish. |

| QUALITY CONTROL: Soil Aggressivity | | | | | Duplicate | | | | Spike Recovery % | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Description | Units | PQL | Method | Blank | # | Base | Dup. | RPD | LCS-1 | [NT] |
| pH 1:5 soil:water | pH Units | | Inorg-001 | [NT] | [NT] | [NT] | [NT] | [NT] | 102 | [NT] |
| Electrical Conductivity 1:5 soil:water | µS/cm | 1 | Inorg-002 | <1 | [NT] | [NT] | [NT] | [NT] | 102 | [NT] |
| Chloride, Cl 1:5 soil:water | mg/kg | 10 | Inorg-081 | <10 | [NT] | [NT] | [NT] | [NT] | 91 | [NT] |
| Sulphate, SO4 1:5 soil:water | mg/kg | 10 | Inorg-081 | <10 | [NT] | [NT] | [NT] | [NT] | 90 | [NT] |

| QUALITY CONTROL: ESP/CEC | | | | | | Duplicate | | | Spike Recovery % | |
|---|---|---|---|---|---|---|---|---|---|---|
| Test Description | Units | PQL | Method | Blank | # | Base | Dup. | RPD | LCS-1 | [NT] |
| Date prepared | - | | | 28/10/2021 | [NT] | [NT] | [NT] | [NT] | 28/10/2021 | [NT] |
| Date analysed | - | | | 28/10/2021 | [NT] | [NT] | [NT] | [NT] | 28/10/2021 | [NT] |
| Exchangeable Ca | meq/100g | 0.1 | Metals-020 | <0.1 | [NT] | [NT] | [NT] | [NT] | 94 | [NT] |
| Exchangeable K | meq/100g | 0.1 | Metals-020 | <0.1 | [NT] | [NT] | [NT] | [NT] | 99 | [NT] |
| Exchangeable Mg | meq/100g | 0.1 | Metals-020 | <0.1 | [NT] | [NT] | [NT] | [NT] | 97 | [NT] |
| Exchangeable Na | meq/100g | 0.1 | Metals-020 | <0.1 | [NT] | [NT] | [NT] | [NT] | 109 | [NT] |

## 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.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

## 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 (not SPOCAS); 60-140% for organics/SPOCAS (+/-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.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

## Report Comments

ESP: Where the exchangeable Sodium is less than the PQL and CEC is less than 10meq/100g, the ESP cannot be calculated.

# Appendix C

Data from Previous Reports (Logs and Laboratory Results)

# TEST PIT LOG

**CLIENT:**
**PROJECT:**
**LOCATION:** Loxford

**SURFACE LEVEL:** 32.0 AHD*
**EASTING:** 361669
**NORTHING:** 6373237

**PIT No:** 1
**PROJECT No:** 81520
**DATE:** 15/7/2014
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.1 | TOPSOIL - Generally comprising medium dense, dark brown silt topsoil with abundant rootlets | | D | 0.05 | | | | |
| | | SILTSTONE - (Low to medium strength) slightly weathered, highly fractured siltstone with some silt | | D | 0.15 | | | | |
| | | | | D | 0.25 | | | | |
| | 0.35 | SILTSTONE - (Low strength) highly weathered, fragmented, red / brown siltstone | | | 0.35 | | | | |
| | | | | B<br>D | 0.5 | | | | |
| | 0.65 | At 0.6m, tree roots | | | 0.65 | | | | |
| | | SILTSTONE - (Medium to high strength) moderately weathered, fragmented, grey and orange siltstone | | D | 0.9 | | | | |
| | 1 | | | | | | | | 1 |
| | 1.1 | Pit discontinued at 1.1m, refusal | | | | | | | |
| | 2 | | | | | | | | 2 |

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

**RIG:** 10 tonne backhoe with 600mm bucket with teeth

**LOGGED:** Fulham

**SURVEY DATUM:** MGA

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** * Surface level interpolated from contour plan is approximate only.

☐ 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) |

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# TEST PIT LOG

**CLIENT:**
**PROJECT:**
**LOCATION:** Loxford

**SURFACE LEVEL:** 38.5 AHD*
**EASTING:** 361633
**NORTHING:** 6372879

**PIT No:** 2
**PROJECT No:** 81520
**DATE:** 15/7/2014
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | | TOPSOIL - Generally comprising medium dense, dark brown silt topsoil with abundant rootlets, moist | | D | 0.1 | | | | |
| | 0.2 | SILT - Medium dense, brown silt with trace clay, moist | | D | 0.3 | | | | |
| | 0.4 | CLAYEY SILT - Very stiff, red / brown clayey silt, moist | | D | 0.6 | | | | |
| | | From 0.8m, grading to rock | | D | 0.85 | | | | |
| | 0.9 | SILTSTONE - (Low to medium strength) moderately weathered, fractured to highly fractured, orange and grey siltstone | | B<br>D | 0.9<br>1.0 | | | | |
| | 1 | | | | 1.1 | | | | |
| | | From 1.1m, (medium to high strength) slightly weathered, highly fractured, grey with some orange siltstone | | D | 1.15 | | | | |
| | 1.2 | Pit discontinued at 1.2m, slow progress | | | | | | | |

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

**RIG:** 10 tonne backhoe with 600mm bucket with teeth

**LOGGED:** Fulham

**SURVEY DATUM:** MGA

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** * Surface level interpolated from contour plan is approximate only.

