Proposed Subdivision – Stage 3.1 Site Classification

Sunset Drive, Thornton

NEW19P-0018H-AA
3 August 2021

Qualtest
LABORATORY (NSW) PTY LTD

GEOTECHNICAL I LABORATORY I EARTHWORKS I QUARRY I CONSTRUCTION MATERIAL TESTING

3 August 2021

Goldspring's Group Pty Ltd
13 Kyle Street
RUTHERFORD NSW 2320

Attention: Mr Eamonn Roach

Dear Eamonn,

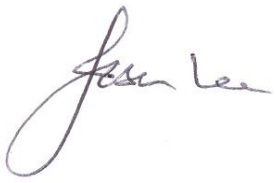
RE: PROPOSED SUBDIVISION – STAGE 3.1
SUNSET DRIVE, THORNTON, NSW
SITE CLASSIFICATION

Please find enclosed our geotechnical report for Stage 3.1 of the residential subdivision located at Sunset Drive, Thornton.

The report includes recommendations for Site Classification in accordance with AS2870-2011, "*Residential Slabs and Footings*", following the completion of site regrading earthworks.

If you have any questions regarding this report, please do not hesitate to contact Ben Edwards, 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 geotechnical report to Goldspring's Group Pty Ltd (Goldsprings) for Stage 3.1 of the residential subdivision, located at Sunset Drive, Thornton.

Based on the brief and plans provided in an email from Goldsprings dated 6 May 2021, Stage 3.1 is understood to include 19 residential lots (Lots 501 to 519), as shown on the attached Figure AA1.

The scope of work for the geotechnical investigation included providing Site Classification in accordance with AS2870-2011, "*Residential Slabs and Footings*", following completion of site regrade works which included controlled filling on Lots 502 to 505.

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

The report also includes selected results from the previous geotechnical assessments carried out for the proposed residential subdivision (Refer to Section 2.0), to supplement information collected during the current investigation where applicable.

2.0 Desktop Study

The scope of work has included a review of the following reports:

- Level 1 Site Re-grade Assessment Report, 'Stage 3.1, Raymond Terrace', (Report Reference: NEW19P-0018G-AC, dated 29 July, 2021);
- Report on Geotechnical Investigation, 'Proposed Residential Subdivision – Stage 1.1, 530 Raymond Terrace Road, Thornton North, (Douglas Partners Report Reference: Project No. 31952.17, May 2018), provided by Goldsprings;
- Geotechnical Assessment report, 'Proposed Subdivision - Stage 1.2, 530 Raymond Terrace Road, Thornton', (Qualtest Report Reference: NEW19P-0018B-AA.Rev1, dated 4 December 2019);
- Site Classification report, 'Proposed Subdivision – Stage 1.3, 530 Raymond Terrace Road, Thornton', (Qualtest Reference: NEW19P-0018D-AB, dated 20 January 2020); and
- Geotechnical Investigation, 'Proposed Subdivision – Thornton Brentwood Stage 3, 530 Raymond Terrace Road, Thornton', (Qualtest Reference: NEW19P-0018E-AF.Rev2, dated 22 March 2021).

This report includes selected results from the reports referenced above, to supplement information collected during the current investigations where applicable. Reference should be made to the reports outlined above for further details of site conditions, field work and laboratory testing conducted carried out.

3.0 Site Regrade Works

Following an initial site visit, stripping assessment and recommendations performed, site re-grading works within Stage 3.1 initially commenced on 19 May 2021, with further works conducted between 13 July 2021 and 14 July 2021.

Re-grade works included filling within portions of Lots 502 to 505 within Stage 3.1.

Refer to attached Figure AA1 for the approximate extent of lot re-grade works for this stage of the development.

Prior to filling, re-grade areas were stripped of all topsoil, existing stockpiles and unsuitable material to expose the suitable natural foundation profile. Re-grade works then consisted of filling with approved site fill to finish design levels.

Filling was performed using suitable material won from excavations cut from around the site and from other stages within the development. The fill material could generally be described as mixtures of Residual (CI-CH) Sandy CLAY, of medium to high plasticity, red / brown in colour, fine to coarse grained Sand, with some fine to coarse grained gravel inclusions.

The approximate depth of fill placed ranged in the order of 0.1m to about 0.9m.

The fill was compacted in maximum lifts of 0.3m thickness. Any unsuitable or deleterious material within the fill was removed by hand or mechanical means prior to final compaction of the material. Undisturbed samples (U50 tubes) were taken for subsequent laboratory testing.

As the geotechnical testing authority engaged for the project, we state that the filling performed for the re-grade areas within Stage 3.1 (as shown on attached Figure AA1), was carried out to Level 1 criteria as defined in Clause 8.2 – Section 8, of AS3798-2007, "*Guidelines on Earthworks for Commercial and Residential Developments*".

4.0 Field Work

The field work investigations were carried out on 24 May and 2 July 2021, and comprised of:

- DBYD search was undertaken to check 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;
- 24 May 2021 – Excavation of 10 test pits (TP501 to TP510) using a 13 tonne excavator equipped with a 450mm wide toothed bucket to depths varying from 1.00m to 2.10m;
    - Undisturbed samples (U50 tubes) and small bag samples were taken for subsequent laboratory testing. Test pits were backfilled with the excavation spoil and compacted using the excavator bucket and tracks;
- 2 July 2021 - Excavation of 4 test pits (TP511 to TP514) using a 13 tonne excavator equipped with a 450mm wide toothed bucket to depths varying from 0.50m to 1.20m;
    - Additional test pits to assess depth of existing topsoil and uncontrolled fill, together with spot checking of topsoil depths at selected locations. Test pits were backfilled with the excavation spoil and compacted using the excavator bucket and tracks;

Investigations were carried out by an experienced Geotechnical Engineer from Qualtest who located the test pits, carried out the testing and sampling, produced field logs of the test pits, and made observations of the site surface conditions.

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

Approximate test pit locations are shown on the attached Figure AA1. Test pits were located in the field by handheld GPS and relative to existing site features including topographic features, lot boundaries and existing developments.

5.0 Site Description

5.1 Surface Conditions

The site of Stage 3.1 is located within the southern portion of Lot 428 DP 1262858, Sunset Drive, Thornton. The site is generally bounded by moderately dense bushland and rural residential lots to the west, existing residential lots to the east, former quarry and future stages to the north, and by previous stages of residential developments to the south.

At the time of the site investigation, trafficability by way of 4WD vehicle was good.

The site was judged to generally be moderately drained primarily by way of surface runoff.

At the time of the field investigations on 24 May 2021, stockpiles were in the process of being removed and/or spread as a topsoil layer over the lots 504 to 505.

Following removal and/or spreading of stockpiles, a Geotechnical Engineer from Qualtest visited the site on 1 July 2021, and carried out visual observations and localised testing to assess total depth of topsoil and uncontrolled fill. The testing indicated historical uncontrolled filling at various locations within Lots 502 to 505 to depths greater than 0.4m from existing ground surface. Therefore requiring additional site regrade works to be completed, as outlined in Section 3.0 of this report.

Selected photographs of the site taken on the day of the site investigation are shown below.

Photograph 1: Facing northwest from near TP510.

Photograph 2: Facing northeast from near TP510.

Photograph 3: Facing near western boundary of Lot 512, facing north.

Photograph 4: Facing near western boundary of Lot 512, facing southeast. Showing 13 tonne excavator at TP505 location.

Photograph 5: Facing north from near TP501.

Photograph 6: Facing east from near TP501.

Photograph 7: Facing southeast from near TP504.

Photograph 8: Facing southwest from near TP504.

5.2 Subsurface Conditions

Reference to the 1:100,000 Newcastle Coalfield Regional Geology Sheet indicates the site to be underlain by the Permian Aged Mulbring Siltstone, which is characterised by Siltstone and Sandstone rock types.

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

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

No groundwater levels or inflows were encountered in the test pits during the limited time that they remained open on the day of the field investigation.

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
1A	FILL - TOPSOIL & MULCH	Generally 0.10m to 0.20m of mulch where encountered.
1B	UNCONTROLLED FILL	Sandy CLAY – low to medium plasticity, dark grey to dark grey-brown, fine grained sand. CLAY – medium to high plasticity, grey to grey-brown, trace pale grey and orange, trace fine to coarse grained sand, trace fine to medium grained sub-rounded to sub-angular gravel.
1C	CONTROLLED FILL	Not Encountered in test pits during current investigation.
2	TOPSOIL	CLAY – medium to high plasticity, dark grey to dark brown, trace fine to coarse grained sand, trace fine to medium grained sub-rounded to sub-angular gravel, trace tree mulch. Sandy CLAY – low plasticity, grey-brown, fine to coarse grained (mostly fine grained) sand, trace fine to medium grained sub-rounded gravel, root affected.
3	COLLUVIUM / SLOPEWASH	Sandy CLAY – low plasticity, fine to coarse grained (mostly fine grained) sand, grey-brown, trace fine to medium grained sub-rounded gravel, root gravel.
4	RESIDUAL SOIL	CLAY – medium to high plasticity, pale grey to grey and brown to red-brown. Silty CLAY – medium plasticity, pale grey to white with pale orange to red-brown.
5	EXTREMELY WEATHERED (XW) ROCK (with soil properties)	Siltstone; breaks down into Silty CLAY – medium plasticity, pale grey to white with pale orange-brown to red-brown, trace highly weathered pockets. Sandy Siltstone; breaks down into CLAY – medium to high plasticity, pale grey and pale red-brown.
6	HIGHLY WEATHERED (HW) ROCK	Sandy SILTSTONE – fine grained sand, pale grey to grey with orange to red-brown, estimated medium to high strength, fractured. SILTSTONE – pale grey and orange-brown to red-brown, estimated low to medium strength, fractured, trace extremely weathered pockets.

