Proposed Expansion of Cessnock Correctional Centre Geotechnical Assessment

Lindsay Street, Cessnock

NEW16P-0119-AD
12 September 2016

Qualtest
LABORATORY (NSW) PTY LTD

GEOTECHNICAL I LABORATORY I EARTHWORKS I QUARRY I CONSTRUCTION MATERIAL TESTING

12 September 2016

Lend Lease
L14, International Towers
Exchange Place, 300 Barangaroo Ave
BARANGAROO NSW 2000

Attention: Mr Jeremy Tompson

Dear Sir

RE: PROPOSED EXPANSION OF CESSNOCK CORRECTIONAL CENTRE
LINDSAY STREET, CESSNOCK
GEOTECHNICAL ASSESSMENT

Please find enclosed our Geotechnical Assessment report for the proposed expansion of Cessnock Correctional Centre.

The report includes recommendations for foundation design parameters, Site Classification in accordance with AS2870-2011, "*Residential Slabs and Footings*", pavement design and construction, site earthworks, and assessment of depth to rock and excavation conditions.

Qualtest previously provided a draft geotechnical report (Ref: NEW16P-0119-AA.Draft, dated 26 August 2016) based on a concept site layout which has been since been revised. This report contains results of additional investigations requested by Lend Lease, based upon the proposed relocation of the subject site from the location identified in the draft geotechnical report (comprising rotation of the proposed development by about 90 degrees clockwise and shifting of the proposed footprint to the east).

This report supersedes the draft geotechnical report (Ref: NEW16P-0119-AA.Draft, dated 26 August 2016).

If you have any questions regarding this report, please do not hesitate to contact Shannon Kelly or the undersigned.

For and on behalf of Qualtest Laboratory (NSW) Pty Ltd

Jason Lee
Principal Geotechnical Engineer

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Attachments:

1.0 Introduction

Qualtest Laboratory NSW Pty Ltd (Qualtest) is pleased to present this report to Lend Lease for the proposed expansion of Cessnock Correctional Centre.

This report supersedes the draft geotechnical report (Ref: NEW16P-0119-AA.Draft, dated 26 August 2016) which was based on a concept site layout which has been revised.

Based on the brief provided (email from Lend Lease dated 26 July 2016), subsequent telephone discussions, and a revised concept site layout provided by Lend Lease in an email dated 25 August 2015, the proposed development is understood to comprise a '400 bed proposed maximum' together with new administration buildings, parking and roads adjacent to the east, covering a total plan area about 400m by 300m. It is also understood that site earthworks are likely to involve cut and fill of depths up to about 5m to create a level platform in the area of the proposed 400 bed facility.

The scope of work for the geotechnical investigation included providing discussion and recommendations on the following:

- Site preparation;
- Excavation conditions and depth to rock (where encountered);
- The suitability of the site soils for use as fill and fill construction procedures;
- Foundation design parameters, including recommended bearing pressures and anticipated settlements (for both shallow footings and pier/pile footings);
- Site classification in accordance with AS2870;
- Pavement design and construction;
- Special requirements for construction procedures and or site drainage.

This report presents the results of the field work investigations and laboratory testing, and provides recommendations for the scope outlined above.

2.0 Field Work

Field work investigations were carried out on 4, 9, 10 and 25 August, and 2 September 2016, and comprised of:

- DBYD search and scanning of proposed test locations using an accredited professional cable locator was undertaken to clear proposed test locations for the presence of underground services;
- Site walkover to make observations of surface features at the property and in the immediate surrounding area;
- Drilling of two boreholes (BH01 and BH02) using a truck mounted drilling rig. Borehole BH01 was drilled into weathered rock to a depth of 2.80m using a TC-bit, then cored by NMLC coring techniques to a depth of 8.80m. Borehole BH02 was drilled into weathered rock to a depth of 2.40m using a TC-bit, then cored by NMLC coring techniques to a depth of 8.05m;
- Excavation of 26 test pits (TP01 to TP26) using a 14 tonne tracked excavator equipped with a 700mm wide smooth bladed bucket, to depths of between 0.80m and 2.60m within the proposed development area;

- Excavation of 6 test pits (TP27 to TP31 and TP33) using a 5 tonne tracked excavator equipped with a 450mm wide toothed bucket, to depths of between 1.15m and 2.15m at additional locations nominated by the client within the revised development area, to the east of the originally proposed development area;
- Drilling of three boreholes (BH03 to BH05) using a 4WD mounted drilling rig. Borehole BH03 was drilled into weathered rock to a depth of 3.20m using a TC-bit, then cored by NMLC coring techniques to a depth of 6.05m. Borehole BH04 was drilled into weathered rock to a depth of 2.00m using a TC-bit, then cored by NMLC coring techniques to a depth of 5.63m. Borehole BH05 was drilled into weathered rock to a depth of 4.25m using a TC-bit, then cored by NMLC coring techniques to a depth of 5.60m;
- Undisturbed samples (U50 tubes), small bag samples and bulk disturbed samples were taken for subsequent laboratory testing;
- Test pits were backfilled with the excavation spoil and compacted using the excavator bucket and tracks.

Investigations were carried out by an experienced Senior Geotechnical Engineer and Geotechnical Engineer from Qualtest who located the test pits and boreholes, carried out the sampling and testing, and provided field logs.

Approximate test pit and borehole locations are shown on the attached Figures AD1 and AD2. Test pits and boreholes were located in the field by handheld GPS and relative to existing site features including topographic features, lot boundaries, existing developments and trees.

Engineering logs of the test pits and boreholes are presented in Appendix A.

3.0 Site Description

3.1 Surface Conditions

The subject site is located to the south west of the existing Cessnock Correctional Centre facility off Lindsay Street, Cessnock, NSW, as shown in Figure AD1 and AD2. The subject site is an irregular shaped parcel of land with a plan area of approximately 15 hectares (ha), comprising part of Lot 2 DP76202 and part of Lot 3 DP76202.

The subject site is bounded by the grounds of Cessnock Correctional Centre, generally comprising grounds used for storage of demountable buildings and maintenance facilities to the north and east, and mostly cleared grounds with scattered trees to the south and west. Residential properties and a golf course are located nearby to the south, and a relatively large dam is located on Oaky creek nearby to the west.

Reference to the NSW Land and Property Information Spatial Information Exchange website indicated the elevation of the site ranged from approximately 100m AHD in the eastern portion of the site to 90m AHD in the western portion of the site.

The subject site is positioned on the mid slopes to crest of a gently sloping hill, with a ridge trending in a north-northeast direction roughly bisecting the site. Site surface slopes are generally in the order of about 2° to 4°. The site generally slopes towards the southeast on the eastern side of the ridge. The portion of the site to the west of the ridge slopes towards the southwest in the northern area, and towards the northwest in the southern area.

Surface water would be expected to infiltrate into site soils, with excess surface water draining to the west towards Oaky Creek, and towards the southeast including towards an unnamed dam located outside the south-eastern corner of the site.

The western side of the site is mostly vegetated by maintained grass lands with scattered mature trees and shrubs, with areas of medium dense tree coverage on the south-western area of the site, generally as visible on Figure AD1. A number of demountable buildings are present in the eastern side of the site. Some of the rows of demountable buildings have been subject to shallow cut/fill to make platforms more level. Gravel access roads were observed in the vicinity of the demountable buildings.

A number of fill mounds/stockpiles are present on the site, with approximate extents shown on Figure AD1. Most of the mounds are of depths in the order of 0.5m to 1.5m, with a deeper berm on the southern part of the site.

Photographs of the site taken on the day of the site investigations are shown below.

Photograph 1: From southwest area of the subject site facing west.

Photograph 2: From fill mound near the middle of southern edge of subject site facing northwest.

Photograph 3: From fill mound near the middle of southern edge facing northeast.

Photograph 4: From fill mound near the middle of southern edge facing east.

Photograph 5: From west of the subject site facing northeast.

Photograph 6: From west of the subject site facing east.

Photograph 7 From northwest of the subject site facing southeast.

Photograph 8: From near TP31 facing east.

Photograph 9: From near BH03 facing northeast.

Photograph 10: From near northeast corner of site facing southeast.

Photograph 11: From near northeast corner of site facing southwest.

Photograph 12: From near northeast corner of site facing west.

Photograph 13: From east of site near TP33 facing southwest.

Photograph 14: From east of site facing west. TP33 in background.

Photograph 15: From south-eastern corner of site facing west.

Photograph 16: From south-eastern corner of site facing northwest.

3.2 Subsurface Conditions

Reference to the 1:100,000 Newcastle Coalfield Regional Geology Series Sheet 9231 indicates the site to be underlain by Farley Formation of the Dalwood Group which is characterised by sandstone and siltstone rock types.

Table 1 presents a summary of the typical soil types encountered at test pit and borehole locations during the field investigation, divided into representative geotechnical units.

No water inflows or groundwater levels were encountered in the test pits during the limited time that they remained open on the days of the field investigations. The addition of water to the boreholes for drilling meant that groundwater levels could not be measured during the limited time that the boreholes remained open on the day of the field investigations.

It should be noted that groundwater conditions can vary due to rainfall and other influences including regional groundwater flow, temperature, permeability, recharge areas, surface condition, and subsoil drainage.

TABLE 1 – SUMMARY OF GEOTECHNICAL UNITS AND SOIL TYPES

Unit	Soil Type	Description
1	FILL	Variable materials at different test pit locations including Sandy CLAY and Sandy Clayey GRAVEL – medium to high plasticity, dark grey-brown, fine to medium grained gravel in places, fine to medium grained sand, root affected in places.
2	TOPSOIL	Clayey SAND - low plasticity, dark grey-brown, fine to medium grained sand, trace fine to coarse grained gravel, sub-angular, trace silt, root affected.
3	SLOPEWASH	Clayey SAND and Silty SAND / Sandy SILT – fine to medium grained, dark brown to grey-brown, fines of low plasticity, trace silt, trace rootlets in places. SAND – fine to medium grained, grey-brown, trace silt.
4	RESIDUAL SOIL	CLAY / Sandy CLAY / Clayey SAND – mostly medium and medium to high plasticity, varying colour combinations of orange-brown with some grey / dark grey and/or red-brown, fine grained sand. Mostly very stiff to hard consistency.
5	EXTREMELY WEATHERED (XW) ROCK (with soil properties)	Extremely weathered SANDSTONE with soil properties, breaks down into Gravelly Clayey SAND / Clayey SAND – fine grained, mostly grey with some orange, fine to medium grained gravel in places. Assessed to generally be of extremely low to low rock strength.
6	HIGHLY WEATHERED (HW) to FRESH (FR) ROCK	SANDSTONE / PEBBLY SANDSTONE – fine to medium / fine to coarse grained, varying in colour combinations of dark grey-black, orange-brown to brown and grey, estimated strength ranging from very low to high. Generally fractured or semi-fractured. Generally highly weathered upper rock, becoming moderately weathered to fresh rock at depth in boreholes. Extremely to highly weathered and/or extremely weathered layers in places.

Table 2 contains a summary of the distribution of the above geotechnical units at the test pit and borehole locations.

Very slow progress at close to practical refusal, or practical refusal on rock of the excavator was encountered as indicated in Table 2 and shown on the appended engineering logs.

TABLE 2 – SUMMARY OF GEOTECHNICAL UNITS ENCOUNTERED AT EACH TEST LOCATION

Location	Unit 1 Fill	Unit 2 Topsoil	Unit 3 Slopewash	Unit 4 Residual Soil	Unit 5 Extremely Weathered Rock	Unit 6 HW to FR Rock
	Depth in metres (m)					
Boreholes						
BH01	-	-	0.00 - 0.10	0.10 - 1.00	1.00 - 3.04	3.04 - 8.90
BH02	-	0.00 - 0.05	-	0.05 - 1.50	1.50 - 2.53	2.53 - 8.05
BH03	0.00 - 0.30	-	-	0.30 - 2.90	2.90 - 3.20	3.20 - 6.05
BH04	-	0.00 - 0.10	-	0.10 - 1.00	1.00 - 2.00	2.00 - 5.63
BH05	-	0.00 - 0.15	-	0.15 - 2.80	2.80 - 4.25	4.25 - 5.60
Test Pits						
TP01	0.00 - 0.45	-	-	0.45 - 1.15	1.15 - 1.20*	-
TP02	-	0.00 - 0.25	-	0.25 - 1.85	-	1.85 - 1.90*
TP03	-	0.00 - 0.15	-	0.15 - 1.80	1.80 - 2.40^	-
TP04	-	0.00 - 0.20	-	0.20 - 1.80	1.80 - 2.40^	-
TP05	-	-	0.00 - 0.55	0.55 - 1.80^		-
TP06	0.00 - 0.15	-	-	0.15 - 1.80	1.80 - 2.60^	-
TP07	-	-	0.00 - 0.55	0.55 - 2.05		2.05 - 2.10*
TP08	0.00 - 0.20	-	0.20 - 0.60	0.60 - 1.80	1.80 - 2.00^	-
TP09	-	0.00 - 0.20	-	0.20 - 2.30^	-	-
TP10	-	0.00 - 0.20	-	0.20 - 2.40^	-	-
TP11	-	0.00 - 0.15	-	0.15 - 2.30^	-	-
TP12	-	0.00 - 0.15	-	0.15 - 1.60^	-	-
TP13	-	0.00 - 0.20	-	0.20 - 0.80	0.80 - 0.90*	-
TP14	-	0.00 – 0.24	-	0.24 - 1.00	1.00 - 1.05*	-
TP15	-	0.00 - 0.25	-	0.25 - 2.10^	-	-
TP16	-	0.00 - 0.30	-	0.30 - 2.00^	-	-

Location	Unit 1 Fill	Unit 2 Topsoil	Unit 3 Slopewash	Unit 4 Residual Soil	Unit 5 Extremely Weathered Rock	Unit 6 HW to FR Rock
	Depth in metres (m)					
TP17	-	0.00 – 0.20	-	0.20 - 1.00	1.00 - 1.40^	-
TP18	-	0.00 – 0.10	-	0.10 - 1.70	1.70 - 1.80^	-
TP19	-	0.00 – 0.10	-	0.10 - 0.90	0.90 - 1.00*	-
TP20	-	0.00 - 0.25	-	0.25 - 1.45	-	1.45 - 1.50*
TP21	-	0.00 - 0.24	-	0.24 - 1.80^	-	-
TP22	-	0.00 - 0.08	-	0.08 - 0.80	-	0.80 - 0.85*
TP23	-	0.00 - 0.14	-	0.14 - 0.75	-	0.75 - 0.80*
TP24	-	0.00 - 0.28	-	0.28 - 1.40	1.40 - 1.50*	-
TP25	-	0.00 - 0.20	-	0.20 - 1.00	-	1.00 - 1.10*
TP26	-	0.00 - 0.10	0.10 - 0.30	0.30 - 1.75	-	1.75 - 1.80*
TP27	-	0.00 - 0.10	-	0.10 - 0.90	0.90 - 1.30	1.30 - 1.40*
TP28	-	0.00 - 0.15	-	0.15 - 2.10	-	2.10 - 2.15*
TP29	-	0.00 - 0.10	0.10 - 0.20	0.20 - 1.40	-	1.40 - 1.50*
TP30	0.00 - 0.10	-	0.10 - 0.20	0.20 - 1.05	-	1.05 - 1.15*
TP31	0.00 - 0.15	-	-	0.15 - 1.60	-	1.60 - 1.80*
TP32	0.00 - 0.20	-	-	0.20 - 0.30	-	-
TP33	-	0.00 - 0.10	-	0.10 - 0.80	0.80 - 1.10	1.10 - 1.40

Notes: * = Refusal or Practical refusal of 14 tonne or 5 tonne excavator met on Highly Weathered Rock.

^ = Slow to very slow progress, close to practical refusal of 14 tonne or 5 tonne excavator on Extremely to Highly Weathered Rock.

4.0 Laboratory Testing

Samples collected during the initial field investigations were returned to our NATA accredited Warabrook Laboratory for testing which comprised:

- (11 no.) Shrink / Swell tests;
- (10 no.) Emerson Class tests;
- (5 no.) California Bearing Ratio (4 day soaked) & Standard Compaction.

Results of the laboratory testing are presented in Appendix B, with a summary of the Shrink/Swell, Emerson Class and CBR test results presented in Table 3, Table 4 and Table 5.

TABLE 3 – SUMMARY OF SHRINK / SWELL TESTING RESULTS

Location	Depth (m)	Material Description	I_{ss} (%)
TP10	0.80 – 1.00	(CH) Sandy CLAY	2.1
TP11	0.50 – 0.68	(CH) Sandy CLAY	0.8
TP12	0.50 – 0.75	(CI) Sandy CLAY	2.5
TP17	0.30 – 0.50	(CI) Sandy CLAY	0.5
TP18	0.50 – 0.90	(CL) Sandy CLAY	1.3
TP20	0.50 – 0.75	(CI) Sandy CLAY	2.5
TP21	0.50 – 0.68	(CI) Sandy CLAY	2.8
TP23	0.40 – 0.70	(CI) Sandy CLAY	1.8
TP27	0.20 – 0.50	(CH) CLAY	1.5
TP31	0.30 – 0.60	(CH) CLAY	2.7
TP33	0.30 – 0.60	(CH) CLAY	0.4

TABLE 4 – SUMMARY OF EMERSON CLASS TESTING RESULTS

Location	Depth (m)	Material Description	EMERSON CLASS
TP03	0.30 – 0.60	(CH) Sandy CLAY	4
TP08	0.60 – 0.80	(CI) Sandy CLAY	2
TP11	0.50 – 0.70	(CH) Sandy CLAY	2
TP18	0.60 – 0.80	(CL) Sandy CLAY	2
TP20	0.50 – 0.75	(CI) Sandy CLAY	2
TP22	0.30 – 0.60	(CI) Sandy CLAY	2
TP23	0.40 – 0.70	(CI) Sandy CLAY	1
TP27	0.20 – 0.50	(CH) CLAY	3
TP29	0.30 – 0.50	(CH) CLAY	3
TP30	0.25 – 0.50	(CH) CLAY	3

TABLE 5 – SUMMARY OF CBR TESTING RESULTS

Location	Sample Depth (m)	Field Moisture Content (%)	Optimum Moisture Content (%)	Relationship of Field MC to OMC (%)	CBR (%)
TP03	0.30 – 0.50	23.8	23.6	0.2 wet	2.5
TP04	0.30 – 0.50	13.7	14.7	1.0 dry	2.0
TP27	0.20 – 0.50	19.8	20.9	1.1 dry	2.0
TP29	0.30 – 0.50	17.4	21.6	4.2 dry	2.5
TP30	0.25 – 0.50	27.1	27.5	0.4 dry	2.5

5.0 Discussion and Recommendations

5.1 Site Classification to AS2870-2011

Based on the results of the field work and laboratory testing the subject site of the proposed expansion of Cessnock Correctional Centre shown on Figure AD2 is classified in its current condition in accordance with AS2870-2011 *'Residential Slabs and Footings'*, as **Class 'M'**, for areas not affected by filling.

Areas affected by fill are classified as **Class 'P'**. These areas are classified as **Class 'P'** due to the presence or inferred possible presence of fill / fill mounds and/or topsoil to depths of greater than 0.4m. There are no records of the placement or compaction of this material; therefore, it has been assessed to be uncontrolled fill. Approximate extent of filling observed is shown in Figure AD1.

The approximate extent of fill / fill mounds, of depths of greater than 0.4m was assessed based on a limited number of test pits and observations of site topography and survey plans provided by the client. If the extent needs to be known more accurately for planning, design or other purposes, then it should be investigated further.

It is envisaged that if removal of fill mounds is witnessed and documented by a geotechnical authority, then it is likely that these areas could be re-classified as **Class 'M'**.

It is understood that extensive earthworks are proposed to create a large level platform as part of the proposed development. As a preliminary guide, if the site is filled with site won Residual Soil (Unit 4), Weathered Rock (Unit 5 & 6) or similar material, carried out to 'Level 1' criteria as defined in Clause 8.2 – Section 8, of AS3798-2007, and incorporate a reasonable thickness of a non-reactive topsoil layer, these areas are likely to be re-classified as **Class 'H1'**.

It is noted that if fill materials of high reactivity (e.g. Iss greater than about 2.5% to 3.0%) are used, re-graded areas may potentially be re-classified as **Class 'H2'**, dependent on depth of filling carried out.

Final site classification will be dependent on a number of factors, including depth of topsoil, depth of fill and residual soil, reactivity of the natural soil and any fill material placed, and the level of supervision carried out. Re-classification should be confirmed by the geotechnical authority at the time of construction following any site re-grade works.

A characteristic free surface movement of 20mm to 40mm is estimated for areas classified as **Class 'M'** in their existing condition.

A characteristic free surface movement of 40mm to 60mm is estimated for the areas which may be potentially re-classified as **Class 'H1'**.

The effects of changes to the soil profile by additional cutting and filling and the effects of past and future trees should be considered in selection of the design value for differential movement.

Footings for the proposed development should be designed and constructed in accordance with the requirements of AS2870-2011.

The classification presented above assumes that:

- All footings are founded in controlled fill (if applicable) or in the residual clayey soils or rock below all non-controlled fill, topsoil material and root zones, and fill under slab panels meets the requirements of AS2870-2011, in particular, the root zone must be removed prior to the placement of fill materials beneath slabs;
- The performance expectations set out in Appendix B of AS2870-2011 are acceptable, and that site foundation maintenance is undertaken to avoid extremes of wetting and drying;
- Footings are to be founded outside of or below all zones of influence resulting from existing or future service trenches;
- The constructional and architectural requirements for reactive clay sites set out in AS2870-2011 are followed;
- Adherence to the detailing requirement outlined in Section 5 of AS2870-2011 'Residential Slabs and Footings' is essential, in particular Section 5.6, 'Additional requirements for Classes M, H1, H2 and E sites' including architectural restrictions, plumbing and drainage requirements;
- Site maintenance complies with the provisions of CSIRO Sheet BTF 18, "Foundation Maintenance and Footing Performance: A Homeowner's Guide", a copy of which is attached in Appendix C.

If any localised areas of uncontrolled fill of depths greater than 0.4m are encountered during construction, footings should be designed in accordance with engineering principles for Class 'P' sites.

All structural elements on all lots regardless of their site classification should be supported on footings founded beneath all uncontrolled fill, layers of inadequate bearing capacity, soft/loose, wet or other potentially deleterious material.

5.2 Foundation Design Parameters

Strip / pad footings, raft slabs, and conventional bored piles are considered to be suitable foundation options for the proposed development.

Shallow footings founded on very stiff or better Residual Clay (Unit 4), or approved controlled fill (placed under Level 1 supervision in accordance with AS3798-2007) may be proportioned for a maximum allowable bearing pressure of 100kPa, provided they are founded below any existing uncontrolled fill, topsoil, deleterious or soft to firm material.

Shallow footings founded on weathered rock below the depth of backhoe / excavator practical refusal may be proportioned for a maximum allowable bearing pressure of 600kPa.

The recommended allowable (serviceability) bearing pressures assume that settlements will be less than about 1% of least footing width.

Table 6 presents a summary of founding parameters for deep footings (founding depth greater than 3 times maximum footing width) that have been adopted for the relevant materials.

TABLE 6 – SUMMARY OF DEEP FOOTING DESIGN PARAMETERS

Soil Description	Typical Depth Range (m)	Serviceability (Allowable) End Bearing Capacity (kPa)	Serviceability (Allowable) Shaft Adhesion (kPa)	Ultimate End Bearing Capacity (kPa)	Ultimate Shaft Adhesion (kPa)
Unit 1, 2 & 3 - Fill, Topsoil & Slopewash	0.00 to 0.25	-	-	-	-
Unit 4 & 5 - Residual Soil & Extremely Weathered Rock, or Level 1 Controlled Fill	0.25 to 2.60	150	25	450	50
Unit 6 - Highly to Moderately Weathered Rock	1.00 to 3.00 and greater	1000	75	3000	150
Unit 6 - Slightly Weathered to Fresh Rock	3.00 to 6.00 and greater	2000	150	6000	300

Notes:

1) Ultimate values occur at large settlements (>5% of minimum footing dimensions).
2) The ultimate pile parameters presented should be used in limit state pile design in accordance with Australian Standard AS 2159-2009, *Piling – Design and Installation*.
3) A geotechnical strength reduction factor should be adopted for use with the above ultimate soil and rock parameters. A geotechnical strength reduction factor of 0.45 is recommended based on available information at this stage.
4) Piles should be no closer than 2.5 pile diameters apart.
5) It is expected that the settlement of deep footings proportioned as recommended above should not exceed about 1% of the effective pile diameter.