☐ 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) |

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# TEST PIT LOG

**CLIENT:**
**PROJECT:**
**LOCATION:** Loxford

**SURFACE LEVEL:** 21.5 AHD*
**EASTING:** 361443
**NORTHING:** 6373293

**PIT No:** 3
**PROJECT No:** 81520
**DATE:** 15/7/2014
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | | TOPSOIL - Generally comprising medium dense, dark brown silt topsoil, damp | | D | 0.1 | | | | |
| | 0.2 | SILT - Loose to medium dense, brown silt with trace clay and trace rootlets, damp | | D | 0.4 | | | | |
| | 0.6 | CLAYEY SILT - Stiff to very stiff, orange mottled grey clayey silt, M<Wp<br>From 0.8m, tree roots | | D | 0.9 | | pp = 230-300 | | |
| | 1.2 | SILTSTONE - (Low to medium strength) moderately weathered, highly fractured, brown and grey siltstone | | D | 1.3 | | | | |
| | 1.55 | Pit discontinued at 1.55m, refusal | | | | | | | |

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

**RIG:** 10 tonne backhoe with 600mm bucket with teeth

**LOGGED:** Fulham

**SURVEY DATUM:** MGA

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** * Surface level interpolated from contour plan is approximate only.

☐ 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) |

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# TEST PIT LOG

**CLIENT:**
**PROJECT:**
**LOCATION:** Loxford

**SURFACE LEVEL:** 35.5 AHD*
**EASTING:** 361488
**NORTHING:** 6373125

**PIT No:** 4
**PROJECT No:** 81520
**DATE:** 15/7/2014
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.15 | TOPSOIL - Generally comprising loose to medium dense, dark brown silt topsoil with abundant rootlets, and trace clay, moist | | | | | | | |
| | | SILT - Medium dense / stiff, dark brown silt with trace clay, moist | | D | 0.25 | | | | |
| | 0.35 | CLAYEY SILT - Stiff to very stiff, orange and grey clayey silt, M<Wp | | D | 0.5 | | pp = 120-150 | | |
| | 0.7 | SILTSTONE - (Low strength) highly weathered, orange and grey siltstone | | D | 0.9 | | | | |
| 1 | | | | | | | | | 1 |
| | | From 1.6m, (Low to medium strength) highly weathered, fractured, red and grey | | D | 1.5 | | | | |
| | | | | D | 1.8 | | | | |
| | 1.9 | Pit discontinued at 1.9m. slow progress | | | | | | | |
| 2 | | | | | | | | | 2 |

**RIG:** 10 tonne backhoe with 600mm bucket with teeth

**LOGGED:** Fulham

**SURVEY DATUM:** MGA

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** * Surface level interpolated from contour plan is approximate only.

☐ 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) |

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# TEST PIT LOG

**CLIENT:**
**PROJECT:**
**LOCATION:** Loxford

**SURFACE LEVEL:** 31.0 AHD*
**EASTING:** 361417
**NORTHING:** 6373042

**PIT No:** 5
**PROJECT No:** 81520
**DATE:** 15/7/2014
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | | TOPSOIL - Generally comprising loose, dark brown silt topsoil with some clay and abundant rootlets, damp | | D | 0.1 | | | | |
| | 0.2 | SILTY CLAY - Firm to stiff, light grey mottled orange or red silty clay, M>Wp | | | 0.2 | | | | |
| | | | | $U_{50}$ | 0.3 | | pp = 80-110 | | |
| | 0.42 | SILTSTONE - (Medium to high strength), moderately weathered, fractured, red and grey siltstone | | B | 0.42 | | | | |
| | | | | D | 0.5 | | | | |
| | 0.55 | Pit discontinued at 0.55m, refusal | | | | | | | |

**RIG:** 10 tonne backhoe with 600mm bucket with teeth

**LOGGED:** Fulham

**SURVEY DATUM:** MGA

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** * Surface level interpolated from contour plan is approximate only.

☐ 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) |

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# TEST PIT LOG

**CLIENT:**
**PROJECT:**
**LOCATION:** Loxford

**SURFACE LEVEL:** 19.0 AHD*
**EASTING:** 361214
**NORTHING:** 6373011

**PIT No:** 6
**PROJECT No:** 81520
**DATE:** 15/7/2014
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | | TOPSOIL - Generally comprising medium dense, brown silt topsoil, with trace clay, humid to damp | | D | 0.1 | | | | |
| | 0.2 | SILT - Medium dense, light brown silt with trace to some fine sized subrounded gravel, damp | | D | 0.3 | | | | |
| | 0.45 | SILTY CLAY - Stiff to very stiff, orange mottled grey silty clay with trace medium sized subangular / subrounded gravel, M>Wp | | D | 0.45<br>0.5 | | pp = 200 | | |
| | | Cable broken at 0.7m depth; pit moved 3m west and recommenced | | $U_{50}$<br>D | 0.7 | | pp = 250-300 | | |
| | | | | | 0.85 | | pp = 200-300 | | |
| 1 | 1.0 | SILTSTONE - (Low strength) highly weathered, fractured, red and orange siltstone | | D | 1.5 | | | | |
| | 1.9 | Pit discontinued at 1.9m, limit of investigation | | | | | | | |
| 2 | | | | | | | | | |

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

**RIG:** 10 tonne backhoe with 600mm bucket with teeth

**LOGGED:** Fulham

**SURVEY DATUM:** MGA

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** * Surface level interpolated from contour plan is approximate only.
High strength rock at 1.2m depth at east end of test pit, >2m at west

☐ 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) |

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# TEST PIT LOG

**CLIENT:**
**PROJECT:**
**LOCATION:** Loxford

**SURFACE LEVEL:** 24.0 AHD*
**EASTING:** 361400
**NORTHING:** 6372856

**PIT No:** 7
**PROJECT No:** 81520
**DATE:** 15/7/2014
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.2 | TOPSOIL - Generally comprising medium dense, brown silt topsoil with abundant rootlets, humid | | | | | | | |
| | | CLAY - Stiff to very stiff, red clay with some silt, M<Wp | | | | | | | |
| | | From 0.4m, very stiff to hard | | D | 0.4 | | pp = 350-450 | | |
| | 0.7 | CLAYEY SILT - Very stiff, grey mottled red clayey silt, with some siltstone fragments, M>Wp | | D | 0.8 | | pp = 200-300 | | |
| | 0.9 | SILTSTONE - (Low strength) highly weathered, grey / brown siltstone | | | | | | | |
| | 1 | | | D | 1.2 | | | | 1 |
| | | From 1.6m, (low to medium strength), moderately weathered, fractured | | D | 1.7 | | | | |
| | 1.8 | Pit discontinued at 1.8m, refusal | | | | | | | |
| | 2 | | | | | | | | 2 |

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

**RIG:** 10 tonne backhoe with 600mm bucket with teeth

**LOGGED:** Fulham

**SURVEY DATUM:** MGA

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** * Surface level interpolated from contour plan is approximate only.

