Geotechnical Investigation

Proposed Commercial Development

Cnr Tyrell Street & Kenneth Street, Tenambit

Report Ref: G0237-GI-001-Rev0

Written by: Jonacani Rabo (Senior Geotechnical Engineer) / Peter Hudson (Principal Geotechnical Engineer – Pavements)

Reviewed by: Nathan Roberts (Geotechnical Engineering Manager)

Email: office@huntercivilab.com.au

SUSTAINABLE CERTIFICATION
✓ ISO 9001
✓ AS/NZS 4801
✓ ISO 14001

NATA
WORLD RECOGNISED ACCREDITATION

10 August 2023

Prepared for

Maitland City Council
263 High Street
Maitland NSW 2320
Ph: 0499 968 861
Email: Allison.Cronin@maitland.nsw.gov.au
Web: maitland.nsw.gov.au

Prepared by

Hunter Civilab
ABN 50 103 355 531
3/62 Sandringham Avenue
PO Box 3127
Thornton NSW 2322
Ph: (02) 4966 1844
Email: office@huntercivilab.com.au
Web: huntercivilab.com.au

Project Details

Site Address:	Cnr Tyrell Street & Kenneth Street, Tenambit
Project Type:	Eastern Precinct Community Centre Project

Project no	Report type	Report no
G0237	GI	001

Report Register

Revision Number	Reported By	Reviewed By	Date
Rev0	JR / PH	NR	10/08/2023

We confirm that the following report has been produced for Maitland City Council, based on the described methods and conditions within.

For and on behalf of Hunter Civilab,

Nathan Roberts
Geotechnical Engineering Manager

Executive Summary

The following report details the geotechnical investigation undertaken by Hunter Civilab (HCL) under the request of Maitland City Council. The investigation was undertaken at the Cnr Tyrell Street & Kenneth Street, Tenambit on the 12th of July 2023 and consisted of a desktop study, a visual site assessment, intrusive excavations, and testing.

The desktop study indicated that the site lies within an area of no known occurrences of acid sulfate soils.

The desktop study also indicated that the site does not lie within a mine subsidence district.

The site was bordered by Tyrell Street to the east, Kenneth Street to the north, Lena Obrien Park to the west, and existing residential developments to the south boundary.

The subsurface profile generally consisted of up to 0.3m of Topsoil, overlying Silty Clay/Sandy Clay residual soils, overlying Sandy Clay, Extremely Weathered Sandstone material from BH1 to BH5. The subsurface profile within the existing carpark area consisted of up to 15mm of Asphalt, overlying up to 0.3m of Sandy Gravel Pavement Base material, overlying general fill Sandy Silt material, and overlying Silty Clay residual soils.

A site classification was undertaken based on the laboratory testing results and the subsurface profile encountered at the time of investigation. The results indicated a Class P site with a reactivity of Class H1, having a characteristic free surface movement of 40-60 mm. Therefore, a site classification of Class P-H1 is recommended for the site.

The site would be suitable for the use of both shallow and deep footings. Refer to **Section 7.2** for footing details and recommended allowable bearing capacity.

A detailed pavement investigation and design was undertaken in accordance with Maitland City Council engineering guidelines, Austroads Design Guide 2017 and APRG21 "A Guide to the Design of New Pavements for Light Traffic", 2006. Based on the results of the laboratory testing a soaked subgrade CBR of 2.0% was adopted for the purpose of the pavement design. For flexible pavement design a traffic loading of 4×10^4 DESA's was adopted for a 20-year design life based on Maitland City Council engineering guidelines. For rigid pavement design a traffic loading of 9×10^4DESA's was adopted for a 40-year design life based on Maitland City Council engineering guidelines. Flexible and rigid pavement design options were determined for the proposed paved area and a summary of the recommended thickness design/s can be seen below in **Table 1**.

Table 1 - Summary of flexible and rigid pavement designs

Flexible pavement option	Rigid pavement option
30 mm of Asphalt wearing course	150mm of Concrete basecourse
100 mm of granular basecourse	100 mm of granular sub-base
200 mm of granular sub-base	100 mm of working platform
100 mm of working platform	

Refer to **Section 8** for the detailed pavement design including material and compaction requirements.

Table of Contents

Annex List:

Annex A	Borehole Location Plan
Annex B	Borehole & DCP Log Report
Annex C	Hunter Civilab Laboratory Test Reports
Annex D	BTF 18-2011 – CSIRO – Foundation Maintenance & Footing Performance – A Homeowner's Guide

1 Introduction

At the request of Maitland City Council, Hunter Civilab (HCL) have carried out a preliminary geotechnical investigation for the purpose at Cnr Tyrell Street & Kenneth Street, Tenambit. It is understood that the proposed development is to consist of the construction of new community centre. The investigation works were undertaken in accordance with HCL services agreement Q1914, dated the 6th of July 2023.

The purpose of the investigation was to provide recommendations on the following:

- surface and sub-surface conditions
- geotechnical laboratory testing results
- site classification to AS 2870-2011
- alternative footing types and foundation design parameters
- temporary and permenant safe batter slopes
- retaining wall options
- retaining wall design parameters
- earthworks advice including, geotechnical suitability of excavated material for reuse as fill and excavatability assessment

This report provides details of the investigation, laboratory testing and provides recommendations for the proposed development.

2 Site Description

The site was located at Cnr Tyrell Street & Kenneth Street, Tenambit. The site was bordered by Tyrell Street to the east, Kenneth Street to the north, Lena Obrien Park to the west, and existing residential developments to the south boundary.

At the time of investigation, existing development consisted of the Tenambit Community Centre.

Existing vegetation included short kept grass, growing and mature trees to the west, southwest, and north boundaries.

Topographically the site slopes towards the south boundary.

A photograph showing the surface conditions at the site is presented below in **Figure 1**.

Figure 1 - Photograph of site

3 Desktop Review

3.1 Geological & Soil Landscape Setting

Reference to the 1:250,000 Newcastle Geological Map indicates that the site is underlain by the Tomago Coal Measures consisting of shale, mudstone, sandstone, tuff, and coal.

Reference to the 1:100,000 Newcastle Soil Landscape Map indicates that the site is located within the Beresfield Soil Landscape. The landscape is characterized by undulating low hills and rises on Permian sediments in the East Maitland Hills region. Slope gradients are generally between 3-15% on local reliefs of up to 50 m and elevations between 20–50 m. The soil is known to consist of moderately deep, moderately well to imperfectly drained Yellow Podzolic Soils, Brown Podzolic Soils and Brown Soloths occur on crests with moderately deep, well-drained Red Podzolic Soils and Red Soloths on upper slopes, moderately well to imperfectly drained Brown Soloths and Yellow Soloths on sideslopes and deep, imperfectly to poorly drained Yellow Podzolic Soils, Yellow Soloths and Gleyed Podzolic Soils on lower slopes. Vegetation consists of partially cleared tall open forest.

3.2 Acid Sulfate Soils Risk Maps

Reference to the NSW Office of Environment and Heritage's online database 'ESPADE' indicates that the site lies in an area of no known occurences of acid sulfate soils.

3.3 Mine Subsidence

Reference to Subsidence Advisory NSW Mine District Maps indicates that the site does not lie within a Mine Subsidence District.

4 Fieldwork Methodology

Fieldwork was undertaken on 12 July 2023 and consisted of:

- underground utility service clearances using a Telstra accredited locator
- a visual assessment of the existing surface of the site and surrounding area
- locating borehole locations by approximate measurements from existing site features
- the drilling of 6 x boreholes (BH1 – BH6) to depths of up to 2.6m
- the driving of 8 x Dynamic Cone Penetrometer (DCP) probes (DCP1 – DCP8) at BH locations (BH1 – BH6) to depths of up to 1.4m

Laboratory testing consisted of:

- 2 x Shrink Swell Index tests
- 1 x Atterberg Limits and Linear Shrinkage tests
- 1 x Particle Size Distribution tests
- 2 x California Bearing Ratio tests.

The fieldwork was supervised by an engineering geologist / geotechnical engineer from HCL who logged the subsurface conditions at borehole locations in accordance with AS1726-2017 and collected disturbed and undisturbed soil samples for laboratory testing and soil identification purposes.

5 Subsurface Conditions

The subsurface soil conditions encountered at test locations are presented in detail in the borehole logs and have been summarised into the following units:

5.1.1 Proposed Development Area

UNIT 1A – TOPSOIL:

- Sandy SILT, dark brown / grey, with organics

UNIT 1B – FILL (GENERAL)

- Silty SAND, dark grey

UNIT 2A – RESIDUAL SOIL:

- Silty CLAY, pale brown / grey / yellow / red / orange, trace fine grained sand, very stiff
- Sandy CLAY, pale grey / yellow / brown, trace silt, firm to very stiff

UNIT 2B – RESIDUAL SOIL (Extremely Weathered Sandstone Material):

- Sandy CLAY, pale brown / white / brown / yellow / orange, very stiff
- Silty SAND, pale grey / white, very dense

5.1.2 Existing Carpark Area

UNIT 3 – WEARING COURSE:

- Bitumen seal

UNIT 4A – FILL (PAVEMENT BASE):

- Sandy GRAVEL, pale brown / yellow, very dense

UNIT 4B – FILL (GENERAL):

- Sandy SILT, pale brown / grey, medium dense

UNIT 4C – RESIDUAL SOIL:

- Silty CLAY, pale brown / orange, pale grey, stiff to very stiff

A summary of the soil unit depths encountered in each borehole are presented below in **Table 5.1** and **Table 5.2**.