The base of the pile should be cleaned using a suitable bucket to remove spoil, as open flight augers usually cannot remove sufficient spoil to expose the majority of the pile base. If seepage occurs, piles should be dewatered prior to pouring concrete.

A suitably experienced geotechnical engineer should inspect the pile excavations to confirm founding conditions and design parameters prior to pouring concrete.

5.3 Pavement Design

5.3.1 Design Subgrade CBR Value

Based on the results of the field work, laboratory testing, and previous experience in the surrounding area, the following design California Bearing Ratio (CBR) values have been adopted for pavement thickness design.

TABLE 7 – DESIGN SUBGRADE CBR VALUES

Subgrade Material	Design CBR (%)	Comment
Residual Clay Soil	2.0	All pavement sections unless stated otherwise
Weathered Rock	8.0	Ripped and re-compacted

Fill placed at road subgrade level should be assessed by a geotechnical authority. If the fill is assessed to have a CBR different to that of the design CBR, then a revised pavement design will be required for that section.

Subgrade should be prepared in accordance with the site preparation requirements presented in Section 5.7.

5.3.2 Design Traffic Loadings

Design traffic loadings adopted for proposed administration area access roads and parking are in accordance with Cessnock City Council requirements for Urban Residential road type classifications in terms of equivalent standard axles (ESA's) as follows:

- Access Roads and Parking Local Access 3×10^5 ESA's

Traffic loadings for a 'Local Access' road have been adopted to allow for use by garbage trucks, delivery vehicles and trucks.

In the event that different design traffic loadings are applicable, then the pavement thickness designs presented in this report should be reviewed.

5.3.3 Flexible Pavement Thickness Design

Flexible pavement thickness design has been based on the procedures outlined in:

- Cessnock City Council – Engineering Requirements for Development, 4.0 Road Design.
- Austroads, "Guide to Pavement Technology, Part 2: Pavement Structural Design".
- Australian Road Research Board, Special Report No. 41 (ARRB-SR41).

Flexible Pavement Thickness Designs are presented in Table 8.

Pavement Material Specification and Compaction Requirements are presented in Table 9.

TABLE 8 – FLEXIBLE PAVEMENT THICKNESS DESIGN SUMMARY

Road Classification	Local Access		
Road Section	Clay Subgrade	Select Fill	Rock Subgrade
Design Traffic Loading (ESA's)	3×10^5	3×10^5	3×10^5
Design Subgrade CBR (%)	2.0	2.0	8.0
Wearing Course (mm)	30AC	30AC	30AC
Base Course (mm)	150	150	150
Subbase (mm)	360	150	150
Select Fill / Stabilised (mm)	-	300*	-
Total Thickness (mm)	540	630	330

Notes:

1) A 7mm primer seal should be placed over the base course prior to placement of the asphaltic concrete wearing course.
2) An allowance for subgrade replacement should be anticipated in any areas where poor, wet or saturated subgrade conditions are encountered.
3) The requirement for, and depth and extent of any subgrade replacement / select filling, should be confirmed by the geotechnical authority at the time of construction.
4) Where rock subgrade materials are encountered, the rock should be ripped and re-compacted for a minimum depth of 300mm to break-up preferential drainage paths and provide a dense homogenous surface on which to construct the pavement.
5) Prior to pavement construction, the exposed subgrade should be assessed by the geotechnical authority to confirm the pavement thickness requirement for that section.

Alternate pavement designs have been provided for areas where poor subgrade (CBR = 2.0%) or wet subgrade conditions are encountered, including the option of incorporating a select layer to minimise overlying pavement thickness.

A bridging layer should be allowed for beneath the pavement where road pavements cross gullies and in any areas where poor, wet or saturated subgrade conditions are encountered. The requirement (if any) for bridging layers is likely to be dependent on the prevailing weather conditions at the time of construction.

Where weathered rock subgrade materials are encountered at subgrade level, the rock should be ripped and re-compacted for a minimum depth of 300mm to break-up preferential drainage paths and provide a dense homogenous surface on which to construct the pavement. Pavement thickness designs are provided for a weathered rock subgrade.

It is recommended that each construction length be boxed out to the minimum subgrade level required by the relevant pavement thickness design. Prior to pavement construction, the exposed subgrade should be assessed by the geotechnical authority to confirm the pavement thickness requirement for that section.

TABLE 9 – PAVEMENT MATERIAL SPECIFICATION AND COMPACTION REQUIREMENTS

Pavement Course	Material Specification	Compaction Requirements
Wearing Course (AC)	Cessnock City Council Spec.	Cessnock City Council Spec.
Base Course	CBR ≥ 80%, PI ≤ 6%	98% Modified (AS1289 5.2.1)
Subbase	CBR ≥ 30%, PI ≤ 12%	95% Modified (AS1289 5.2.1)
Select Fill / Stabilised Subgrade	Select, CBR ≥ 15%, PI ≤ 15%, max particle size 75mm Or 2% cement stabilised subbase material Or Stabilised Subgrade - lime stabilised with either 3% quicklime or 4% hydrated lime	95% Modified (AS1289 5.2.1)
Subgrade (top 300mm)	Minimum CBR = Refer Table	100% Standard (AS1289 5.1.1)
Subgrade / Fill Below	Minimum CBR = Refer Table	95% Standard (AS1289 5.1.1)

Notes:

1) In accordance with Cessnock City Council Engineering Requirements for Development, pavement materials for sub-base and base course shall comply with A.R.R.B. Special Report No. 41 Section 5, "Pavement Materials".
2) CBR = California Bearing Ratio, PI = Plasticity Index.
3) Select Fill adopted will be dependent on subgrade moisture conditions.

5.3.4 Construction Considerations & Site Drainage

The enclosed pavement thickness designs assume the provision of adequate surface and subsurface drainage of the pavement and adjacent areas. As a minimum, it is recommended that subsoil drains be installed:

- Along the high side of roads aligned across site slopes;
- Along both sides of roads aligned down slope.

Pavement surface and subsurface drainage should be carried out in accordance with Cessnock City Council, Engineering Requirements for Development.

Adequate surface and subsurface drainage should be installed and connected to the stormwater disposal system.

Inspection should be carried out by a geotechnical authority during construction to confirm the conditions assumed in this report and in the design.

Care should be taken to follow recommended construction practices when constructing new pavement adjacent to existing, including:

- A clean, vertical perpendicular surface at full depth should be cut for both transverse and longitudinal jointing. This will reduce the risk of plating and heaving effects on the pavement;
- Ensuring joints are not in wheel paths;
- Ensuring joints in sub-base / select layers are offset to joints in the base layer;
- Ramping between layers, and at the entry and exit points to the pavement, must be removed at all times. During construction, any temporary access ramps to properties or driveways must also be removed.

5.4 Excavation Conditions

The depths of fill, topsoil, slopewash, residual soils and weathered rock, together with depths of practical refusal of the 14 tonne or 5 tonne excavator where encountered are summarised in Table 2. In terms of excavation conditions, site materials can generally be divided into:

- Clayey and Granular Soils (Units 1, 2, 3 & 4). It is anticipated that these materials could be excavated by a conventional excavator or backhoe bucket;
- Weathered Rock (Unit 5 & 6). Rippability is dependent on rock strength, depth, degree of weathering and number of defects within the rock mass which can vary significantly.

It is anticipated that the Weathered Rock (Unit 5 & 6) material encountered could be excavated by conventional 14 to 20 tonne excavator or equivalent at least to the depths indicated on the appended test pit logs.

It is expected that material below the depth of 14 tonne / 5 tonne excavator bucket refusal will be excavatable by ripping to some greater depth.

The five boreholes (BH01 to BH05) indicate that the majority of the rock that is likely to be encountered will be sandstone, pebbly sandstone and interlaminated siltstone and sandstone, of medium to high rock strength, with variable fracture spacings.

Below depths of about 3m to 4m (up to about 5m in places), rock strength and defect spacing increases and it is assessed that the that ripping may become difficult. If these bands are highly fractured, they should still be rippable, but may require additional effort such as impact ripping or a larger dozer. It is recommended that an allowance for rock breakers or pre-splitting prior to ripping be made for areas where such hard bands may be encountered.

The results from the boreholes have been plotted indicatively on Figure AD3 on the excavatability graph published as Figure 10 in the paper by G. S. Pettifer & P.G. Fookes "*A revision of the graphical method for assessing the excavatability of rock", 1994*. This indicates that rock to depths of about 3m to 4m (up to about 5m in places) may be mostly classed as "easy ripping" to "hard ripping" requiring machines equivalent to a Caterpillar D8 Tractor, or larger, equipped with a ripping tine.

It also indicates that below depths of about 3m to 4m conditions are mostly expected to range from "hard ripping" to "blasting required". It would be expected that in a large bulk excavation such as that proposed, where ripping directions can be adjusted readily to optimise ripping direction relative to fracture orientation, the majority of rock would be excavatable by a large dozer such as a Caterpillar D9 to D11 or equivalent equipped with a single ripping tine, with allowance for impact ripping, hydraulic breaking and/or pre-splitting in places. Blasting may be required in some areas to achieve normal rates of production.

Factors other than geotechnical conditions may influence selection of excavation methods. It may be worthwhile attempting ripping using large machinery before resorting to blasting.

Conditions least conducive to ripping were encountered in borehole BH03, where medium to high strength rock was encountered with a large defect spacing possibly in the order of 3m.

The discontinuity spacing index has been estimated to an approximate level based on the defect spacings on the engineering logs and core photographs. The approximate range of point load strength index has been adopted based on the results of laboratory point load tests on Unit 6 Weathered Rock recovered from boreholes BH01 to BH05.

Based on Figure AD3, it is assessed that rippability will be highly dependent on three dimensional defect spacing. This assessment has been largely based on the results of boreholes which may be considered to provide 1 dimensional defect spacing information; therefore, it is recommended that consideration be given to potential for different conditions to be encountered when selecting excavation methods and equipment.

It is recommended that additional targeted investigations are carried out if a better understanding of potential variations in geotechnical conditions are critical to selection of excavation methods and equipment. Only field trials will determine conclusively whether a rock mass can or cannot be excavated using particular methods or plant.

Groundwater may exist at localised areas of the site such as within the topsoil / slopewash profile, from water perched above the residual clay / bedrock profile, or in areas of former drainage channels. It is possible that slow water inflow may be encountered from such layers, particularly if earthworks are carried out during or following periods of wet weather.

Care should be taken not to disturb or destabilise existing underground services or structures.

5.5 Recommended Batter Slopes

Recommended batter slopes for each inferred geotechnical unit are summarised in Table 12.

TABLE 10 - RECOMMENDED BATTER SLOPES

GEOTECHNICAL UNIT	MATERIAL TYPE	MAXIMUM SLOPE OF EXCAVATED UNSUPPORTED BATTER	
		Temporary Excavations *	Permanent Excavations
UNIT 1, 2 & 3	Fill, Topsoil & Slopewash	1V:1.5H	1V:3H
UNIT 4	Residual Soil	1V:1H	1V:2H
UNIT 5	Extremely Weathered Rock	1V:0.5H	1V:1.5H
UNIT 6	Highly Weathered Rock	1V:0.5H	1V:1H
NOTE: * Subject to inspection during excavation to check for water inflow, adversely orientated defects or other conditions that could affect stability of the slope.			

The safe working procedures of Work Cover NSW *Excavation work code of practice*, dated July 2014 should be followed.

5.6 Suitability of Site Materials for Re-Use as Fill

The following comments are made with respect to suitability of site materials for re-use as fill:

- Unit 1 Fill material may be suitable for re-use as general fill for engineering purposes, however this would be subject to contamination testing and waste classification (contamination assessment being carried out and reported separately);
- Unit 2 Topsoil materials are expected to be suitable for landscaping purposes only;
- Unit 3 Slopewash may be variable and suitability for re-use should be confirmed at the time of construction. These materials will likely require some moisture conditioning;
- Unit 4 Residual Soils are generally expected to be suitable for re-use as general fill for engineering purposes. These materials may require some moisture conditioning;
- Unit 5 Extremely Weathered Rock and Unit 6 Highly Weathered Rock are generally expected to be suitable for re-use as general fill for engineering purposes. These materials may require sorting or processing by crushing / screening depending upon excavation methods, source material characteristics and proposed uses.

Final selection of fill materials should consider properties such as reactivity which is typically moderate for site won Unit 4 Residual Soils, and low to moderate for site won Unit 5 Extremely Weathered Rock and Unit 6 Highly Weathered Rock.

Results of Emerson testing provide an indication into potential susceptibility to erosion. The results indicate that most site materials are likely to be dispersive. This means that erosion protection is likely to be required to prevent erosion by rainfall etc. The addition of gypsum may provide improved performance in some cases.

The suitability of material for re-use should be assessed and confirmed by the geotechnical authority at the time of construction.

5.7 Site Preparation

Site preparation and earthworks suitable for pavement support and site re-grading should consist of:

- Following bulk excavation to proposed subgrade level, all areas of proposed pavement construction or site re-grading should be stripped to remove all existing uncontrolled fill, vegetation, topsoil, root affected or other potentially deleterious materials;
- Stripping is generally expected to be required to depths of about 0.1m to 0.3m to remove topsoil and root affected material.
- Stripping of fill material in addition to topsoil and root affected material is anticipated in areas affected by fill mounds as indicated on Figure AD1;
- Additional stripping may be required in any areas where poor, wet or saturated subgrade conditions are encountered;
- Following stripping, the exposed subgrade should be proof rolled (minimum 10 tonne static roller), to identify any wet or excessively deflecting material. Any such areas should be over excavated and backfilled with an approved select material;
- The moisture content of the subgrade materials and therefore the need for moisture conditioning or over-excavation and replacement, will be largely dependent on pre-existing and prevailing weather conditions at the time of construction;

- Subgrade preparation should be carried out using a tracked excavator equipped with a smooth sided ('gummy') bucket to minimise the risk of over-disturbance of soils;
- Protect the area after subgrade preparation to maintain moisture content as far as practicable. The placement of subbase gravel would normally provide adequate protection;
- Site preparation should include provision of drainage and erosion control as required, as well as sedimentation control measures.

Subgrade soils are likely to have a propensity to soften relatively quickly with moisture ingress; therefore, it is particularly important that care be taken to ensure that the subgrade is not exposed to wet conditions.

At the time of the field investigation, moisture content for the clay subgrade material tested varied from 0.2% wet to 4.2% dry of standard Optimum Moisture Content (OMC). It should be anticipated that some moisture conditioning of the subgrade may be necessary prior to compaction and placement of pavement materials.

The required time period to prepare the subgrade is likely to be dependent on the prevailing weather conditions at the time of construction.

If over wet subgrades exist at the time of construction or deleterious fill materials are encountered at subgrade level, these materials should be over-excavated and be replaced with a minimum depth of 300mm of well graded granular select material with CBR of greater than 15%, or a 2% cement stabilised subbase material. The selection of select material where required will be dependent on moisture condition of subgrades at the time of construction.

5.8 Fill Construction Procedures

Earthworks for pavement construction or support of foundations should consist of the following measures:

- Approved fill beneath pavements should be compacted in layers not exceeding 300mm loose thickness to the compaction requirements provided in Table 9;
- The top 300mm of natural subgrade below pavements or the final 300mm of road subgrade fill should be compacted to provide a subgrade that is within the moisture range of 60% to 90% of Optimum Moisture Content (OMC);
- Site fill beneath structures should be compacted to a minimum density ratio of 98% Standard Compaction within ±2% of OMC in cohesive soils;
- All fill should be supported by properly designed and constructed retaining walls or else battered at 1V:2H or flatter and protected against erosion;
- Where fill is to be placed on slopes in excess of 1V:8H (7°), a prepared surface should be benched or stepped into the natural slope;
- Earthworks should be carried out in accordance with the recommendations outlined in AS3798-2007 'Guidelines for Earthworks for Commercial and Residential Developments'.

6.0 Limitations

The findings presented in the report and used as the basis for recommendations presented herein were obtained using normal, industry accepted geotechnical design practices and standards. To our knowledge, they represent a reasonable interpretation of the general conditions of the site.

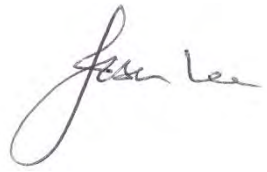
The extent of testing associated with this assessment is limited to discrete test locations. It should be noted that subsurface conditions between and away from the test locations may be different to those observed during the field work and used as the basis of the recommendations contained in this report.

If subsurface conditions encountered during construction differ from those given in this report, further advice should be sought without delay.

Data and opinions contained within the report may not be used in other contexts or for any other purposes without prior review and agreement by Qualtest. If this report is reproduced, it must be in full.

If you have any further questions regarding this report, please do not hesitate to contact Shannon Kelly or the undersigned.

For and on behalf of Qualtest Laboratory (NSW) Pty Ltd.



Jason Lee
Principal Geotechnical Engineer

FIGURES

FIGURE AD1:

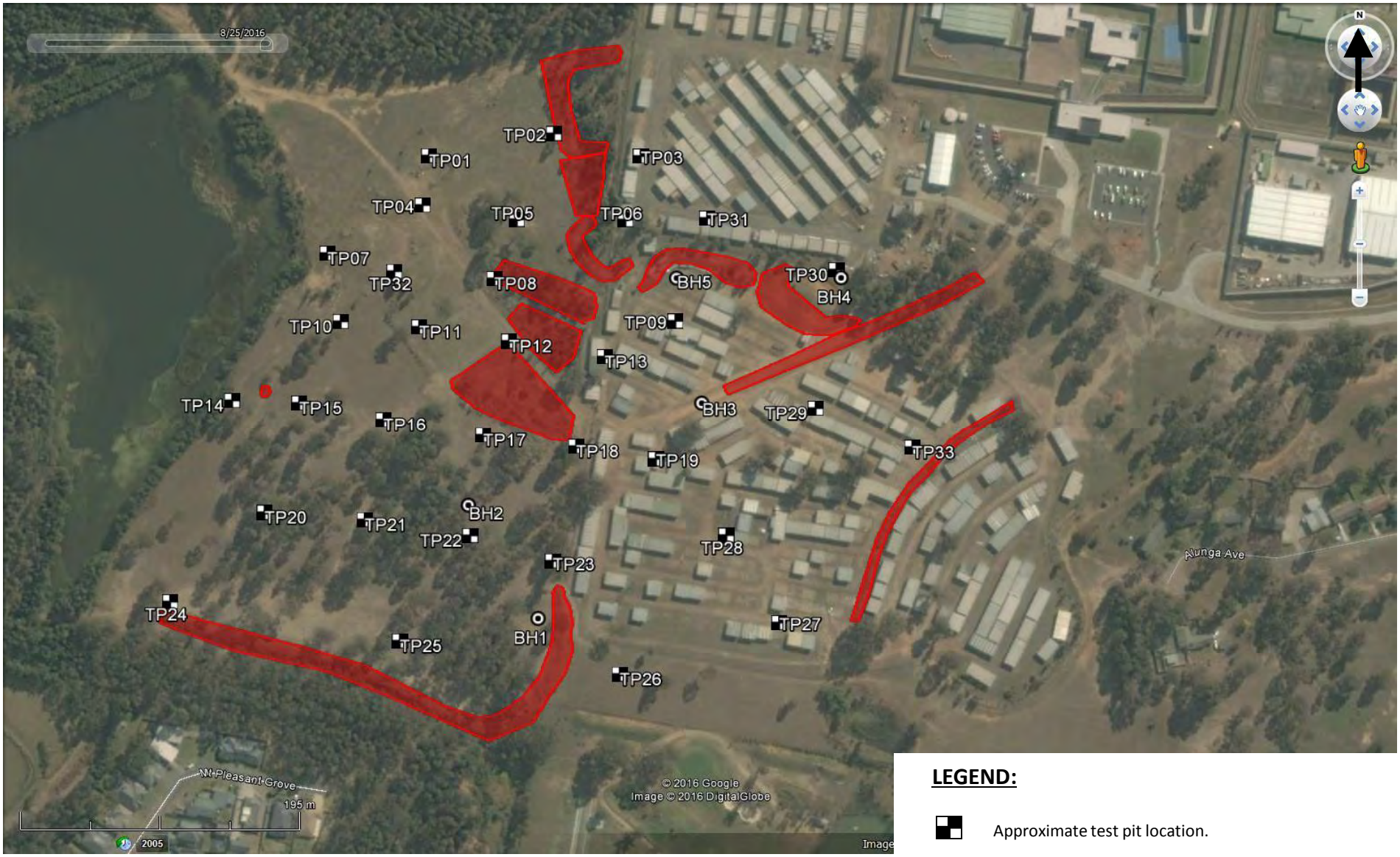
Approximate Test Locations

FIGURE AD2:

Approximate Test Locations with Concept Overlay

FIGURE AD3:

Excavatability Graph



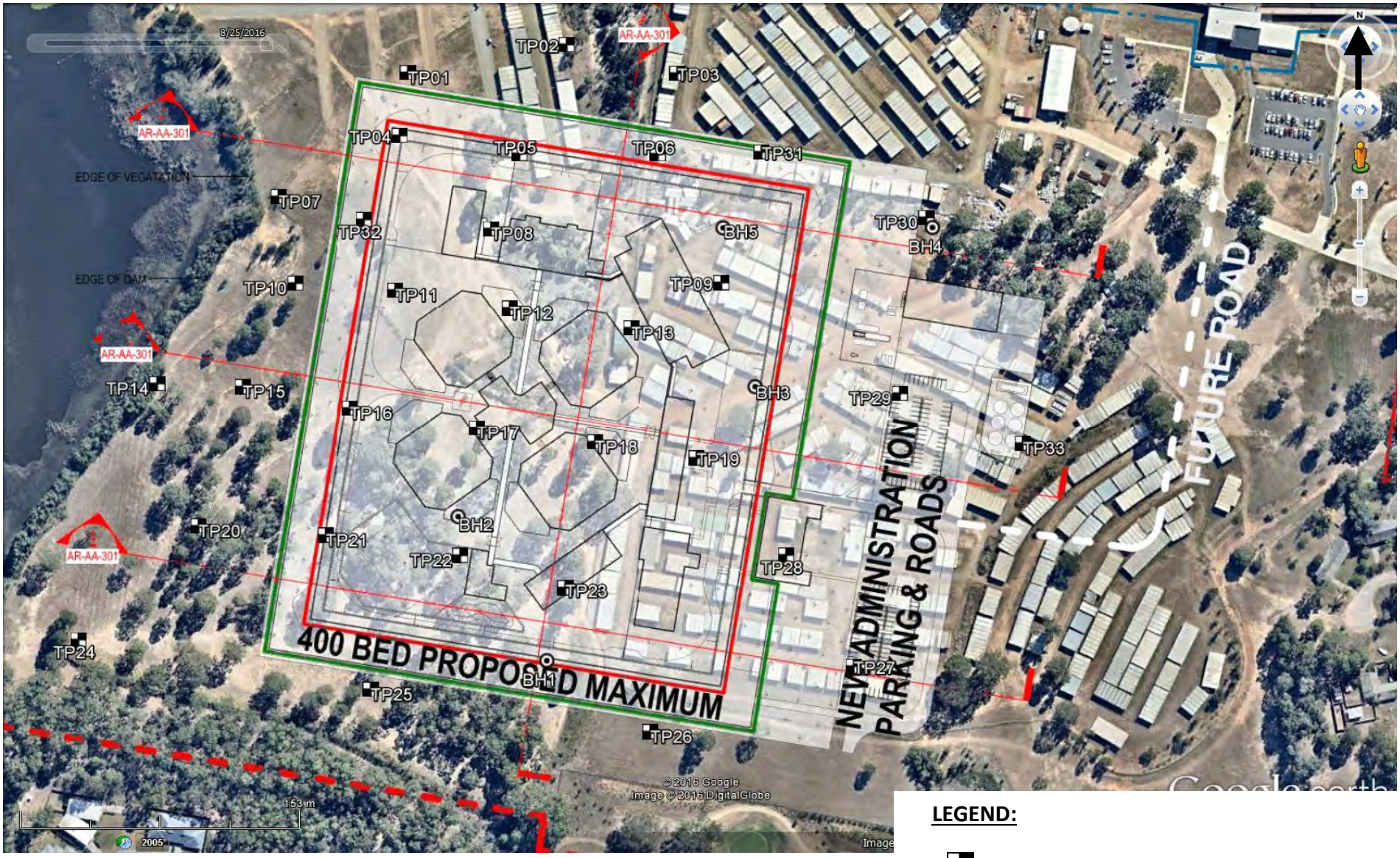
Based on Google Earth image.