☐ 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) |

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# TEST PIT LOG

**CLIENT:**
**PROJECT:**
**LOCATION:** Loxford

**SURFACE LEVEL:** 26.0 AHD*
**EASTING:** 361722
**NORTHING:** 6372614

**PIT No:** 8
**PROJECT No:** 81520
**DATE:** 14/7/2014
**SHEET** 1 OF 1

| RL | Depth (m) | Description of Strata | Graphic Log | Sampling & In Situ Testing: Type | Depth | Sample | Results & Comments | Water | Dynamic Penetrometer Test (blows per 150mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 0.15 | TOPSOIL - Generally comprising medium dense, dark brown, fine grained sandy silt topsoil with abundant rootlets | | D | 0.1 | | | | |
| | | SILT - Medium dense, light brown silt with trace fine grained sand, moist | | D | 0.3 | | | | |
| | 0.6 | SILTY CLAY - Very stiff to hard, grey mottled orange silty clay, M>Wp | | $U_{50}$ | 0.6 | | | | |
| | 1 | | | | 1.0 | | pp >400 | | |
| | 1.5 | CLAY - Hard, light grey mottled orange clay, M<Wp | | D | 1.8 | | pp >400 | | |
| | 2 | 2.0 Pit discontinued at 2.0m, limit of investigation | | | | | | | |

Dynamic Penetrometer Test (blows per 150mm): 5, 10, 15, 20

**RIG:** 10 tonne backhoe with 600mm bucket with teeth

**LOGGED:** Fulham

**SURVEY DATUM:** MGA

**WATER OBSERVATIONS:** No free groundwater observed

**REMARKS:** * Surface level interpolated from contour plan is approximate only.

☐ 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) |

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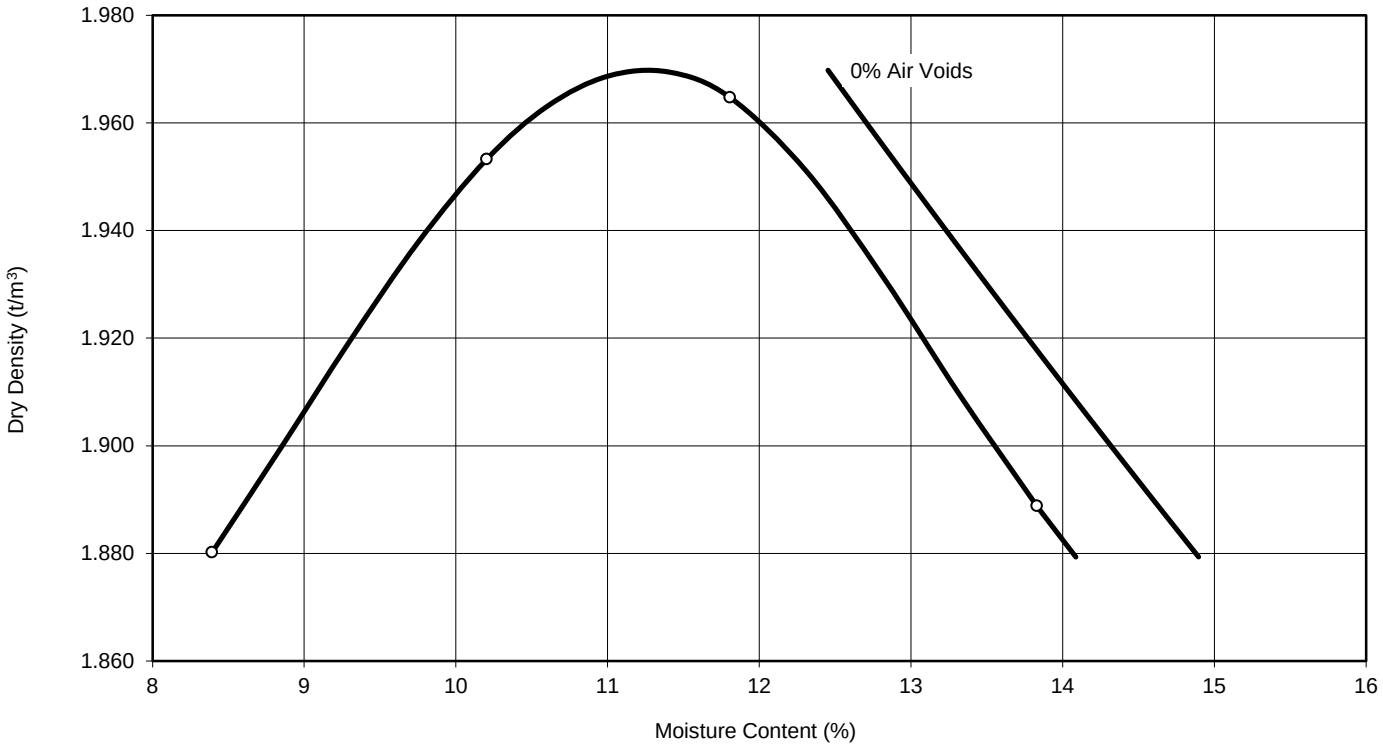
# Results of Compaction Test

| | | | |
|---|---|---|---|
| **Client :** | | **Project No. :** | 81520 |
| | | **Report No. :** | N14-278_1 |
| **Project :** | | **Report Date :** | 30.07.2014 |
| **Location :** | Kurri Kurri / Loxford | **Date of Test:** | 22.07.2014 |
| | | **Page:** | 1 of 1 |