Table 5.1 - Summary of the soil unit depths encountered on proposed development area.

Proposed Development Area					
Borehole	Borehole Depth from Surface (m)*	Unit Depth (m)			
		UNIT 1A	UNIT 1B	UNIT 2A	UNIT 2B
BH1	1.1	0.0 – 0.2	-	0.2 – 1.0	1.0 – 1.1
BH2	1.5	0.0 – 0.3	-	0.3 – 1.2	1.2 – 1.5
BH3	1.4	0.0 – 0.2	0.2 – 0.6	0.6 – 1.3	1.3 – 1.4
BH4	2.6	0.0 – 0.2	-	0.2 – 0.9	0.9 – 2.6
BH5	1.4	0.0 – 0.2	-	0.2 – 1.3	1.3 – 1.4

Table 5.2 - Summary of the soil unit depths encountered on the existing carpark area.

Existing Carpark Area					
Borehole	Borehole Depth from Surface (m)*	Unit Depth (m)			
		UNIT 3	UNIT 4A	UNIT 4B	UNIT 4C
BH6	1.5	0.0 – 0.015	0.015 – 0.3	0.3 – 0.5	0.5 – 1.5

*1) Boreholes BH1 to BH5 encountered refusal on inferred Extremely Weathered Sandstone Material at depth of up to 2.6m, and BH6 encountered was terminated at 1.5m; 2) Borehole Surface RL was not measured.

Neither groundwater nor surface water were encountered at the site.

Refer to **Annex A** for the borehole location plan and **Annex B** for detailed borehole logs.

6 Laboratory Test Results

2 x undisturbed samples and 2 x bulk disturbed samples were recovered from the boreholes for geotechnical laboratory testing. The samples were transported to HCL's NATA accredited soil testing laboratory for analysis.

The laboratory test results are summarised below in **Table 6.1**, **Table 6.2**, **Table 6.3**, and **Table 6.4** below.

Table 6.1 - Shrink Swell Index test results.

Borehole	Depth (m)	Soil Description	Iss (%)
BH2	0.55 – 0.8	Silty CLAY	2.6
BH4	0.7 – 0.9	Silty CLAY	3.9

Table 6.2 - Atterberg Limit test results

Borehole	Depth (m)	Soil Description	Plasticity Index (%)	Linear Shrinkage (%)
BH6	0.02 – 0.3	Sandy GRAVEL	4.0	2.5

Table 6.3 - California Bearing Ratio test results.

Borehole	Depth (m)	Soil Description	FMC (%)	OMC (%)	MDD (t/m³)	Swell (%)	CBR (%)
BH5	0.3 – 1.0	Silty CLAY	20.8	19.0	1.71	3.5	2.0
BH6	0.5 – 0.9	Silty CLAY	12.0	17.5	1.72	4.0	2.0

Table 6.4 - Particle Size Distribution test results

Borehole	Depth (m)	Soil Description	Percentage Passing						
			53mm (%)	19mm (%)	4.75mm (%)	2.36mm (%)	0.6mm (%)	0.3mm (%)	75µm (%)
BH6	0.02 – 0.3	Sandy GRAVEL	100	96	69	55	40	32	19

Laboratory test results from the soil samples can be found in **Annex C.**

7 Comments and Recommendations

7.1 Site Classification

AS2870-2011 applies to residential construction, however, may have some relevance to the proposed building on this site. The principles of design, construction, and maintenance on which AS2870-2011 is based, should be taken into consideration for the development of the site.

7.1.1 Background Information

Site classification is based off the characteristic surface movements encountered at the site due to the moisture variations within the soil profile. Characteristic surface movements are estimated in accordance with AS2870-2011 "Residential Slabs & Footings". Surface movement calculation take into consideration the depth of the soil profile layers, the soil reactivity and the soil suction depth.

The site classification based on characteristic surface movements are summarised below in **Table 7.1**.

Table 7.1 - Summary of AS2870-2011 characteristic surface movement & site classification

Characteristic Surface Movement (y_s) (mm)	Site Classification AS2870-2011	Underlying Soil / Geology
0	Class A	SAND or ROCK site (non-reactive)
0 – 20	Class S	CLAY (slightly reactive)
20 – 40	Class M	CLAY (moderately reactive)
40 – 60	Class H1	CLAY (highly reactive)
60 – 75	Class H2	CLAY (highly reactive)
> 75	Class E	CLAY (extremely reactive)

Sites subjected to deep-seated moisture change are modified with the addition of "-D". As defined by AS2870-2011 and other sites should be classified as a Class P (Problem) site. Sites classified as Class P have one or more of the following geotechnical related issues:

- inadequate bearing capacity
- expected excessive foundation settlement due to loading on the foundation
- significant moisture variations
- mine subsidence risk
- slope stability risk
- erosion issues
- greater than 0.8m of fill for sand sites and greater than 0.4m for other sites (in general)

7.1.2 Site Classification Recommendations

The proposed development should be designed in accordance with AS2870-2011 “Residential Slabs and Footings”. Based on the visual inspection, dynamic cone penetrometer tests and soil profile shown above in **Section 5**, the site classification is summarised below in **Table 7.2**.

Table 7.2 - Site classification & characteristic surface movement (y_s)

Site Classification	Site Reactivity	Characteristic Surface Movement (y_s) (mm)
Class P	Class H1	40 – 60

The site was classified as a Class P due to the presence of presence of trees and existing development that may create abnormal moisture conditions.

Based on the subsurface profile and the results of the laboratory testing a site reactivity of Class H1 has been assigned to the Class P site.

The estimated characteristic surface movement assumes fill has been present on site for at least five years. It should be noted that in the event of placement of additional fill or cut into the existing profile, a more severe characteristic surface movement would apply.

Classification of the site **has not** taken into account the effects of abnormal moisture conditions listed in **Section 7.1.2** and **Section 7.1.3** below. If the site undergoes any earthworks operations, the site shall be reclassified in accordance with AS2870-2011.

7.1.3 Abnormal Moisture Effects

Abnormal moisture conditions in the foundation can be caused by the following:

- existing development
- leaking water services
- prolonged periods of draught or heavy rainfall
- trenches or other man-made water courses
- poor roof plumbing or obstruction to the roof plumbing system
- poor rainfall runoff control
- corroded gutters or downpipes

Abnormal moisture conditions specified above can cause adverse effects to the development’s foundation such as:

- erosion significantly effecting the lateral and founding support of the structure’s footing system.
- saturation of the founding material which can cause a significant decrease in the strength of the founding material.
- shrinkage creating subsidence of the founding material and causing additional stresses within the building structure.

- swelling which creates an upward force in the footings which causes additional stresses within the building structure.

7.1.4 Effects from Trees

The existence of trees within or adjacent to the building footprint can cause significant soil movement due to the following:

- roots growing within the foundation and causing an upward force on footings.
- roots drawing in and absorbing the moisture below a footing system causing subsidence due to shrinkage of the soil volume.

The site should take into account the tree score effect in accordance with and designed to AS2870-2011. The site was found to have a "Moderate" tree score effect and has not been taken into consideration in the characteristic surface movement calculation.

7.2 Footing Recommendations

The site is suitable for the use of both shallow strip, pad, and pier foundation systems dependant on the development and structural bearing pressure required. Alternatively, piled foundation solutions could be considered. Recommended bearing pressures are provided in **Section 7.2.1** and **Section 7.2.2** below.

7.2.1 Shallow Footings

A maximum allowable bearing capacity of 150 kPa is recommended at the site for shallow level footings founded within Unit 2A very stiff clay soils that were encountered at the site, below topsoil, or other deleterious material (e.g. root affected soils, soft / loose soils, silt soils, uncontrolled 'existing' fill etc).

If weathered rock is exposed at the base of the excavation of footings it is recommended that the rest of the footing system be piered / taken to bedrock to reduce the risk of differential settlement.

Bearing pressures of all exposed foundation areas should be confirmed at the time of earthworks and prior to concrete pour by a qualified geotechnical engineer.

The footing systems must be designed by a structural engineer in accordance with engineering principles and AS 2870 - 2011 "Residential Slabs and Footings" for no less than the minimum requirements for the site classification and soil reactivity given as per **Section 7.1.2** above.

The bearing pressures presented above have been correlated from Dynamic Cone Penetration (DCP) tests and should be considered as estimates only.

7.2.2 Deep Footings

Bored piers socketed at least 0.5 m into Unit 2A stiff to very stiff residual soil could be proportioned for an allowable bearing pressure of 150kPa, and Unit 2B very stiff to hard residual soil (extremely weathered sandstone) could be proportioned for an allowable bearing pressure of 250kPa. The estimated bearing pressure has been inferred from falling weight penetrometer testing.

Care should be taken during construction to ensure that the base of the bored pile holes are clean and free from loose debris or water prior to placement of concrete. Pile hole inspections should be undertaken during construction by a suitably qualified geotechnical engineer to confirm that the appropriate foundation stratum is achieved.

All pile types should be suitably protected against decay or corrosion, taking account of the subsurface conditions, water table fluctuations and site-specific conditions (existing chemical concentrations at the site).

7.2.3 Footing Construction

Pile installation should be accompanied by appropriate verification inspections and testing, for example, load test results, pile driving records, grout pressure records, pile integrity testing, in keeping with the requirements of AS 2159-2009.