LEGEND:

- Approximate test pit location.
- Approximate borehole location.
- Approximate area of fill mounds/stockpiles with depth of about 0.4m or more.

Qualtest LABORATORY (NSW) PTY LTD

Client:	LEND LEASE	Drawing No:	FIGURE AD1
Project:	PROPOSED EXPANSION	Project No:	NEW16P-0119
Location:	CESSNOCK CORRECTIONAL CENTRE	Scale:	AS SHOWN
Title:	APPROXIMATE TEST LOCATIONS	Date:	9/09/2016



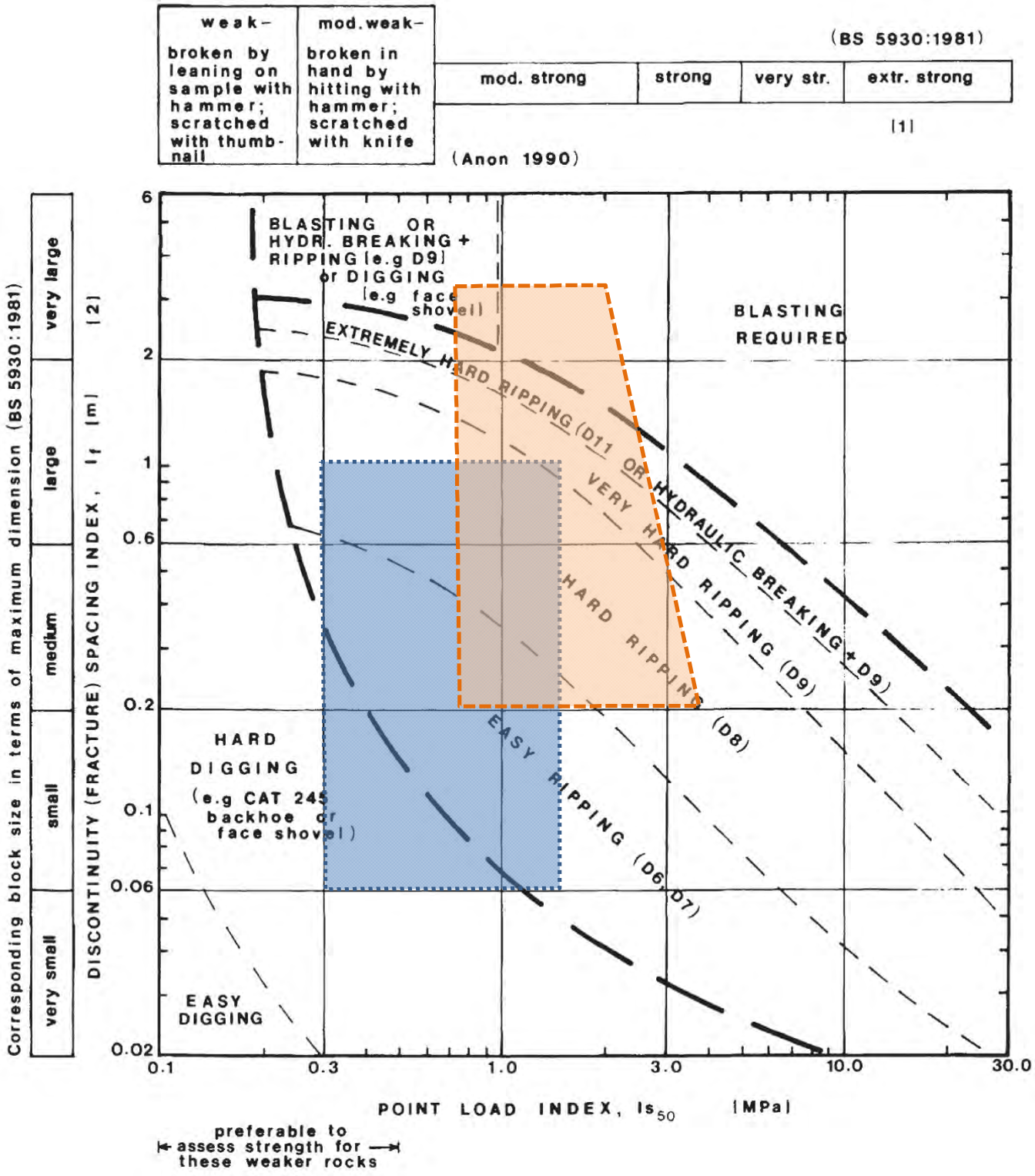
Based on concept plan provided by client (by email dated 25/08/16) overlain approximately on Google Earth image by Qualtest.

LEGEND:

- Approximate test pit location.
- Approximate borehole location.

Qualtest LABORATORY (NSW) PTY LTD

Client:	LEND LEASE	Drawing No:	FIGURE AD2
Project:	PROPOSED EXPANSION	Project No:	NEW16P-0119
Location:	CESSNOCK CORRECTIONAL CENTRE	Scale:	AS SHOWN
Title:	APPROXIMATE TEST LOCATIONS WITH CONCEPT OVERLAY	Date:	9/09/2016



LEGEND

Indicative range of conditions in BH01 to BH05 to depths of about 3m to 4m (about 5m in places).

Indicative range of conditions in BH01 to BH05 to depths below about 3m to 4m (about 5m in places).

Based on "Revised excavatability graph" by G. S. Pettifer & P. G. Fookes, 1994.

Qualtest LABORATORY (NSW) PTY LTD	Client:	LEND LEASE	Drawing No:	FIGURE AD3
	Project:	PROPOSED EXPANSION	Project No:	NEW16P-0119
	Location:	CESSNOCK CORRECTIONAL CENTRE	Scale:	NOT TO SCALE
	Title:	EXCAVATABILITY GRAPH	Date:	9/09/2016

APPENDIX A:

Results of Field Investigations

Test Pit & Borehole Locations

Client LEND LEASE
Project PROPOSED EXPANSION
Location CESSNOCK CORRECTIONAL CENTRE

Job Number: NEW16P-0119

Universal Grid Reference

Grid Zone 56H

Test Pit / Borehole No.	Easting (m) E	Northing (m) S
BH01	343908	6367317
BH02	343858	6367396
BH03	344021	6367470
BH04	344117	6367560
BH05	344002	6367558
TP01	343827	6367641
TP02	343914	6367658
TP03	343975	6367643
TP04	343823	6367606
TP05	343889	6367597
TP06	343965	6367598
TP07	343757	6367571
TP08	343874	6367555
TP09	344001	6367527
TP10	343767	6367523
TP11	343822	6367520
TP12	343885	6367511
TP13	343952	6367501
TP14	343692	6367466
TP15	343739	6367465
TP16	343798	6367454
TP17	343868	6367444
TP18	343933	6367437
TP19	343989	6367429
TP20	343716	6367387
TP21	343786	6367383
TP22	343860	6367373
TP23	343918	6367356
TP24	343651	6367323
TP25	343812	6367298
TP26	343966	6367277
TP27	344077	6367315
TP28	344039	6367376
TP29	344100	6367467
TP30	344114	6367567
TP31	344022	6367600
TP32	343804	6367559
TP33	344168	6367440

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP01
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
E	Not Encountered	E 0.10m				GC	FILL: Sandy Clayey GRAVEL - fine to medium grained, sub-angular to sub-rounded, dark grey-brown, trace silt, root affected.	M				FILL - TOPSOIL
		0.30m					0.23m					
		B E 0.45m				CH	FILL: Sandy CLAY - medium to high plasticity, red-brown and dark brown, fine grained sand, with fine to coarse grained gravel, sub-angular to sub-rounded.	M ~ w_P		HP	420	FILL
				0.5			0.45m					
						CH	Sandy CLAY - medium to high plasticity, orange-brown and orange, fine grained sand.			HP	500	RESIDUAL SOIL
							0.70m					
						CL	Sandy CLAY / Clayey SAND - low to medium plasticity, grey and orange-brown, fine grained sand.	M < w_P	H			
				1.0			1.15m					
							1.20m Extremely Weathered SANDSTONE, breaks down into Clayey SAND - fine grained, grey and orange-brown, estimated very low strength.	D - M				EXTREMELY TO HIGHLY WEATHERED ROCK
							Hole Terminated at 1.20 m Practical Refusal					
				1.5								
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP02
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m		0.5		SC	Clayey SAND - fine to medium grained, dark brown, with fine to medium grained gravel, sub-angular to sub-rounded, root affected.	M				TOPSOIL
							0.25m Sandy CLAY - medium to high plasticity, orange-brown and red-brown, trace fine to medium grained sand.			HP	550	RESIDUAL SOIL
				1.0		CH				HP	520	
				1.5				M < w_P	H	HP	450	
							1.20m Sandy CLAY / Clayey SAND - low to medium plasticity, grey and orange-brown to red-brown, fine grained sand.					
						CL						
				2.0			1.85m 1.90m SANDSTONE - fine grained, dark grey-black and brown, estimated low stength.	M				HIGHLY WEATHERED ROCK
							Hole Terminated at 1.90 m Refusal					
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP03
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
E	Not Encountered	E / QC1 / QC2 0.10m				SC	Clayey SAND - low plasticity, dark grey-brown, fine to medium grained sand, trace fine to coarse grained gravel, sub-angular, with silt, root affected.	M				TOPSOIL
		0.15m					0.15m					
		0.20m					Sandy CLAY - medium to high plasticiity, orange-brown to red-brown, fine grained sand.					RESIDUAL SOIL
		E 0.30m						$M > w_P$	VSt	HP	280	
		0.40m										
		B 0.50m		0.5			Becoming red-brown to orange-brown and grey.			HP	360	
										HP	480 - 500	
								$M \sim w_P$				
										HP	560	
				1.0		CH		$M < w_P$	H			
				1.5								
							1.80m					
							Extremely Weathered SANDSTONE, breaks down into Gravelly Clayey SAND - fine grained, grey, with some orange-brown, fine to medium grained gravel (sandstone fragments), estimated very low strength.					EXTREMELY TO HIGHLY WEATHERED ROCK
				2.0				M	D - VD			
							Increasing in strength with depth.					
							2.40m					
				2.5			Hole Terminated at 2.40 m Very slow progress					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP04
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				GP	FILL: Sandy GRAVEL - fine to coarse grained (max 40mm), dark brown, fine to coarse grained sand, with clay, root affected.	M				FILL - TOPSOIL
							0.20m					RESIDUAL SOIL
		0.50m		0.5			Sandy CLAY - medium to high plasticity, orange-brown with some red-brown, fine grained sand.			HP	570	
		B 0.80m								HP	500	
										HP	>600	
				1.0		CH	Becoming grey and orange-brown to red-brown.	$M < w_P$	H			
				1.5								
							1.80m					
				2.0		CL	Sandy CLAY / Clayey SAND - low plasticity, grey and orange-brown, fine grained sand.	M	D - VD			
							2.40m					
				2.5			Hole Terminated at 2.40 m Very slow progress					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP05
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m		0		SM	Sandy SILT - low plasticity, grey-brown, fine to medium grained sand, trace fine to medium grained gravel, sub-rounded, trace rootlets.	M				SLOPE WASH
		0.45m E 0.55m		0.5			0.55m			HP	>600	RESIDUAL SOIL
				1.0		CH	Sandy CLAY - medium plasticity, orange-brown and red-brown, fine grained sand.	M < w_P	H			
				1.5			Becoming grey and orange-brown to red-brown.			HP	>600	
				2.0			1.80m Hole Terminated at 1.80 m Very slow progress					
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP06
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				GC	FILL: Sandy Clayey GRAVEL - fine to coarse grained, sub-angular to angular, dark grey-brown, fine to medium grained sand, fines of medium plasticity, root affected.	M				FILL - TOPSOIL
							0.15m					
		0.30m					Sandy CLAY - medium to high plasticity, orange-brown to red-brown, fine grained sand.			HP	460	RESIDUAL SOIL
		E 0.40m								HP	530	
				0.5						HP	>600	
							Becoming grey and orange-brown to red-brown.					
				1.0		CH		$M < w_P$ - $M \sim w_P$	H			
				1.5								
							1.80m					
							Extremely Weathered SANDSTONE, breaks down into Gravelly Clayey SAND - fine grained, grey, with some orange-brown, fine to medium grained gravel (sandstone fragments), estimated very low strength.					EXTREMELY WEATHERED ROCK
				2.0		SC		M				
				2.5			2.60m					
							Hole Terminated at 2.60 m Very slow progress					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP07
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SP	SAND - fine to coarse grained, brown, trace silt, root affected.					TOPSOIL - SLOPE WASH
							0.15m					
						SC	Clayey SAND - fine to medium grained, dark brown, fines of low plasticity, trace silt.	M	MD			SLOPE WASH
		0.40m					0.40m					
		E 0.50m		0.5		SP	SAND - fine to medium grained, grey-brown, trace silt.					
							0.55m					
						CI	Sandy CLAY - medium plasticity, orange-brown and dark grey, fine grained sand.	M > w_P	St	HP	180	RESIDUAL SOIL
										HP	180	
									VSt	HP	280	
				1.0						HP	320	
							1.00m					
				1.5		CL	Sandy CLAY / Clayey SAND - low plasticity, grey and orange-brown, fine grained sand.	M < w_P	H			
				2.0			2.05m					
							2.10m SANDSTONE - fine to coarse grained, orange-brown to brown and grey, estimated low to medium strength.	M				HIGHLY WEATHERED ROCK
							Hole Terminated at 2.10 m Refusal					
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP08
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				CH	FILL: Sandy CLAY - medium to high plasticity, orange-brown with some grey, fine grained sand, with fine to coase grained gravel, sub-angular.		H			FILL
							0.20m					
				0.5		SM	Sandy SILT / Silty SAND - low plasticity, grey-brown, fine grained sand, trace rootlets.		MD - D	HP	>600	SLOPE WASH
		0.50m					Becoming grey.					
		E 0.60m					0.60m					
		0.80m					Sandy CLAY / Clayey SAND - medium plasticity, orange-brown with some grey, fine grained sand.					RESIDUAL SOIL
		B 0.80m						$M < W_P$		HP	>600	
				1.0								
						CI			H			
				1.5								
							1.80m					
				2.0		SC	Extremely weathered SANDSTONE, breaks down into Clayey SAND - fine to medium grained, orange and grey, with fine to medium grained gravel, estimated very low strength.	M				EXTREMELY WEATHERED ROCK
							2.00m					
							Hole Terminated at 2.00 m Very slow progress					
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP09
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m		0		SM	Silty SAND - fine to medium grained, grey-brown, with clay, with fine to medium grained gravel, sub-angular to sub-rounded, root affected.	M				TOPSOIL
							0.20m					RESIDUAL SOIL
				0.5			Sandy CLAY - medium to high plasticity, orange-brown with some red-brown, fine grained sand.			HP	350	
										HP	280	
										HP	300	
								M > w_P	VSt			
				1.0		CH						
										HP	360	
				1.5						HP	380	
							Becoming grey and orange-brown to red-brown.		VSt - H	HP	410	
							1.70m					
							Sandy CLAY / Clayey SAND - low plasticity, grey and orange-brown to brown, fine to medium grained sand.	M < w_P	H			
				2.0		CL						
							2.30m					
							Hole Terminated at 2.30 m Very slow progress					
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP10
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SC	Clayey SAND - fine to medium grained, dark brown, trace silt, root affected.	M				TOPSOIL
							0.20m					RESIDUAL SOIL
				0.5		CH	Sandy CLAY - medium to high plasticity, dark brown and orange-brown, fine grained sand.	M ~ w_P	VSt	HP	210	
										HP	220	
										HP	230	
							Becoming orange-brown.			HP	280	
										HP	300	
		0.80m										
		U50								HP	400	
		1.00m		1.0			1.00m					
				1.5		CL	Sandy CLAY / Clayey SAND - low plasticity, dark brown to orange-brown and grey, fine grained sand.	M < w_P	H			
				2.0			2.40m					
				2.5			Hole Terminated at 2.40 m Very slow progress					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP11
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	Silty SAND - fine to medium grained, grey-brown, root affected.	M				TOPSOIL
							0.15m					RESIDUAL SOIL
							Sandy CLAY - medium to high plasticity, dark grey and orange-brown, fine grained sand.			HP	280	
										HP	210	
		0.50m		0.5						HP	280	
								M ~ w_P - M > w_P		HP	310	
		B U50 0.68m				CH			VSt	HP	300	
										HP	390	
				1.0						HP	410	
		1.20m					Becoming pale grey and orange-brown.					
							1.20m					
		B					Sandy CLAY / Clayey SAND - low to medium plasticity, orange-brown to brown and grey, fine grained sand.			HP	>600	
		1.50m		1.5				M < w_P	H			
						CL						
				2.0								
							2.30m					
							Hole Terminated at 2.30 m Very slow progress					
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP12
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	Silty SAND - fine to medium grained, grey-brown, root affected.	D - M				TOPSOIL
							0.15m					
							Sandy CLAY - medium plasticity, orange-brown to red-brown and brown, fine grained sand.			HP	>600	RESIDUAL SOIL
		0.50m		0.5						HP	>600	
		U50				CH		$M < w_P$	H			
		0.75m								HP	>600	
				1.0								
							1.40m					
				1.5		CL	Sandy CLAY / Clayey SAND - low to medium plasticity, orange-brown to red-brown and grey, fine grained sand.					
							1.60m					
							Hole Terminated at 1.60 m Very slow progress					
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP13
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
	Not Encountered	E 0.10m				SM	Clayey SAND - fine to medium grained, dark brown, with fine to medium grained gravel, sub-angular, trace silt, root affected.	M				TOPSOIL
							0.20m					
				0.5		CH	Sandy CLAY - medium to high plasticity, dark grey and orange-brown, fine grained sand.	M ~ w_P	VSt	HP HP	300 350	RESIDUAL SOIL
								M < w_P	H	HP	500	
							0.80m					
							0.90m Extremely Weathered SANDSTONE, breaks down into Clayey SAND - fine to medium grained, grey, with some orange-brown, trace fine to medium grained gravel (sandstone fragments), estimated very low to low strength.					EXTREMELY TO HIGHLY WEATHERED ROCK
				1.0			Hole Terminated at 0.90 m Practical Refusal					
				1.5								
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP14
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	Silty SAND - fine to medium grained, grey-brown, root affected.	D - M				TOPSOIL
							0.24m					
				0.5		CH	Sandy CLAY - medium plasticity, orange-brown, fine grained sand.	M < w_P	H	HP	>600	RESIDUAL SOIL
										HP	>600	
										HP	480	
										HP	>600	
				1.0			1.00m					
							1.05m SANDSTONE - fine to medium grained, brown and orange-brown, estimated medium to high strength.	M				HIGHLY WEATHERED ROCK
							Hole Terminated at 1.05 m Refusal					
				1.5								
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP15
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m		0.5 1.0 1.5 2.0 2.5		SM CH	Silty SAND - fine to medium grained, grey-brown, root affected. 0.25m Sandy CLAY - medium plasticity, orange-brown, fine grained sand. Becoming grey and orange-brown. 2.10m Hole Terminated at 2.10 m Very slow progress	D - M M < w_P	H			TOPSOIL RESIDUAL SOIL

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP16
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	Silty SAND - fine to medium grained, grey-brown, root affected.	D - M				TOPSOIL
							0.30m					
		0.70m		0.5			Sandy CLAY - medium plasticity, dark grey and orange-brown, fine grained sand.					RESIDUAL SOIL
		U50		1.0		CH	Becoming pale grey and orange-brown.	M < w_P	H			
		1.10m		1.5								
				2.0			2.00m					
				2.5			Hole Terminated at 2.00 m Very slow progress					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP17
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	Silty SAND - fine to medium grained, grey-brown, root affected.	D - M				TOPSOIL
							0.20m					
		0.45m		0.5		CI	Sandy CLAY - medium plasticity, red-brown to orange-brown and grey, with fine to medium grained gravel, sub-rounded.			HP	>600	RESIDUAL SOIL / POSSIBLE FILL
		E 0.55m					0.55m					
		0.60m				CL	Sandy CLAY - low to medium plasticity, orange-brown and pale grey, with some red-brown, fine grained sand.			HP	>600	RESIDUAL SOIL
		U50						M < w_P	H			
		1.00m		1.0			1.00m					
							Extremely Weathered SANDSTONE, breaks down into Clayey SAND - fine to medium grained, yellow-brown with some pale grey, trace fine grained gravel (sandstone fragments), estimated very low strength.					EXTREMELY WEATHERED ROCK
							1.40m					
				1.5			Hole Terminated at 1.40 m Very slow progress					
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP18
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	0.10m Silty SAND - fine to medium grained, grey, with fine to medium grained gravel, root affected.					TOPSOIL
		0.30m				CH	Sandy CLAY - medium to high plasticity, grey-brown and orange-brown, fine grained sand.			HP	>600	RESIDUAL SOIL / POSSIBLE FILL
		E 0.40m					0.40m			HP	>600	
		0.50m		0.5			Sandy CLAY - low to medium plasticity, orange-brown and pale grey, with some red-brown, fine grained sand.					RESIDUAL SOIL
		0.60m								HP	>600	
		U50 B 0.80m					Becoming pale orange and pale grey.	$M < w_P$	H			
		0.90m		1.0		CL						
				1.5			1.70m					
							1.80m Extremely Weathered SANDSTONE, breaks down into Clayey SAND - fine to medium grained, yellow-brown with some pale grey, trace fine grained gravel (sandstone fragments), estimated very low to low strength.	M				EXTREMELY TO HIGHLY WEATHERED ROCK
				2.0			Hole Terminated at 1.80 m Practical Refusal					
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP19
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m		0.5		SM	0.10m FILL: Silty SAND - fine to medium grained, grey-brown, root affected.	M				TOPSOIL
						CI	FILL: Sandy CLAY - medium plasticity, red-brown and orange-brown.	M > w_P	VSt	HP	280	RESIDUAL SOIL / POSSIBLE FILL
										HP	280	
										HP	310	
				1.0		CL	0.70m Sandy CLAY / Clayey SAND - low to medium plasticity, orange-brown and grey, fine grained sand.	M ~ w_P	H	HP	480	RESIDUAL SOIL
							0.90m SANDSTONE, breaks down into Clayey SAND - fine to medium grained, yellow-brown with some pale grey, with fine to medium grained gravel (sandstone fragments), estimated very low to low strength.	M				EXTREMELY TO HIGHLY WEATHERED ROCK
				1.5			1.00m Hole Terminated at 1.00 m Refusal					
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP20
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	Silty SAND - fine to medium grained, grey-brown, root affected.	M				TOPSOIL
							0.25m					
		0.50m		0.5			Sandy CLAY - medium plasticity, orange-brown and dark grey, fine grained sand.			HP	500	RESIDUAL SOIL
										HP	550	
		U50								HP	500	
		0.75m				CI		M < w_P	H			
				1.0						HP	480	
							1.45m					
				1.5			1.50m SANDSTONE - fine to coarse grained, orange-brown to brown and grey, estimated low to medium strength.	M				HIGHLY WEATHERED ROCK
							Hole Terminated at 1.50 m Practical Refusal					
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP21
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	Silty SAND - fine to medium grained, grey-brown, root affected.	D - M				TOPSOIL
							0.24m					
		0.50m		0.5			Sandy CLAY - medium plasticity, orange-brown and dark grey, fine grained sand.			HP	>600	RESIDUAL SOIL
		U50 0.68m								HP	>600	
				1.0		CI	Becoming red-brown to orange-brown and pale grey.	M < w_P	H	HP	>600	
				1.5			1.60m					
							Hole Terminated at 1.60 m Very slow progress					
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP22
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
	Not Encountered	E 0.10m 0.30m B 0.50m 0.60m U50 0.80m		0.5		SM CI	0.05m Silty SAND - fine to medium grained, grey-brown, root affected. Sandy CLAY - medium plasticity, orange-brown and red-brown, fine grained sand.	D - M M < w_P	H			TOPSOIL RESIDUAL SOIL
				1.0 1.5 2.0 2.5			0.80m 0.83m SANDSTONE - fine to coarse grained, brown and pale grey, estimated medium to high strength. Hole Terminated at 0.83 m Refusal	M				HIGHLY WEATHERED ROCK