**Sample Details:** **Location:** 2
**Depth:** 0.9 - 1.1m

**Particles > 19mm:** 46%

**Description:** SILTSTONE - Orange grey

| | |
|---|---|
| **Maximum Dry Density:** | **1.97 t/m$^3$** |
| **Optimum Moisture Content:** | **11.5 %** |

**Remarks:** Field Moisture Content - 8.4%

**Test Methods:** AS 1289.5.1.1, AS 1289.2.1.1

**Sampling Methods:** Sampled by DP Engineering Department

NATA Accredited Laboratory Number: 828
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025

| | |
|---|---|
| Tested: | JH |
| Checked: | NH |

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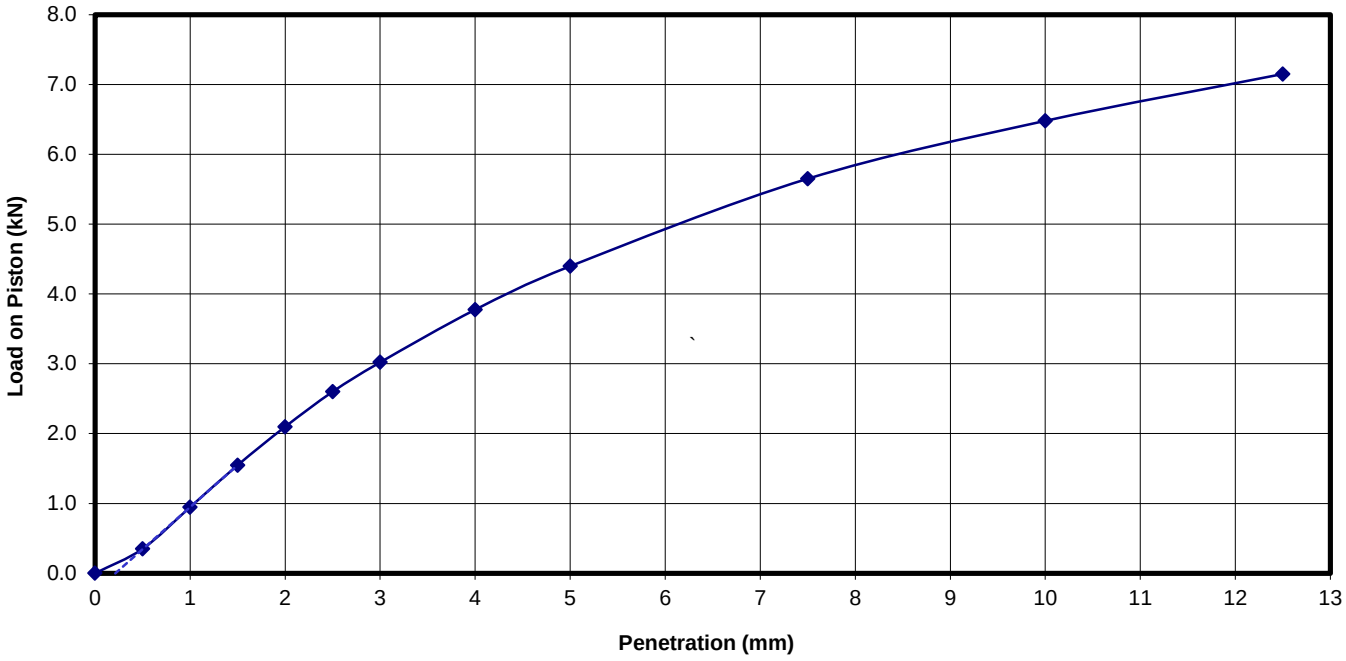
# Result of California Bearing Ratio Test

| | | | |
|---|---|---|---|
| **Client :** | | **Project No. :** | 81520 |
| | | **Report No. :** | N14-278_2 |
| **Project :** | | **Report Date :** | 30.07.2014 |
| | | **Date Sampled :** | 14-16.07.14 |
| **Location :** | Kurri Kurri / Loxford | **Date of Test:** | 28.07.2014 |
| **Test Location :** | 2 | | |
| **Depth / Layer :** | 0.9 - 1.1m | **Page:** | 1 of 1 |




**Description:** SILTSTONE - Orange grey **Test Method(s):** AS 1289.6.1.1, AS 1289.2.1.1

**Sampling Method(s):** Sampled by DP Engineering Department

**Remarks:**

**Percentage > 19mm:** 46.0% (Excluded)

**LEVEL OF COMPACTION:** 98% of STD MDD **SURCHARGE:** 4.5 kg **SWELL:** 0.1%

**MOISTURE RATIO:** 100% of STD OMC **SOAKING PERIOD:** 4 days

| CONDITION | | MOISTURE CONTENT % | DRY DENSITY t/m$^3$ |
|---|---|---|---|
| At compaction | | 11.5 | 1.94 |
| After soaking | | 13.9 | 1.94 |
| After test | Top 30mm of sample | 14.1 | - |
| | Remainder of sample | 12.9 | - |
| Field values | | 8.4 | - |
| Standard Compaction | | 11.5 | 1.97 |

| RESULTS | | |
|---|---|---|
| **TYPE** | **PENETRATION** | **CBR (%)** |
| **TOP** | **5.0mm** | **25** |

NATA Accredited Laboratory Number: 828

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| | |
|---|---|
| Tested: | JH |
| Checked: | NH |