All footings should be excavated, cleaned, and inspected by a qualified Geotechnical Engineer. Concrete should be poured with minimal delay. If delays in pouring mass concrete footings is anticipated, a concrete blinding layer should be provided to protect the foundation material.

Should softening of exposed foundation occur, the effected material should be over excavated and backfilled to design footing level by engineered fill or mass concrete.

7.2.4 Ongoing Footing Maintenance

Foundations including effective site drainage are required to be maintained over the life of the development to ensure footing performance. Refer to **Annex D** for the following:

- BTF 18-2011- CSIRO - Foundation Maintenance and Footing Performance – A Homeowner's Guide

7.3 Retaining Walls

Recommended site soil parameters for retaining wall design at the site are provided in **Table 7.3** below.

Table 7.3 - Recommended retaining wall design soil parameters

Parameter	Supported material	
	Unit 2A Silty Clay Stiff to Very Stiff	**Unit 2B Sandy Clay (Extremely Weathered Sandstone Material) Very Stiff to Hard**
γ (kN/m^3)	20	20
Φ' (°)	24	26
C' (kPa)	20	5
Cu (kPa)	100	150
K_a	0.42	0.39
K_p	2.37	2.56
K_o	0.59	0.56

Legend:

γ – unit weight

Φ' – angle of friction

C' – drained cohesion

Cu – undrained cohesion

K_a – coefficient of active earth pressure

K_p – coefficient of passive earth pressure

K_o – coefficient of at rest earth pressure

Parameters shown assume horizontal and free draining granular backfill behind the retaining wall.

The parameters above are unfactored and appropriate factors of safety should be used in design.

The design of retaining walls should account for the separate hydrostatic water pressures behind the walls unless adequate subsurface and surface drainage is provided behind the wall to prevent build-up of water pressure including the provision for maintenance (i.e. flushing points).

The pressure distribution given above assumes that no surcharging of the walls occurs from nearby footings. If the footings behind retaining walls from existing retaining walls, or proposed structures are not taken below the retaining wall zone of influence (which is approximated by a line drawn at 45° above the horizontal from the base of the wall) or to low strength rock or stronger, than additional allowance should be made for the load from the footings.

Cantilever walls should not be used to support nearby building foundations or underground services.

Where drainage is provided behind retaining walls, retaining wall backfill should include geotextile encapsulated free draining backfill (ie single sized aggregate) behind the wall with a slotted drainage pipe at the base of this backfill. The slotted drain should discharge downslope of the wall. If the retaining wall is integral to the proposed building, an impermeable membrane should be installed between the geotextile encapsulated free draining material and the wall of the building.

7.4 California Bearing Ratio (CBR) Correlations

6 x Dynamic Cone Penetrometer (DCP) probe tests were undertaken within the excavated boreholes at subgrade depth. In-situ California Bearing Ratio (CBR) values have been correlated for each borehole based off the DCP probe results as per Austroads "*Guide to Pavement Technology Part 2: Pavement Structural Design*" Figure 5.3.

California Bearing Ratio correlations can be seen below in **Table 7.4**.

Table 7.4 – California Bearing Ratio (CBR) correlations and comparisons.

Borehole	Laboratory CBR result	DCP Correlated CBR Value
BH1	-	4
BH2	-	3.5
BH3	-	<2
BH4	-	8
BH5	2.0	2.5
BH6	2.0	2.5
DCP7	-	3.5
DCP8	-	<2

Refer to **Annex B** for the DCP logs and **Annex C** for the laboratory testing reports.

8 Pavement Thickness Design

8.1 Standards and Specifications Adopted for Design

Pavement design was completed in accordance with:

- Maitland City Council Engineering Guidelines.
- AP-T36-06 Pavement Design for Light Traffic: A supplement to the Austroads Pavement Design Guide, 2006.
- Austroads Design Guide 2017.

CIRCLY 7 was utilised for forward calculations to determine critical strains and pavement damage.

Adopted design CBR:

Based on laboratory test results as described in **Section 6** and **Section 7 ,** sub-grade soaked CBR values adopted were as follows:

- Soaked CBR of 2% for the proposed new pavement.

Adopted Traffic Loadings:

As per Maitland City Council Engineering Guidelines / AP-T36/06 the following traffic loadings were adopted for design:

Flexible Pavements:

- 4 x 10^4Design ESA's. (Table 7.9 – Local access with no buses)

Rigid Pavements:

- 9 x 10^4 Design ESA's. (Table 7.9 – Local access with no buses)

Adopted Design Life:

As per Maitland City Council Engineering Guidelines / Austroads Design Guide 2017 the following design life is was adopted for design:

Flexible Pavements:

- 20-year design life

Rigid Pavements:

- 40-year design life

Recommended Pavement Material Specifications to be adopted for construction are as follows:

Lightly loaded pavements:

- <1 x 10^6 ESA traffic: ARRB SR 41 / AP-T36-06

8.2 Flexible Pavement Thickness Design

The recommended flexible pavement thickness, pavement material and compaction specification are presented in **Table 8.1** and **Table 8.2** below.

Table 8.1 – Summary of flexible pavement minimum thickness design

Pavement	Depth (mm)
AC10 Wearing course (C320 bitumen binder)	30
Primer seal	(10)
Base course (DGB20 or equivalent)	100
Subbase (DGS40 or equivalent)	200
Working Platform	100
Total thickness (mm)	430
Subgrade CBR	2.0%

*a construction tolerance of 10mm should be allowed for above the minimum thickness

NOTE: ASPHALT THICKNESS for lightly loaded traffic Check Table 12.1 (AUSTROADS): Typical asphalt layer thicknesses.

Table 8.2 – Flexible pavement compaction criteria

Pavement	Compaction criteria
AC10 wearing course (C320 bitumen binder)	NA
Primer seal	NA
Base course (DGB20 or equivalent)	98% Modified (AS 1289.5.2.1)
Subbase (DGS40 or equivalent)	95% Modified (AS 1289.5.2.1)
Working Platform	98% Modified (AS 1289.5.2.1)
Subgrade	100% Standard (AS 1289.5.1.1)

8.3 Rigid Pavement Thickness Design

The recommended rigid pavement thickness, pavement material and compaction specifications are presented in **Table 8.3** and **Table 8.4** below.

Table 8.3 – Summary of rigid pavement minimum thickness design

Pavement	Depth (mm)
Base course (32 MPa concrete with SL82 reinforcement)	150
Subbase (crushed rock subbase min soaked CBR 80%, max PI = 6%, or equivalent)	100
Working platform	100
Total thickness (mm)	350
Subgrade CBR	2.0%

*a construction tolerance of 10mm should be allowed for above the minimum thickness;

**or as specified by Council

NOTE: Refer Min Subbase thickness (Table 9.1 AUSTROADS), Min Rigid Pavement thickness refer (Table 9.7 AUSTROADS), min dowel bar diameter (Table 9.9 AUSTROADS,

Table 8.4 – Rigid pavement compaction criteria

Pavement	Compaction Criteria
Base course (32 MPa concrete with SL82 reinforcement)	NA
Subbase (crushed rock subbase min soaked CBR 80%, max PI = 6%, or equivalent)	98% Modified (AS 1289.5.2.1)
Working platform	98% Modified (AS 1289.5.2.1)
Subgrade	100% Standard (AS 1289.5.1.1)

8.4 Pavement Drainage and Pavement Interfaces

The pavement thickness is dependent on the provision of adequate surface and subsurface drainage as specified by a qualified civil or pavement engineer. It is recommended that an intra pavement subsoil drain be installed at the interfaces between pavement types.

Where new pavement construction abuts existing pavement, care shall be taken to create a clean vertical construction joint along with a benched transition zone. The transition zone should be across a 0.5m distance and benched to tie in with existing profiles.

It is recommended that all construction joints should be located outside of wheel paths, and where practical should be located in the centre of the lanes or along edge lines.

It should be noted that when variable pavements are abutted then the potential for localised failure is greater. Care should be exercised in the placement and compaction of the subgrade and pavements in this area to maximise the performance of the pavement.

Consideration should also be given to sealing any cracks that may develop between existing and new pavements, benching to tie in pavements. The use of a strain relieving membrane at the interface may be appropriate in some cases.

8.5 Recommendations During Construction

Following excavation, site visits should be made by an experienced geotechnical engineer to inspect exposed subgrade and pavement conditions.

8.6 Earthworks

Any earthworks conducted at the site should be controlled in accordance with AS3798-2007 and guided by the sections below.

8.6.1 Site Preparation

It is recommended that the following be undertaken where controlled filling is to be undertaken:

- remove all topsoil, root effected zones, material assessed as unsuitable and other deleterious zones (noting the stripped soil is not considered suitable as engineered fill but may be considered for landscaping purposes)
- exposed suitable foundation areas should then be ripped 300mm and re-compacted to 100% standard maximum dry density (SMDD) at ±2% of optimum moisture content (OMC)
- the foundation area should then be proof rolled under the supervision of an experienced geotechnical consultant and any soft spots / heaving areas identified. If identified, these areas should be over excavated under the direction of the geotechnical consultant and replaced with engineered fill.