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP23
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	Silty SAND - fine to medium grained, grey-brown, root affected.	M				TOPSOIL
							0.14m					
		0.40m		0.5		CI	Sandy CLAY - medium plasticity, red-brown with some orange-brown and grey, fine grained sand.	M < w_P	H			RESIDUAL SOIL
		B U50 0.70m										
							0.75m					
							0.80m SANDSTONE - fine to medium grained, orange-brown and pale grey, estimated low strength.	M				EXTREMELY TO HIGHLY WEATHERED ROCK
				1.0			Hole Terminated at 0.80 m Refusal					
				1.5								
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP24
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
						SM	Sandy SILT - low plasticity, fine to medium grained, grey-brown, trace fine to medium gravel, sub-rounded to sub-angular, root affected.	D - M				TOPSOIL
							0.28m					
							Sandy CLAY - medium plasticity, red-brown with some orange-brown and grey, fine grained sand.			HP	>600	RESIDUAL SOIL
				0.5						HP	>600	
E	Not Encountered					CI		M < w_P	H	HP	>600	
				1.0								
							1.40m					
				1.5			SANDSTONE - fine to medium grained, orange-brown and pale grey, estimated low to medium strength.	M				HIGHLY WEATHERED ROCK
							1.50m					
							Hole Terminated at 1.50 m Refusal					
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP25
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	Silty SAND - fine to medium grained, grey-brown, with fine to medium grained gravel, sub-rounded to sub-angular, root affected.	M				TOPSOIL
		0.30m					0.20m					
		B 0.50m		0.5		CI	Sandy CLAY - medium plasticity, red-brown with some orange-brown, fine grained sand.	M < w_P	H	HP	>600	RESIDUAL SOIL
										HP	>600	
				1.0			1.00m					
							SANDSTONE - fine to medium grained, orange-brown and pale grey, estimated medium strength.	M				HIGHLY WEATHERED ROCK
							1.10m					
							Hole Terminated at 1.10 m Refusal					
				1.5								
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP26
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 9/8/16

EQUIPMENT TYPE: CAT - 14 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.7 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	0.10m Silty SAND - fine to medium grained, grey-brown, root affected.					TOPSOIL
						SC	Clayey SAND - fine to medium grained, grey, with fine to medium grained, gravel, sub-rounded.	M	MD			SLOPE WASH
				0.5			0.30m Sandy CLAY - medium to high plasticity, grey-brown and orange, fine grained sand.	$M > w_P$	VSt	HP HP HP	280 300 360	RESIDUAL SOIL
		0.60m B 0.90m		1.0		CI	Becoming red-brown with some grey.	$M < w_P$ - $M \sim w_P$	H	HP HP HP	580 580 >600	
				1.5			1.75m 1.80m SANDSTONE - fine to medium grained, orange-brown to red-brown and grey, estimated low strength to medium strength.	M				EXTREMELY TO HIGHLY WEATHERED ROCK
				2.0			Hole Terminated at 1.80 m Refusal					
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP27
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: SJK
DATE: 25/8/16

EQUIPMENT TYPE: 5 TONNE EXCAVATOR
TEST PIT LENGTH: 3.0 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	0.10m Silty SAND - fine to coarse grained, brown to grey, fines of low plasticity, root affected.	M				TOPSOIL
		0.20m					CLAY - medium to high plasticity, pale brown, some fine to medium grained sand.					RESIDUAL SOIL
		CBR U50 0.50m		0.5		CH		M ~ w_P		HP	450	
										HP	600	
									H	HP	>600	
		1.00m		1.0			0.90m Extremely weathered Silty SANDSTONE with soil properties, breaks down into Sandy Clayey GRAVEL - fine to coarse grained, angular, pale grey and brown to grey, fines of medium plasticity, some highly weathered pockets.	M				EXTREMELY WEATHERED ROCK
		D 1.10m					1.30m					
							1.40m Silty SANDSTONE - fine to medium grained, pale brown and brown to grey, estimated low strength.	D				HIGHLY WEATHERED ROCK
				1.5			Hole Terminated at 1.40 m Practical Refusal					
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP28
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: SJK
DATE: 25/8/16

EQUIPMENT TYPE: 5 TONNE EXCAVATOR
TEST PIT LENGTH: 3.0 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	Silty Gravelly SAND - fine to coarse grained, brown to pale brown, fine to medium grained sub-rounded gravel, fines of low plasticity, root affected.	M				TOPSOIL
							0.15m CLAY - medium to high plasticity, pale brown, with some brown to red and grey, some fine to medium grained sand.			HP	270	RESIDUAL SOIL
				0.5		CH		M > w_P	VSt	HP	270	
										HP	550	
				1.0			1.10m Sandy CLAY - medium to high plasticity, pale brown and pale grey, with some brown to red.			HP	450	
		1.20m D 1.50m		1.5		CH	Some highly weathered pockets.	M ~ w_P	H			
				2.0			2.10m					
							2.15m SANDSTONE - fine to coarse grained, brown, pale brown to orange and pale grey, estimated low to medium strength.	D - M				HIGHLY WEATHERED ROCK
							Hole Terminated at 2.15 m Refusal					
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP29
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: SJK
DATE: 25/8/16

EQUIPMENT TYPE: 5 TONNE EXCAVATOR
TEST PIT LENGTH: 3.0 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	0.10m Silty SAND - fine to coarse grained, brown to grey, fines of low plasticity, root affected.	D				TOPSOIL
						SM	0.20m Silty Gravelly SAND - fine to coarse grained, pale brown, fine to medium grained sub-rounded gravel, fines of low plasticity.					SLOPE WASH
		0.30m					CLAY - medium to high plasticity, pale brown, with some brown to red and grey, some fine to coarse grained sand.			HP	>600	RESIDUAL SOIL
		CBR 0.50m		0.5			Becoming brown to red, pale brown and grey.			HP	>600	
						CH		$M < w_P$	H			
				1.0						HP	>600	
							1.40m					
				1.5			1.50m SANDSTONE - fine to coarse grained, pale grey, pale brown to orange and brown to red, estimated low to medium strength.	D				HIGHLY WEATHERED ROCK
							Hole Terminated at 1.50 m Practical Refusal					
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP30
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: SJK
DATE: 25/8/16

EQUIPMENT TYPE: 5 TONNE EXCAVATOR
TEST PIT LENGTH: 3.0 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	0.10m FILL: Silty SAND - fine to coarse grained, brown to grey, fines of low plasticity, trace fine to coarse grained sub-angular gravel, root affected.	M				FILL - TOPSOIL
		0.20m				SM	0.20m Silty SAND - mostly fine to medium grained, pale brown, fines of low plasticity.					SLOPE WASH
		E 0.30m					CLAY - medium to high plasticity, brown to red and pale brown, some fine to coarse grained sand.					RESIDUAL SOIL
		CBR **0.50m**		0.5		CI		$M > w_P$	VSt	HP	250	
										HP	300	
		U50								HP	>600	
		0.80m							H			
		0.90m										
		D 1.00m		1.0			1.05m					
							1.15m SANDSTONE - fine to coarse grained, pale grey, pale brown to orange and brown to red, estimated low to medium strength. 10 scrapes for 50mm with toothed excavator bucket.	D				HIGHLY WEATHERED ROCK
							Hole Terminated at 1.15 m Practical Refusal					
				1.5								
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP31
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: SJK
DATE: 25/8/16

EQUIPMENT TYPE: 5 TONNE EXCAVATOR
TEST PIT LENGTH: 3.0 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
E	Not Encountered	E 0.10m				GM	FILL: Silty Sandy GRAVEL - fine to coarse grained, grey to brown, fine to coarse grained sand, fines of low plasticity, some grass roots.	M				FILL - ACCESS TRACK EDGE
							0.15m CLAY - medium to high plasticity, pale brown, some fine to coarse grained sand.					RESIDUAL SOIL
		0.30m								HP	400	
		U50		0.5					VSt - H	HP	430	
		0.60m						M > w_P		HP	410	
				1.0		CH				HP	550	
							Becoming extremely weathered Sandstone.		H	HP	550	
				1.5			1.60m					
							SANDSTONE - fine to coarse grained, pale brown to orange, pale grey and grey to brown, estimated medium strength.					HIGHLY WEATHERED ROCK
							1.80m 10 scrapes for 90mm with toothed excavator bucket.					
							Hole Terminated at 1.80 m Practical Refusal					
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP32
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: SJK
DATE: 25/8/16

EQUIPMENT TYPE: 5 TONNE EXCAVATOR
TEST PIT LENGTH: 1.2 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	FILL: Silty SAND - fine to medium grained, dark brown, trace brick and glass fragments, root affected.	M				FILL - TOPSOIL
							0.20m					
						CH	CLAY - medium to high plasticity, pale brown, some fine to coarse grained sand.	M ~ w_P				RESIDUAL SOIL
							0.30m Hole Terminated at 0.30 m					
				0.5								
				1.0								
				1.5								
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

TEST PIT NO: TP33
PAGE: 1 OF 1
JOB NO: NEW16P-0119
LOGGED BY: SJK
DATE: 25/8/16

EQUIPMENT TYPE: 5 TONNE EXCAVATOR
TEST PIT LENGTH: 3.0 m **WIDTH:** 0.5 m
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
E	Not Encountered	E 0.10m				SM	0.10m Silty SAND - mostly fine to medium grained, grey to brown, fines of low plasticity, root affected.	M				TOPSOIL
		0.30m				CH	CLAY - medium to high plasticity, brown to red and pale brown, some fine to medium sand.	M < w_P	H	HP	550	RESIDUAL SOIL
		U50 0.60m		0.5						HP	>600	
		0.90m					0.80m			HP	>600	
		D 1.00m		1.0		GC	Extremely weatthered SANDSTONE with soil properties, breaks down into Sandy Clayey GRAVEL - fine to coarse grained, angular, pale brown, pale grey and brown to grey, fines of medium plasticity, some highly weathered pockets.	M				EXTREMELY WEATHERED ROCK
							1.10m Silty SANDSTONE - mostly fine to medium grained, grey to brown, pale brown to orange and pale grey to white, estimated low to medium strength.	D - M				HIGHLY WEATHERED ROCK
							1.40m					
				1.5			Hole Terminated at 1.40 m Slow progress					
				2.0								
				2.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - BOREHOLE

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

BOREHOLE NO: BH01
PAGE: 1 OF 4
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 4-8-16

DRILL TYPE: TRUCK MOUNTED RIG
BOREHOLE DIAMETER: 100/50 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
AD/T	Not Observed					SP	Gravelly SAND - fine to coarse grained, brown, fine to medium grained gravel, sub-angular, with clay.	M				SLOPE WASH
							0.10m					RESIDUAL SOIL
							Sandy CLAY - medium to high plasticity, red-brown and orange-brown, fine to medium grained sand.			HP	>600	
		0.50m SPT 5, 11, 16 N* = 27 D 0.95m		0.5		CH		M < w_P		HP	>600	0.50: SPT Recovery: 0.45 m
				1.0			1.00m					
							Extremely weathered SANDSTONE, excavates as Sandy CLAY / Clayey SAND - fine to medium grained, pale brown.					EXTREMELY WEATHERED ROCK
				1.5					H			
							Becoming brown.					
				2.0		SC		D - M				
							Becoming pale brown.					
				2.5								
							2.80m					
							Continued as Cored Drill Hole					
				3.0								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - CORED BOREHOLE

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

BOREHOLE NO: BH01
PAGE: 2 OF 4
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 4-8-16

DRILL TYPE: TRUCK MOUNTED RIG
BOREHOLE DIAMETER: 100/50 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information				Testing	Rock Mass Defects		
METHOD	WATER	CORE LIFT / TEST	RL (m)	DEPTH (m)	GRAPHIC LOG	Material Description: Rock type, particle characteristics, colour, minor components, structure	WEATHERING	ESTIMATED STRENGTH	$I_{s(50)}$D/A	RQD %	Defect Spacing mm	Defect Description: Type, inclination, planarity, roughness, coating, thickness
				0.5								
				1.0								
				1.5								
				2.0								
				2.5		START CORING AT 2.80m						
NMLC	Not Observed			3.0		Extremely weathered SANDSTONE, breaks down into Sandy CLAY / Clayey SAND - fine to medium grained, pale brown.	EW	VL				
						SANDSTONE - medium to coarse grained, grey to yellow-brown, with some iron staining in places.	SW - MW	M	D=0.66 A=0.32	83	1180	JT 80° SN UN RO 190 mm

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Method

AS	Auger Screwing
AD	Auger Drilling
RR	Roller/tricone
CB	Claw or Blade bit
NMLC	NMLC Core

Field Tests

HP	Hand Penetrometer

Weathering

EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
FR	Fresh

Strength

		$I_{s(50)}$
VL	Very Low	<0.1
L	Low	0.1 - 0.3
M	Medium	0.3 - 1
H	High	1 - 3
VH	Very High	3 - 10
EH	Extremely High	>10

Defect Type

JT	Joint
PT	Parting
SM	Seam
SZ	Shear Zone
SS	Sheared Surface
CS	Crushed Seam

Roughness

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slickensided

Coating

CN	Clean
SN	Stained
VN	Veneer
CO	Coating

Planarity

PL	Planar
CU	Curved
ST	Stepped
IR	Irregular

ENGINEERING LOG - CORED BOREHOLE

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

BOREHOLE NO: BH01
PAGE: 3 OF 4
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 4-8-16

DRILL TYPE: TRUCK MOUNTED RIG
BOREHOLE DIAMETER: 100/50 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information				Testing	Rock Mass Defects		
METHOD	WATER	CORE LIFT / TEST	RL (m)	DEPTH (m)	GRAPHIC LOG	Material Description: Rock type, particle characteristics, colour, minor components, structure	WEATHERING	ESTIMATED STRENGTH	$I_{s(50)}$D/A	RQD %	Defect Spacing mm	Defect Description: Type, inclination, planarity, roughness, coating, thickness
NMLC	Not Observed	5.8				SANDSTONE - medium to coarse grained, grey to yellow-brown, with some iron staining in places. *(continued)*	SW - MW	M				
				4.0					D=0.69 A=0.95		1180	
						INTERLAMINATED SILTSTONE AND SANDSTONE - Sandstone is fine to medium grained, grey with some dark grey carbonaceous streaks.						JT 35° SN UN RO
				4.5					D=1.22 A=1.88	83	580	
							FR - SW	H				JT 15° CN UN RO
				5.0							660	
				5.5		PEBBLY SANDSTONE - medium to coarse grained, grey to yellow-brown.	HW	M - H	D=0.96 A=1.15		20	JT 60° CN UN RO JT 60° CN UN RO
		5.8										
				6.0		INTERLAMINATED SILTSTONE AND SANDSTONE - Sandstone is fine to medium grained, grey with some dark grey carbonaceous streaks.					940	
				6.5			FR	M	D=0.74 A=0.71	96		
											80	JT 15° SN PL RO
											50	JT 15° SN PL RO JT 15° SN PL RO

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Method

AS	Auger Screwing
AD	Auger Drilling
RR	Roller/tricone
CB	Claw or Blade bit
NMLC	NMLC Core

Field Tests

HP	Hand Penetrometer

Weathering

EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
FR	Fresh

Strength

		$I_{s(50)}$
VL	Very Low	<0.1
L	Low	0.1 - 0.3
M	Medium	0.3 - 1
H	High	1 - 3
VH	Very High	3 - 10
EH	Extremely High	>10

Defect Type

JT	Joint
PT	Parting
SM	Seam
SZ	Shear Zone
SS	Sheared Surface
CS	Crushed Seam

Roughness

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slickensided

Coating

CN	Clean
SN	Stained
VN	Veneer
CO	Coating

Planarity

PL	Planar
CU	Curved
ST	Stepped
IR	Irregular

ENGINEERING LOG - CORED BOREHOLE

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

BOREHOLE NO: BH01
PAGE: 4 OF 4
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 4-8-16

DRILL TYPE: TRUCK MOUNTED RIG
BOREHOLE DIAMETER: 100/50 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information				Testing	Rock Mass Defects		
METHOD	WATER	CORE LIFT / TEST	RL (m)	DEPTH (m)	GRAPHIC LOG	Material Description: Rock type, particle characteristics, colour, minor components, structure	WEATHERING	ESTIMATED STRENGTH	$I_{s(50)}$D/A	RQD %	Defect Spacing mm	Defect Description: Type, inclination, planarity, roughness, coating, thickness
NMLC	Not Observed	8.8		7.5		INTERLAMINATED SILTSTONE AND SANDSTONE - Sandstone is fine to medium grained, grey with some dark grey carbonaceous streaks. *(continued)*	FR	M		96		
		8.8		8.0								
				8.5								
				9.0		Hole Terminated at 8.80 m Target depth			D=0.97 A=0.73			
				9.5								
				10.0								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Method

AS	Auger Screwing
AD	Auger Drilling
RR	Roller/tricone
CB	Claw or Blade bit
NMLC	NMLC Core

Field Tests

HP	Hand Penetrometer

Weathering

EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
FR	Fresh

Strength

		$I_{s(50)}$
VL	Very Low	<0.1
L	Low	0.1 - 0.3
M	Medium	0.3 - 1
H	High	1 - 3
VH	Very High	3 - 10
EH	Extremely High	>10

Defect Type

JT	Joint
PT	Parting
SM	Seam
SZ	Shear Zone
SS	Sheared Surface
CS	Crushed Seam

Roughness

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slickensided

Coating

CN	Clean
SN	Stained
VN	Veneer
CO	Coating

Planarity

PL	Planar
CU	Curved
ST	Stepped
IR	Irregular

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: **BH02**
PAGE: 1 OF 4
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 4-8-16

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

DRILL TYPE: TRUCK MOUNTED RIG
BOREHOLE DIAMETER: 100/50 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Observed	0.50m SPT 5, 12, 17 N* = 29 D 0.95m		0.5 1.0 1.5		SM CL	0.05m Silty SAND - fine to medium grained, grey-brown, with fine to medium grained gravel, sub-angular to sub-rounded, root affected. Sandy CLAY - low to medium plasticity, red-brown and orange-brown, fine to medium grained sand.	M M ~ w_P M < w_P	VSt H	HP HP	310 >600	TOPSOIL RESIDUAL SOIL 0.50: SPT Recovery: 0.45 m
		2.00m D 2.20m		2.0		SC	1.50m Extremely weathered SANDSTONE - breaks down into Clayey SAND - fine to medium grained, yellow-brown.	D - M				EXTREMELY WEATHERED ROCK
				2.5 3.0			2.40m Becoming grey. Continued as Cored Drill Hole					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - CORED BOREHOLE

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

BOREHOLE NO: BH02
PAGE: 2 OF 4
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 4-8-16

DRILL TYPE: TRUCK MOUNTED RIG
BOREHOLE DIAMETER: 100/50 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information				Testing	Rock Mass Defects		
METHOD	WATER	CORE LIFT / TEST	RL (m)	DEPTH (m)	GRAPHIC LOG	Material Description: Rock type, particle characteristics, colour, minor components, structure	WEATHERING	ESTIMATED STRENGTH	$I_{s(50)}D/A$	RQD %	Defect Spacing mm	Defect Description: Type, inclination, planarity, roughness, coating, thickness
				0.5								
				1.0								
				1.5								
				2.0		START CORING AT 2.40m						
NMLC	Not Observed			2.5		Extremely weathered SANDSTONE - breaks down into Clayey SAND - fine to medium grained, yellow-brown.						
				3.0		SANDSTONE -fine to medium grained, dark grey, ironstaining in some places.	SW - MW	H	D=1.20 A=1.35	65	400	JT 60° SN ST RO
								L - M			200	SM 5° Clay CO 20 mm
											900	SM 30° Clay CO 50 mm

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Method

AS	Auger Screwing
AD	Auger Drilling
RR	Roller/tricone
CB	Claw or Blade bit
NMLC	NMLC Core

Field Tests

HP	Hand Penetrometer

Weathering

EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
FR	Fresh

Strength

		$I_{s(50)}$
VL	Very Low	<0.1
L	Low	0.1 - 0.3
M	Medium	0.3 - 1
H	High	1 - 3
VH	Very High	3 - 10
EH	Extremely High	>10

Defect Type

JT	Joint
PT	Parting
SM	Seam
SZ	Shear Zone
SS	Sheared Surface
CS	Crushed Seam

Roughness

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slickensided

Coating

CN	Clean
SN	Stained
VN	Veneer
CO	Coating

Planarity

PL	Planar
CU	Curved
ST	Stepped
IR	Irregular

ENGINEERING LOG - CORED BOREHOLE

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

BOREHOLE NO: BH02
PAGE: 3 OF 4
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 4-8-16

DRILL TYPE: TRUCK MOUNTED RIG
BOREHOLE DIAMETER: 100/50 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information				Testing	Rock Mass Defects		
METHOD	WATER	CORE LIFT / TEST	RL (m)	DEPTH (m)	GRAPHIC LOG	Material Description: Rock type, particle characteristics, colour, minor components, structure	WEATHERING	ESTIMATED STRENGTH	$I_{s(50)}$D/A	RQD %	Defect Spacing mm	Defect Description: Type, inclination, planarity, roughness, coating, thickness
NMLC	Not Observed	5		4.0		SANDSTONE -fine to medium grained, dark grey, ironstaining in some places. *(continued)*	SW - MW	L - M	D=0.71 A=0.63	65	900	
				4.5			MW - HW				50	SM 5° Clay CO 10 mm
											50	SM 5° Clay CO 20 mm
												SM 10° Clay CO 50 mm
											100	
												SM 5° Clay CO 50 mm
											70	
											60	JT 10° CN PL RO
											20	JT 30° CN PL RO
											70	JT 30° CN PL RO
		5		5.0							150	JT 85° CN UN RO
						Silty SANDSTONE - fine to coarse grained, dark grey.			D=0.14 A=0.15		40	
											30	PT 5° CN PL RO
				5.5			SW - HW				40	JT 30° SN ST RO
												SM 30° Clay CO 90 mm
				6.0						92		
									D=1.64 A=1.34			
				6.5			FR	H				
						INTERLAMINATED SILTSTONE AND SANDSTONE - Sandstone is fine to coarse grained, grey and dark grey (carbonaceous).						