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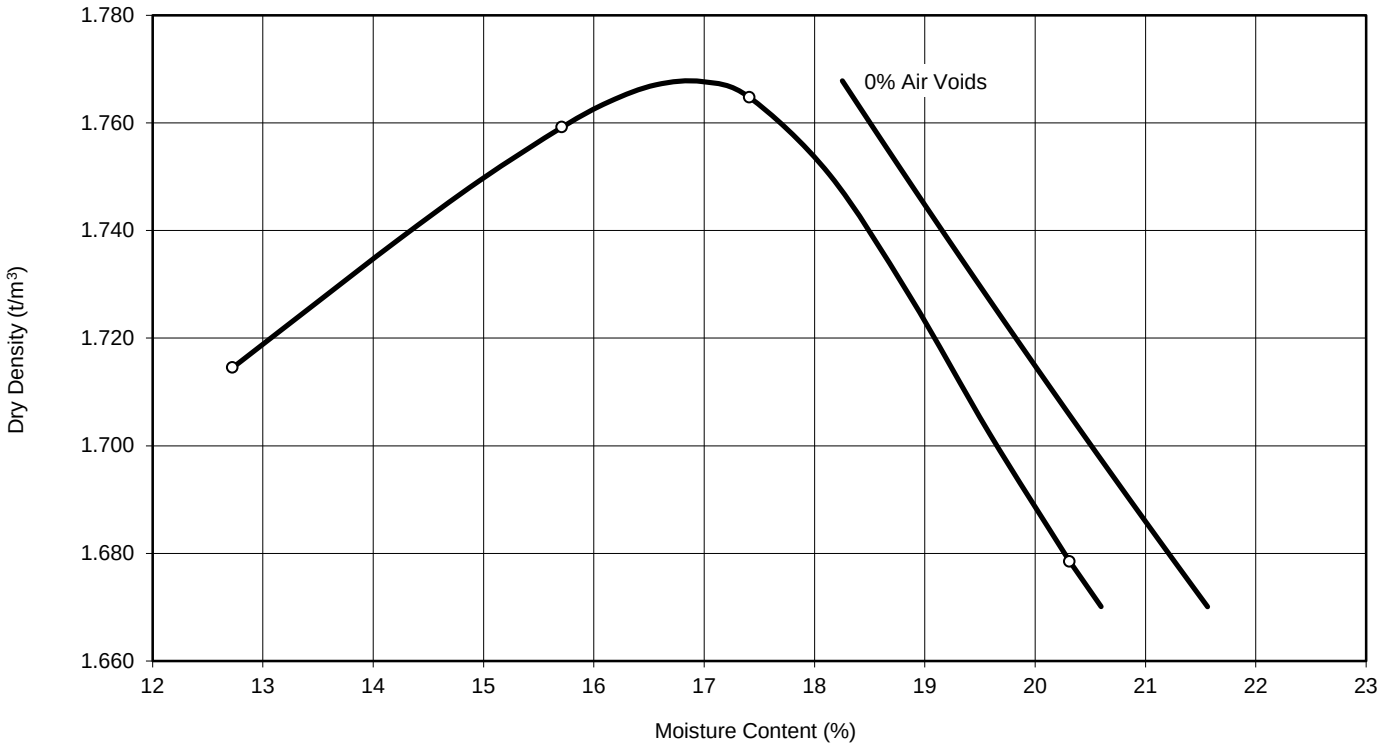
# Results of Compaction Test

| | | | |
|---|---|---|---|
| **Client :** | | **Project No. :** | 81520 |
| | | **Report No. :** | N14-278_3 |
| **Project :** | | **Report Date :** | 30.07.2014 |
| **Location :** | Kurri Kurri / Loxford | **Date of Test:** | 22.07.2014 |
| | | **Page:** | 1 of 1 |




**Sample Details:** **Location:** 5
**Depth:** 0.2 - 0.42m

**Particles > 19mm:** 0%

**Description:** Silty CLAY - Grey mottled orange red

| | |
|---|---|
| **Maximum Dry Density:** | **1.77 t/m$^3$** |
| **Optimum Moisture Content:** | **17.0 %** |

**Remarks:** Field Moisture Content - 19.0%

**Test Methods:** AS 1289.5.1.1, AS 1289.2.1.1

**Sampling Methods:** Sampled by DP Engineering Department

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| | |
|---|---|
| Tested: | MF |
| Checked: | NH |

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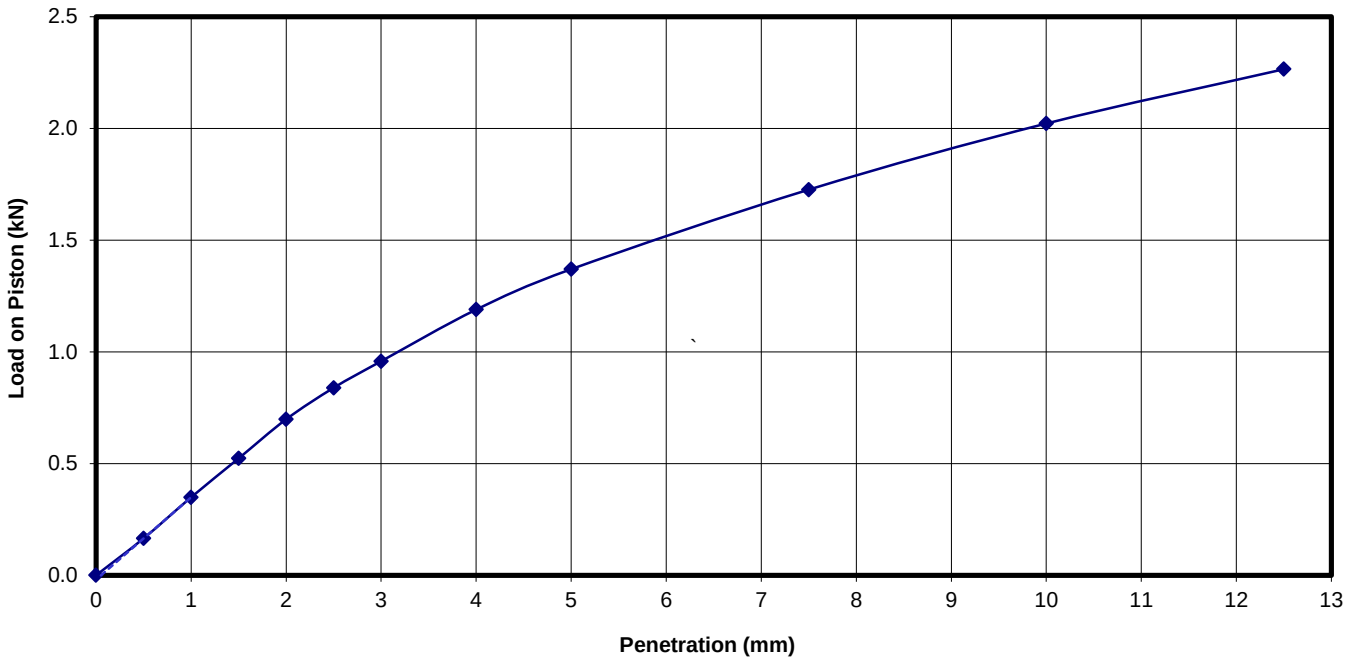
# Result of California Bearing Ratio Test