8.6.2 Controlled Fill

Any earthworks conducted at the site should be controlled in accordance with AS3798-2007. Based on the soil profile shown above in **Section 7.4** visual observations and in-situ Dynamic Cone Penetrometer (DCP) testing, the material encountered at the site is deemed suitable for re-use on site as controlled fill from a geotechnical perspective given the following is considered:

- Topsoil – it is recommended that where topsoil is encountered that is high in organic content, this soil is separated and stockpiled and assessed for potential re-use as topsoil in landscaped areas on site.

- Natural soils and weathered rock – the results of the investigation suggest that the natural soils and weathered rock would typically be suitable for re-use as engineered fill, provided sufficient energy is applied during fill placement and compaction to break down oversize rock to a particle size that is no greater than one-third of the uncompacted fill layer thickness.
- Where natural soils are encountered with an elevated moisture condition, drying back of the material will be required. It should be taken into account that the time taken to dry back the material will likely be a function of material properties, prevailing weather conditions at the time of earthworks, size, and area available to spread out the material and moisture re-conditioning methodology used.

If the sub-surface conditions encountered at the site during construction differ from those discussed in **Section 5**, then HCL should be consulted to determine if the material is suitable for controlled fill. Similarly, any won material imported from external sites should consult HCL to determine if the fill is suitable for controlled fill.

8.6.3 Compaction Criteria

Fill material should be compacted in near-horizontal uniform layers with a maximum compacted thickness of 300mm. It is important to ensure layers are placed in such a way that provides adequate drainage and prevent ponding during construction. The thickness of fill placed during construction should take into account the compaction equipment available.

The moisture of the fill material should be controlled within a specified range of OMC in order to achieve the compaction criteria. In general, soils should be compacted within a moisture range of ±2% of OMC.

For commercial developments the following compaction criteria applies:

- cohesive soils – 98% Minimum Density Ratio (standard compactive effort)
- non-cohesive soils – 75% Minimum Density Index

Where fill is placed on sloping ground, any slope wash/deleterious should be removed and the fill should be adequately keyed/benched into the sloping ground profile.

Geotechnical inspections and testing should be performed in accordance with Level 1 procedures with reference to AS3798-2007.

8.6.4 Excavations Conditions

Excavations within the fill, natural soils and extremely low to very low strength rock that was encountered during the investigations is thought to be achievable with conventional earthmoving equipment such excavators, backhoes and dozers. Very low to low strength rock may also require ripper tynes attached to excavator arms or dozers for effective excavation. Rock of low strength or greater may possibly require a 12-tonne excavator (or greater) with rock ripper or hydraulic rock hammer, depending on the degree of strength and fracturing in the rock. Excavations in rock would require minimising vibration to neighbouring residences and structures, else other methods may be required (for example pre-drilling the rock, rock sawing using diamond wire saw equipment, grinding or engaging a rock breaking and removal specialist).

Bored piers could be drilled using a 12-tonne excavator or greater with an attached auger. It is recommended that the bottom of bored pier holes should be cleaned out with the excavator fitted with a bucket attachment.

Excavations should be conducted in accordance with The Safe Work Australia “Excavation Work” Code of Practice October 2018.

https://www.safeworkaustralia.gov.au/doc/model-codes-practice/model-code-practice-excavation-work

Excavations can seriously affect the stability of adjacent buildings. Careful consideration must be taken in order to prevent the collapse of partial collapse of adjacent structures.

Construction material and equipment should not be placed within the zone of influence of an excavation unless a suitably qualified geotechnical engineer has designed ground support structures to withstand these loads. The zone of influence is dependent on the material encountered at the site and is the area in which possible failures can occur.

Refer to Council development guidelines before conducting any excavation works.

8.6.5 Batter Slopes

8.6.5.1 Temporary Batter Slopes

Temporary excavations in natural material or extremely low to very low strength rock may be near vertical provided that:

- the depth does not exceed 1.5m
- they are open for no more than 24hrs.
- no surcharge loading is applied to the surface within 2.5m of the excavation.
- no one enters the excavation e.g., workers.

All other temporary batter slopes during construction should not exceed 1H:1V in soils and 1H:4V in rock and benched, planned and managed in accordance with Safe Work Australia “Excavation Work” Code of Practice October 2018.

Specific geotechnical assessment will be required where temporary excavations exceed 2m vertical height.

8.6.5.2 Permanent Batter Slopes

Recommended permanent batter slopes in general are as follows:

- 2H:1V in cohesive soils (e.g. clays) or extremely to very low weathered rock else retained by an engineered retaining wall
- 3H:1V in non-cohesive soils (e.g. sands) else retained by an engineered retaining wall

- 1H:1V in low strength rock or greater (permanent rock batters may be steepened to near vertical – subject to inspection by a qualified geotechnical engineer)

Flatter slopes of 3H:1V or flatter and/or provision of benching would be required for maintenance requirements and should be topsoiled (at least 100 mm thickness) and vegetated. The optimum type of grass species selected to promote growth should be based on local climatic conditions and soil types. Also, regular watering during establishment and during dry weather periods along with initial fertilisation to promote growth is recommended.

Specific geotechnical assessment will be required where permanent batters exceed 2 m vertical height.

9 Report Limitations

This report has been prepared by HCL for the specific site and purposes described within this report. HCL will accept no responsibility or liability for the use of this report by any third party, without the express consent of HCL or the Client, or for use at any other site or purpose than that described in this report.

This report and the services provided have been completed in accordance with relevant professional and industry standards of interpretation and analysis. This report must be read in its entirety without separation of pages or sections and without any alterations, other than those provided by HCL.

The scope of the investigation described in this report is based on information and plans provided to HCL by the Client as well as any additional limitations imposed by either the Client and / or site restraints. Such limitations may include but are not limited to budget restraints, the presence of underground services or accessibility issues to a site. Where the report has been prepared for a specific design proposal the information and interpretation may not be relevant if the design proposal is changed. HCL should be consulted if site plans, or design proposal is changed as the recommendations and / or opinions presented may not be suitable for the new revisions or variations made.

The conclusions, recommendations and opinions expressed within this report are subject to the specific conditions encountered and the limited geotechnical data gathered at the site during the time of the current investigation. The sub-surface conditions and results presented in this report are indicative of the conditions encountered at the discrete sampling and testing locations within the site at the time of the investigation and within the depths investigated. Variations in ground conditions may exist between the locations that were investigated, and the subsurface profile cannot be inferred or extrapolated from the limited investigation conducted by HCL. For this reason, the report must be regarded as interpretative, rather than a factual document.

Sub-surface conditions are subject to constant change and can vary abruptly as a result of human influences and /or natural geological and / or climatic processes and events. As such, conditions may exist at the site that could not be identified during or may develop after the current investigation has been conducted and as such, may impact the accuracy of this report. HCL should be contacted for further consultation and site re-assessment should sub-surface conditions differ from those conditions identified in this report.

References

Council of Standards Australia. (2009). *AS2159-2009 Piling - Design and Insallation.* Sydney: Standards Australia Limited.

Council of Standards Australia. (2011). *AS2870-2011 Residential Slabs & Footings.* Sydney: Standards Australia Limited.

Council of Standards Australia. (2007). *AS3798-2007 Guidelines on Earthworks for Commercial and Residential Developments*. Sydney: Standards Australia Limited

CSIRO. (2011). *Foundation Maintenance and Footing Performance: A Homeowner's Guide.* Collingwood: CSIRO Publishing.

Maitland City Council. (2011.). *Development Control Plan – Part C – Design Guidelines.* Maitland: Maitland City Council.

NSW Office of Environment & Heritage. (2018). *eSPADE v2.0 | NSW Office of Environment & Heritage*. Retrieved from Environment.nsw.gov.au: https://www.environment.nsw.gov.au/eSpade2Webapp#

Safe Work Australia. (2018). *Excavation Work Code of Practice.* Safe Work Australia.

Subsidence Advisory NSW. (n.d.). *Mine Subsidence Districts*. Retrieved from Subsidence Advisory: https://www.subsidenceadvisory.nsw.gov.au/districts

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by HCL.

Safety in design assessment is outside the current scope of work of this report. HCL has had no involvement in any design that relies upon the geotechnical advice contained in this report. HCL cannot be held liable for any loss of life or property damage arising from any hazards that arise from the geotechnical advice.

We are pleased to present this report and trust that the recommendations provided are sufficient for your present requirements. If you have any further questions about this report, please contact the undersigned.

For and on behalf of

Valley Civilab Pty Ltd, trading as Hunter Civilab

Reported by:

Jonacani Rabo
Senior Geotechnical Engineer
Bachelor of Engineering Technology (Mechanical)
GradCert of Engineering Technology (Civil)

Reviewed by:

Nathan Roberts
Geotechnical Engineering Manager
Bachelor of Engineering (Civil)

Peter Hudson
Principal Geotechnical Engineer - Pavements
Bachelor of Engineering (Civil)
Grad Diploma of Municipal Engineering (Traffic & Transportation Planning)

Annex A

Borehole Location Plan

*Image taken from NearMaps

Figure 1 – Overhead image of the Corner of Tyrell Street and Kenneth Street showing the approximate location of the Geotechnical boreholes & DCP tests.