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Method

AS	Auger Screwing
AD	Auger Drilling
RR	Roller/tricone
CB	Claw or Blade bit
NMLC	NMLC Core

Field Tests

HP	Hand Penetrometer

Weathering

EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
FR	Fresh

Strength

		$I_{s(50)}$
VL	Very Low	<0.1
L	Low	0.1 - 0.3
M	Medium	0.3 - 1
H	High	1 - 3
VH	Very High	3 - 10
EH	Extremely High	>10

Defect Type

JT	Joint
PT	Parting
SM	Seam
SZ	Shear Zone
SS	Sheared Surface
CS	Crushed Seam

Roughness

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slickensided

Coating

CN	Clean
SN	Stained
VN	Veneer
CO	Coating

Planarity

PL	Planar
CU	Curved
ST	Stepped
IR	Irregular

ENGINEERING LOG - CORED BOREHOLE

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

BOREHOLE NO: BH02
PAGE: 4 OF 4
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 4-8-16

DRILL TYPE: TRUCK MOUNTED RIG
BOREHOLE DIAMETER: 100/50 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information				Testing	Rock Mass Defects		
METHOD	WATER	CORE LIFT / TEST	RL (m)	DEPTH (m)	GRAPHIC LOG	Material Description: Rock type, particle characteristics, colour, minor components, structure	WEATHERING	ESTIMATED STRENGTH	$I_{s(50)}$D/A	RQD %	Defect Spacing mm	Defect Description: Type, inclination, planarity, roughness, coating, thickness
NMLC	Not Observed	8.05		7.5		INTERLAMINATED SILTSTONE AND SANDSTONE - Sandstone is fine to coarse grained, grey and dark grey (carbonaceous). *(continued)*	FR	H	D=2.34 A=3.34	92		
		8.05		8.0					D=0.91 A=1.29			
				8.5		Hole Terminated at 8.05 m Target depth						
				9.0								
				9.5								
				10.0								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Method

AS	Auger Screwing
AD	Auger Drilling
RR	Roller/tricone
CB	Claw or Blade bit
NMLC	NMLC Core

Field Tests

HP	Hand Penetrometer

Weathering

EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
FR	Fresh

Strength

		$I_{s(50)}$
VL	Very Low	<0.1
L	Low	0.1 - 0.3
M	Medium	0.3 - 1
H	High	1 - 3
VH	Very High	3 - 10
EH	Extremely High	>10

Defect Type

JT	Joint
PT	Parting
SM	Seam
SZ	Shear Zone
SS	Sheared Surface
CS	Crushed Seam

Roughness

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slickensided

Coating

CN	Clean
SN	Stained
VN	Veneer
CO	Coating

Planarity

PL	Planar
CU	Curved
ST	Stepped
IR	Irregular

ENGINEERING LOG - BOREHOLE

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

BOREHOLE NO: BH03
PAGE: 1 OF 3
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 2-9-16

DRILL TYPE: 4WD MOUNTED RIG
BOREHOLE DIAMETER: 100/50 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Observed			0.5		CI	FILL: Sandy CLAY - medium plasticity, red-brown to orange-brown, fine to medium grained sand, trace fine to medium grained gravel in top 20mm.	M > w_P				FILL - ACCESS TRACK
							0.30m Sandy CLAY - medium plasticity, red-brown and grey, fine to medium grained sand.					RESIDUAL SOIL
				1.0								
				1.5		CI		M ~ w_P	St - VSt			
				2.0								
				2.5			2.90m Extremely Weathered SANDSTONE, with soil properties: breaks down into Clayey SAND - fine to medium grained, yellow-brown with some pale grey, estimated very low strength.	D - M	D - VD			EXTREMELY WEATHERED ROCK
				3.0			3.20m Continued as Cored Drill Hole					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - CORED BOREHOLE

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

BOREHOLE NO: BH03
PAGE: 2 OF 3
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 2-9-16

DRILL TYPE: 4WD MOUNTED RIG
BOREHOLE DIAMETER: 100/50 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information				Testing	Rock Mass Defects		
METHOD	WATER	CORE LIFT / TEST	RL (m)	DEPTH (m)	GRAPHIC LOG	Material Description: Rock type, particle characteristics, colour, minor components, structure	WEATHERING	ESTIMATED STRENGTH	$I_{s(50)}$D/A	RQD %	Defect Spacing mm	Defect Description: Type, inclination, planarity, roughness, coating, thickness
				0.5								
				1.0								
				1.5								
				2.0								
				2.5								
				3.0		START CORING AT 3.20m						
NMLC						Pebbly SANDSTONE - fine to medium grained, brown.	SW - MW	M - H	D=0.85 A=1.04	100		
						Grey.	FR		D=0.85			

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Method

AS	Auger Screwing
AD	Auger Drilling
RR	Roller/tricone
CB	Claw or Blade bit
NMLC	NMLC Core

Field Tests

HP	Hand Penetrometer

Weathering

EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
FR	Fresh

Strength

		$I_{s(50)}$
VL	Very Low	<0.1
L	Low	0.1 - 0.3
M	Medium	0.3 - 1
H	High	1 - 3
VH	Very High	3 - 10
EH	Extremely High	>10

Defect Type

JT	Joint
PT	Parting
SM	Seam
SZ	Shear Zone
SS	Sheared Surface
CS	Crushed Seam

Roughness

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slickensided

Coating

CN	Clean
SN	Stained
VN	Veneer
CO	Coating

Planarity

PL	Planar
CU	Curved
ST	Stepped
IR	Irregular

ENGINEERING LOG - CORED BOREHOLE

BOREHOLE NO: **BH03**

CLIENT: LEND LEASE
PAGE: 3 OF 3

PROJECT: PROPOSED EXPANSION
JOB NO: NEW16P-0119

LOGGED BY: BE

LOCATION: CESSNOCK CORRECTIONAL CENTRE
DATE: 2-9-16

DRILL TYPE: 4WD MOUNTED RIG
SURFACE RL:

BOREHOLE DIAMETER: 100/50 mm
DATUM:

Drilling and Sampling					Material description and profile information				Testing	Rock Mass Defects		
METHOD	WATER	CORE LIFT / TEST	RL (m)	DEPTH (m)	GRAPHIC LOG	Material Description: Rock type, particle characteristics, colour, minor components, structure	WEATHERING	ESTIMATED STRENGTH	$I_{s(50)}$D/A	RQD %	Defect Spacing mm	Defect Description: Type, inclination, planarity, roughness, coating, thickness
NMLC	Not Observed	3.7				Pebbly SANDSTONE - fine to medium grained, brown. *(continued)*	FR		A=1.18	100		
		3.7				Brown.	SW - MW					
						Grey.						
				4.0			FR	M - H				
						Brown.	SW - MW					
						Grey.						
				4.5					D=1.29 A=1.68	100		
				5.0			FR					
				5.5				H				
		6.05		6.0					D=1.65 A=1.85			
						Hole Terminated at 6.05 m						
				6.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Method

AS	Auger Screwing
AD	Auger Drilling
RR	Roller/tricone
CB	Claw or Blade bit
NMLC	NMLC Core

Field Tests

HP	Hand Penetrometer

Weathering

EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
FR	Fresh

Strength

		$I_{s(50)}$
VL	Very Low	<0.1
L	Low	0.1 - 0.3
M	Medium	0.3 - 1
H	High	1 - 3
VH	Very High	3 - 10
EH	Extremely High	>10

Defect Type

JT	Joint
PT	Parting
SM	Seam
SZ	Shear Zone
SS	Sheared Surface
CS	Crushed Seam

Roughness

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slickensided

Coating

CN	Clean
SN	Stained
VN	Veneer
CO	Coating

Planarity

PL	Planar
CU	Curved
ST	Stepped
IR	Irregular

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: **BH04**

CLIENT: LEND LEASE

PAGE: 1 OF 3

PROJECT: PROPOSED EXPANSION

JOB NO: NEW16P-0119

LOGGED BY: BE

LOCATION: CESSNOCK CORRECTIONAL CENTRE

DATE: 2-9-16

DRILL TYPE: 4WD MOUNTED RIG

SURFACE RL:

BOREHOLE DIAMETER: 100/50 mm

DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Observed			0.5		GP	0.10m Silty Sandy GRAVEL - fine to medium grained, grey to brown, fine to coarse grained sand, fines of low plasticity, root affected.	M				FILL - TOPSOIL
						CH	Sandy CLAY - medium to high plasticity, pale brown, fine to medium grained sand.	M ~ w_P	VSt - H			RESIDUAL SOIL
				1.0		SC	1.00m Extremely Weathered SANDSTONE, with soil properties: breaks down into Clayey SAND - fine to medium grained, yellow-brown, estimated low strength.		VD			EXTREMELY TO HIGHLY WEATHERED ROCK
				1.5			1.20m Extremely Weathered SANDSTONE, with soil properties: breaks down into Clayey SAND - fine to medium grained, yellow-brown, estimated very low strength.	D - M	D - VD			EXTREMELY WEATHERED ROCK
				2.0			2.00m Continued as Cored Drill Hole					
				2.5								
				3.0								

LEGEND:

Water

- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes

- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - CORED BOREHOLE

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

BOREHOLE NO: BH04
PAGE: 2 OF 3
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 2-9-16

DRILL TYPE: 4WD MOUNTED RIG
BOREHOLE DIAMETER: 100/50 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information				Testing	Rock Mass Defects		
METHOD	WATER	CORE LIFT / TEST	RL (m)	DEPTH (m)	GRAPHIC LOG	Material Description: Rock type, particle characteristics, colour, minor components, structure	WEATHERING	ESTIMATED STRENGTH	$I_{s(50)}$D/A	RQD %	Defect Spacing mm	Defect Description: Type, inclination, planarity, roughness, coating, thickness
				0.5								
				1.0								
				1.5								
				2.0		START CORING AT 2.00m						
NMLC	Not Observed					SANDSTONE - fine to medium grained, dark brown, with extremely weathered sandstone (Sandy CLAY) bands - 20mm to 80mm thick.	HW - EW	M - H			220	SM Clay PL 220 mm
						NO CORE: 60mm core loss between 2.00 to 4.20m, judged to have occured from 2.24 to 2.30m.			D=0.82 A=1.03	10	250	
				2.5		SANDSTONE - fine to medium grained, dark brown, with extremely weathered sandstone (Sandy CLAY) bands - 20mm to 80mm thick.	HW - EW	M - H			60	SM Clay PL 60 mm
											120	
											20	SM Clay PL 20 mm
		3									70	
				3.0							30	SM Clay PL 30 mm
											80	
						INTERLAMINATED SILTSTONE & PEBBLY SANDSTONE - sandstone is fine to medium grained, grey to dark grey (carbonaceous).	FR - SW	H	D=0.94 A=1.31	100	280	JT 25° CN UN RO

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Method

AS	Auger Screwing
AD	Auger Drilling
RR	Roller/tricone
CB	Claw or Blade bit
NMLC	NMLC Core

Field Tests

HP	Hand Penetrometer

Weathering

EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
FR	Fresh

Strength

		$I_{s(50)}$
VL	Very Low	<0.1
L	Low	0.1 - 0.3
M	Medium	0.3 - 1
H	High	1 - 3
VH	Very High	3 - 10
EH	Extremely High	>10

Defect Type

JT	Joint
PT	Parting
SM	Seam
SZ	Shear Zone
SS	Sheared Surface
CS	Crushed Seam

Roughness

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slickensided

Coating

CN	Clean
SN	Stained
VN	Veneer
CO	Coating

Planarity

PL	Planar
CU	Curved
ST	Stepped
IR	Irregular

ENGINEERING LOG - CORED BOREHOLE

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

BOREHOLE NO: BH04
PAGE: 3 OF 3
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 2-9-16

DRILL TYPE: 4WD MOUNTED RIG
BOREHOLE DIAMETER: 100/50 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information				Testing	Rock Mass Defects		
METHOD	WATER	CORE LIFT / TEST	RL (m)	DEPTH (m)	GRAPHIC LOG	Material Description: Rock type, particle characteristics, colour, minor components, structure	WEATHERING	ESTIMATED STRENGTH	$I_{s(50)}$D/A	RQD %	Defect Spacing mm	Defect Description: Type, inclination, planarity, roughness, coating, thickness
NMLC	Not Observed	4.2		4.0		INTERLAMINATED SILTSTONE & PEBBLY SANDSTONE - sandstone is fine to medium grained, grey to dark grey (carbonaceous). *(continued)* 100mm band of CONGLOMERATE.	FR - SW	H	D=1.38 A=1.79	100		
		4.2		4.5		100mm band of CONGLOMERATE. Possible Tuffaceous SANDSTONE (250mm thick) - fine to medium grained, pale yellow brown.		M	D=0.42 A=0.52	100		
		5.63		5.0 5.5				H	D=1.23 A=1.50			
				6.0 6.5		Hole Terminated at 5.63 m						

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Method

AS	Auger Screwing
AD	Auger Drilling
RR	Roller/tricone
CB	Claw or Blade bit
NMLC	NMLC Core

Field Tests

HP	Hand Penetrometer

Weathering

EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
FR	Fresh

Strength

		$I_{s(50)}$
VL	Very Low	<0.1
L	Low	0.1 - 0.3
M	Medium	0.3 - 1
H	High	1 - 3
VH	Very High	3 - 10
EH	Extremely High	>10

Defect Type

JT	Joint
PT	Parting
SM	Seam
SZ	Shear Zone
SS	Sheared Surface
CS	Crushed Seam

Roughness

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slickensided

Coating

CN	Clean
SN	Stained
VN	Veneer
CO	Coating

Planarity

PL	Planar
CU	Curved
ST	Stepped
IR	Irregular

ENGINEERING LOG - BOREHOLE

BOREHOLE NO: **BH05**

CLIENT: LEND LEASE

PAGE: 1 OF 3

PROJECT: PROPOSED EXPANSION

JOB NO: NEW16P-0119

LOGGED BY: BE

LOCATION: CESSNOCK CORRECTIONAL CENTRE

DATE: 2-9-16

DRILL TYPE: 4WD MOUNTED RIG

SURFACE RL:

BOREHOLE DIAMETER: 100/50 mm

DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T	Not Observed			0.0		SM	Silty SAND - fine to medium grained, grey-brown, root affected.	M				TOPSOIL
				0.15m			Sandy CLAY - medium to high plasticity, orange-brown with some red-brown and pale grey, fine to medium grained sand.	M ~ w_P	VSt			RESIDUAL SOIL
				0.5								
				1.0								
				1.5		CH		M < w_P	H			
				2.0								
				2.5			Becoming yellow-brown.					
				2.80m			Extremely Weathered SANDSTONE, with soil properties: breaks down into Clayey SAND - fine to medium grained, yellow-brown, estimated very low strength.	D - M	D - VD			EXTREMELY WEATHERED ROCK
				3.0								

LEGEND:

Water

- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes

- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - BOREHOLE

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

BOREHOLE NO: BH05
PAGE: 2 OF 3
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 2-9-16

DRILL TYPE: 4WD MOUNTED RIG
BOREHOLE DIAMETER: 100/50 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information					Field Test		
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T				4.0			Extremely Weathered SANDSTONE, with soil properties: breaks down into Clayey SAND - fine to medium grained, yellow-brown, estimated very low strength. *(continued)*	D - M	D - VD			EXTREMELY WEATHERED ROCK
							4.25m Continued as Cored Drill Hole					
				4.5								
				5.0								
				5.5								
				6.0								
				6.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency

		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - CORED BOREHOLE

CLIENT: LEND LEASE
PROJECT: PROPOSED EXPANSION
LOCATION: CESSNOCK CORRECTIONAL CENTRE

BOREHOLE NO: BH05
PAGE: 3 OF 3
JOB NO: NEW16P-0119
LOGGED BY: BE
DATE: 2-9-16

DRILL TYPE: 4WD MOUNTED RIG
BOREHOLE DIAMETER: 100/50 mm
SURFACE RL:
DATUM:

Drilling and Sampling					Material description and profile information				Testing	Rock Mass Defects		
METHOD	WATER	CORE LIFT / TEST	RL (m)	DEPTH (m)	GRAPHIC LOG	Material Description: Rock type, particle characteristics, colour, minor components, structure	WEATHERING	ESTIMATED STRENGTH	$I_{s(50)}$D/A	RQD %	Defect Spacing mm	Defect Description: Type, inclination, planarity, roughness, coating, thickness
				4.0		START CORING AT 4.25m						
NMLC	Not Observed			4.5		Silty SANDSTONE - fine to medium grained, dark grey.	SW - MW	M	D=0.42 A=0.34	86	40	JT 30° SN PL RO
						Brown.					70	JT 30° SN PL RO
												JT 30° SN PL RO
						Dark grey.						
				5.0		Brown.			D=0.49 A=0.63		1000	
						Dark grey.						
				5.5		Brown.			D=0.89 A=0.74			
		5.6										JT 45° VN PL SO
				6.0		Hole Terminated at 5.60 m						
				6.5								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Method

AS	Auger Screwing
AD	Auger Drilling
RR	Roller/tricone
CB	Claw or Blade bit
NMLC	NMLC Core

Field Tests

HP	Hand Penetrometer

Weathering

EW	Extremely Weathered
HW	Highly Weathered
MW	Moderately Weathered
SW	Slightly Weathered
FR	Fresh

Strength

		$I_{s(50)}$
VL	Very Low	<0.1
L	Low	0.1 - 0.3
M	Medium	0.3 - 1
H	High	1 - 3
VH	Very High	3 - 10
EH	Extremely High	>10

Defect Type

JT	Joint
PT	Parting
SM	Seam
SZ	Shear Zone
SS	Sheared Surface
CS	Crushed Seam

Roughness

VR	Very Rough
RO	Rough
SO	Smooth
SL	Slickensided

Coating

CN	Clean
SN	Stained
VN	Veneer
CO	Coating

Planarity

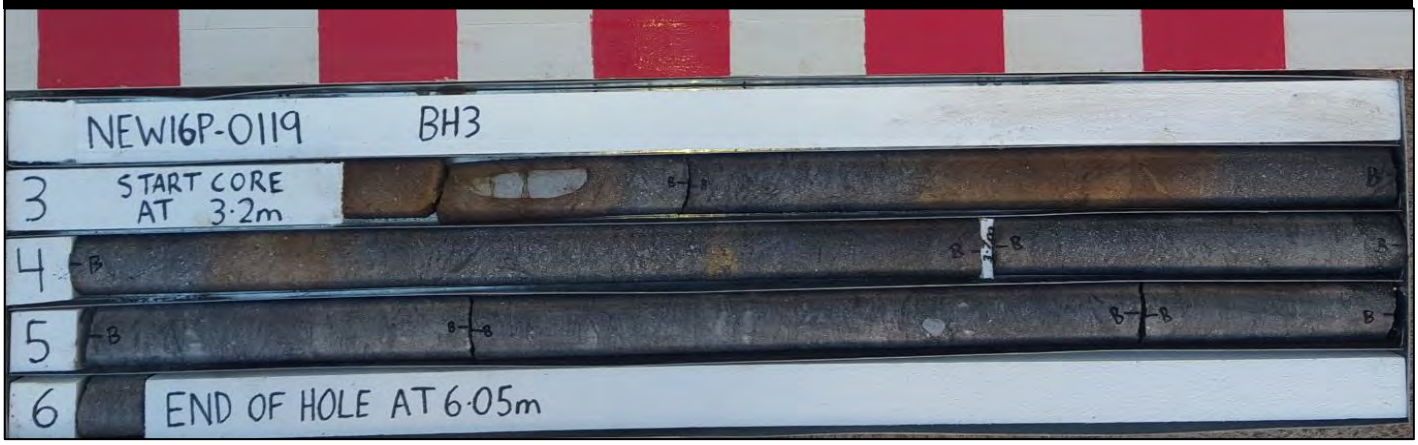
PL	Planar
CU	Curved
ST	Stepped
IR	Irregular

NEW16P-0119
PROPOSED **CESSCNOCK CORRECTIONAL CENTRE EXPANSION**
BOREHOLE - BH01, 2.80m to 8.80m
BOX 1 & 2

NEW16P-0119
PROPOSED CESSCNOCK CORRECTIONAL CENTRE EXPANSION
BOREHOLE - BH02, 2.40m to 8.05m

	Client:	LEND LEASE	Project No:	NEW16P-0026	
	Project:	PROPOSED EXPANSION	Date:	4/03/2016	
	Location:	CESSNOCK CORRECTIONAL CENTRE	Drawing No:	BH1-2	Sheet 1 of 3
	Title:	CORE PHOTOGRAPHS			

NEW16P-0119
PROPOSED **CESSCNOCK CORRECTIONAL CENTRE EXPANSION**
BOREHOLE - BH03, 3.20m to 6.05m
BOX 1 OF 1



NEW16P-0119
PROPOSED CESSCNOCK CORRECTIONAL CENTRE EXPANSION
BOREHOLE - BH04, 2.00m to 5.63m

NEW16P-0119
PROPOSED CESSCNOCK CORRECTIONAL CENTRE EXPANSION
BOREHOLE - BH05, 4.25m to 5.60m

Qualtest LABORATORY (NSW) PTY LTD	Client:	LEND LEASE	Project No:	NEW16P-0119	
	Project:	PROPOSED EXPANSION	Date:	6/09/2016	
	Location:	CESSNOCK CORRECTIONAL CENTRE	Drawing No:	BH3-5	Sheet 1 of 1
	Title:	CORE PHOTOGRAPHS			

APPENDIX B:

Results of Laboratory Testing

Qualtest LABORATORY (NSW) PTY LTD

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ABN: 98 153 268 896

Point Load Strength Report - Diametral and Axial Testing of Rock Core

Issue Number: 1
This report replaces all previous issues

Accredited for compliance with ISO/IEC 17025.

NATA WORLD RECOGNISED ACCREDITATION

Client:	Lend Lease	Report No.:	PL:NEW16W-2197
Project:	Geotechnical Assesment - Cessnock Correctional Centre	Project No.:	NEW16P-0119
Location:	Cessnock, NSW	Work Order No:	NEW16W-2197
		Sample No.:	S01

Date Sampled:	10-08-16
Date Tested:	12-08-16

Approved Signatory: Alan Cullen
Title: Principal Geotechnician
Date of Issue: 12-08-16
NATA Accredited Laboratory Number: 18686

Test Method: AS 4133.4.1 - 2007, Clause 3.4, RMS T223 Test Machine: HMA 6500 Date of Calibration: 10-12-13

Borehole	Test Depth (m)	Rock Type	Moisture Condition	Diametral Test							Axial Test							
				Length L (mm)	Diameter D (mm)	Load P (kN)	I_s (Mpa)	Size Correction	$I_{s(50)}$ (Mpa)	Strength Classification	Width W (diameter) (mm)	Platen Separation D (mm)	Load P (kN)	I_s (Mpa)	Size Correction	$I_{s(50)}$ (Mpa)	Strength Classification	Anisotropy Index $I_{a(50)}$
1	3.24	Sandstone	N	40.0	50.0	1.66	0.66	1.00	0.66	M	50.0	36.0	0.75	0.33	0.981	0.32	M	2.07
1	4.00	Sandstone	N	35.0	50.0	1.73	0.69	1.00	0.69	M	50.0	32.0	2.02	0.99	0.955	0.95	M	0.73
1	4.50	Interlaminated Siltstone & Sandstone	N	42.0	50.0	3.05	1.22	1.00	1.22	H	50.0	37.0	4.49	1.91	0.987	1.88	H	0.65
1	5.50	Pebbly Sandstone	N	42.0	50.0	2.39	0.96	1.00	0.96	M	50.0	37.0	2.74	1.16	0.987	1.15	H	0.83
1	6.49	Interlaminated Siltstone & Sandstone	N	40.0	50.0	1.86	0.74	1.00	0.74	M	50.0	36.0	1.65	0.72	0.981	0.71	M	1.05
1	8.77	Interlaminated Siltstone & Sandstone	N	45.0	50.0	2.42	0.97	1.00	0.97	M	50.0	38.0	1.79	0.74	0.993	0.73	M	1.32
2	2.96	Sandstone	N	40.0	50.0	2.99	1.20	1.00	1.20	H	50.0	36.0	3.15	1.37	0.981	1.35	H	0.89
2	3.81	Sandstone	N	38.0	50.0	1.77	0.71	1.00	0.71	M	50.0	34.0	1.41	0.65	0.968	0.63	M	1.12
2	5.32	Interlaminated Siltstone & Sandstone	N	50.0	50.0	0.35	0.14	1.00	0.14	L	50.0	47.0	0.44	0.15	1.041	0.15	L	0.91
2	6.09	Interlaminated Siltstone & Sandstone	N	45.0	50.0	4.10	1.64	1.00	1.64	H	50.0	42.0	3.52	1.32	1.015	1.34	H	1.23
2	7.90	Interlaminated Siltstone & Sandstone	N	34.0	50.0	2.27	0.91	1.00	0.91	M	50.0	30.0	2.61	1.37	0.941	1.29	H	0.71
2	7.00	Interlaminated Siltstone & Sandstone	N	45.0	50.0	5.86	2.34	1.00	2.34	H	50.0	40.0	8.47	3.33	1.004	3.34	VH	0.70

Moisture Condition:
D = Dry
N = Natural
S = Saturated

Strength Classification:

$I_{s(50)}$ Mpa	Term	Abbreviation
> 10	Extremely High Strength	EH
3 to 10	Very High Strength	VH
1 to 3	High Strength	H
0.3 to 1	Medium Strength	M
0.1 to 0.3	Low Strength	L
< 0.1	Very Low Strength	VL

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ABN: 98 153 268 896

Point Load Strength Report - Diametral and Axial Testing of Rock Core

Issue Number: 1
This report replaces all previous issues

Accredited for compliance with ISO/IEC 17025.