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

Location	Unit 1A Fill: Topsoil & Mulch	Unit 1B Uncontrolled Fill	Unit 1C Controlled Fill	Unit 2 Topsoil	Unit 3 Colluvium / Slopewash	Unit 4 Residual Soil	Unit 5 Extremely Weathered Rock	Unit 6 Highly Weathered Rock
	Depth (m)							
Current Investigation (Qualtest – June & July 2021) – Prior to Site Regrade Works								
TP501	-	-	-	0.00 – 0.10	0.10 – 0.25	0.25 – 2.00	-	-
TP502	0.00 – 0.10	-	-	0.10 – 0.20	-	0.20 – 1.10	1.10 – 1.80	1.80 – 1.90^
TP503	0.00 – 0.10	-	-	0.10 – 0.25	-	0.25 – 1.60	1.60 – 2.00^	-
TP504	0.00 – 0.05	-	-	0.05 – 0.25	-	0.25 – 1.90^	-	-
TP505	0.00 – 0.20	-	-	-	-	0.20 – 0.40	0.40 – 1.20	1.20 – 1.40^
TP506	0.00 – 0.10	0.10 – 0.40	-	-	-	0.40 – 0.80	0.80 – 1.20	1.20 – 1.40^
TP507	0.00 – 0.20	0.20 – 0.40	-	-	-	0.40 – 1.90	1.90 – 2.00	2.00 – 2.05*
TP508	0.00 – 0.10	0.10 – 0.40	-	-	-	0.40 – 1.10	1.10 – 2.10	-
TP509	0.00 – 0.10	0.10 – 0.50	-	-	-	0.50 – 2.00	2.00 – 2.10	-
TP510	0.00 – 0.05	0.05 – 0.40	-	-	-	0.40 – 1.60	1.60 – 2.00	-
TP511	0.00 – 0.20	0.20 – 0.40	-	-	-	0.40 – 0.60	-	-
TP512	0.00 – 0.10	0.10 – 0.40	-	-	-	0.40 – 0.50	-	-
TP513	-	0.00 – 0.40	-	-	-	-	-	-
TP514	-	0.00 – 0.60	-	-	-	0.60 – 1.20	-	-
Previous Investigation (Qualtest, NEW19P-0018E-AF.Rev1 – 22 March 2021)								
TPQ-501	-	-	-	0.00 – 0.10	-	0.10 – 1.40	-	1.40 – 2.00
TPQ-503	-	-	0.00 – 2.00	-	-	-	-	-

Location	Unit 1A Fill: Topsoil & Mulch	Unit 1B Uncontrolled Fill	Unit 1C Controlled Fill	Unit 2 Topsoil	Unit 3 Colluvium / Slopewash	Unit 4 Residual Soil	Unit 5 Extremely Weathered Rock	Unit 6 Highly Weathered Rock
	Depth (m)							
TPQ-505	-	-	0.00 – 2.00	-	-	-	-	-
Previous Investigation (Qualtest, NEW19P-0018D-AA – 20 January 2020)								
TP406	0.00 – 0.10	-	-	0.10 – 0.25	-	0.25 – 1.90	-	1.90 – 2.00
TP407	0.00 – 0.10	-	-	0.10 – 0.30	-	0.30 – 2.00	2.00 – 2.10^	-
TP412	0.00 – 0.10	-	-	0.10 – 0.20	-	0.20 – 1.50	1.50 – 2.00^	-
Previous Investigation (Qualtest, NEW19P-0018B-AA.Rev1 - December 2019)								
TP201	0.00 – 0.05	-	-	0.05 – 0.20	-	0.20 – 1.20	1.20 – 1.90	-
TP202	-	-	-	0.00 – 0.10	0.10 – 0.30	0.30 – 1.20	1.20 – 2.00	-
TP213	-	-	-	0.00 – 0.20	0.20 – 0.30	0.30 – 1.20	1.20 – 1.40	1.40 – 1.90
Previous Investigation (Douglas Partners, Project No. 31952.17 - May 2018) #								
Pit No. 4	-	-	-	0.00 – 0.15	-	0.15 – 1.00	1.00 – 1.50	-
Pit No. 5	-	-	-	0.00 – 0.15	-	0.15 – 1.20	1.20 – 1.50	-
Pit No. 6	-	-	-	0.00 – 0.15	-	0.15 – 1.00	1.00 – 1.30	1.30 – 1.50
Pit No. 7	-	-	-	0.00 – 0.20	-	0.20 – 1.00	1.00 – 1.60	-

Note: ^ = Slow to very slow progress, close to practical refusal of Backhoe / 13 tonne excavator.

* = Practical refusal of 13 tonne excavator.

= Douglas Partners (DP) test pit logs do not show origin of most soil layers. Possible/probable origins have been inferred by Qualtest for the purposes of this assessment based on the DP soil / rock descriptions. DP soil and rock descriptions may differ from those shown in Table 1.

6.0 Laboratory Testing

Samples collected during the current field investigations were returned to our NATA accredited Newcastle Laboratory for testing which comprised of:

- (14 no.) Shrink / Swell tests.

  12 samples during the test pit investigations (TP501 to TP510) and an additional 2 samples taken within Level 1 Controlled Fill (S01 and S02).

Results of the laboratory testing are presented in Appendix B, with a summary of the Shrink/Swell test results presented in Table 3.

TABLE 3 – SUMMARY OF SHRINK / SWELL TESTING RESULTS

Location	Depth (m)	Material Description	I_{ss} (%)
TP501	0.50 – 0.68	(CH) CLAY	2.2
TP502	0.80 – 1.10	(CH) CLAY	1.9
TP503	0.60 – 0.90	(CH) CLAY	3.2
TP504	0.75 – 1.00	(CH) CLAY	2.3
TP505	0.40 – 0.53	XW Siltstone; (CI) Silty CLAY	0.6
TP506	0.50 – 0.65	(CH) CLAY	1.6
TP507	0.50 – 0.90	(CH) CLAY	2.6
TP508	0.20 – 0.50	FILL: (CH) CLAY	2.0
TP508	0.50 – 0.80	(CH) CLAY	5.3
TP509	1.00 – 1.15	(CH) CLAY	3.2
TP510	0.10 – 0.24	FILL: (CH) CLAY	2.0
TP510	0.70 – 0.90	(CH) CLAY	3.7
Additional Undisturbed (U50) samples taken during site re-grade works (July 2021)			
S01	0.25 – 0.37	FILL: (CH) CLAY	2.9
S02	0.30 – 0.45	FILL: (CH) CLAY	2.7
Previous Investigation (Qualtest, NEW19P-0018D-AA – 20 January 2020)			
TP406	0.90 - 1.10	(CH) CLAY	2.8
TP407	0.50 - 0.75	(CH) CLAY	3.0
TP412	0.70 - 0.90	(CH) Silty CLAY	1.3
Previous Investigation (NEW19P-0018B-AA.Rev1, dated 4 December 2019)			
TP201	0.50 – 0.70	(CH) CLAY	2.0
TP202	0.50 – 0.70	(CH) CLAY	1.9
TP213	0.50 - 0.90	(CH) CLAY	1.7

7.0 Site Classification to AS2870-2011

Based on the results of the field work and laboratory testing carried out, residential lots within Stage 3.1 of the subdivision located at Sunset Drive, Thornton, as shown in the attached Figure AA1 are classified in their current condition in accordance with AS2870-2011 *'Residential Slabs and Footings'*, as shown in Table 4.

TABLE 4 – SITE CLASSIFICATION TO AS2870-2011

Lot Numbers	Site Classification to AS2870-2011
510 to 516	**M**
501, 507 to 509 & 517 to 519	**H1**
502 to 506	**H2**

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

A characteristic free surface movement in the range of 40mm to 60mm is estimated for the lots classified as **Class 'H1'** in their existing condition.

A characteristic free surface movement in the range of 60mm to 75mm is estimated for the lots classified as **Class 'H2'** in their existing condition.

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. If site re-grading works involving cutting or filling are performed after the date of this assessment the classification may change and further advice should be sought.

If any site regrade works take place, final site classification will be dependent on the type of fill and level of supervision carried out. Re-classification of lots should be confirmed by the geotechnical authority at the time of construction following any site re-grade works.

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; and,
- 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.

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

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.

8.0 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.

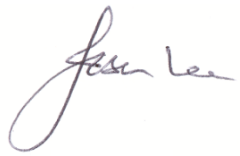
The extent of testing associated with this assessment is limited to discrete test pit locations. It should be noted that subsurface conditions between and away from the test pit locations may be different to those observed during the field work and used as the basis of the recommendations contained in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

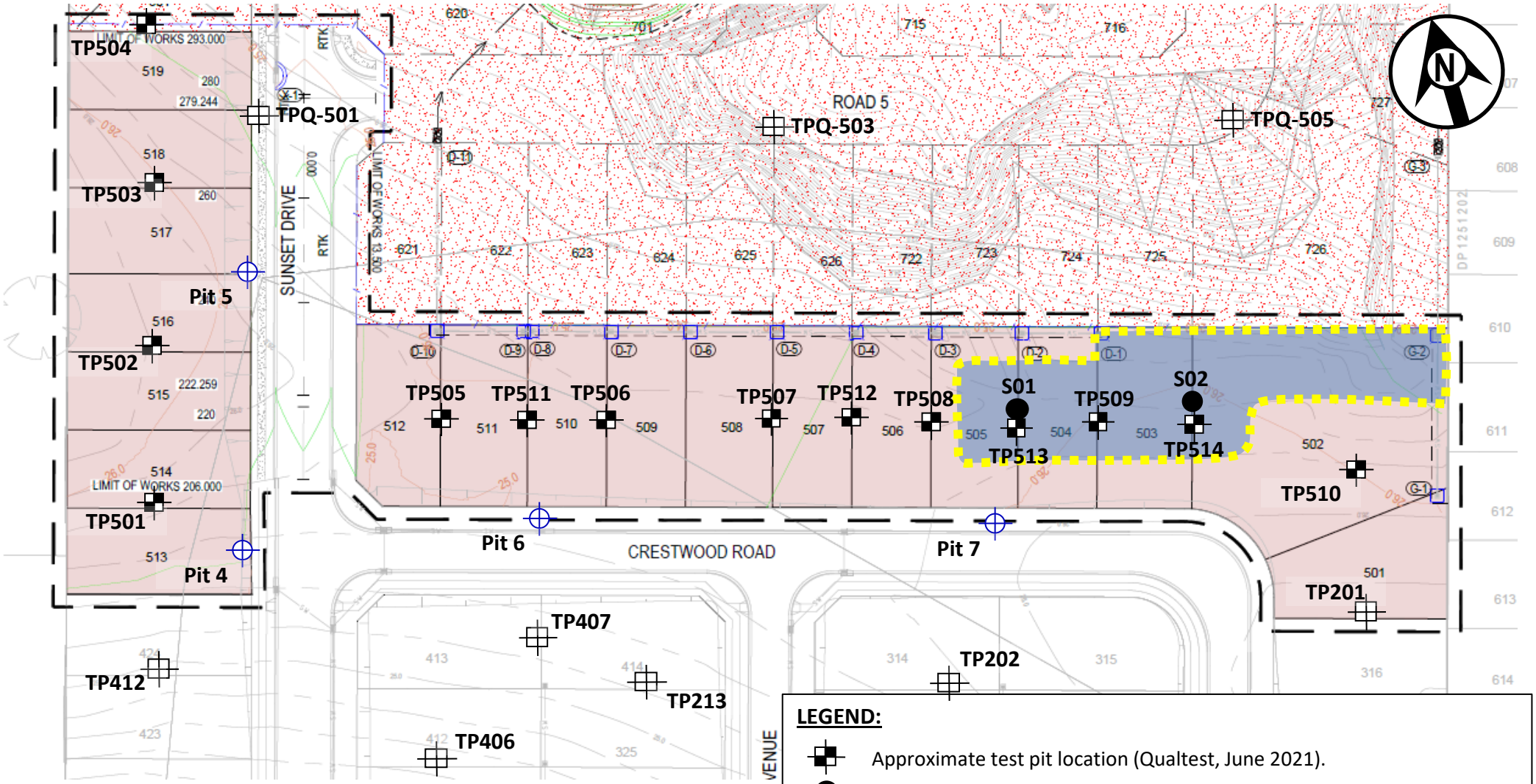
For and on behalf of Qualtest Laboratory (NSW) Pty Ltd.