Annex B

Hunter Civilab

Unit 3, 62 Sandringham Avenue Thornton NSW 2322

Phone: (02) 4966 1844

Geotechnical Log - Borehole

BH1

UTM	:	**Driller Rig**	: Ute Mounted Drill Rig	**Job Number**	: G0237
Easting (m)	: 0.0	**Driller Supplier**	: Hunter Civilab	**Client**	: Maitland City Council
Northing (m)	: 0.0	**Logged By**	: JR	**Project**	: Geotechnical Investigation
Ground Elevation	: Not Surveyed	**Reviewed By**	: KS	**Location**	: Tyrell Street & Kenneth Street, Tenambit NSW
Total Depth	: 1.1 m BGL	**Date**	: 12/07/2023	**Loc Comment**	:

Water	DCP graph	PSP	Testing	Samples	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Soil Origin	Remarks
	3					⁙	SM	Sandy SILT, low plasticity, dark grey / brown, fine grained sand, (with organics).	w < PL	VS	Topsoil	
	5					⁙						
	7				0.2	▨	CI-CH	Silty CLAY, medium to high plasticity, pale brown / grey / yellow, trace fine grained sand.		St	Residual	
	8					▨						
	6		PP: 300-320 kPa			▨						
	3				0.5	▨						
	4					▨						
	4					▨						
	3					▨						
	7/50mm					▨						
	Refusal (D/Bounce)		PP: 300 kPa		1	☰	CL	Sandy CLAY, low plasticity, pale brown / white / grey, fine grained sand, (extremely weathered sandstone material).		St-VSt	Residual	
								BH1 refusal at 1.1 m (On Sandstone)				
					1.5							
					2							
					2.5							

Hunter Civilab

Unit 3, 62 Sandringham Avenue Thornton NSW 2322

Phone: (02) 4966 1844

Geotechnical Log - Borehole

BH2

UTM :
Easting (m) : 0.0
Northing (m) : 0.0
Ground Elevation : Not Surveyed
Total Depth : 1.5 m BGL

Driller Rig : Ute Mounted Drill Rig
Driller Supplier : Hunter Civilab
Logged By : JR
Reviewed By : KS
Date : 12/07/2023

Job Number : G0237
Client : Maitland City Council
Project : Geotechnical Investigation
Location : Tyrell Street & Kenneth Street, Tenambit NSW
Loc Comment :

Water	DCP graph	PSP	Testing	Samples	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Soil Origin	Remarks
	5 6 7				0.3		SM	Sandy SILT, low plasticity, dark brown / grey, fine grained sand, (with organics).	w < PL	VS	Topsoil	
	13 7 4 6 5		PP: 300-350 kPa	Undisturbed: U50	0.5 0.8		CI-CH	Silty CLAY, medium to high plasticity, pale brown / grey / red, trace fine grained sand.		VSt	Residual	
	4 5 5 5		PP: 300-350 kPa		1 1.2		CI-CH	Sandy CLAY, medium to high plasticity, pale grey / yellow / brown, fine to medium grained sand, (trace silt).		St-VSt	Residual	
	4 6 18				1.5		CL	Sandy CLAY, low plasticity, pale grey / white / brown, fine grained sand, (extremely weathered sandstone material).		VSt	Residual	
	Refusal (D/Bounce)				2 2.5			**BH2 refusal at 1.5 m (On inferred Sandstone Rock)**				

Hunter Civilab
Unit 3, 62 Sandringham Avenue Thornton NSW 2322
Phone: (02) 4966 1844

Geotechnical Log - Borehole

BH3

UTM :
Easting (m) : 0.0
Northing (m) : 0.0
Ground Elevation : Not Surveyed
Total Depth : 1.4 m BGL

Driller Rig : Ute Mounted Drill Rig
Driller Supplier : Hunter Civilab
Logged By : JR
Reviewed By : KS
Date : 12/07/2023

Job Number : G0237
Client : Maitland City Council
Project : Geotechnical Investigation
Location : Tyrell Street & Kenneth Street, Tenambit NSW
Loc Comment :

Water	DCP graph	PSP	Testing	Samples	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Soil Origin	Remarks
	0 0				0.2		SM	Sandy SILT, low plasticity, dark grey / brown, fine grained sand, (with organics).	w > PL	VS	Topsoil	
	0 3 1 3				0.5 0.6		SM	FILL: silty SAND, fine to medium grained, dark grey.	W	VL	Fill	
	1 3 2 3		PP: 100-120 kPa		1		CI-CH	Silty CLAY, medium to high plasticity, pale brown / grey / yellow, trace fine grained sand.	w > PL	F-St	Residual	
	3 3 4/50mm		PP: 100-120 kPa		1.3		CI-CH	Sandy CLAY, medium to high plasticity, pale brown / yellow, fine grained sand, (trace silt).			Residual	
	Refusal (D/Bounce)						CL	Sandy CLAY, low plasticity, pale brown / yellow / white, fine grained sand, (extremely weathered sandstone material).	w < PL	St	Residual	
					1.5 2 2.5			**BH3 refusal at 1.4 m (On Sandstone)**				

Hunter Civilab

Unit 3, 62 Sandringham Avenue Thornton NSW 2322

Phone: (02) 4966 1844

Geotechnical Log - Borehole

BH4

UTM :
Easting (m) : 0.0
Northing (m) : 0.0
Ground Elevation : Not Surveyed
Total Depth : 2.6 m BGL

Driller Rig : Ute Mounted Drill Rig
Driller Supplier : Hunter Civilab
Logged By : JR
Reviewed By : KS
Date : 12/07/2023

Job Number : G0237
Client : Maitland City Council
Project : Geotechnical Investigation
Location : Tyrell Street & Kenneth Street, Tenambit NSW
Loc Comment :

Water	DCP graph	PSP	Testing	Samples	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Soil Origin	Remarks
	2 6				0.2	░	SM	Sandy SILT, low plasticity, dark grey / brown, fine grained sand, (with organics).	w < PL	VS	Topsoil	
	21 13 17 8 9 9 12		PP: 350 kPa	Undisturbed: U50	0.5 0.9	▨	CI-CH	Silty CLAY, medium to high plasticity, pale grey / brown / orange, trace fine grained sand.		St-VSt	Residual	
	20 Refusal				1 1.5 2 2.5	░	SM	Silty SAND, fine grained, pale grey / white, with fine sized gravel, (extremely weathered sandstone material)	D	D	Residual	
					2.5	≡	CL	Sandy CLAY, low plasticity, pale brown / orange / yellow, fine to medium grained sand, (extremely weathered sandstone material).	w < PL	St	Residual	

BH4 refusal at 2.6 m (On Sandstone)

Hunter Civilab

Unit 3, 62 Sandringham Avenue Thornton NSW 2322

Phone: (02) 4966 1844

Geotechnical Log - Borehole

BH5

UTM :
Easting (m) : 0.0
Northing (m) : 0.0
Ground Elevation : Not Surveyed
Total Depth : 1.4 m BGL

Driller Rig : Ute Mounted Drill Rig
Driller Supplier : Hunter Civilab
Logged By : JR
Reviewed By : KS
Date : 12/07/2023

Job Number : G0237
Client : Maitland City Council
Project : Geotechnical Investigation
Location : Tyrell Street & Kenneth Street, Tenambit NSW
Loc Comment :

Water	DCP graph	PSP	Testing	Samples	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Soil Origin	Remarks
	4						SM	Sandy SILT, low plasticity, dark grey / brown, fine grained sand.	w < PL	VS	Topsoil	
	5											
	4				0.2		CI-CH	Silty CLAY, medium to high plasticity, pale grey / brown / red, trace fine grained sand.		St-VSt	Residual	
	6			Bulk: CBR								
	6											
	4				0.5							
	3											
	3											
	2											
	5											
	5		PP: 250-300 kPa		1							
	7											
	8/20mm											
	Refusal (D/Bounce)				1.3		CL	Sandy CLAY, low plasticity, pale grey / white / brown / yellow, fine grained sand, (extremely weathered sandstone material).		VSt	Residual	
								BH5 refusal at 1.4 m				
					1.5							
					2							
					2.5							

Hunter Civilab

Unit 3, 62 Sandringham Avenue Thornton NSW 2322

Phone: (02) 4966 1844

Geotechnical Log - Borehole

BH6

UTM :
Easting (m) : 0.0
Northing (m) : 0.0
Ground Elevation : Not Surveyed
Total Depth : 1.5 m BGL

Driller Rig : Ute Mounted Drill Rig
Driller Supplier : Hunter Civilab
Logged By : JR
Reviewed By : KS
Date : 12/07/2023

Job Number : G0237
Client : Maitland City Council
Project : Geotechnical Investigation
Location : Tyrell Street & Kenneth Street, Tenambit NSW
Loc Comment : Existing Carpark

Water	DCP graph	PSP	Testing	Samples	Depth (m)	Graphic Log	Classification Code	Material Description	Moisture	Consistency/Density	Soil Origin	Remarks
					0.02		ASP	Asphalt			Non-Soil	
				Bulk: PSD	0.3		GW	FILL: sandy GRAVEL, sub-rounded, fine to coarse sized, fine to medium grained sand, pale brown / yellow.	D		Fill	
	4				0.5		SM	FILL: sandy SILT, fine grained sand, low plasticity, pale brown / grey.	w < PL		Fill	
	9 6 4 3 3 5 5 6 9 11			Bulk: CBR	1.5		CI-CH	Silty CLAY, medium to high plasticity, brown / orange / pale grey, trace fine grained sand.		St-VSt	Residual	
	12 14 Terminated				2 2.5			**BH6 Terminated at 1.5 m**				