| | | | |
|---|---|---|---|
| **Client :** | | **Project No. :** | 81520 |
| | | **Report No. :** | N14-278_4 |
| **Project :** | | **Report Date :** | 30.07.2014 |
| | | **Date Sampled :** | 14-16.07.14 |
| **Location :** | Kurri Kurri / Loxford | **Date of Test:** | 28.07.2014 |
| **Test Location :** | 5 | | |
| **Depth / Layer :** | 0.2 - 0.42m | **Page:** | 1 of 1 |




**Description:** Silty CLAY - Grey orange red **Test Method(s):** AS 1289.6.1.1, AS 1289.2.1.1

**Sampling Method(s):** Sampled by DP Engineering Department

**Remarks:**

**Percentage > 19mm:** 0.0%

**LEVEL OF COMPACTION:** 101% of STD MDD **SURCHARGE:** 4.5 kg **SWELL:** 1.1%

**MOISTURE RATIO:** 98% of STD OMC **SOAKING PERIOD:** 4 days

| CONDITION | | MOISTURE CONTENT % | DRY DENSITY t/m$^3$ |
|---|---|---|---|
| At compaction | | 16.6 | 1.78 |
| After soaking | | 19.4 | 1.76 |
| After test | Top 30mm of sample | 20.4 | - |
| | Remainder of sample | 18.2 | - |
| Field values | | 19.0 | - |
| Standard Compaction | | 17.0 | 1.77 |

| RESULTS | | |
|---|---|---|
| **TYPE** | **PENETRATION** | **CBR (%)** |
| **TOP** | **5.0mm** | **7** |

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| | |
|---|---|
| Tested: | JH |
| Checked: | NH |

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# Result of Shrink-Swell Index Determination

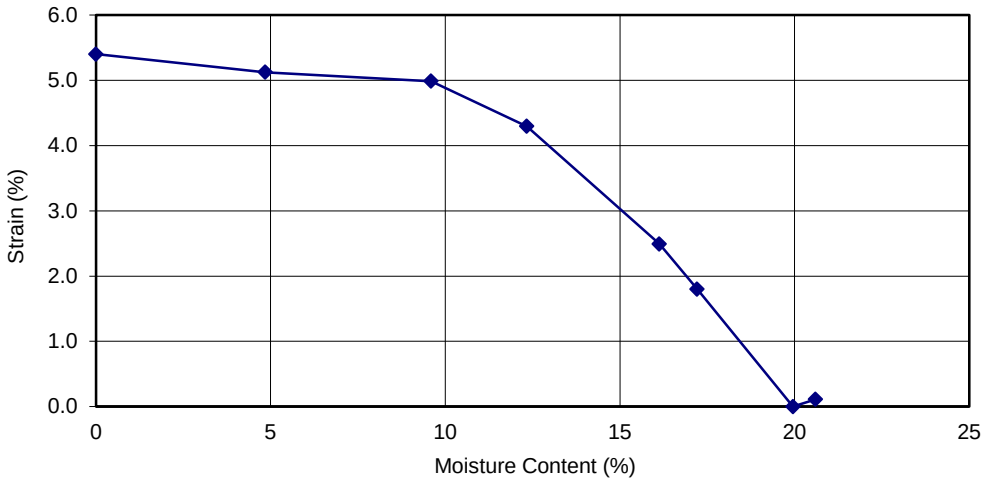
| | | | |
|---|---|---|---|
| **Client :** | | **Project No. :** | 81520.00 |
| | | **Report No. :** | N14-278_11 |
| **Project :** | | **Report Date :** | 30.07.2014 |
| | | **Date Sampled :** | 14-16.07.14 |
| **Location :** | Kurri Kurri / Loxford | **Date of Test:** | 21.07.2014 |
| **Test Location :** | 5 | | |
| **Depth / Layer :** | 0.3 - 0.42m | **Page:** | 1 of 1 |

## CORE SHRINKAGE TEST

| | |
|---|---|
| Shrinkage - air dried | 5.1 % |
| Shrinkage - oven dried | 5.4 % |
| Significant inert inclusions | Nil % |
| Extent of cracking | SC |
| Extent of soil crumbling | Nil % |
| Moisture content of core | 20.0 % |

## SWELL TEST

| | |
|---|---|
| Pocket penetrometer reading at initial moisture content | 150 kPa |
| Pocket penetrometer reading at final moisture content | 120 kPa |
| Initial Moisture Content | 18.8 % |
| Final Moisture Content | 20.6 % |
| Swell under 25kPa | -0.1 % |




**SHRINK-SWELL INDEX Iss 3.0% per Δ pF**

**Description:** Silty CLAY - Grey mottled orange

**Test Method(s):** AS 1289.7.1.1, AS 1289.2.1.1

**Sampling Method(s):** Sampled by DP Engineering Department

**Extent of Cracking:**
**UC** - Uncracked
**SC** - Slightly cracked
**MC** - Moderately cracked
**HC** - Highly cracked
**FR** - Fractured

**Remarks:**

Note that NATA accreditation does not cover the performance of pocket penetrometer readings

NATA Accredited Laboratory Number: 828

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| | |
|---|---|
| Tested: | NH |
| Checked: | NH |

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# Result of Shrink-Swell Index Determination