NATA WORLD RECOGNISED ACCREDITATION

Client:	Lend Lease Building Pty Ltd	Report No.:	PL:NEW16W-2197
Project:	Geotechnical Assessment - Cessnock Correctional Centre	Project No.:	NEW16P-0119
Location:	Cessnock, NSW	Work Order No:	NEW16W-2197
		Sample No.:	S02

Date Sampled:	2/09/2016
Date Tested:	6/09/2016

Approved Signatory: Alan Cullen
Title: Principal Geotechnician
Date of Issue: 8/09/2016
NATA Accredited Laboratory Number: 18686

Test Method: AS 4133.4.1 - 2007, Clause 3.4 Test Machine: HMA 6500 Date of Calibration: 10/12/2013

Borehole	Test Depth (m)	Rock Type	Moisture Condition	Diametral Test							Axial Test							
				Length L (mm)	Diameter D (mm)	Load P (kN)	I_s (Mpa)	Size Correction	$I_{s(50)}$ (Mpa)	Strength Classification	Width W (diameter) (mm)	Platen Separation D (mm)	Load P (kN)	I_s (Mpa)	Size Correction	$I_{s(50)}$ (Mpa)	Strength Classification	Anisotropy Index $I_{a(50)}$
3	3.25	Pebbly SANDSTONE	N	40.0	50.0	2.13	0.85	1.00	0.85	M	50.0	35.0	2.37	1.06	0.974	1.04	H	0.82
3	3.47	Pebbly SANDSTONE	N	40.0	50.0	2.13	0.85	1.00	0.85	M	50.0	33.0	2.58	1.23	0.962	1.18	H	0.72
3	4.70	Pebbly SANDSTONE	N	38.0	50.0	3.22	1.29	1.00	1.29	H	50.0	35.0	3.84	1.72	0.974	1.68	H	0.77
3	5.95	Pebbly SANDSTONE	N	37.0	50.0	4.13	1.65	1.00	1.65	H	50.0	39.0	4.60	1.85	0.998	1.85	H	0.89
4	2.40	SANDSTONE	N	36.0	50.0	2.06	0.82	1.00	0.82	M	50.0	33.0	2.25	1.07	0.962	1.03	H	0.80
4	3.00	SILTSTONE / Pebbly SANDSTONE	N	35.0	50.0	2.35	0.94	1.00	0.94	M	50.0	29.0	2.58	1.40	0.934	1.31	H	0.72
4	3.66		N	50.0	50.0	3.44	1.38	1.00	1.38	H	50.0	48.0	5.24	1.71	1.046	1.79	H	0.77
4	4.96	Tuffaceous SANDSTONE	N	40.0	50.0	1.06	0.42	1.00	0.42	M	50.0	35.0	1.18	0.53	0.974	0.52	M	0.82
4	5.38	SILTSTONE / Pebbly SANDSTONE	N	35.0	50.0	3.08	1.23	1.00	1.23	H	50.0	29.0	2.96	1.60	0.934	1.50	H	0.82
5	4.28	Silty SANDSTONE	N	35.0	50.0	1.05	0.42	1.00	0.42	M	50.0	30.0	0.68	0.36	0.941	0.34	M	1.25
5	4.95	Silty SANDSTONE	N	50.0	50.0	1.22	0.49	1.00	0.49	M	50.0	48	1.85	0.61	1.046	0.63	M	0.77
5	5.34	Silty SANDSTONE	N	45.0	50.0	2.22	0.89	1.00	0.89	M	50.0	38	1.80	0.74	0.993	0.74	M	1.20

Moisture Condition:
D = Dry
N = Natural
S = Saturated

Strength Classification:

$I_{s(50)}$ Mpa	Term	Abbreviation
> 10	Extremely High Strength	EH
3 to 10	Very High Strength	VH
1 to 3	High Strength	H
0.3 to 1	Medium Strength	M
0.1 to 0.3	Low Strength	L
< 0.1	Very Low Strength	VL

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California Bearing Ratio Test Report

Report No: CBR:NEW16W-2185--S01
Issue No: 2
this report replaces all previous issues of report no 'CBR:NEW16W-2185--S01'.

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

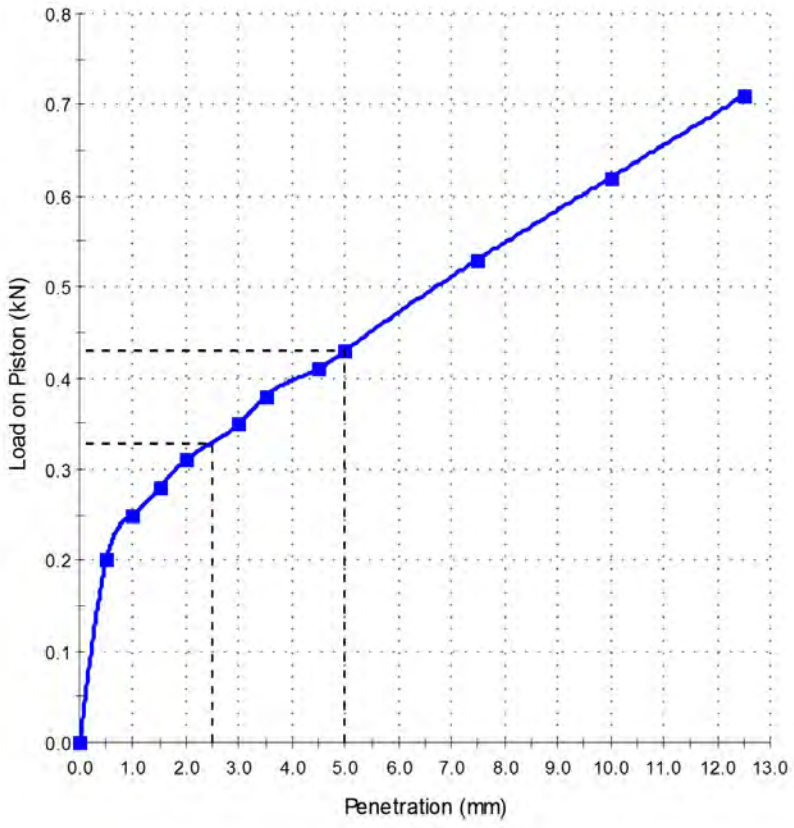
Accredited for compliance with ISO/IEC 17025
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 26/08/2016

Sample Details

Sample ID:	NEW16W-2185--S01	Date Sampled:	10/08/2016
Sampling Method:	AS1289.1.2.1 cl 6.5.4		
Specification:	No Specification	Source:	On-Site
Location:	TP03 - (0.3 - 0.5m)	Material:	Sandy Clay
Project Location:	Cessnock, NSW		

Load vs Penetration



Test Results

AS 1289.6.1.1

CBR At 2.5mm (%):	2.5
Maximum Dry Density (t/m³):	1.62
Optimum Moisture Content (%):	23.6
Dry Density before Soaking (t/m³):	1.61
Density Ratio before Soaking (%):	100
Moisture Content before Soaking (%):	24.0
Moisture Ratio before Soaking (%):	101
Dry Density after Soaking (t/m³):	1.58
Density Ratio after Soaking (%):	98
Swell (%):	2.0
Moisture Content of Top 30mm (%):	37.4
Moisture Content of Remaining Depth (%):	27.5
Compactive Effort:	Standard
Surcharge Mass (kg):	9.00
Period of Soaking (Days):	4
Oversize Material (%):	0.0

Moisture Content

Field Moisture Content (%):	23.8

Comments

Moisture Content Method Performed as Per AS1289.2.1.1.
Laboratory Moisture Ratio (LMR): 101.5% Laboratory Density Ratio (LDR): 99.5%

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California Bearing Ratio Test Report

Report No: CBR:NEW16W-2185--S02
Issue No: 2
this report replaces all previous issues of report no 'CBR:NEW16W-2185--S02'.

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

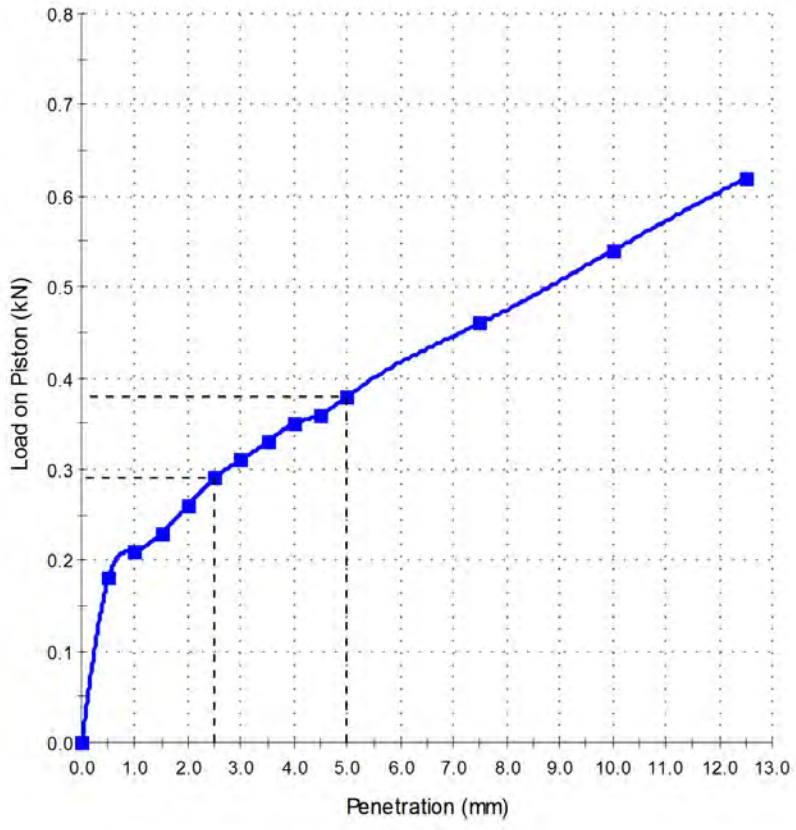
Accredited for compliance with ISO/IEC 17025
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 26/08/2016

Sample Details

Sample ID:	NEW16W-2185--S02	Date Sampled:	10/08/2016
Sampling Method:	AS1289.1.2.1 cl 6.5.4		
Specification:	No Specification	Source:	On-Site
Location:	TP04 - (0.5 - 0.8m)	Material:	Sandy Clay
Project Location:	Cessnock, NSW		

Load vs Penetration



Test Results

AS 1289.6.1.1

CBR At 2.5mm (%):	2.0
Maximum Dry Density (t/m³):	1.81
Optimum Moisture Content (%):	14.7
Dry Density before Soaking (t/m³):	1.81
Density Ratio before Soaking (%):	100
Moisture Content before Soaking (%):	14.5
Moisture Ratio before Soaking (%):	99
Dry Density after Soaking (t/m³):	1.75
Density Ratio after Soaking (%):	97
Swell (%):	3.0
Moisture Content of Top 30mm (%):	27.4
Moisture Content of Remaining Depth (%):	16.9
Compactive Effort:	Standard
Surcharge Mass (kg):	9.00
Period of Soaking (Days):	4
Oversize Material (%):	0.0

Moisture Content

Field Moisture Content (%):	13.7

Comments

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California Bearing Ratio Test Report

Report No: CBR:NEW16W-2403--S01
Issue No: 2
this report replaces all previous issues of report no 'CBR:NEW16W-2403--S01'.

Client:	Lend Lease Building Pty Ltd L14, International Towers Exchange Place, 300 Barangaroo Ave, Sydney NSW 2000
Principal:	
Project No.:	NEW16P-0119
Project Name:	Proposed Expansion of Cessnock Correctional Centre

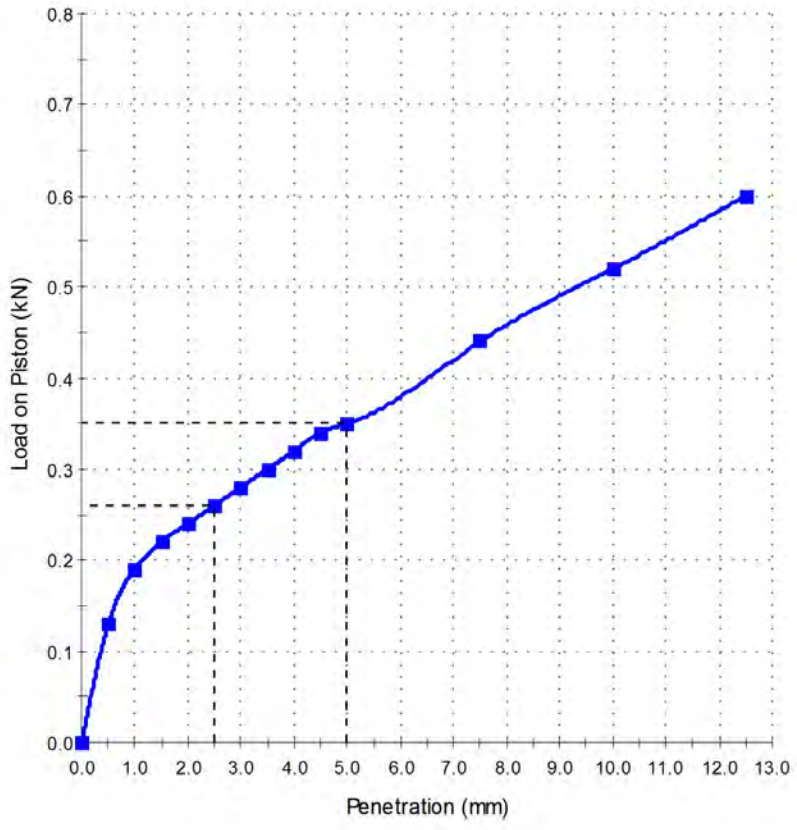
Accredited for compliance with ISO/IEC 17025
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 12/09/2016

Sample Details

Sample ID:	NEW16W-2403--S01	Date Sampled:	25/08/2016
Sampling Method:	AS1289.1.2.1 cl 6.5.4		
Specification:	No Specification	Source:	On-Site
Location:	TP27 - (0.2 - 0.5m)	Material:	Clay
Project Location:	Cessnock, NSW		

Load vs Penetration



Test Results

AS 1289.6.1.1

CBR At 2.5mm (%):	2.0
Maximum Dry Density (t/m³):	1.66
Optimum Moisture Content (%):	20.9
Dry Density before Soaking (t/m³):	1.65
Density Ratio before Soaking (%):	100
Moisture Content before Soaking (%):	21.1
Moisture Ratio before Soaking (%):	101
Dry Density after Soaking (t/m³):	1.61
Density Ratio after Soaking (%):	97
Swell (%):	2.5
Moisture Content of Top 30mm (%):	32.9
Moisture Content of Remaining Depth (%):	23.8
Compactive Effort:	Standard
Surcharge Mass (kg):	9.00
Period of Soaking (Days):	4
Oversize Material (%):	0.0

Moisture Content

Field Moisture Content (%):	19.8

Comments

Moisture Content Method Performed as Per AS1289.2.1.1.
Laboratory Moisture Ratio (LMR): 101.0% Laboratory Density Ratio (LDR): 100.0%

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California Bearing Ratio Test Report

Report No: CBR:NEW16W-2403--S02
Issue No: 1

Client: Lend Lease Building Pty Ltd
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

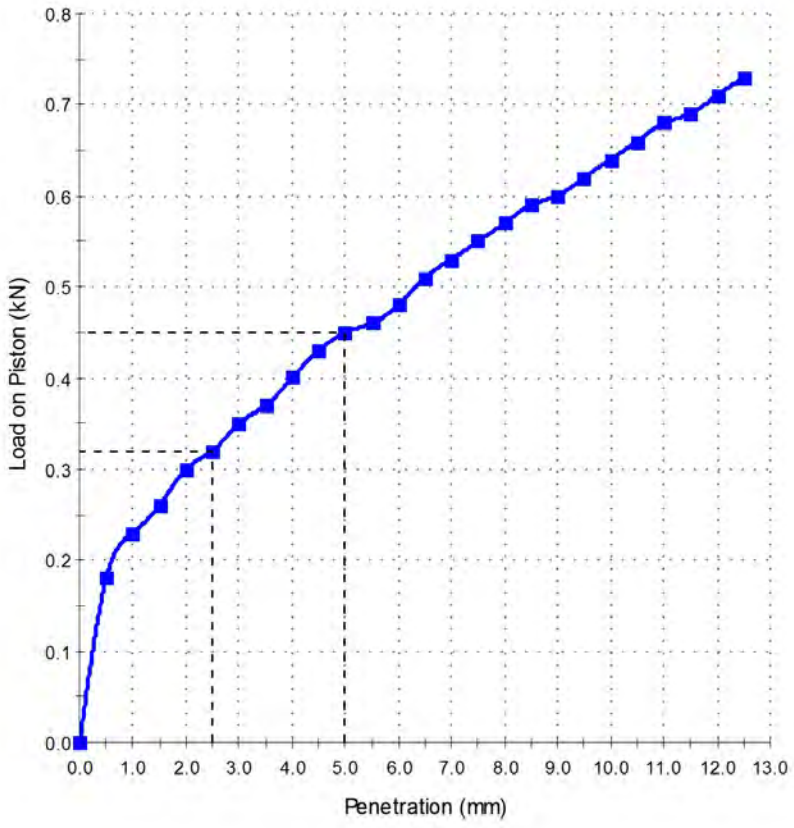
Accredited for compliance with ISO/IEC 17025
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 7/09/2016

Sample Details

Sample ID:	NEW16W-2403--S02	Date Sampled:	25/08/2016
Sampling Method:	AS1289.1.2.1 cl 6.5.4		
Specification:	No Specification	Source:	On-Site
Location:	TP29 - (0.3 - 0.5m)	Material:	Clay
Project Location:	Cessnock, NSW		

Load vs Penetration



Test Results

AS 1289.6.1.1

CBR At 2.5mm (%):	2.5
Maximum Dry Density (t/m³):	1.64
Optimum Moisture Content (%):	21.6
Dry Density before Soaking (t/m³):	1.64
Density Ratio before Soaking (%):	100
Moisture Content before Soaking (%):	21.8
Moisture Ratio before Soaking (%):	101
Dry Density after Soaking (t/m³):	1.61
Density Ratio after Soaking (%):	98
Swell (%):	1.5
Moisture Content of Top 30mm (%):	32.6
Moisture Content of Remaining Depth (%):	24.9
Compactive Effort:	Standard
Surcharge Mass (kg):	9.00
Period of Soaking (Days):	4
Oversize Material (%):	0.0

Moisture Content

Field Moisture Content (%):	17.4

Comments

Moisture Content Method Performed as Per AS1289.2.1.1.
Laboratory Moisture Ratio (LMR): 101.0% Laboratory Density Ratio (LDR): 99.5%

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ABN: 98 153 268 896

California Bearing Ratio Test Report

Report No: CBR:NEW16W-2403--S03
Issue No: 1

Client:	Lend Lease Building Pty Ltd Level 13, 224 Bunda Street Canberra City ACT 2600
Principal:	
Project No.:	NEW16P-0119
Project Name:	Proposed Expansion of Cessnock Correctional Centre

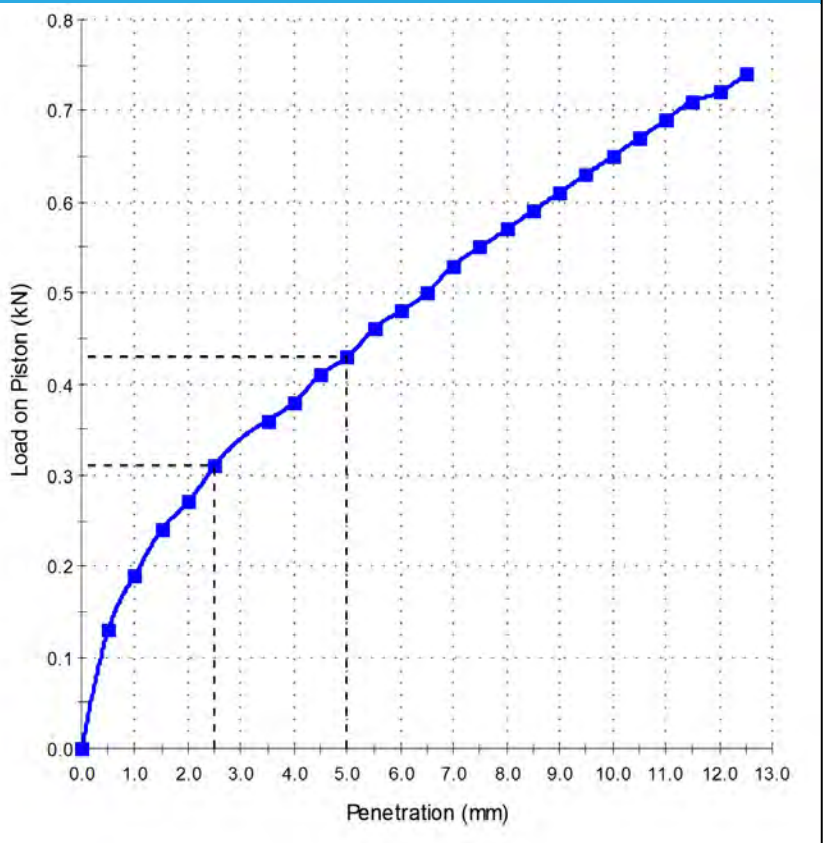
Accredited for compliance with ISO/IEC 17025
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 7/09/2016

Sample Details

Sample ID:	NEW16W-2403--S03	Date Sampled:	25/08/2016
Sampling Method:	AS1289.1.2.1 cl 6.5.4		
Specification:	No Specification	Source:	On-Site
Location:	TP30 - (0.25 - 0.5m)	Material:	Clay
Project Location:	Cessnock, NSW		

Load vs Penetration



Test Results

AS 1289.6.1.1

CBR At 2.5mm (%):	2.5
Maximum Dry Density (t/m³):	1.51
Optimum Moisture Content (%):	27.5
Dry Density before Soaking (t/m³):	1.52
Density Ratio before Soaking (%):	100
Moisture Content before Soaking (%):	26.9
Moisture Ratio before Soaking (%):	98
Dry Density after Soaking (t/m³):	1.50
Density Ratio after Soaking (%):	99
Swell (%):	1.5
Moisture Content of Top 30mm (%):	37.4
Moisture Content of Remaining Depth (%):	28.9
Compactive Effort:	Standard
Surcharge Mass (kg):	9.00
Period of Soaking (Days):	4
Oversize Material (%):	0.0

Moisture Content

Field Moisture Content (%):	27.1

Comments

Moisture Content Method Performed as Per AS1289.2.1.1.
Laboratory Moisture Ratio (LMR): 98.0% Laboratory Density Ratio (LDR): 100.5%

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ABN: 98 153 268 896

Shrink Swell Index Report

Report No: SSI:NEW16W-2185--S03
Issue No: 1

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 23/08/2016

Sample Details

Sample ID:	NEW16W-2185--S03	Client Sample ID:	
Test Request No.:		Sampling Method:	AS1289.1.2.1 cl 6.5.4
Material:	Sandy Clay	Date Sampled:	10/08/2016
Source:	On-Site	Date Submitted:	11/08/2016
Specification:	No Specification		
Project Location:	Cessnock, NSW		
Sample Location:	TP10 - (0.8 - 1.0m)		
Borehole Number:	TP10		
Borehole Depth (m):	0.8 - 1.0		