Hunter Civilab

Unit 3, 62 Sandringham Avenue Thornton NSW 2322

Phone: (02) 4966 1844

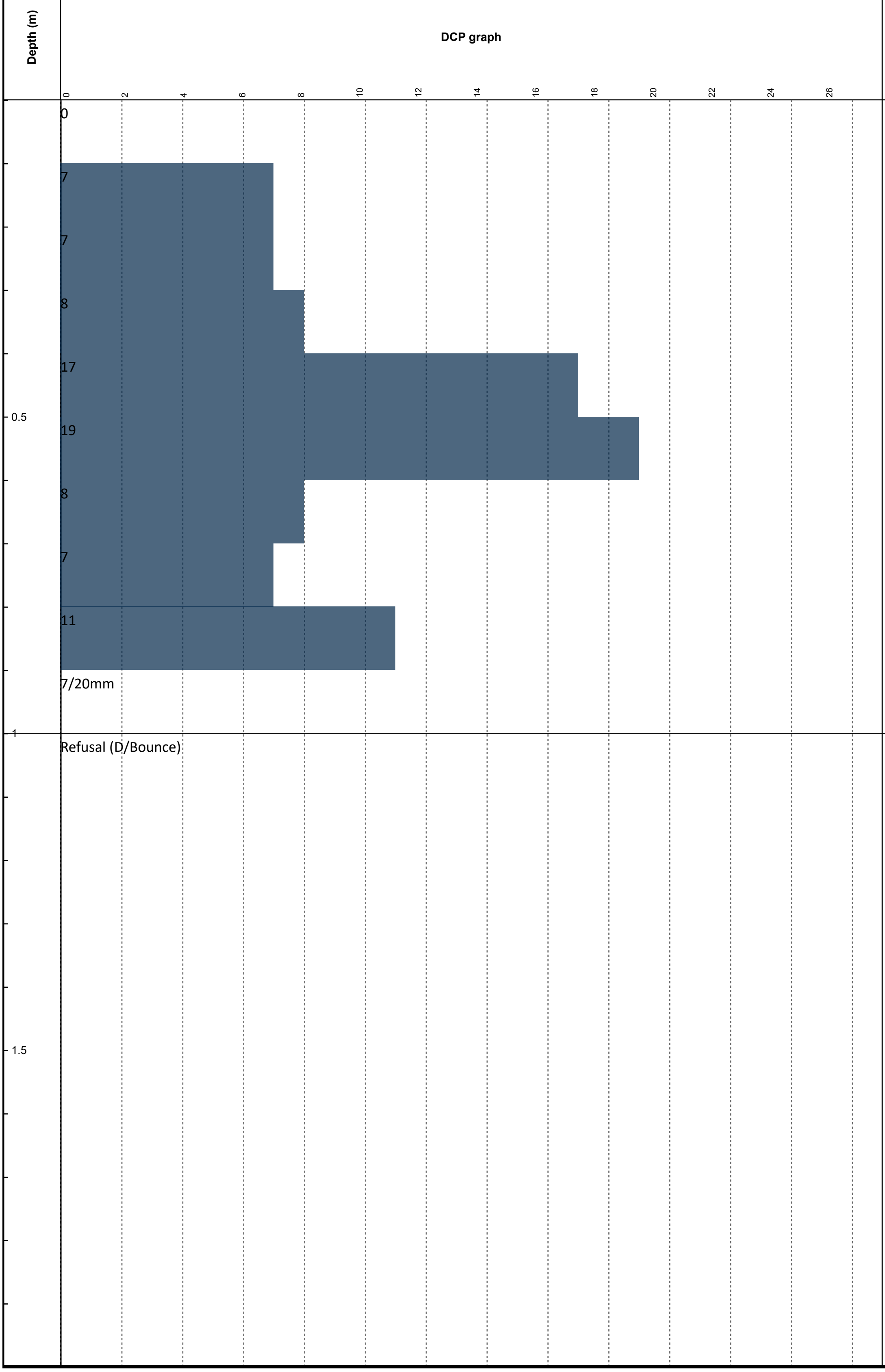
Geotechnical Log - Borehole

DCP7

UTM :
Easting (m) : 0.0
Northing (m) : 0.0
Ground Elevation : Not Surveyed
Total Depth : 1 m BGL

Driller Rig : DCP
Driller Supplier : Hunter Civilab
Logged By : JR
Reviewed By : KS
Date : 12/07/2023

Job Number : G0237
Client : Maitland City Council
Project : Geotechnical Investigation
Location : Tyrell Street & Kenneth Street, Tenambit NSW
Loc Comment :



Remarks

Hunter Civilab

Unit 3, 62 Sandringham Avenue Thornton NSW 2322

Phone: (02) 4966 1844

Geotechnical Log - Borehole

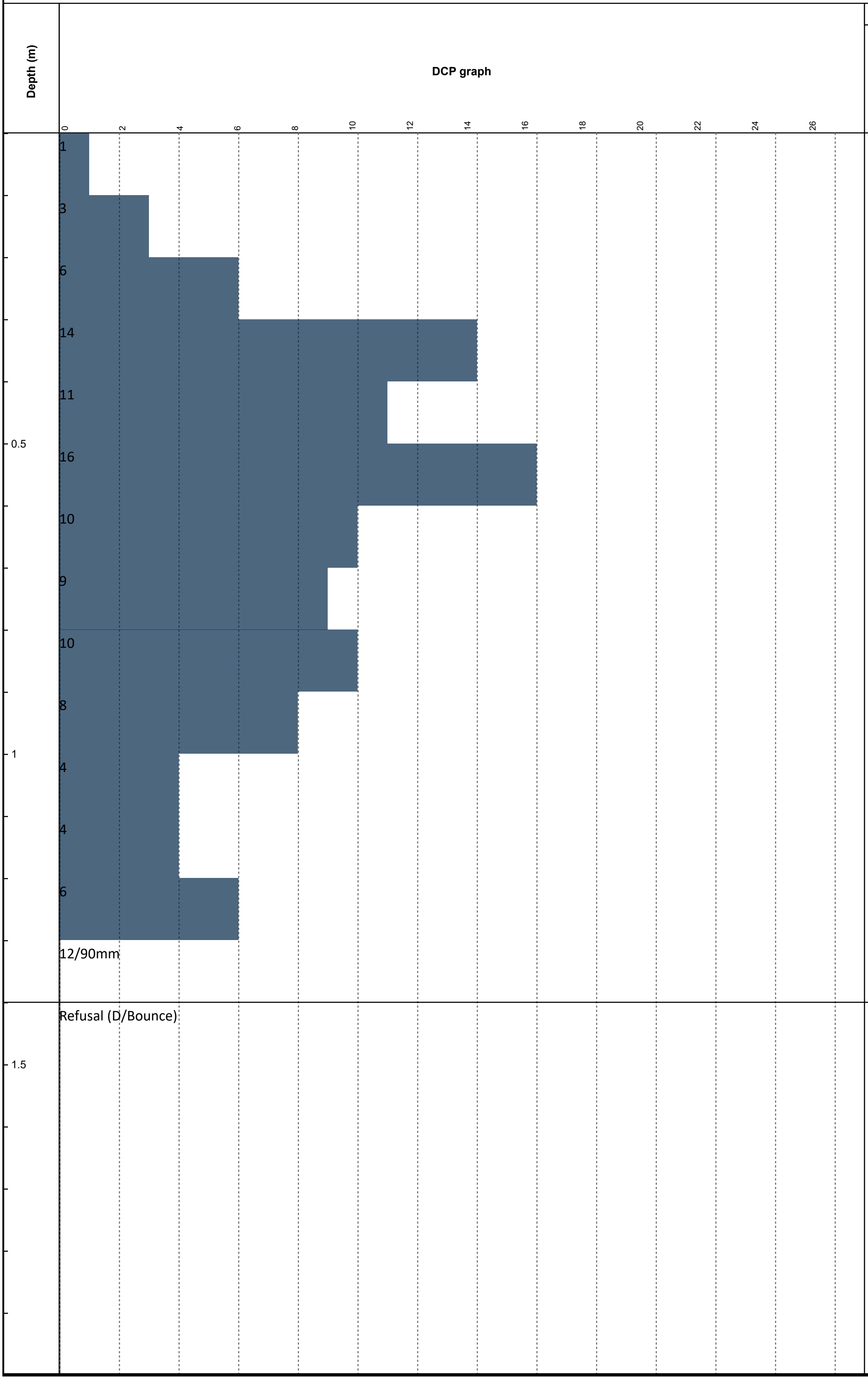
DCP8

UTM :
Easting (m) : 0.0
Northing (m) : 0.0
Ground Elevation : Not Surveyed
Total Depth : 1.4 m BGL

Driller Rig : DCP
Driller Supplier : Hunter Civilab
Logged By : JR
Reviewed By : KS
Date : 12/07/2023

Job Number : G0237
Client : Maitland City Council
Project : Geotechnical Investigation
Location : Tyrell Street & Kenneth Street, Tenambit NSW
Loc Comment :

Remarks



Annex C

Material Test Report

Report Number: **P22767-191C**
Issue Number: 1
Date Issued: 27/07/2023
Client: Hunter Civilab
3/62 Sandringham Avenue, Thornton New South Wales 2322
Contact: Nathan Roberts
Project Number: P22767
Project Name: Geotechnical Consulting Services
Project Location: Eastern Precinct Community Centres Project, Tenambit
Client Reference: G0237
Work Request: 11959
Sample Number: 23-11959A
Date Sampled: 12/07/2023
Dates Tested: 13/07/2023 - 25/07/2023
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Preparation Method: In accordance with the test method
Site Selection: Selected by Client
Sample Location: **BH2, Depth: 0.55 - 0.8**
Material: Silty Clay
Material Source: Onsite Won