Jason Lee
Principal Geotechnical Engineer

FIGURE AA1

Site Plan and Approximate Test Locations



Based on Site Plan prepared by ACOR Consultants Pty Ltd
(Project No. NSW200057, Dwg No. Dwg No. C03.01, Issue B, dated 22/03/2021)

LEGEND:

- Approximate test pit location (Qualtest, June 2021).
- Approximate undisturbed (U50) sample location (Qualtest July 2021).
- Approximate test pit location (Qualtest, 2019 to March 2021).
- Approximate test pit location (Douglas Partners, 2018).
- Approximate extent of Re-grade Works (Filling).

Qualtest LABORATORY (NSW) PTY LTD

Client:	THORNTON BRENTWOOD PTY LIMITED	Drawing No:	FIGURE AA1
Project:	PROPOSED SUBDIVISION - THORNTON BRENTWOOD STAGE 3.1	Project No:	NEW19P-0018H
Location:	SUNSET DRIVE, THORNTON	Scale:	NOT TO SCALE
Title:	SITE PLAN AND APPROXIMATE TEST LOCATIONS	Date:	29/07/2021

APPENDIX A:

Results of Field Investigations

ENGINEERING LOG - TEST PIT

CLIENT: THORNTON BRENTWOOD PTY LIMITED
PROJECT: THORNTON BRENTWOOD ESTATE - STAGE 3.1
LOCATION: SUNSET DRIVE, THORNTON

TEST PIT NO: TP501
PAGE: 1 OF 1
JOB NO: NEW19P-0018H
LOGGED BY: BE
DATE: 24/5/21

EQUIPMENT TYPE: 13 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 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	
						CH	TOPSOIL: CLAY - medium to high plasticity, dark grey to dark brown, trace fine to coarse grained sand, trace fine to medium grained sub-rounded to sub-angular gravel, trace tree mulch.	$M > w_P$				TOPSOIL
						0.10m						
						CL	Sandy CLAY - low plasticity, grey-brown, fine to coarse grained (mostly fine grained) sand, trace fine to medium grained sub-rounded gravel, root affected.	$M < w_P$				SLOPE WASH
						0.25m						
						CH	CLAY - medium to high plasticity, grey to brown, trace red-brown.			HP	550	RESIDUAL SOIL
		0.50m		0.5		0.50m				HP	400	
		U50					CLAY - medium plasticity, pale grey and red-brown.					
		0.68m								HP	420	
E	Not Encountered			1.0				$M \sim w_P$	H	HP	550	
						CI				HP	480	
				1.5						HP	450	
										HP	450	
				2.0		2.00m						
							Hole Terminated at 2.00 m					

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

TEST PIT NO: TP502

CLIENT: THORNTON BRENTWOOD PTY LIMITED
PAGE: 1 OF 1

PROJECT: THORNTON BRENTWOOD ESTATE - STAGE 3.1
JOB NO: NEW19P-0018H

LOCATION: SUNSET DRIVE, THORNTON
LOGGED BY: BE

DATE: 24/5/21

EQUIPMENT TYPE: 13 TONNE EXCAVATOR
SURFACE RL:

TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
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	
							FILL: MULCH	M				MULCH
							0.10m					
						CL	TOPSOIL: Sandy CLAY - low plasticity, grey-brown, fine grained sand, root affected.	M < w_P				TOPSOIL
							0.20m					
							CLAY - medium to high plasticity, grey to brown, trace red-brown.					RESIDUAL SOIL
										HP	260	
										HP	350	
				0.5			Pale grey and red-brown.					
						CH		M > w_P	VSt			
		0.80m								HP	380	
E	Not Encountered	U50		1.0						HP	450	
		1.10m					1.10m					
							Extremely Weathered Siltstone with soil properties; breaks down into Silty CLAY - medium plasticity, pale grey with red-brown, trace highly weathered pockets.					EXTREMELY WEATHERED ROCK
										HP	550	
										HP	>600	
				1.5		CI		M < w_P	H			
							1.80m					
							Sandy SILTSTONE - fine grained sand, pale grey to grey with orange to red-brown, estimated medium to high strength, fractured.	D				HIGHLY WEATHERED ROCK
							1.90m					
				2.0			Hole Terminated at 1.90 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: THORNTON BRENTWOOD PTY LIMITED
PROJECT: THORNTON BRENTWOOD ESTATE - STAGE 3.1
LOCATION: SUNSET DRIVE, THORNTON

TEST PIT NO: TP503
PAGE: 1 OF 1
JOB NO: NEW19P-0018H
LOGGED BY: BE
DATE: 24/5/21

EQUIPMENT TYPE: 13 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 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	
							FILL: MULCH	M				FILL
							0.10m					
						CL	TOPSOIL: Sandy CLAY - low plasticity, grey-brown, fine to coarse grained (mostly fine grained) sand, trace fine to medium grained sub-rounded gravel, trace fine to medium grained sub-rounded gravel, root affected.					TOPSOIL
							0.25m					
							CLAY - medium to high plasticity, grey to brown, trace red-brown.			HP	220	RESIDUAL SOIL
				0.5			Pale grey and red-brown.					
		0.60m						M > w_P		HP	300	
		U50				CH			VSt			
E	Not Encountered	0.90m								HP	280	
				1.0						HP	350	
							1.20m			HP	400	
							Silty CLAY - medium plasticity, pale grey to white with pale orange to red-brown.			HP	450	
						CI		M ~ w_P				
				1.5						HP	450	
							1.60m		H			EXTREMELY WEATHERED ROCK
							Extremely Weathered Siltstone with soil properties; breaks down into Silty CLAY - medium plasticity, pale grey to white with pale orange to red-brown.			HP	>600	
						CH		M < w_P				
				2.0			2.00m					
							Hole Terminated at 2.00 m 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

TEST PIT NO: TP504

CLIENT: THORNTON BRENTWOOD PTY LIMITED
PAGE: 1 OF 1
PROJECT: THORNTON BRENTWOOD ESTATE - STAGE 3.1
JOB NO: NEW19P-0018H
LOCATION: SUNSET DRIVE, THORNTON
LOGGED BY: BE
DATE: 24/5/21

EQUIPMENT TYPE: 13 TONNE EXCAVATOR
SURFACE RL:
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
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	
							0.05m FILL: MULCH	M				MULCH
						CL	TOPSOIL: Sandy CLAY - low plasticity, grey-brown, fine to coarse grained (mostly fine grained) sand, trace fine to medium grained sub-rounded gravel, root affected.					TOPSOIL
							0.25m CLAY - medium to high plasticity, pale grey and red-brown.		St	HP	180	RESIDUAL SOIL
										HP	200	
				0.5						HP	220	
E	Not Encountered	0.75m U50 1.00m				CH		M > w_P	VSt	HP	300	
				1.0								
							1.30m Silty CLAY - medium plasticity, pale grey with pale orange to red-brown.			HP	380 - 420	
				1.5		CI		M < w_P	VSt - H	HP	>600	
										HP	380 - 420	
							1.90m					
				2.0			Hole Terminated at 1.90 m 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

TEST PIT NO: TP505

CLIENT: THORNTON BRENTWOOD PTY LIMITED
PAGE: 1 OF 1
PROJECT: THORNTON BRENTWOOD ESTATE - STAGE 3.1
JOB NO: NEW19P-0018H
LOCATION: SUNSET DRIVE, THORNTON
LOGGED BY: BE
DATE: 24/5/21

EQUIPMENT TYPE: 13 TONNE EXCAVATOR
SURFACE RL:
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
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	
							FILL: MULCH	M				MULCH
							0.20m					
						CH	CLAY - medium to high plasticity, pale grey and orange to red-brown.			HP	480	RESIDUAL SOIL
		0.40m					0.40m					
		U50 0.53m		0.5			Extremely Weathered Siltstone with soil properties; breaks down into Silty CLAY - medium to high plasticity, pale grey and orange to red-brown.			HP	>600	EXTREMELY WEATHERED ROCK
E	Not Encountered							M < W_P	H	HP	>600	
						CH				HP	>600	
				1.0								
							1.20m					
							SILTSTONE - pale grey and orange-brown to red-brown, estimated low to medium strength, fractured, trace extremely weathered pockets.	D				HIGHLY WEATHERED SANDSTONE
							1.40m					
							Hole Terminated at 1.40 m Very slow progress					
				1.5								
				2.0								

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 - TEST PIT

TEST PIT NO: TP506

CLIENT: THORNTON BRENTWOOD PTY LIMITED
PAGE: 1 OF 1

PROJECT: THORNTON BRENTWOOD ESTATE - STAGE 3.1
JOB NO: NEW19P-0018H

LOCATION: SUNSET DRIVE, THORNTON
LOGGED BY: BE

DATE: 24/5/21

EQUIPMENT TYPE: 13 TONNE EXCAVATOR
SURFACE RL:

TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
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	
							FILL: MULCH	M				MULCH
							0.10m					
						CL	FILL: Sandy CLAY - low to medium plasticity, dark grey to dark grey-brown, fine grained sand.	M > w_P				FILL
							0.40m					
		0.50m		0.5			CLAY - medium to high plasticity, pale grey and orange to red-brown.			HP	480	RESIDUAL SOIL
E	Not Encountered	U50 0.65m				CH				HP	550	
										HP	580	
							0.80m	M < w_P	H	HP	>600	EXTREMELY WEATHERED ROCK
				1.0		CH	Extremely Weathered Siltstone with soil properties; breaks down into Silty CLAY - medium to high plasticity, pale grey and orange to red-brown.					
							1.20m					
							SILTSTONE - pale grey and orange-brown to red-brown, estimated low to medium strength, fractured, trace extremely weathered pockets.	D				HIGHLY WEATHERED SANDSTONE
							1.40m					
				1.5			Hole Terminated at 1.40 m Very slow progress					
				2.0								