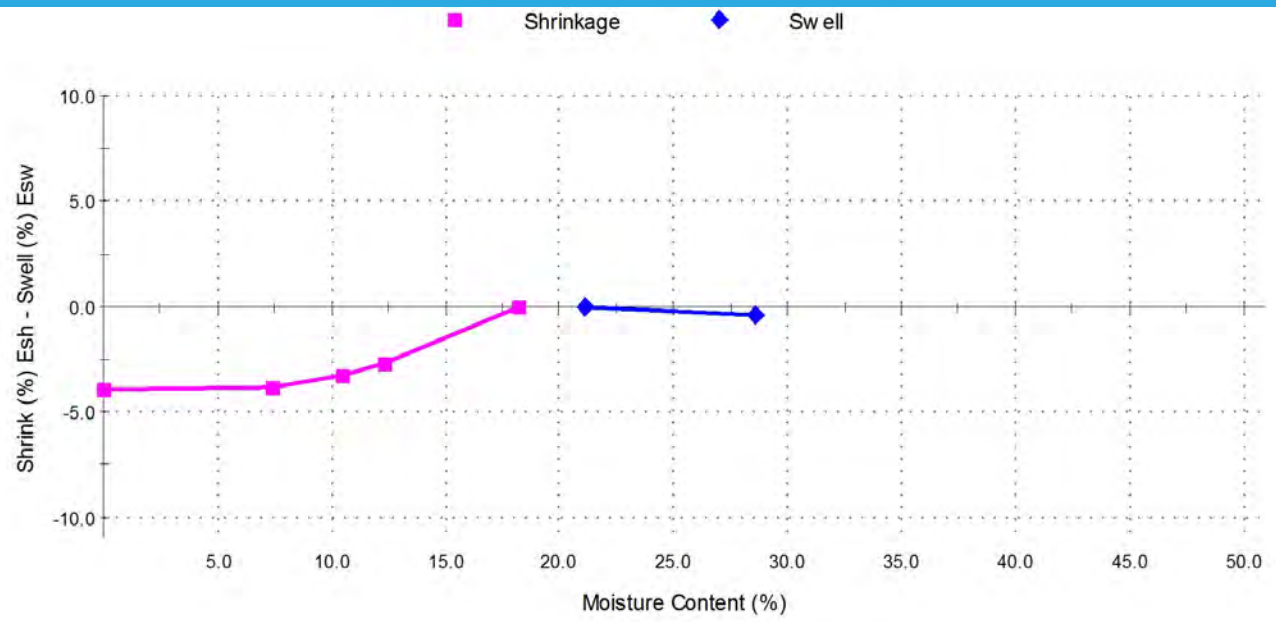
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	-0.4
Moisture Content before (%):	21.1
Moisture Content after (%):	28.6
Est. Unc. Comp. Strength before (kPa):	500
Est. Unc. Comp. Strength after (kPa):	200

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	3.9
Shrinkage Moisture Content (%):	18.2
Est. inert material (%):	0%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Minor

Shrink Swell



Shrink Swell Index - Iss (%): 2.1

Comments

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Shrink Swell Index Report

Report No: SSI:NEW16W-2185--S04
Issue No: 1

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 23/08/2016

Sample Details

Sample ID:	NEW16W-2185--S04	Client Sample ID:	
Test Request No.:		Sampling Method:	AS1289.1.2.1 cl 6.5.4
Material:	Sandy Clay	Date Sampled:	10/08/2016
Source:	On-Site	Date Submitted:	11/08/2016
Specification:	No Specification		
Project Location:	Cessnock, NSW		
Sample Location:	TP11 - (0.5 - 0.68m)		
Borehole Number:	TP11		
Borehole Depth (m):	0.5 - 0.68		

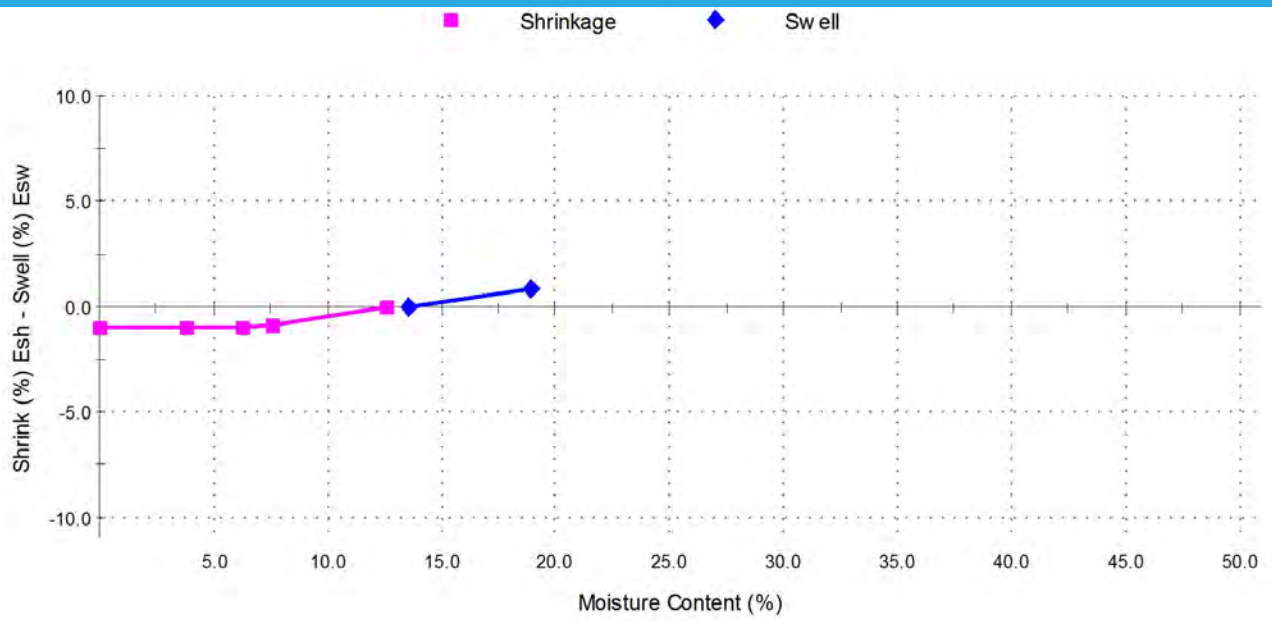
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	0.8
Moisture Content before (%):	13.6
Moisture Content after (%):	18.9
Est. Unc. Comp. Strength before (kPa):	480
Est. Unc. Comp. Strength after (kPa):	250

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	1.0
Shrinkage Moisture Content (%):	12.5
Est. inert material (%):	0%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Major

Shrink Swell



Shrink Swell Index - Iss (%): 0.8

Comments

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Report No: SSI:NEW16W-2185--S05
Issue No: 1

Shrink Swell Index Report

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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Approved Signatory: Dane Cullen
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NATA Accredited Laboratory Number: 18686
Date of Issue: 23/08/2016

Sample Details

Sample ID:	NEW16W-2185--S05	Client Sample ID:	
Test Request No.:		Sampling Method:	AS1289.1.2.1 cl 6.5.4
Material:	Sandy Clay	Date Sampled:	10/08/2016
Source:	On-Site	Date Submitted:	11/08/2016
Specification:	No Specification		
Project Location:	Cessnock, NSW		
Sample Location:	TP12 - (0.5 - 0.75m)		
Borehole Number:	TP12		
Borehole Depth (m):	0.5 - 0.75		

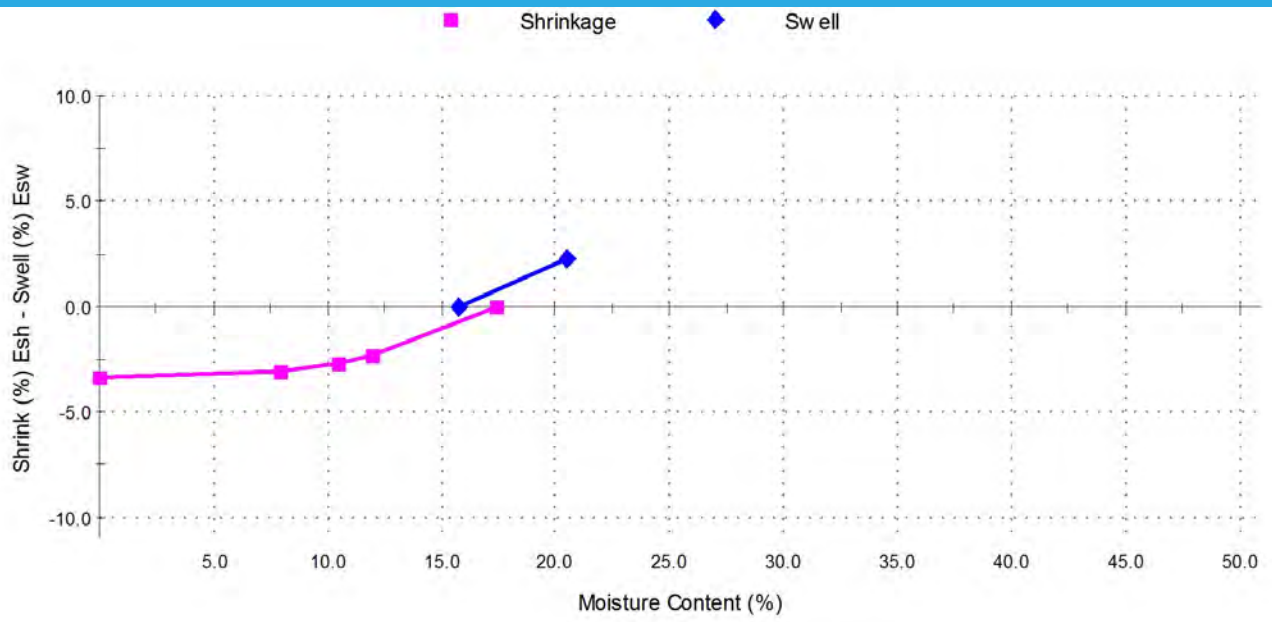
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	2.3
Moisture Content before (%):	15.7
Moisture Content after (%):	20.5
Est. Unc. Comp. Strength before (kPa):	580
Est. Unc. Comp. Strength after (kPa):	250

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	3.4
Shrinkage Moisture Content (%):	17.4
Est. inert material (%):	0%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Nil

Shrink Swell



Shrink Swell Index - Iss (%): 2.5

Comments

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Shrink Swell Index Report

Report No: SSI:NEW16W-2185--S06
Issue No: 1

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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Approved Signatory: Dane Cullen
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NATA Accredited Laboratory Number: 18686
Date of Issue: 23/08/2016

Sample Details

Sample ID:	NEW16W-2185--S06	Client Sample ID:	
Test Request No.:		Sampling Method:	AS1289.1.2.1 cl 6.5.4
Material:	Sandy Clay	Date Sampled:	10/08/2016
Source:	On-Site	Date Submitted:	11/08/2016
Specification:	No Specification		
Project Location:	Cessnock, NSW		
Sample Location:	TP17 - (0.6 - 1.0m)		
Borehole Number:	TP17		
Borehole Depth (m):	0.6 - 1.0		

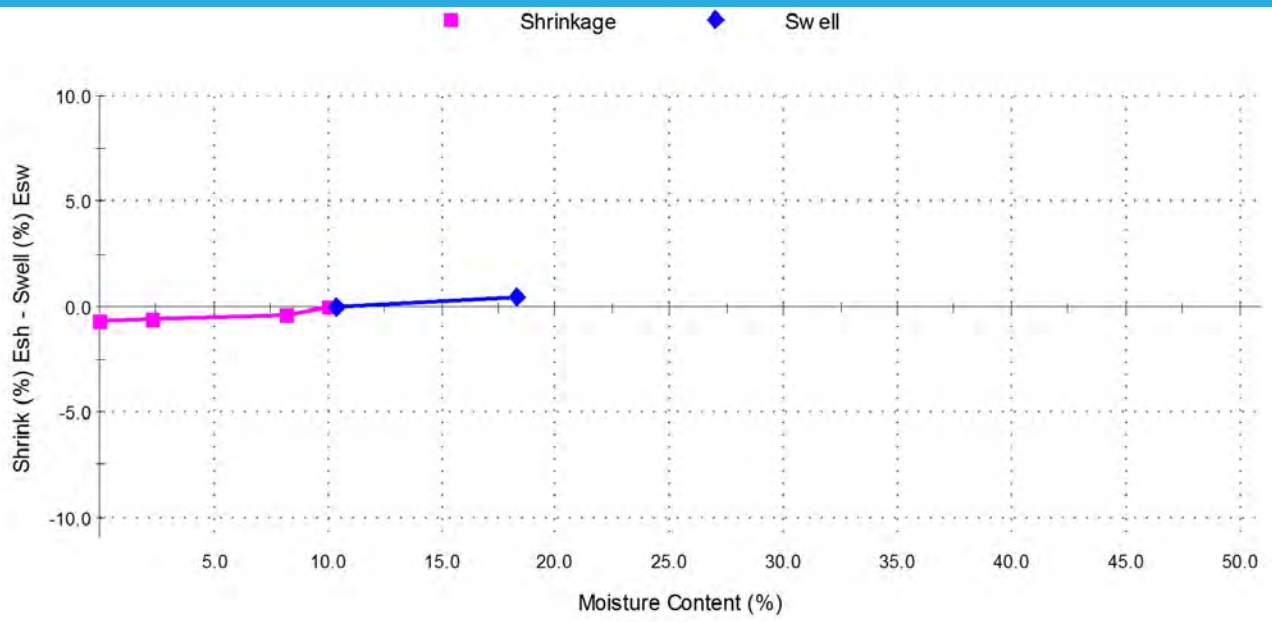
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	0.4
Moisture Content before (%):	10.4
Moisture Content after (%):	18.3
Est. Unc. Comp. Strength before (kPa):	600
Est. Unc. Comp. Strength after (kPa):	400

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	0.7
Shrinkage Moisture Content (%):	10.0
Est. inert material (%):	0%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Nil

Shrink Swell



Shrink Swell Index - Iss (%): 0.5

Comments

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Shrink Swell Index Report

Report No: SSI:NEW16W-2185--S07
Issue No: 1

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 23/08/2016

Sample Details

Sample ID:	NEW16W-2185--S07	Client Sample ID:	
Test Request No.:		Sampling Method:	AS1289.1.2.1 cl 6.5.4
Material:	Sandy Clay	Date Sampled:	10/08/2016
Source:	On-Site	Date Submitted:	11/08/2016
Specification:	No Specification		
Project Location:	Cessnock, NSW		
Sample Location:	TP18 - (0.5 - 0.90m)		
Borehole Number:	TP18		
Borehole Depth (m):	0.5 - 0.9		

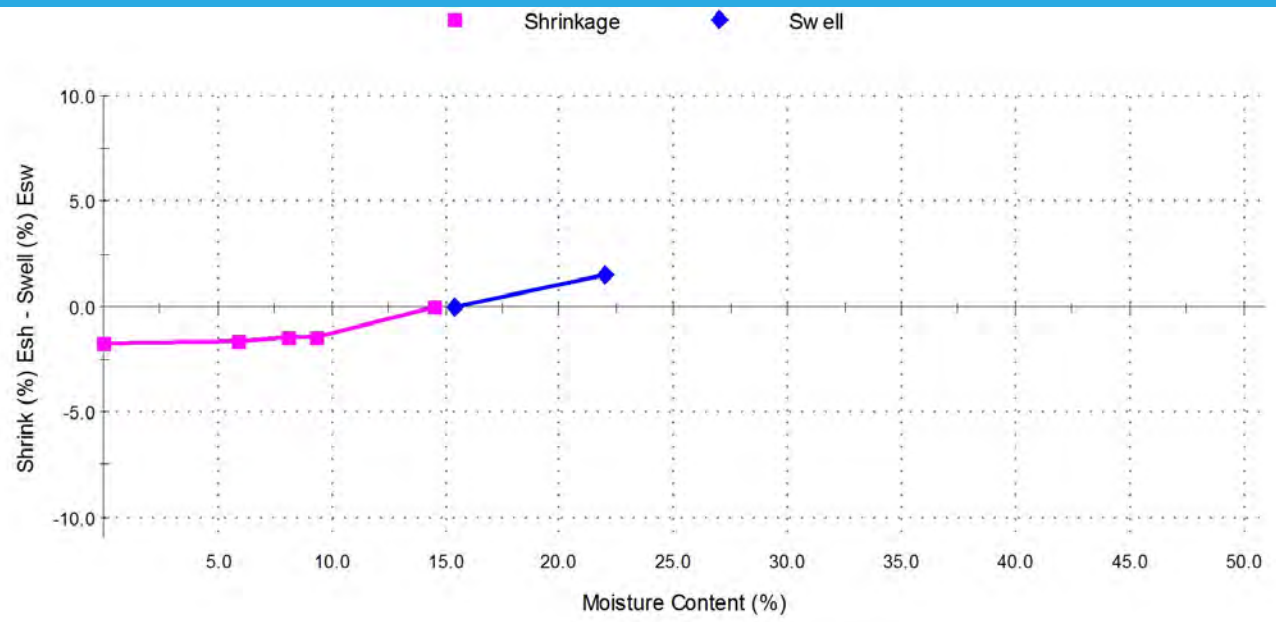
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	1.5
Moisture Content before (%):	15.4
Moisture Content after (%):	22.0
Est. Unc. Comp. Strength before (kPa):	
Est. Unc. Comp. Strength after (kPa):	

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	1.7
Shrinkage Moisture Content (%):	14.5
Est. inert material (%):	0%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Moderate

Shrink Swell



Shrink Swell Index - Iss (%): 1.3

Comments

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Report No: SSI:NEW16W-2185--S08
Issue No: 1

Shrink Swell Index Report

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 23/08/2016

Sample Details

Sample ID:	NEW16W-2185--S08	Client Sample ID:	
Test Request No.:		Sampling Method:	AS1289.1.2.1 cl 6.5.4
Material:	Sandy Clay	Date Sampled:	10/08/2016
Source:	On-Site	Date Submitted:	11/08/2016
Specification:	No Specification		
Project Location:	Cessnock, NSW		
Sample Location:	TP20 - (0.5 - 0.75m)		
Borehole Number:	TP20		
Borehole Depth (m):	0.5 - 0.75		

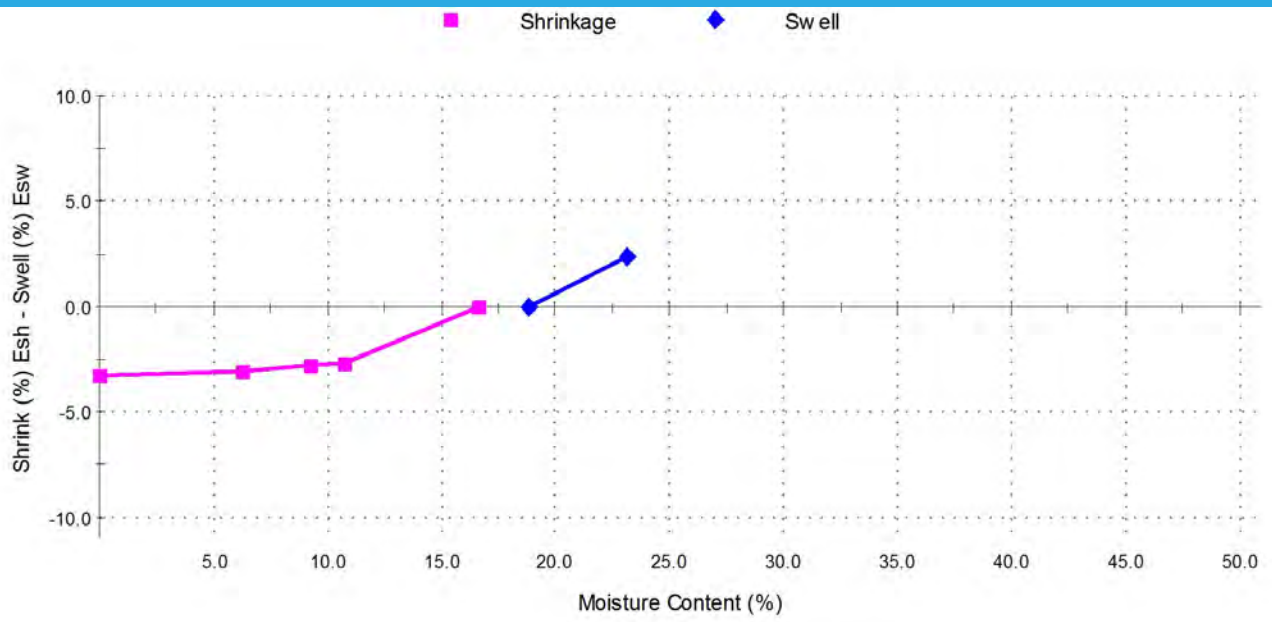
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	2.3
Moisture Content before (%):	18.8
Moisture Content after (%):	23.1
Est. Unc. Comp. Strength before (kPa):	520
Est. Unc. Comp. Strength after (kPa):	300

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	3.3
Shrinkage Moisture Content (%):	16.6
Est. inert material (%):	0%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Minor

Shrink Swell



Shrink Swell Index - Iss (%): 2.5

Comments

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Shrink Swell Index Report

Report No: SSI:NEW16W-2185--S09
Issue No: 1

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 23/08/2016

Sample Details

Sample ID:	NEW16W-2185--S09	Client Sample ID:	
Test Request No.:		Sampling Method:	AS1289.1.2.1 cl 6.5.4
Material:	Sandy Clay	Date Sampled:	10/08/2016
Source:	On-Site	Date Submitted:	11/08/2016
Specification:	No Specification		
Project Location:	Cessnock, NSW		
Sample Location:	TP21 - (0.5 - 0.68m)		
Borehole Number:	TP21		
Borehole Depth (m):	0.5 - 0.68		

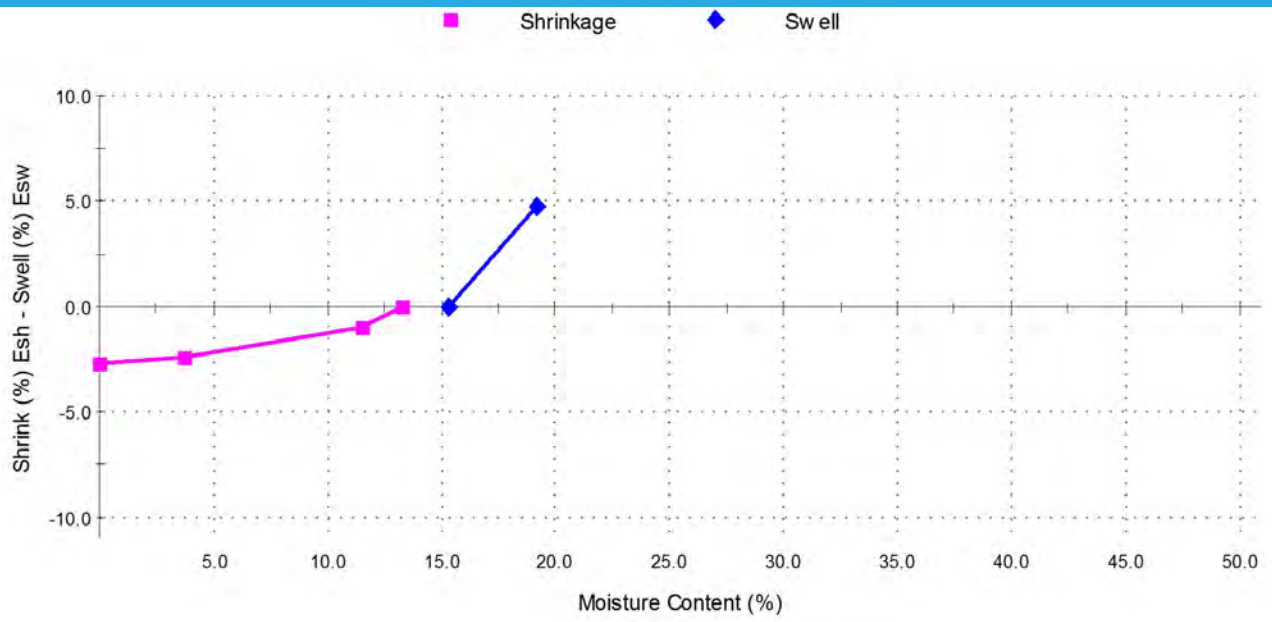
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	4.8
Moisture Content before (%):	15.3
Moisture Content after (%):	19.1
Est. Unc. Comp. Strength before (kPa):	600
Est. Unc. Comp. Strength after (kPa):	390

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	2.7
Shrinkage Moisture Content (%):	13.3
Est. inert material (%):	0%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Nil