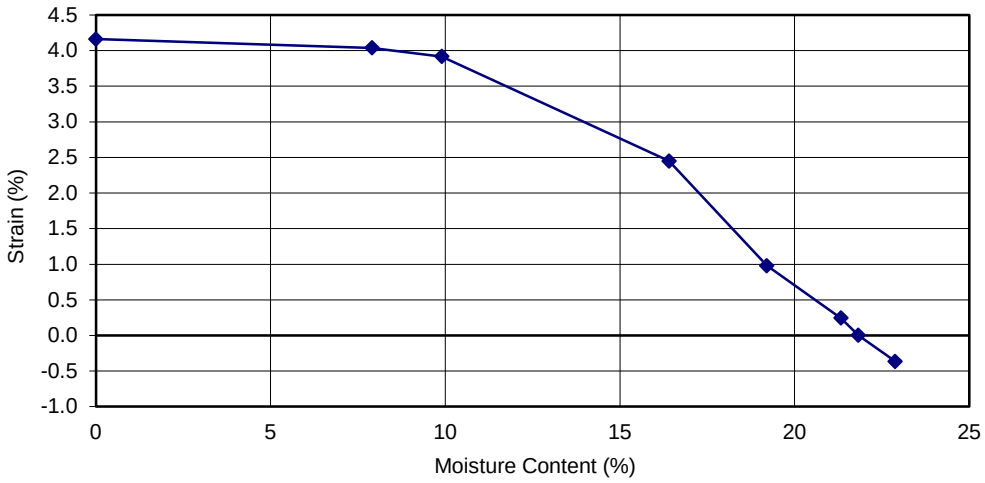
| | | | |
|---|---|---|---|
| **Client :** | | **Project No. :** | 81520.00 |
| | | **Report No. :** | N14-278_12 |
| **Project :** | | **Report Date :** | 30.07.2014 |
| | | **Date Sampled :** | 14-16.07.14 |
| **Location :** | Kurri Kurri / Loxford | **Date of Test:** | 22.07.2014 |
| **Test Location :** | 6A | | |
| **Depth / Layer :** | 0.45 - 0.85m | **Page:** | 1 of 1 |

## CORE SHRINKAGE TEST

| | | |
|---|---|---|
| Shrinkage - air dried | 4.0 | % |
| Shrinkage - oven dried | 4.2 | % |
| Significant inert inclusions | Nil | % |
| Extent of cracking | SC | |
| Extent of soil crumbling | Nil | % |
| Moisture content of core | 21.8 | % |

## SWELL TEST

| | | |
|---|---|---|
| Pocket penetrometer reading at initial moisture content | 270 | kPa |
| Pocket penetrometer reading at final moisture content | 220 | kPa |
| Initial Moisture Content | 18.9 | % |
| Final Moisture Content | 22.9 | % |
| Swell under 25kPa | 0.4 | % |




**SHRINK-SWELL INDEX Iss 2.4% per Δ pF**

**Description:** Silty CLAY - Orange mottled light grey

**Test Method(s):** AS 1289.7.1.1, AS 1289.2.1.1

**Sampling Method(s):** Sampled by DP Engineering Department

**Extent of Cracking:**
**UC** - Uncracked
**SC** - Slightly cracked
**MC** - Moderately cracked
**HC** - Highly cracked
**FR** - Fractured

**Remarks:**

Note that NATA accreditation does not cover the performance of pocket penetrometer readings

NATA Accredited Laboratory Number: 828

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| | |
|---|---|
| Tested: | NH |
| Checked: | NH |

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# Result of Shrink-Swell Index Determination

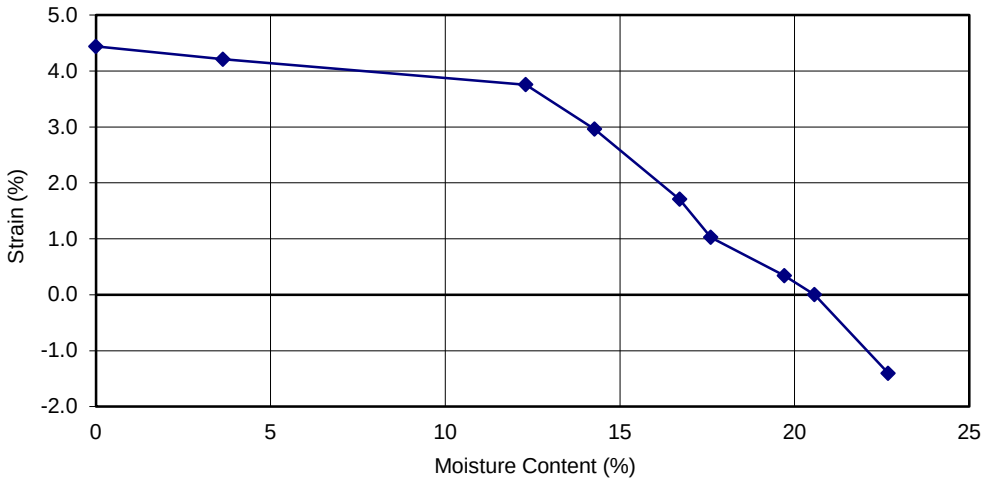
| | | | |
|---|---|---|---|
| **Client :** | | **Project No. :** | 81520.00 |
| | | **Report No. :** | N14-278_13 |
| **Project :** | | **Report Date :** | 30.07.2014 |
| | | **Date Sampled :** | 14-16.07.14 |
| **Location :** | Kurri Kurri / Loxford | **Date of Test:** | 22.07.2014 |
| **Test Location :** | 8 | | |
| **Depth / Layer :** | 0.6 - 1.0m | **Page:** | 1 of 1 |

## CORE SHRINKAGE TEST

| | |
|---|---|
| Shrinkage - air dried | 4.2 % |
| Shrinkage - oven dried | 4.4 % |
| Significant inert inclusions | Nil % |
| Extent of cracking | SC |
| Extent of soil crumbling | Nil % |
| Moisture content of core | 20.6 % |