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 - TEST PIT

CLIENT: THORNTON BRENTWOOD PTY LIMITED
PROJECT: THORNTON BRENTWOOD ESTATE - STAGE 3.1
LOCATION: SUNSET DRIVE, THORNTON

TEST PIT NO: TP507
PAGE: 1 OF 1
JOB NO: NEW19P-0018H
LOGGED BY: BE
DATE: 24/5/21

EQUIPMENT TYPE: 13 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 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	
							FILL: MULCH	M				MULCH
							0.20m					
						CL	FILL: Sandy CLAY - low to medium plasticity, dark grey to dark grey-brown, fine grained sand.	M < w_P				FILL
							0.40m					
		0.50m		0.5			CLAY - medium to high plasticity, pale grey and pale red-brown.	M > w_P	VSt	HP	380	RESIDUAL SOIL
E	Not Encountered	U50								HP	450	
		0.90m		1.0		CH		M < w_P	H	HP	480	
				1.5						HP	480	
										HP	>600	
							1.90m					
				2.0		CH	Extremely Weathered Sandy Siltstone with soil properties; breaks down into CLAY - medium to high plasticity, pale grey and pale red-brown.					EXTREMELY WEATHERED ROCK
							2.00m	D				
							2.05m					HIGHLY WEATHERED ROCK
							Sandy SILTSTONE - fine grained sand, pale grey and orange to red-brown, estimated low to medium strength.					
							Hole Terminated at 2.05 m Practical Refusal					

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: THORNTON BRENTWOOD PTY LIMITED
PROJECT: THORNTON BRENTWOOD ESTATE - STAGE 3.1
LOCATION: SUNSET DRIVE, THORNTON

TEST PIT NO: TP508
PAGE: 1 OF 1
JOB NO: NEW19P-0018H
LOGGED BY: BE
DATE: 24/5/21

EQUIPMENT TYPE: 13 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 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
							FILL: MULCH					MULCH
							0.10m					
		0.20m				CH	FILL: CLAY - medium to high plasticity, grey to grey-brown, trace pale grey and orange, trace fine to coarse grained sand, trace fine to medium grained sub-rounded to sub-angular gravel.			HP	180	FILL
		U50								HP	300	
							0.40m					
		0.50m		0.5			CLAY - medium to high plasticity, pale grey with red-brown to brown.	M > w_P		HP	280	RESIDUAL SOIL
		U50				CH			VSt	HP	350	
		0.80m								HP	400	
E	Not Encountered			1.0								
							1.10m					
							Extremely Weathered Siltstone with soil properties; breaks down into CLAY - medium to high plasticity, pale grey with red-brown to brown.			HP	450	EXTREMELY WEATHERED ROCK
				1.5		CH		M < w_P	H	HP	450	
										HP	550	
										HP	>600	
				2.0								
							2.10m					
							Hole Terminated at 2.10 m					

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

TEST PIT NO: TP509

CLIENT: THORNTON BRENTWOOD PTY LIMITED
PAGE: 1 OF 1

PROJECT: THORNTON BRENTWOOD ESTATE - STAGE 3.1
JOB NO: NEW19P-0018H

LOCATION: SUNSET DRIVE, THORNTON
LOGGED BY: BE

DATE: 24/5/21

EQUIPMENT TYPE: 13 TONNE EXCAVATOR
SURFACE RL:

TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
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	
							FILL: MULCH					MULCH
							0.10m					
							FILL: CLAY - medium to high plasticity, grey to grey-brown, trace pale grey and orange, trace fine to coarse grained sand, trace fine to medium grained sub-rounded to sub-angular gravel.					FILL
						CH				HP	120	
										HP	120	
				0.5			0.50m					
							CLAY - medium to high plasticity, pale grey with red-brown to brown.					RESIDUAL SOIL
										HP	210	
										HP	280	
								M > w_P				
		1.00m		1.0					VSt			
E	Not Encountered	U50										
		1.15m										
						CH						
										HP	280	
				1.5						HP	380	
										HP	420	
								M < w_P	VSt - H	HP	450	
				2.0			2.00m					
						CH	Extremely Weathered Siltstone with soil properties; breaks down into Silty CLAY - medium to high plasticity, pale grey to white, trace pale red-brown.					EXTREMELY WEATHERED ROCK
							2.10m					
							Hole Terminated at 2.10 m					

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

TEST PIT NO: TP510

CLIENT: THORNTON BRENTWOOD PTY LIMITED
PAGE: 1 OF 1

PROJECT: THORNTON BRENTWOOD ESTATE - STAGE 3.1
JOB NO: NEW19P-0018H

LOCATION: SUNSET DRIVE, THORNTON
LOGGED BY: BE

DATE: 24/5/21

EQUIPMENT TYPE: 13 TONNE EXCAVATOR
SURFACE RL:

TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
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	
							0.05m FILL: MULCH	M				MULCH
		0.10m					FILL: CLAY - medium to high plasticity, grey to grey-brown, trace pale grey and orange, trace fine to coarse grained sand, trace fine to medium grained sub-rounded to sub-angular gravel.					FILL
		U50 0.24m				CH				HP	180	
										HP	180	
							0.40m CLAY - medium to high plasticity, pale grey with red-brown to brown.					RESIDUAL SOIL
				0.5					St	HP	150	
		0.70m						M > w_P				
		U50 0.90m								HP	180	
E	Not Encountered			1.0		CH				HP	190	
									VSt	HP	150	
										HP	300	
				1.5						HP	450	
							1.60m Extremely Weathered Siltstone with soil properties; breaks down into CLAY - medium to high plasticity, pale grey with red-brown to brown.	M < w_P	H	HP	>600	EXTREMELY WEATHERED ROCK
						CH				HP	>600	
				2.0			2.00m					
							Hole Terminated at 2.00 m					

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

TEST PIT NO: TP511

CLIENT: THORNTON BRENTWOOD PTY LIMITED
PAGE: 1 OF 1

PROJECT: THORNTON BRENTWOOD ESTATE - STAGE 3.1
JOB NO: NEW19P-0018H

LOCATION: SUNSET DRIVE, THORNTON
LOGGED BY: BE

DATE: 2/7/21

EQUIPMENT TYPE: 13 TONNE EXCAVATOR
SURFACE RL:

TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
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						FILL: MULCH	M				MULCH
							0.20m FILL: Sandy CLAY - low to medium plasticity, dark grey to dark grey-brown, fine grained sand.	M > w_P				FILL
						CL	0.40m					
				0.5		CH	CLAY - medium to high plasticity, pale grey and orange to red-brown.	M < w_P	H	HP	480	RESIDUAL SOIL
							0.60m Hole Terminated at 0.60 m					
				1.0								
				1.5								
				2.0								

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	

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

TEST PIT NO: TP512

CLIENT: THORNTON BRENTWOOD PTY LIMITED
PAGE: 1 OF 1
PROJECT: THORNTON BRENTWOOD ESTATE - STAGE 3.1
JOB NO: NEW19P-0018H
LOCATION: SUNSET DRIVE, THORNTON
LOGGED BY: BE
DATE: 2/7/21

EQUIPMENT TYPE: 13 TONNE EXCAVATOR
SURFACE RL:
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
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						FILL: MULCH	M				MULCH
							0.10m					
						CL	FILL: Sandy CLAY - low to medium plasticity, dark grey to dark grey-brown, fine grained sand.	M > w_P				FILL
							0.40m					
				0.5		CH	CLAY - medium to high plasticity, pale grey and orange to red-brown.	M < w_P	H	HP	480	RESIDUAL SOIL
							0.50m					
							Hole Terminated at 0.50 m					
				1.0								
				1.5								
				2.0								

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 - TEST PIT

TEST PIT NO: TP513

CLIENT: THORNTON BRENTWOOD PTY LIMITED
PAGE: 1 OF 1
PROJECT: THORNTON BRENTWOOD ESTATE - STAGE 3.1
JOB NO: NEW19P-0018H
LOCATION: SUNSET DRIVE, THORNTON
LOGGED BY: BE
DATE: 2/7/21

EQUIPMENT TYPE: 13 TONNE EXCAVATOR
SURFACE RL:
TEST PIT LENGTH: 2.0 m **WIDTH:** 0.5 m
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					CH	FILL: CLAY - medium to high plasticity, grey to grey-brown, trace pale grey and orange, trace fine to coarse grained sand, trace fine to medium grained sub-rounded to sub-angular gravel.	M < w_P				FILL
				0.5		CH	0.40m CLAY - medium to high plasticity, pale grey with red-brown to brown. 0.50m	M > w_P	VSt			RESIDUAL SOIL
							Hole Terminated at 0.50 m					
				1.0								
				1.5								
				2.0								

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 - TEST PIT

Qualtest LABORATORY (NSW) PTY LTD

CLIENT: THORNTON BRENTWOOD PTY LIMITED
PROJECT: THORNTON BRENTWOOD ESTATE - STAGE 3.1
LOCATION: SUNSET DRIVE, THORNTON

TEST PIT NO: TP514
PAGE: 1 OF 1
JOB NO: NEW19P-0018H
LOGGED BY: BE
DATE: 2/7/21

EQUIPMENT TYPE: 13 TONNE EXCAVATOR
TEST PIT LENGTH: 2.0 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			0.5		CH	FILL: CLAY - medium to high plasticity, grey to grey-brown, trace pale grey and orange, trace fine to coarse grained sand, trace fine to medium grained sub-rounded to sub-angular gravel.	$M > w_P$				FILL
							0.60m CLAY - medium to high plasticity, pale grey with red-brown to brown.		F	HP	50 - 80	RESIDUAL SOIL
				1.0		CH				HP	50 - 80	
										HP	100	
							1.20m		St	HP	120	
				1.5			Hole Terminated at 1.20 m					
				2.0								

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

APPENDIX B:

Results of Laboratory Testing

QUALTEST Laboratory (NSW) Pty Ltd (20708)
2 Murray Dwyer Circuit, Mayfield West, NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: SSI:NEW21W-2348-S01
Issue No: 1

Shrink Swell Index Report

Client: Thornton Brentwood Pty Limited
28 Bolton Street
Newcastle NSW 2300

Project No.: NEW19P-0018H
Project Name: Proposed Subdivision, Thornton Brentwood - Stage 3.1

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.

Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 17/06/2021

Sample Details

Sample ID:	NEW21W-2348-S01		
Sampling Method:	The results outlined below apply to the sample as received		
Material:	CLAY	**Date Sampled:**	25/05/2021
Source:	On-Site Insitu	**Date Submitted:**	26/05/2021
Specification:	No Specification		
Project Location:	Raymond Terrace Road, Thornton		
Sample Location:	TP501 - (0.5 - 0.68m)		
Date Tested:	8/06/2021		

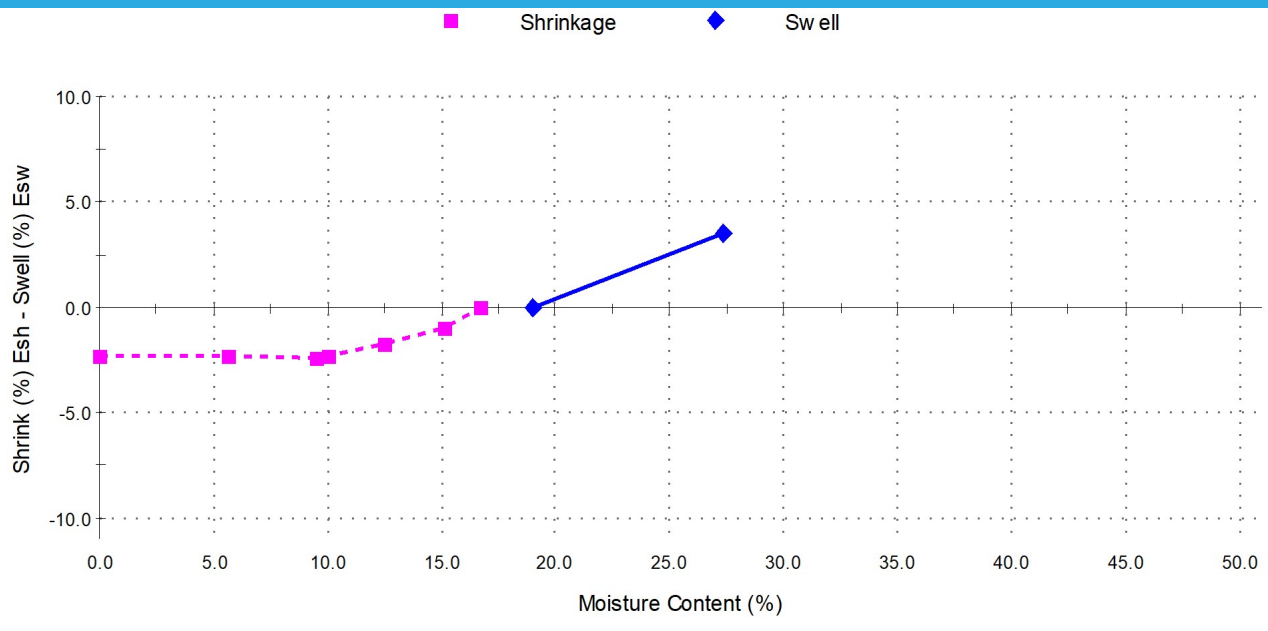
Swell Test — AS 1289.7.1.1

Swell on Saturation (%):	3.6
Moisture Content before (%):	19.0
Moisture Content after (%):	27.3
Est. Unc. Comp. Strength before (kPa):	400
Est. Unc. Comp. Strength after (kPa):	160

Shrink Test — AS 1289.7.1.1

Shrink on drying (%):	2.3
Shrinkage Moisture Content (%):	16.7
Est. inert material (%):	<1%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Major

Shrink Swell



Shrink Swell Index - Iss (%): 2.2

Comments

QUALTEST Laboratory (NSW) Pty Ltd (20708)
2 Murray Dwyer Circuit, Mayfield West, NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: SSI:NEW21W-2348-S02
Issue No: 1

Shrink Swell Index Report

Client: Thornton Brentwood Pty Limited
28 Bolton Street
Newcastle NSW 2300

Project No.: NEW19P-0018H
Project Name: Proposed Subdivision, Thornton Brentwood - Stage 3.1

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.

Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 17/06/2021

Sample Details

Sample ID: NEW21W-2348-S02
Sampling Method: The results outlined below apply to the sample as received
Material: CLAY
Source: On-Site Insitu
Specification: No Specification
Project Location: Raymond Terrace Road, Thornton
Sample Location: TP502 - (0.8 - 1.1m)
Date Tested: 8/06/2021
Date Sampled: 25/05/2021
Date Submitted: 26/05/2021

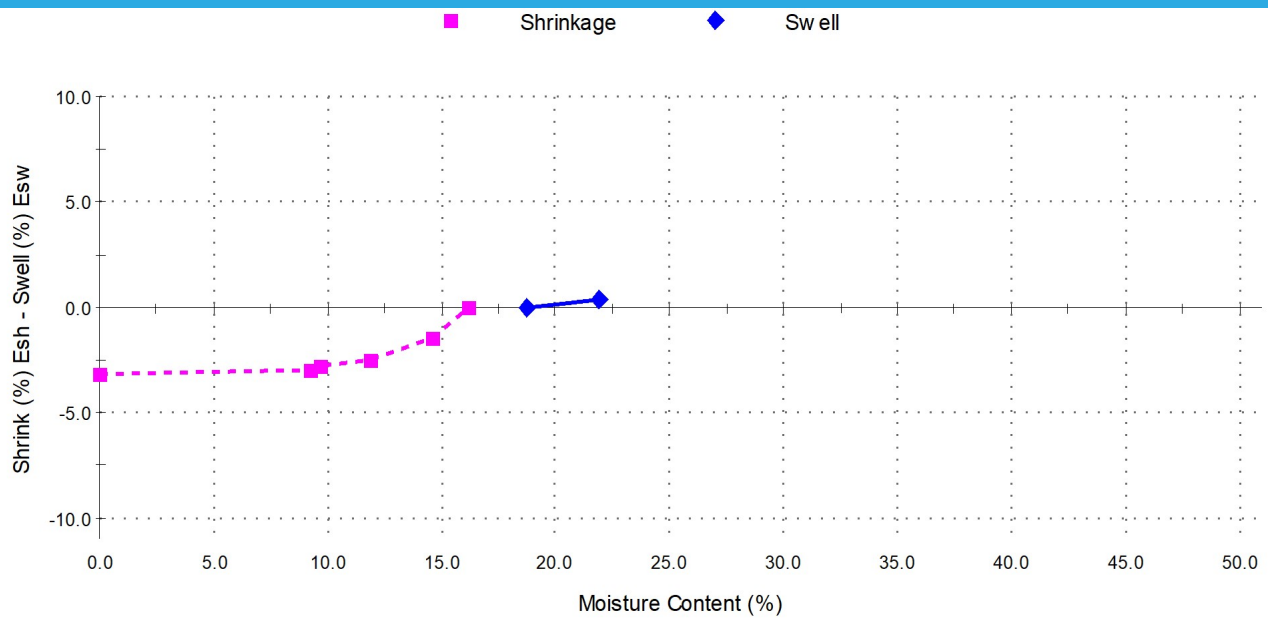
Swell Test — AS 1289.7.1.1

Swell on Saturation (%):	0.4
Moisture Content before (%):	18.7
Moisture Content after (%):	21.9
Est. Unc. Comp. Strength before (kPa):	370
Est. Unc. Comp. Strength after (kPa):	290

Shrink Test — AS 1289.7.1.1

Shrink on drying (%):	3.2
Shrinkage Moisture Content (%):	16.2
Est. inert material (%):	<1%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Major

Shrink Swell



Shrink Swell Index - Iss (%): 1.9

Comments

QUALTEST Laboratory (NSW) Pty Ltd (20708)
2 Murray Dwyer Circuit, Mayfield West, NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: SSI:NEW21W-2348-S03
Issue No: 1

Shrink Swell Index Report

Client: Thornton Brentwood Pty Limited
28 Bolton Street
Newcastle NSW 2300

Project No.: NEW19P-0018H
Project Name: Proposed Subdivision, Thornton Brentwood - Stage 3.1

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.

Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 22/06/2021

Sample Details

Sample ID: NEW21W-2348-S03
Sampling Method: The results outlined below apply to the sample as received
Material: CLAY
Source: On-Site Insitu
Specification: No Specification
Project Location: Raymond Terrace Road, Thornton
Sample Location: TP503 - (0.6 - 0.9m)
Date Tested: 8/06/2021
Date Sampled: 25/05/2021
Date Submitted: 26/05/2021

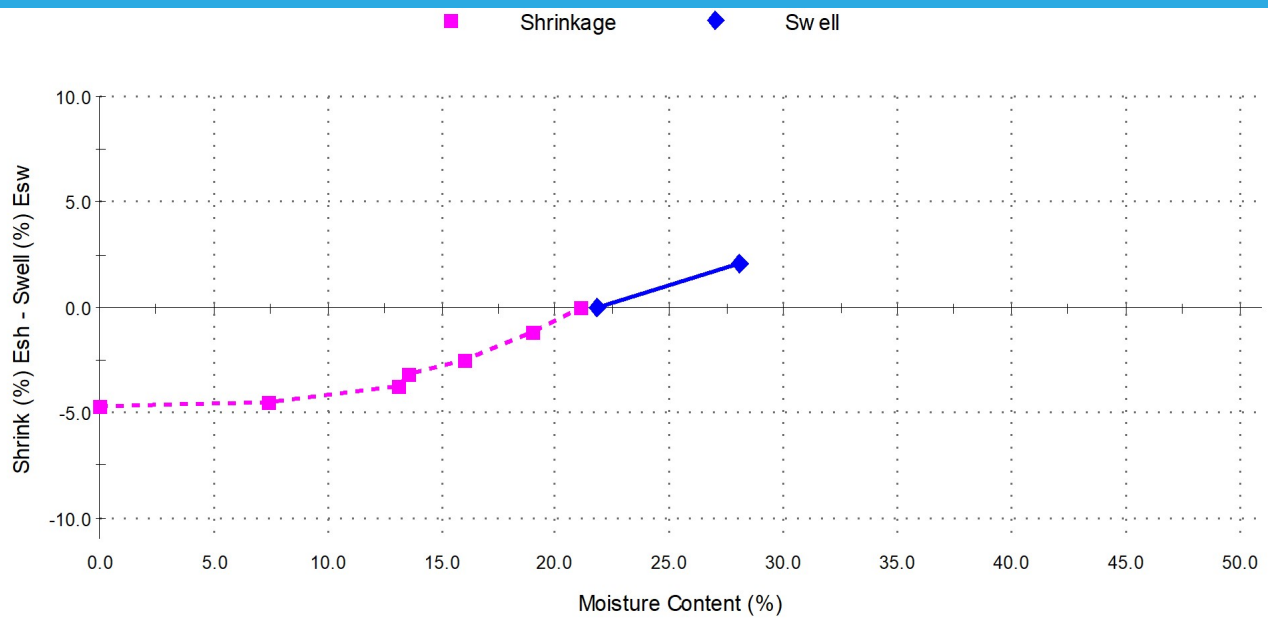
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	2.1
Moisture Content before (%):	21.8
Moisture Content after (%):	28.0
Est. Unc. Comp. Strength before (kPa):	300
Est. Unc. Comp. Strength after (kPa):	80

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	4.7
Shrinkage Moisture Content (%):	21.1
Est. inert material (%):	2%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Nil

Shrink Swell



Shrink Swell Index - Iss (%): 3.2

Comments

QUALTEST Laboratory (NSW) Pty Ltd (20708)
2 Murray Dwyer Circuit, Mayfield West, NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: SSI:NEW21W-2348-S04
Issue No: 1

Shrink Swell Index Report

Client: Thornton Brentwood Pty Limited
28 Bolton Street
Newcastle NSW 2300

Project No.: NEW19P-0018H
Project Name: Proposed Subdivision, Thornton Brentwood - Stage 3.1

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.

Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 17/06/2021

Sample Details

Sample ID: NEW21W-2348-S04
Sampling Method: The results outlined below apply to the sample as received
Material: CLAY
Source: On-Site Insitu
Specification: No Specification
Project Location: Raymond Terrace Road, Thornton
Sample Location: TP504 - (0.75 - 1.0m)
Date Tested: 8/06/2021
Date Sampled: 25/05/2021
Date Submitted: 26/05/2021

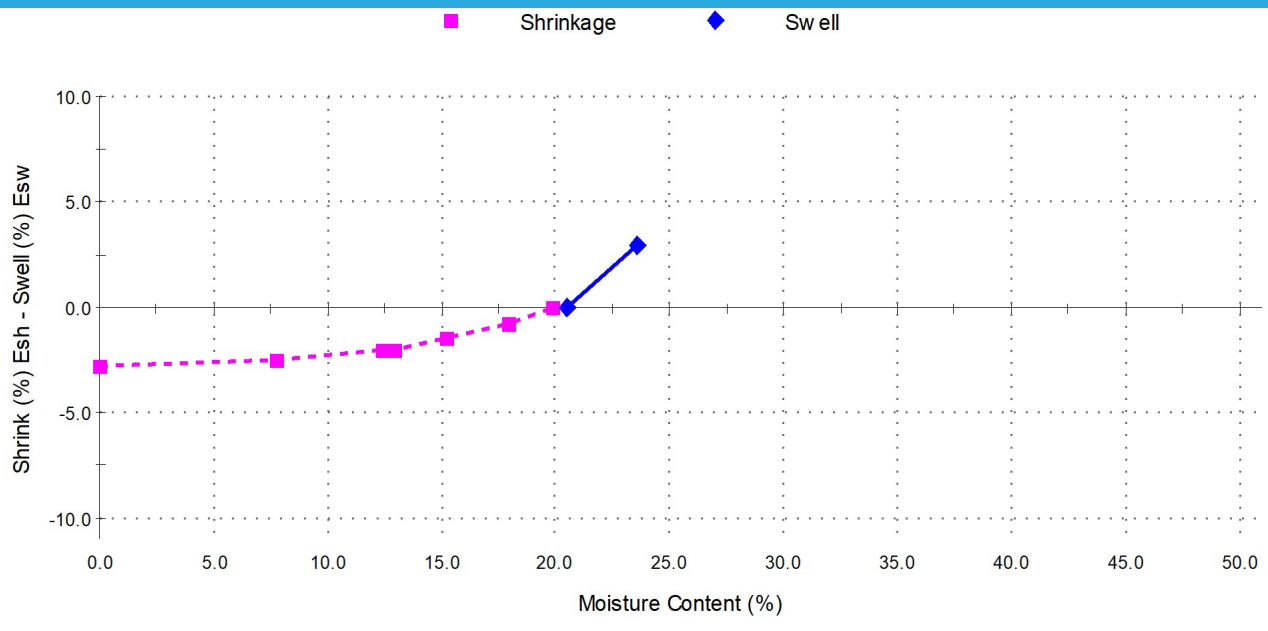
Swell Test — AS 1289.7.1.1

Swell on Saturation (%):	2.9
Moisture Content before (%):	20.5
Moisture Content after (%):	23.6
Est. Unc. Comp. Strength before (kPa):	>600
Est. Unc. Comp. Strength after (kPa):	190

Shrink Test — AS 1289.7.1.1

Shrink on drying (%):	2.8
Shrinkage Moisture Content (%):	19.9
Est. inert material (%):	5%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Major

Shrink Swell



Shrink Swell Index - Iss (%): 2.3

Comments

QUALTEST Laboratory (NSW) Pty Ltd (20708)
2 Murray Dwyer Circuit, Mayfield West, NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: SSI:NEW21W-2348-S05
Issue No: 1

Shrink Swell Index Report

Client: Thornton Brentwood Pty Limited
28 Bolton Street
Newcastle NSW 2300

Project No.: NEW19P-0018H
Project Name: Proposed Subdivision, Thornton Brentwood - Stage 3.1

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.

Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 18/06/2021

Sample Details

Sample ID:	NEW21W-2348-S05		
Sampling Method:	The results outlined below apply to the sample as received		
Material:	CLAY	**Date Sampled:**	25/05/2021
Source:	On-Site Insitu	**Date Submitted:**	26/05/2021
Specification:	No Specification		
Project Location:	Raymond Terrace Road, Thornton		
Sample Location:	TP505 - (0.4 - 0.53m)		
Date Tested:	10/06/2021		

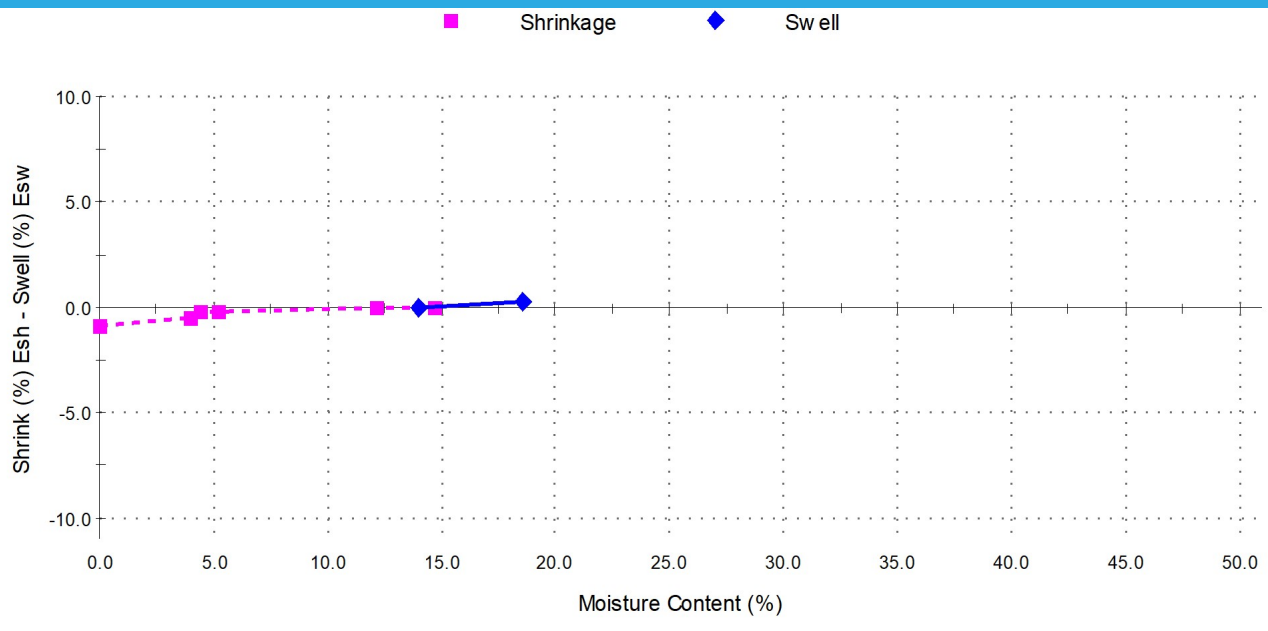
Swell Test — AS 1289.7.1.1

Swell on Saturation (%):	0.2
Moisture Content before (%):	14.0
Moisture Content after (%):	18.6
Est. Unc. Comp. Strength before (kPa):	>600
Est. Unc. Comp. Strength after (kPa):	>600

Shrink Test — AS 1289.7.1.1

Shrink on drying (%):	0.9
Shrinkage Moisture Content (%):	14.7
Est. inert material (%):	1%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Moderate

Shrink Swell



Shrink Swell Index - Iss (%): 0.6

Comments

QUALTEST Laboratory (NSW) Pty Ltd (20708)
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ABN: 98 153 268 896

Shrink Swell Index Report

Report No: SSI:NEW21W-2348-S06
Issue No: 2
This report replaces all previous issues of report no 'SSI:NEW21W-2348-S06'.

Client: Thornton Brentwood Pty Limited
28 Bolton Street
Newcastle NSW 2300

Project No.: NEW19P-0018H
Project Name: Proposed Subdivision, Thornton Brentwood - Stage 3.1

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.

Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 29/07/2021

Sample Details

Sample ID: NEW21W-2348-S06
Sampling Method: The results outlined below apply to the sample as received
Material: CLAY
Source: On-Site Insitu
Specification: No Specification
Project Location: Raymond Terrace Road, Thornton
Sample Location: TP506 - (0.5 - 0.65m)
Date Tested: 10/06/2021
Date Sampled: 25/05/2021
Date Submitted: 26/05/2021