Shrink Swell



Shrink Swell Index - Iss (%): 2.8

Comments

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Shrink Swell Index Report

Report No: SSI:NEW16W-2185--S10
Issue No: 1

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 23/08/2016

Sample Details

Sample ID:	NEW16W-2185--S10	Client Sample ID:	
Test Request No.:		Sampling Method:	AS1289.1.2.1 cl 6.5.4
Material:	Sandy Clay	Date Sampled:	10/08/2016
Source:	On-Site	Date Submitted:	11/08/2016
Specification:	No Specification		
Project Location:	Cessnock, NSW		
Sample Location:	TP23 - (0.4 - 0.70m)		
Borehole Number:	TP23		
Borehole Depth (m):	0.4 - 0.7		

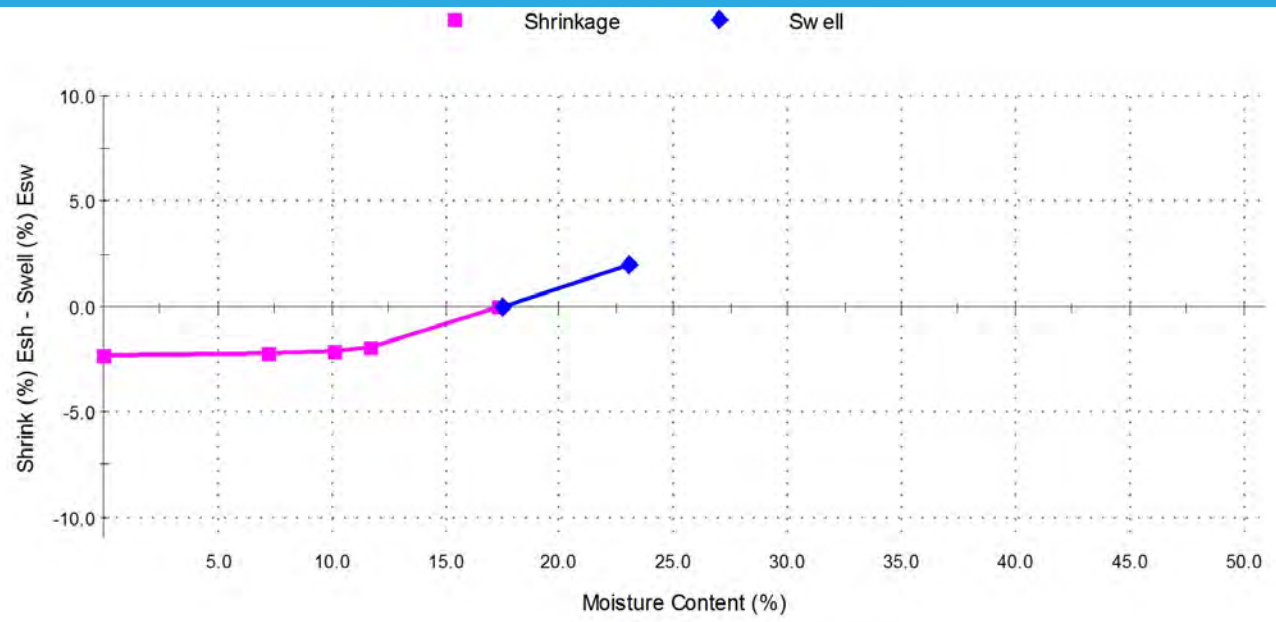
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	2.0
Moisture Content before (%):	17.5
Moisture Content after (%):	23.0
Est. Unc. Comp. Strength before (kPa):	600
Est. Unc. Comp. Strength after (kPa):	350

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	2.3
Shrinkage Moisture Content (%):	17.3
Est. inert material (%):	0%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Major

Shrink Swell



Shrink Swell Index - Iss (%): 1.8

Comments

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Report No: SSI:NEW16W-2403--S04
Issue No: 1

Shrink Swell Index Report

Client: Lend Lease Building Pty Ltd
L14, International Towers
Exchange Place, 300 Barangaroo Ave, Sydney NSW 2000

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 12/09/2016

Sample Details

Sample ID:	NEW16W-2403--S04	Client Sample ID:	
Test Request No.:		Sampling Method:	AS1289.1.2.1 cl 6.5.4
Material:	Clay	Date Sampled:	25/08/2016
Source:	On-Site	Date Submitted:	30/08/2016
Specification:	No Specification		
Project Location:	Cessnock, NSW		
Sample Location:	TP27 - (0.2 - 0.5m)		
Borehole Number:	TP27		
Borehole Depth (m):	0.2 - 0.5		

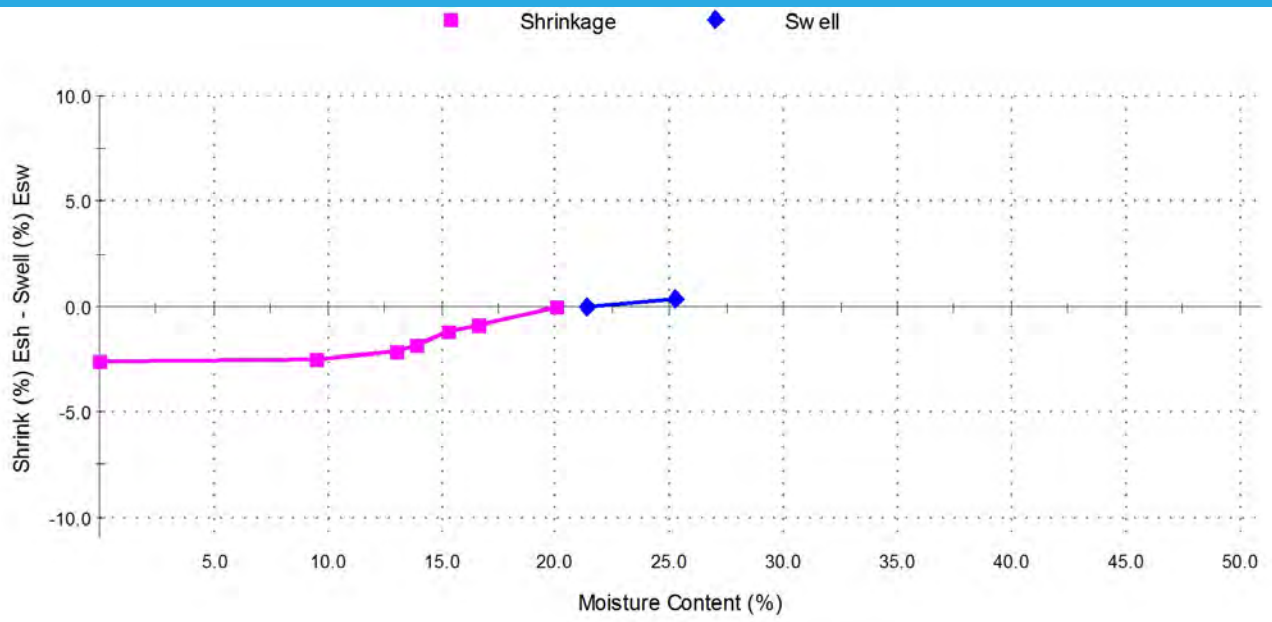
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	0.4
Moisture Content before (%):	21.4
Moisture Content after (%):	25.2
Est. Unc. Comp. Strength before (kPa):	570
Est. Unc. Comp. Strength after (kPa):	340

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	2.6
Shrinkage Moisture Content (%):	20.1
Est. inert material (%):	0%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Moderate

Shrink Swell



Shrink Swell Index - Iss (%): 1.5

Comments

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Shrink Swell Index Report

Report No: SSI:NEW16W-2403--S05
Issue No: 1

Client:	Lend Lease Building Pty Ltd L14, International Towers Exchange Place, 300 Barangaroo Ave, Sydney NSW 2000
Principal:	
Project No.:	NEW16P-0119
Project Name:	Proposed Expansion of Cessnock Correctional Centre

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Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 12/09/2016

Sample Details

Sample ID:	NEW16W-2403--S05	Client Sample ID:	
Test Request No.:		Sampling Method:	AS1289.1.2.1 cl 6.5.4
Material:	Clay	Date Sampled:	25/08/2016
Source:	On-Site	Date Submitted:	30/08/2016
Specification:	No Specification		
Project Location:	Cessnock, NSW		
Sample Location:	TP31 - (0.3 - 0.6m)		
Borehole Number:	TP31		
Borehole Depth (m):	25.07		

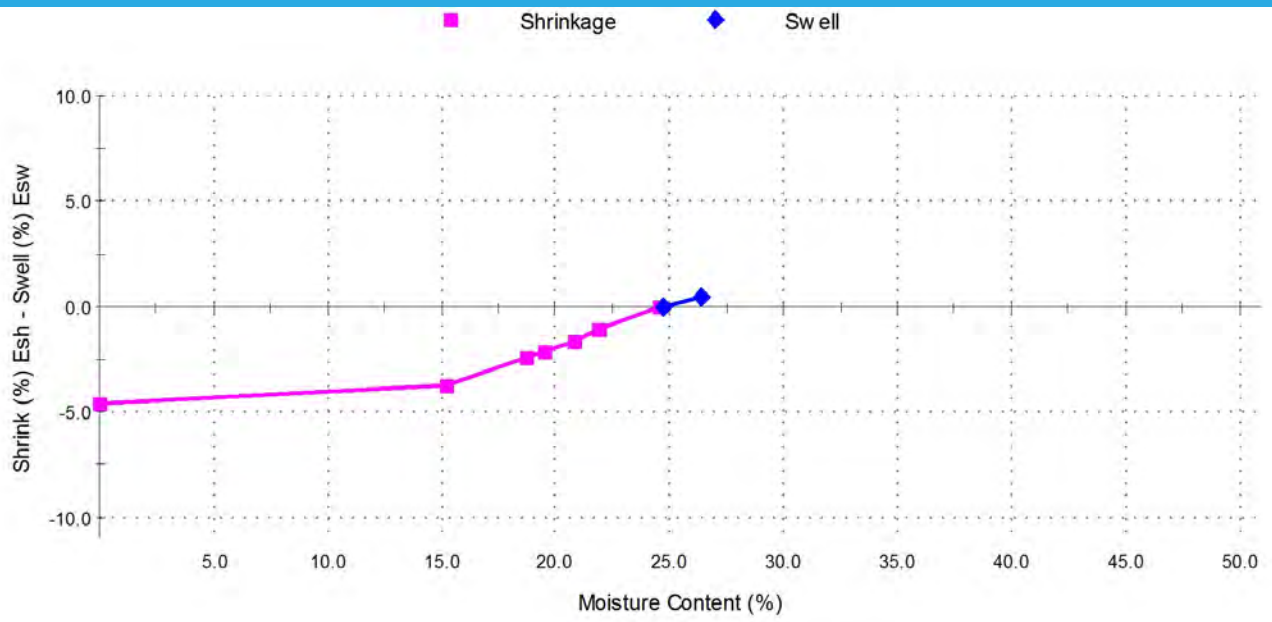
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	0.4
Moisture Content before (%):	24.7
Moisture Content after (%):	26.3
Est. Unc. Comp. Strength before (kPa):	450
Est. Unc. Comp. Strength after (kPa):	280

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	4.6
Shrinkage Moisture Content (%):	24.6
Est. inert material (%):	0%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Nil

Shrink Swell



Shrink Swell Index - Iss (%): 2.7

Comments

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ABN: 98 153 268 896

Shrink Swell Index Report

Report No: SSI:NEW16W-2403--S06
Issue No: 1

Client: Lend Lease Building Pty Ltd
L14, International Towers
Exchange Place, 300 Barangaroo Ave, Sydney NSW 2000

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 12/09/2016

Sample Details

Sample ID:	NEW16W-2403--S06	Client Sample ID:	
Test Request No.:		Sampling Method:	AS1289.1.2.1 cl 6.5.4
Material:	Clay	Date Sampled:	25/08/2016
Source:	On-Site	Date Submitted:	30/08/2016
Specification:	No Specification		
Project Location:	Cessnock, NSW		
Sample Location:	TP33 - (0.3 - 0.6m)		
Borehole Number:	TP33		
Borehole Depth (m):	0.3 - 0.6		

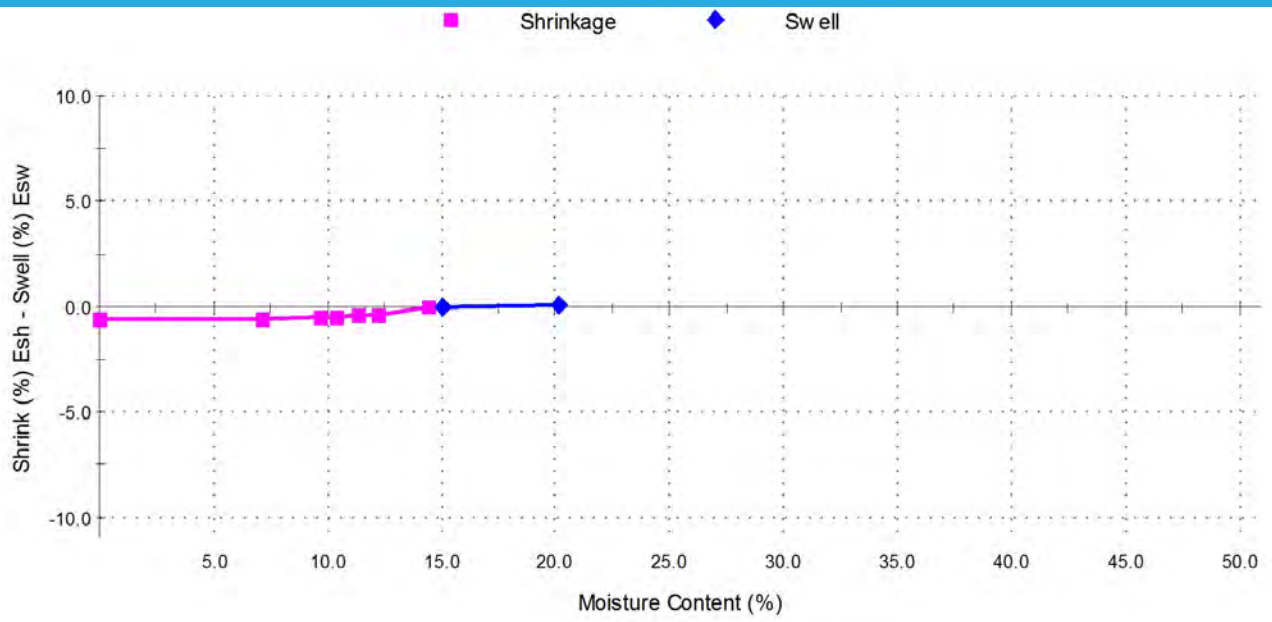
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	0.0
Moisture Content before (%):	15.0
Moisture Content after (%):	20.1
Est. Unc. Comp. Strength before (kPa):	560
Est. Unc. Comp. Strength after (kPa):	330

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	0.6
Shrinkage Moisture Content (%):	14.5
Est. inert material (%):	0%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Major

Shrink Swell



Shrink Swell Index - Iss (%): 0.4

Comments

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Material Test Report

Report No: MAT:NEW16W-2198--S01
Issue No: 1

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 16/08/2016

Sample Details

Sample ID:	NEW16W-2198--S01
Sampling Method:	AS1289.1.2.1 cl 6.5
Date Sampled:	10/08/2016
Source:	On-Site
Material:	Sandy Clay
Specification:	No Specification
Project Location:	Cessnock, NSW
Sample Location:	TP03 - (0.30 to 0.60m)

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	4	
Soil Description		Sandy CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		20.0	

Comments

N/A

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Material Test Report

Report No: MAT:NEW16W-2198--S02
Issue No: 1

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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Approved Signatory: Dane Cullen
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NATA Accredited Laboratory Number: 18686
Date of Issue: 16/08/2016

Sample Details

Sample ID:	NEW16W-2198--S02
Sampling Method:	AS1289.1.2.1 cl 6.5
Date Sampled:	10/08/2016
Source:	On-Site
Material:	Sandy Clay
Specification:	No Specification
Project Location:	Cessnock, NSW
Sample Location:	TP08 - (0.60 to 0.80m)

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	2	
Soil Description		Sandy CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		20.0	

Comments

N/A

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Material Test Report

Report No: MAT:NEW16W-2198--S03
Issue No: 1

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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Approved Signatory: Dane Cullen
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NATA Accredited Laboratory Number: 18686
Date of Issue: 16/08/2016

Sample Details

Sample ID:	NEW16W-2198--S03
Sampling Method:	AS1289.1.2.1 cl 6.5
Date Sampled:	10/08/2016
Source:	On-Site
Material:	Sandy Clay
Specification:	No Specification
Project Location:	Cessnock, NSW
Sample Location:	TP11 - (0.50 to 0.70m)

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	2	
Soil Description		Sandy CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		20.0	

Comments

N/A

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Material Test Report

Report No: MAT:NEW16W-2198--S04
Issue No: 1

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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Approved Signatory: Dane Cullen
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NATA Accredited Laboratory Number: 18686
Date of Issue: 16/08/2016

Sample Details

Sample ID:	NEW16W-2198--S04
Sampling Method:	AS1289.1.2.1 cl 6.5
Date Sampled:	10/08/2016
Source:	On-Site
Material:	Sandy Clay
Specification:	No Specification
Project Location:	Cessnock, NSW
Sample Location:	TP18 - (0.60 to 0.80m)

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	2	
Soil Description		Sandy CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		20.0	

Comments

N/A

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Material Test Report

Report No: MAT:NEW16W-2198--S07
Issue No: 1

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 16/08/2016

Sample Details

Sample ID:	NEW16W-2198--S07
Sampling Method:	AS1289.1.2.1 cl 6.5
Date Sampled:	10/08/2016
Source:	On-Site
Material:	Sandy Clay
Specification:	No Specification
Project Location:	Cessnock, NSW
Sample Location:	TP20 - (0.50 to 0.75m)

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	2	
Soil Description		Sandy CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		20.0	

Comments

N/A

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Material Test Report

Report No: MAT:NEW16W-2198--S05
Issue No: 1

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 16/08/2016

Sample Details

Sample ID:	NEW16W-2198--S05
Sampling Method:	AS1289.1.2.1 cl 6.5
Date Sampled:	10/08/2016
Source:	On-Site
Material:	Sandy Clay
Specification:	No Specification
Project Location:	Cessnock, NSW
Sample Location:	TP22 - (0.30 to 0.60m)

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	2	
Soil Description		Sandy CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		20.0	

Comments

N/A

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Material Test Report

Report No: MAT:NEW16W-2198--S06
Issue No: 1

Client: Lend Lease
Level 13, 224 Bunda Street
Canberra City ACT 2600

Principal:
Project No.: NEW16P-0119
Project Name: Proposed Expansion of Cessnock Correctional Centre

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Approved Signatory: Dane Cullen
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NATA Accredited Laboratory Number: 18686
Date of Issue: 16/08/2016

Sample Details

Sample ID:	NEW16W-2198--S06
Sampling Method:	AS1289.1.2.1 cl 6.5
Date Sampled:	10/08/2016
Source:	On-Site
Material:	Sandy Clay
Specification:	No Specification
Project Location:	Cessnock, NSW
Sample Location:	TP23 - (0.40 to 0.70m)

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	1	
Soil Description		Sandy CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		20.0	

Comments

N/A

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Material Test Report

Report No: MAT:NEW16W-2403--S01
Issue No: 3
This report replaces all previous issues of report no 'MAT:NEW16W-2403--S01'.

Client:	Lend Lease Building Pty Ltd L14, International Towers Exchange Place, 300 Barangaroo Ave, Sydney NSW 2000
Principal:	
Project No.:	NEW16P-0119
Project Name:	Proposed Expansion of Cessnock Correctional Centre

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

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 12/09/2016

Sample Details

Sample ID:	NEW16W-2403--S01
Sampling Method:	AS1289.1.2.1 cl 6.5.4
Date Sampled:	25/08/2016
Source:	On-Site
Material:	Clay
Specification:	No Specification
Project Location:	Cessnock, NSW
Sample Location:	TP27 - (0.2 - 0.5m)

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	3	
Soil Description		Clay	
Type of Water		Distilled	
Temperature of Water (°C)		17.3	

Comments

N/A

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Material Test Report

Report No: MAT:NEW16W-2403--S02
Issue No: 1

Client: Lend Lease Building Pty Ltd
L14, International Towers
Exchange Place, 300 Barangaroo Ave, Sydney NSW 2000

Principal:

Project No.: NEW16P-0119

Project Name: Proposed Expansion of Cessnock Correctional Centre

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

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 12/09/2016

Sample Details

Sample ID:	NEW16W-2403--S02
Sampling Method:	AS1289.1.2.1 cl 6.5.4
Date Sampled:	25/08/2016
Source:	On-Site
Material:	Clay
Specification:	No Specification
Project Location:	Cessnock, NSW
Sample Location:	TP29 - (0.3 - 0.5m)

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	3	
Soil Description		Clay	
Type of Water		Distilled	
Temperature of Water (°C)		17.3	

Comments

N/A

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Material Test Report

Report No: MAT:NEW16W-2403--S03
Issue No: 2
This report replaces all previous issues of report no 'MAT:NEW16W-2403--S03'.

Client:	Lend Lease Building Pty Ltd L14, International Towers Exchange Place, 300 Barangaroo Ave, Sydney NSW 2000
Principal:	
Project No.:	NEW16P-0119
Project Name:	Proposed Expansion of Cessnock Correctional Centre

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

Approved Signatory: Dane Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 12/09/2016

Sample Details

Sample ID:	NEW16W-2403--S03
Sampling Method:	AS1289.1.2.1 cl 6.5.4
Date Sampled:	25/08/2016
Source:	On-Site
Material:	Clay
Specification:	No Specification
Project Location:	Cessnock, NSW
Sample Location:	TP30 - (0.25 - 0.5m)

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	3	
Soil Description		Clay	
Type of Water		Distilled	
Temperature of Water (°C)		17.3	

Comments

N/A

APPENDIX C:

CSIRO Sheet BTF 18

Foundation Maintenance and Footing Performance: A Homeowner's Guide

Foundation Maintenance and Footing Performance:
A Homeowner's Guide

CSIRO

BTF 18 replaces Information Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction
There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion
All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation
This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume – particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil
All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure
This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.
- In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
H	Highly reactive clay sites, which can experience high ground movement from moisture changes
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes
A to P	Filled sites
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

Tree root growth
Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation
Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay
Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

Trees can cause shrinkage and damage

As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Movement caused by tree roots
In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself
Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures
Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures
Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation cause a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures
Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem.
Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870.

AS 2870 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing
Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage
In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

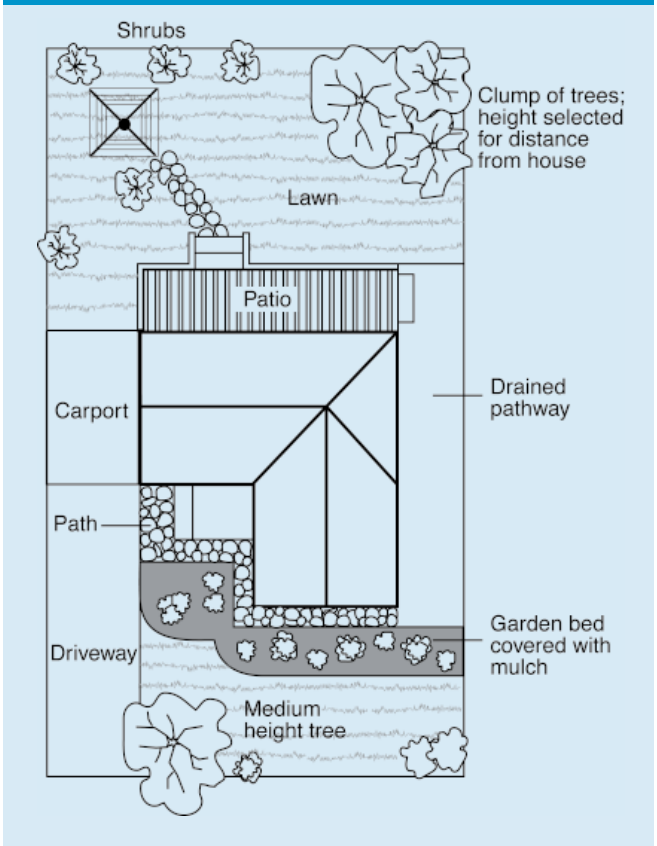
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted	15–25 mm but also depend on number of cracks	4

Gardens for a reactive site



should extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

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