Hunter Civilab
62 Sandringham Avenue Thornton NSW 2322
Phone: (02) 4966 1844
Email: office@huntercivilab.com.au

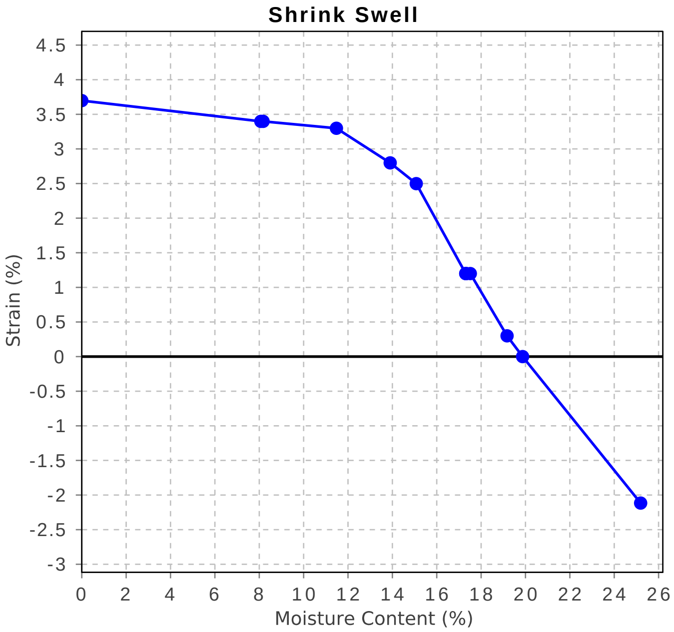
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: James Wyatt
Laboratory Manager
NATA Accredited Laboratory Number: 14975

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**2.6**
Visual Description	Silty Clay brown
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	
Variation to the test method: Readings between some shrink & swell measurements exceed 12 hours.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**3.7**
Estimated % by volume of significant inert inclusions	0
Cracking	Uncracked
Crumbling	No
Moisture Content (%)	19.9

Swell Test	
Initial Pocket Penetrometer (kPa)	1000
Final Pocket Penetrometer (kPa)	350
Initial Moisture Content (%)	19.6
Final Moisture Content (%)	25.2
Swell (%)	**2.1**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

Report Number:	**P22767-191C**
Issue Number:	1
Date Issued:	27/07/2023
Client:	Hunter Civilab 3/62 Sandringham Avenue, Thornton New South Wales 2322
Contact:	Nathan Roberts
Project Number:	P22767
Project Name:	Geotechnical Consulting Services
Project Location:	Eastern Precinct Community Centres Project, Tenambit
Client Reference:	G0237
Work Request:	11959
Sample Number:	23-11959B
Date Sampled:	12/07/2023
Dates Tested:	13/07/2023 - 26/07/2023
Sampling Method:	Sampled by Engineering Department *The results apply to the sample as received*
Preparation Method:	In accordance with the test method
Site Selection:	Selected by Client
Sample Location:	**BH4, Depth: 0.7 - 0.9**
Material:	Silty Clay
Material Source:	Onsite Won

Hunter Civilab
62 Sandringham Avenue Thornton NSW 2322
Phone: (02) 4966 1844
Email: office@huntercivilab.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

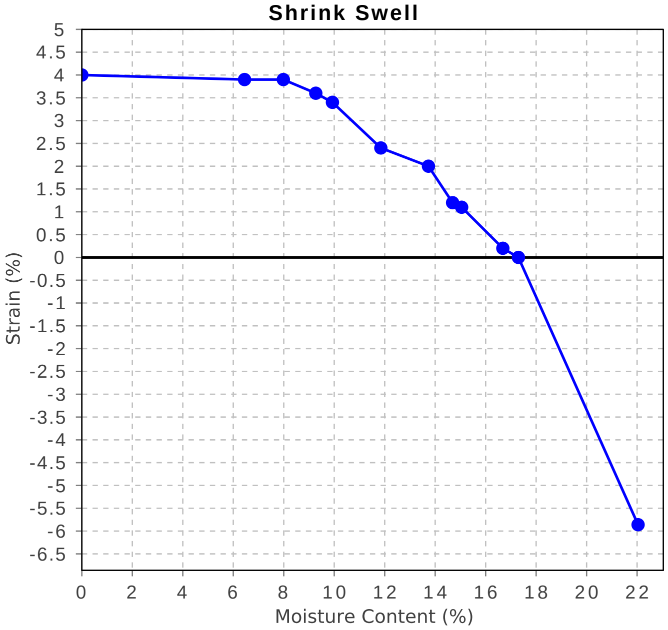
Approved Signatory: James Wyatt
Laboratory Manager

NATA Accredited Laboratory Number: 14975

Shrink Swell Index (AS 1289 7.1.1 & 2.1.1)	
Iss (%)	**3.9**
Visual Description	Silty Clay brown
* Shrink Swell Index (Iss) reported as the percentage vertical strain per pF change in suction.	
Variation to the test method: Readings between some shrink & swell measurements exceed 12 hours.	

Core Shrinkage Test	
Shrinkage Strain - Oven Dried (%)	**4.0**
Estimated % by volume of significant inert inclusions	0
Cracking	Uncracked
Crumbling	No
Moisture Content (%)	17.3

Swell Test	
Initial Pocket Penetrometer (kPa)	825
Final Pocket Penetrometer (kPa)	225
Initial Moisture Content (%)	16.9
Final Moisture Content (%)	22.0
Swell (%)	**5.9**
* NATA Accreditation does not cover the performance of pocket penetrometer readings.	



Material Test Report

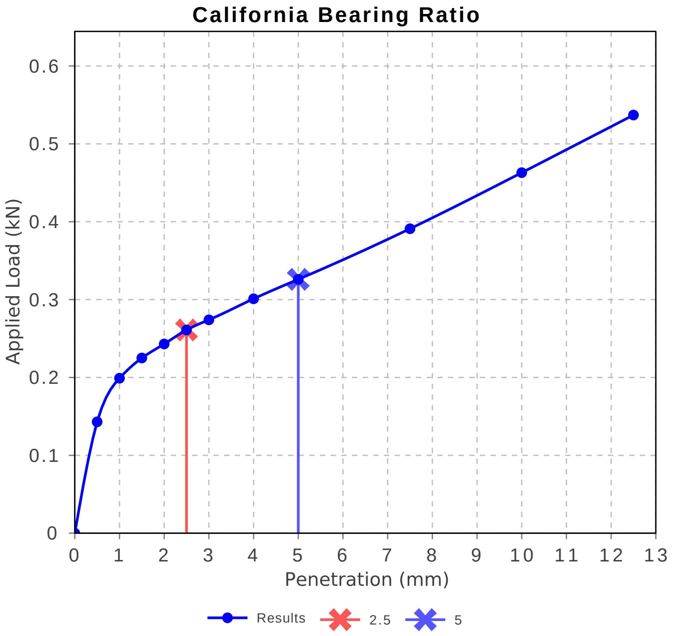
Report Number: **P22767-191C**
Issue Number: 1
Date Issued: 27/07/2023
Client: Hunter Civilab
3/62 Sandringham Avenue, Thornton New South Wales 2322
Contact: Nathan Roberts
Project Number: P22767
Project Name: Geotechnical Consulting Services
Project Location: Eastern Precinct Community Centres Project, Tenambit
Client Reference: G0237
Work Request: 11959
Sample Number: 23-11959C
Date Sampled: 12/07/2023
Dates Tested: 13/07/2023 - 24/07/2023
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Preparation Method: In accordance with the test method
Site Selection: Selected by Client
Sample Location: **BH5, Depth: 0.3 - 1.0**
Material: Silty Clay
Material Source: Onsite Won

Hunter Civilab
62 Sandringham Avenue Thornton NSW 2322
Phone: (02) 4966 1844
Email: office@huntercivilab.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: James Wyatt
Laboratory Manager
NATA Accredited Laboratory Number: 14975

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	2.5 mm		
CBR %	**2.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Vt		
Maximum Dry Density (t/m^3)	1.71		
Optimum Moisture Content (%)	19.0		
Laboratory Density Ratio (%)	100.0		
Laboratory Moisture Ratio (%)	99.5		
Dry Density after Soaking (t/m^3)	1.65		
Field Moisture Content (%)	20.8		
Moisture Content at Placement (%)	19.0		
Moisture Content Top 30mm (%)	28.4		
Moisture Content Rest of Sample (%)	20.5		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	149.6		
Swell (%)	3.5		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