## SWELL TEST

| | |
|---|---|
| Pocket penetrometer reading at initial moisture content | 160 kPa |
| Pocket penetrometer reading at final moisture content | 120 kPa |
| Initial Moisture Content | 22.2 % |
| Final Moisture Content | 22.7 % |
| Swell under 25kPa | 1.4 % |




**SHRINK-SWELL INDEX Iss 2.9% per Δ pF**

**Description:** Silty CLAY - Light grey mottled orange

**Test Method(s):** AS 1289.7.1.1, AS 1289.2.1.1

**Sampling Method(s):** Sampled by DP Engineering Department

**Extent of Cracking:**
**UC** - Uncracked
**SC** - Slightly cracked
**MC** - Moderately cracked
**HC** - Highly cracked
**FR** - Fractured

**Remarks:**

Note that NATA accreditation does not cover the performance of pocket penetrometer readings

NATA Accredited Laboratory Number: 828

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| | |
|---|---|
| Tested: | NH |
| Checked: | NH |

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# Results of Moisture Content, Plasticity and Linear Shrinkage Tests

**Client:**

**Project:**

**Location:** Kurri Kurri / Loxford

**Project No:** 81520
**Report No:** N14-278_19
**Report Date:** 30.07.2014

**Date Sampled:** 14-16.07.14
**Date of Test:** 25.07.2014
**Page:** 1 of 1

| Test Location | Depth (m) | Description | Code | $W_F$ % | $W_L$ % | $W_P$ % | PI % | *LS % |
|---|---|---|---|---|---|---|---|---|
| 5 | 0.2 – 0.42 | Silty CLAY – Grey mottled orange red | 2,5 | 19.0 | 50 | 19 | 31 | - |
| 6A | 0.45 – 0.85 | Silty CLAY – Orange mottled light grey | 2,5 | 19.8 | 67 | 18 | 49 | - |
| 8 | 0.6 – 1.0 | Silty CLAY – Light grey mottled orange | 2,5 | 22.6 | 74 | 17 | 57 | - |
| 11 | 0.4 – 0.7 | CLAY – Brown | 2,5 | 24.0 | 67 | 18 | 49 | - |
| 16 | 0.05 – 0.4 | SILT – Brown | 2,5 | 9.7 | 19 | 18 | 1 | - |
| 23 | 0.45 – 0.85 | CLAY, slightly silty – Red brown | 2,5 | 22.7 | 88 | 22 | 66 | - |
| 25 | 0.5 – 0.9 | Clayey SILT / Silty CLAY – Grey orange | 2,5 | 22.5 | 45 | 15 | 30 | - |

**Legend:**

$W_F$ Field Moisture Content
$W_L$ Liquid limit
$W_P$ Plastic limit
PI Plasticity index
LS Linear shrinkage from liquid limit condition (Mould length125mm)

**Test Methods:**

Moisture Content: AS 1289 2.1.1
Liquid Limit: AS 1289 3.1.2
Plastic Limit: AS 1289 3.2.1
Plasticity Index: AS 1289 3.3.1

**Code:**

**Sample history for plasticity tests**

1. Air dried
2. Low temperature (<50ºC) oven dried
3. Oven (105ºC) dried
4. Unknown

**Method of preparation for plasticity tests**

5. Dry sieved
6. Wet sieved
7. Natural

**Sampling Methods:** Sampled by DP Engineering Department

**Remarks:**

NATA Accredited Laboratory Number: 828

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Tested: MF
Checked: NH

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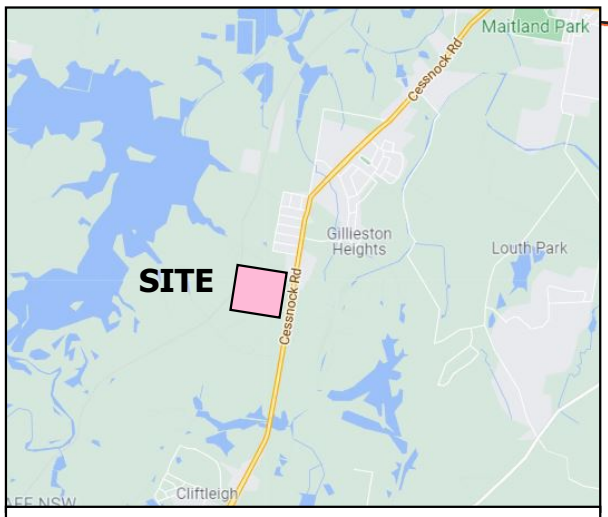
Earthworks Manager

# Appendix D

Drawing 1 -Test Location Plan




Site Location

ROAD MC11
ROAD MC09
ROAD MC10
ROAD MC02
AUBURN STREET
ROAD MC05
ROAD MC03
ROAD MC01
ROAD MC08
ROAD MC15
ROAD MC14
ROAD MC13
ROAD MC12
CESSNOCK ROAD
1022
1023
131
130
326
101
102
103
104
105
106
1
2
3
4
5
6
7
8
DP302745
DP601226

DETAIL PLAN
SCALE 1:1500

level information
DATUM:
CONTOUR INTERVAL:
infrastructure
scale (A1 original size)
notes
social impact

0 50 100 150 200 m

Drawing adapted from Lot Diversity Plam provided by client, ADW Johnson Drawing Ref 240289(1)-DA-012, ver B, dated 28.01.22
Test Locations were located using a differential GPS and are approximate only.

## Legend

- Site Extents
- Approximate Test Pit (Current Investigation)
- Approximate Test Pit (Previous Investigation)

**Douglas Partners**
*Geotechnics / Environment / Groundwater*

TITLE: Test Location Plan
Proposed Residential Subdivision
Cessnock Road, Gillieston Heights

N

OFFICE: Newcastle
DRAWN BY: JAW
DATE: 15.February.2022

CLIENT: Loxford Project Management Pty Ltd
PROJECT No: 81520.01
DRAWING No: 1
REVISION: 1
SCALE: 1:2,500 (A3 Sheet)