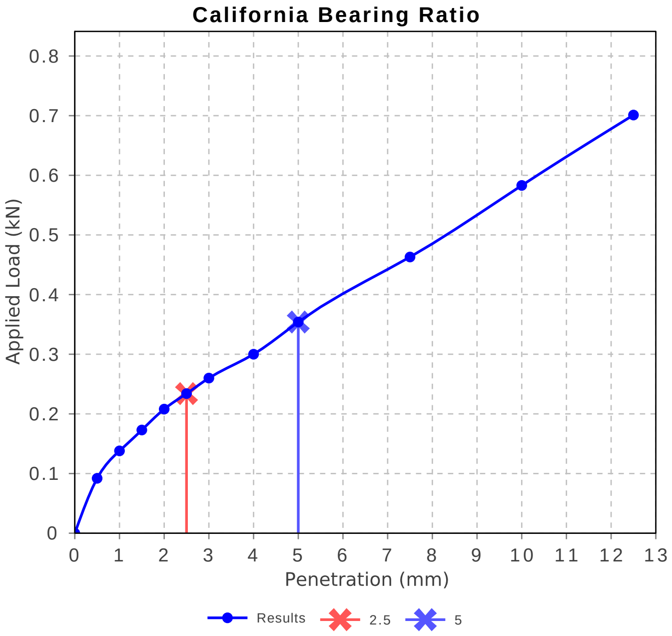
Report Number: **P22767-191C**
Issue Number: 1
Date Issued: 27/07/2023
Client: Hunter Civilab
3/62 Sandringham Avenue, Thornton New South Wales 2322
Contact: Nathan Roberts
Project Number: P22767
Project Name: Geotechnical Consulting Services
Project Location: Eastern Precinct Community Centres Project, Tenambit
Client Reference: G0237
Work Request: 11959
Sample Number: 23-11959D
Date Sampled: 12/07/2023
Dates Tested: 13/07/2023 - 24/07/2023
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Preparation Method: In accordance with the test method
Site Selection: Selected by Client
Sample Location: **BH6, Depth: 0.5 - 0.9**
Material: Silty Clay
Material Source: Onsite Won

Hunter Civilab
62 Sandringham Avenue Thornton NSW 2322
Phone: (02) 4966 1844
Email: office@huntercivilab.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: James Wyatt
Laboratory Manager
NATA Accredited Laboratory Number: 14975

California Bearing Ratio (AS 1289 6.1.1 & 2.1.1)		Min	Max
CBR taken at	5 mm		
CBR %	**2.0**		
Method of Compactive Effort	Standard		
Method used to Determine MDD	AS 1289 5.1.1 & 2.1.1		
Method used to Determine Plasticity	Vt		
Maximum Dry Density (t/m^3)	1.72		
Optimum Moisture Content (%)	17.5		
Laboratory Density Ratio (%)	99.5		
Laboratory Moisture Ratio (%)	101.5		
Dry Density after Soaking (t/m^3)	1.65		
Field Moisture Content (%)	12.0		
Moisture Content at Placement (%)	17.8		
Moisture Content Top 30mm (%)	19.8		
Moisture Content Rest of Sample (%)	14.9		
Mass Surcharge (kg)	4.5		
Soaking Period (days)	4		
Curing Hours	148.0		
Swell (%)	4.0		
Oversize Material (mm)	19		
Oversize Material Included	Excluded		
Oversize Material (%)	0.0		



Material Test Report

Report Number: **P22767-191C**
Issue Number: 1
Date Issued: 27/07/2023
Client: Hunter Civilab
3/62 Sandringham Avenue, Thornton New South Wales 2322
Contact: Nathan Roberts
Project Number: P22767
Project Name: Geotechnical Consulting Services
Project Location: Eastern Precinct Community Centres Project, Tenambit
Client Reference: G0237
Work Request: 11959
Sample Number: 23-11959E
Date Sampled: 12/07/2023
Dates Tested: 13/07/2023 - 27/07/2023
Sampling Method: Sampled by Engineering Department
The results apply to the sample as received
Preparation Method: In accordance with the test method
Site Selection: Selected by Client
Sample Location: **BH6, Depth: 0.02 - 0.3**
Material: Sandy Gravel
Material Source: Onsite Won

Hunter Civilab
62 Sandringham Avenue Thornton NSW 2322
Phone: (02) 4966 1844
Email: office@huntercivilab.com.au

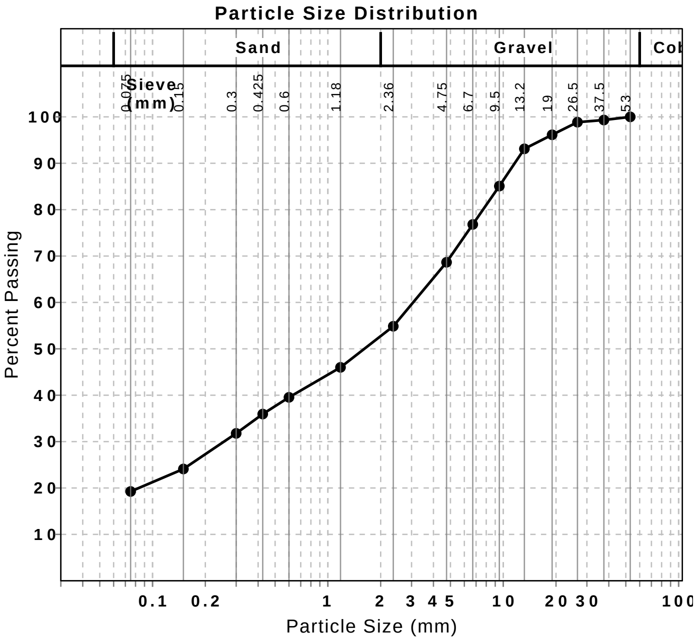
Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: James Wyatt
Laboratory Manager
NATA Accredited Laboratory Number: 14975

Atterberg Limit (AS1289 3.1.2 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Oven Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	28		
Plastic Limit (%)	24		
Plasticity Index (%)	**4**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.2		
Linear Shrinkage (%)	**2.5**		
Cracking Crumbling Curling	Cracking		

Particle Size Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
53 mm	**100**		
37.5 mm	**99**		
26.5 mm	**99**		
19 mm	**96**		
13.2 mm	**93**		
9.5 mm	**85**		
6.7 mm	**77**		
4.75 mm	**69**		
2.36 mm	**55**		
1.18 mm	**46**		
0.6 mm	**40**		
0.425 mm	**36**		
0.3 mm	**32**		
0.15 mm	**24**		
0.075 mm	**19**		



HUNTER
CIVILAB

Annex D

Foundation Maintenance and Footing Performance:
A Homeowner's Guide

PUBLISHING

BTF 18-2011
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 2870-2011, 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, which may experience only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes

Notes

1. Where controlled fill has been used, the site may be classified A to E according to the type of fill used.
2. Filled sites. Class P is used for sites which include soft fills, such as clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soil subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise.
3. Where deep-seated moisture changes exist on sites at depths of 3 m or greater, further classification is needed for Classes M to E (M-D, H1-D, H2-D and E-D).

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

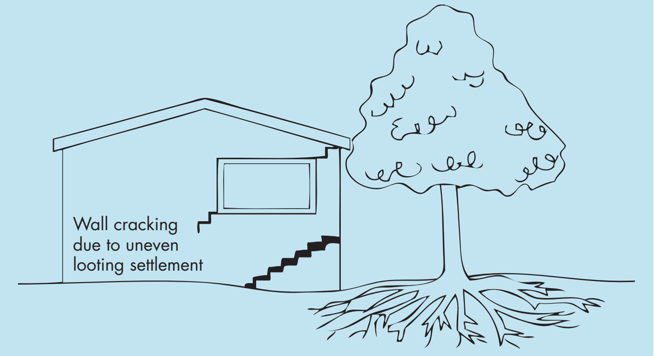
Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the 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.

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.

Trees can cause shrinkage and damage



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 causes 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 2870-2011.

AS 2870-2011 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.

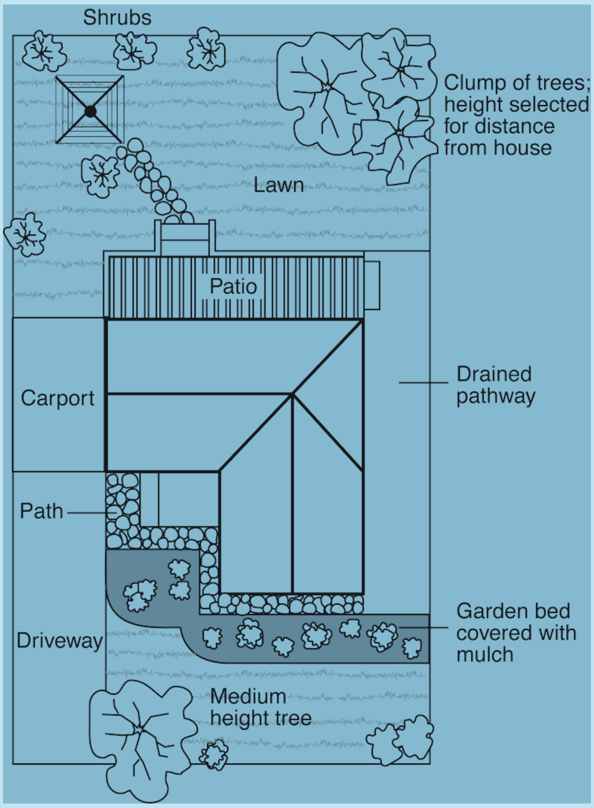
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

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 should

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 depends on number of cracks	4

Gardens for a reactive site



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.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

Distributed by
CSIRO PUBLISHING PO Box 1139, Collingwood 3066, Australia
Tel (03) 9662 7666 Fax (03) 9662 7555 www.publish.csiro.au
Email: publishing.sales@csiro.au