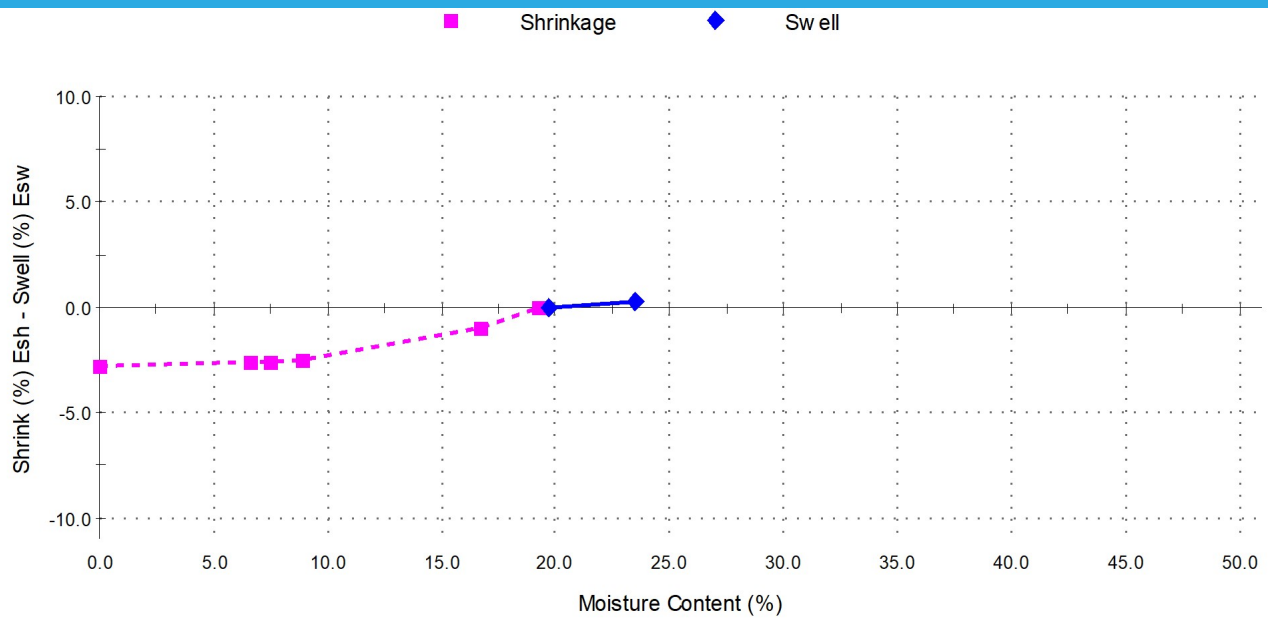
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	0.3
Moisture Content before (%):	19.7
Moisture Content after (%):	23.5
Est. Unc. Comp. Strength before (kPa):	490
Est. Unc. Comp. Strength after (kPa):	360

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	2.8
Shrinkage Moisture Content (%):	19.3
Est. inert material (%):	1%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Moderate

Shrink Swell



Shrink Swell Index - Iss (%): 1.6

Comments

Report re-issued due to amendment of Sample test depth

QUALTEST Laboratory (NSW) Pty Ltd (20708)
2 Murray Dwyer Circuit, Mayfield West, NSW 2304
T: 02 4968 4468
F: 02 4960 9775
E: admin@qualtest.com.au
W: www.qualtest.com.au
ABN: 98 153 268 896

Report No: SSI:NEW21W-2348-S07
Issue No: 1

Shrink Swell Index Report

Client: Thornton Brentwood Pty Limited
28 Bolton Street
Newcastle NSW 2300

Project No.: NEW19P-0018H
Project Name: Proposed Subdivision, Thornton Brentwood - Stage 3.1

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.

Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 22/06/2021

Sample Details

Sample ID: NEW21W-2348-S07
Sampling Method: The results outlined below apply to the sample as received
Material: CLAY
Source: On-Site Insitu
Specification: No Specification
Project Location: Raymond Terrace Road, Thornton
Sample Location: TP507 - (0.5 - 0.9m)
Date Tested: 10/06/2021
Date Sampled: 25/05/2021
Date Submitted: 26/05/2021

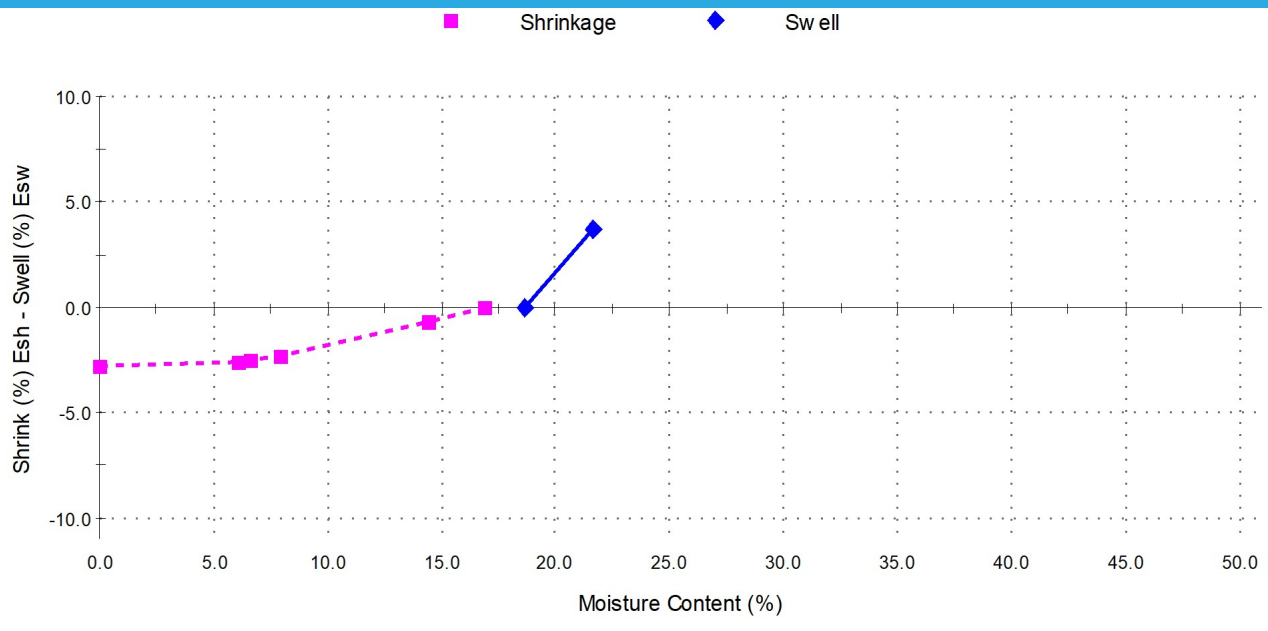
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	3.7
Moisture Content before (%):	18.6
Moisture Content after (%):	21.6
Est. Unc. Comp. Strength before (kPa):	>600
Est. Unc. Comp. Strength after (kPa):	310

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	2.8
Shrinkage Moisture Content (%):	16.9
Est. inert material (%):	3%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Major

Shrink Swell



Shrink Swell Index - Iss (%): 2.6

Comments

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Report No: SSI:NEW21W-2348-S08
Issue No: 2
This report replaces all previous issues of report no 'SSI:NEW21W-2348-S08'.

Shrink Swell Index Report

Client: Thornton Brentwood Pty Limited
28 Bolton Street
Newcastle NSW 2300

Project No.: NEW19P-0018H
Project Name: Proposed Subdivision, Thornton Brentwood - Stage 3.1

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.

Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 1/07/2021

Sample Details

Sample ID: NEW21W-2348-S08
Sampling Method: The results outlined below apply to the sample as received
Material: CLAY
Source: On-Site Insitu
Specification: No Specification
Project Location: Raymond Terrace Road, Thornton
Sample Location: TP508 - (0.0 - 0.2m)
Date Tested: 10/06/2021
Date Sampled: 25/05/2021
Date Submitted: 26/05/2021

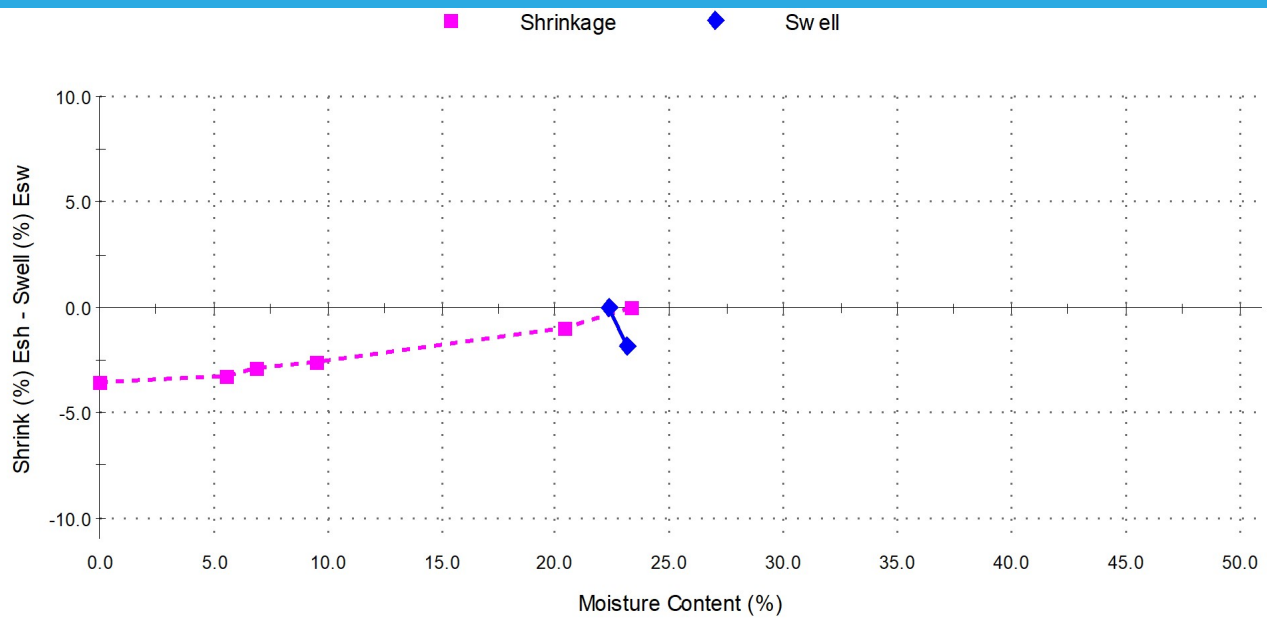
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	-1.8
Moisture Content before (%):	22.4
Moisture Content after (%):	23.2
Est. Unc. Comp. Strength before (kPa):	210
Est. Unc. Comp. Strength after (kPa):	150

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	3.6
Shrinkage Moisture Content (%):	23.3
Est. inert material (%):	5%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Minor

Shrink Swell



Shrink Swell Index - Iss (%): 2.0

Comments

Report re-issued due to amendment of test location

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Report No: SSI:NEW21W-2348-S09
Issue No: 1

Shrink Swell Index Report

Client: Thornton Brentwood Pty Limited
28 Bolton Street
Newcastle NSW 2300

Project No.: NEW19P-0018H
Project Name: Proposed Subdivision, Thornton Brentwood - Stage 3.1

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.

Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 22/06/2021

Sample Details

Sample ID: NEW21W-2348-S09
Sampling Method: The results outlined below apply to the sample as received
Material: CLAY
Source: On-Site Insitu
Specification: No Specification
Project Location: Raymond Terrace Road, Thornton
Sample Location: TP508 - (0.5 - 0.8m)
Date Tested: 10/06/2021
Date Sampled: 25/05/2021
Date Submitted: 26/05/2021

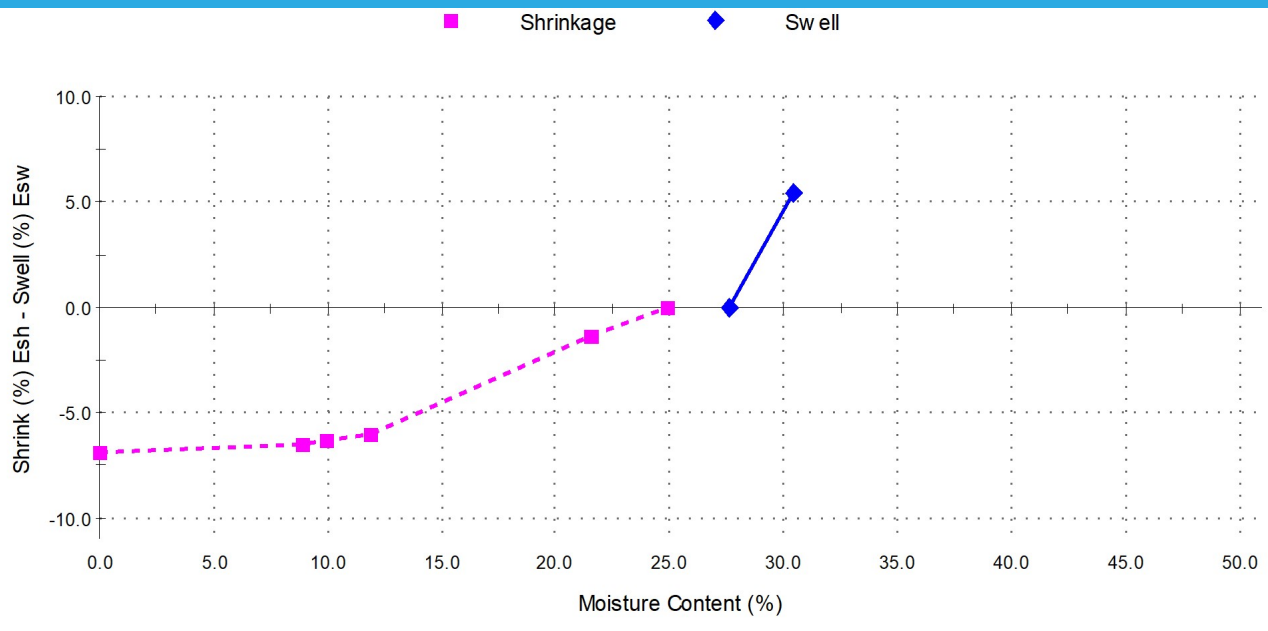
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	5.4
Moisture Content before (%):	27.6
Moisture Content after (%):	30.4
Est. Unc. Comp. Strength before (kPa):	250
Est. Unc. Comp. Strength after (kPa):	150

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	6.9
Shrinkage Moisture Content (%):	24.9
Est. inert material (%):	1%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Nil

Shrink Swell



Shrink Swell Index - Iss (%): 5.3

Comments

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Report No: SSI:NEW21W-2348-S10
Issue No: 1

Shrink Swell Index Report

Client: Thornton Brentwood Pty Limited
28 Bolton Street
Newcastle NSW 2300

Project No.: NEW19P-0018H
Project Name: Proposed Subdivision, Thornton Brentwood - Stage 3.1

Accredited for compliance with ISO/IEC 17025-Testing.
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Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 22/06/2021

Sample Details

Sample ID: NEW21W-2348-S10
Sampling Method: The results outlined below apply to the sample as received
Material: CLAY
Source: On-Site Insitu
Specification: No Specification
Project Location: Raymond Terrace Road, Thornton
Sample Location: TP509 - (1.0 - 1.15m)
Date Tested: 10/06/2021
Date Sampled: 25/05/2021
Date Submitted: 26/05/2021

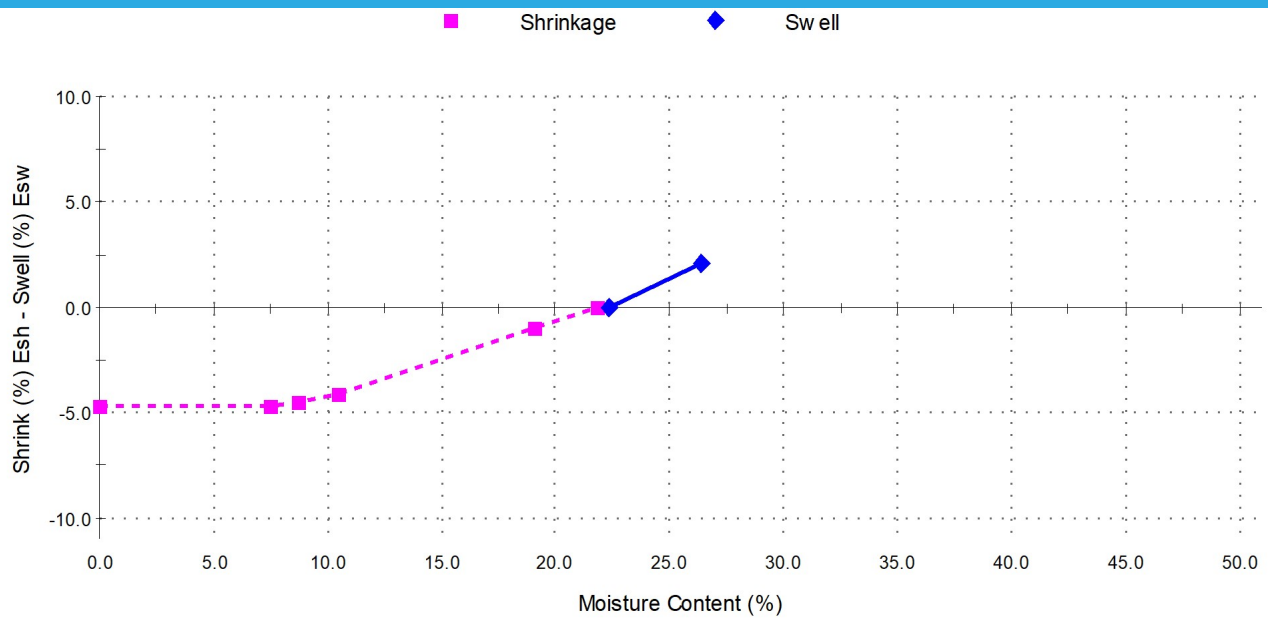
Swell Test — AS 1289.7.1.1

Swell on Saturation (%):	2.1
Moisture Content before (%):	22.3
Moisture Content after (%):	26.3
Est. Unc. Comp. Strength before (kPa):	280
Est. Unc. Comp. Strength after (kPa):	150

Shrink Test — AS 1289.7.1.1

Shrink on drying (%):	4.7
Shrinkage Moisture Content (%):	21.8
Est. inert material (%):	1%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Nil

Shrink Swell



Shrink Swell Index - Iss (%): 3.2

Comments

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Report No: SSI:NEW21W-2348-S11
Issue No: 1

Shrink Swell Index Report

Client: Thornton Brentwood Pty Limited
28 Bolton Street
Newcastle NSW 2300

Project No.: NEW19P-0018H
Project Name: Proposed Subdivision, Thornton Brentwood - Stage 3.1

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Results provided relate only to the items tested or sampled.

Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 18/06/2021

Sample Details

Sample ID: NEW21W-2348-S11
Sampling Method: The results outlined below apply to the sample as received
Material: CLAY
Source: On-Site Insitu
Specification: No Specification
Project Location: Raymond Terrace Road, Thornton
Sample Location: TP510 - (0.1 - 0.24m)
Date Tested: 10/06/2021
Date Sampled: 25/05/2021
Date Submitted: 26/05/2021

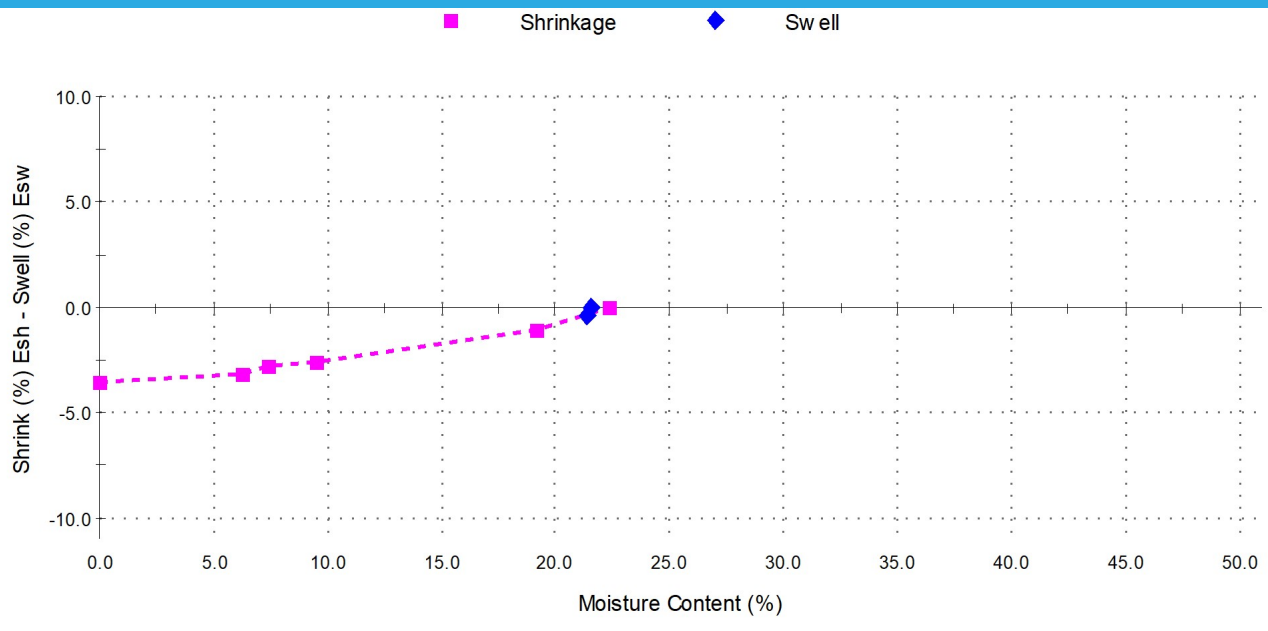
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	-0.4
Moisture Content before (%):	21.6
Moisture Content after (%):	21.4
Est. Unc. Comp. Strength before (kPa):	190
Est. Unc. Comp. Strength after (kPa):	230

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	3.6
Shrinkage Moisture Content (%):	22.4
Est. inert material (%):	5%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Moderate

Shrink Swell



Shrink Swell Index - Iss (%): 2.0

Comments

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Report No: SSI:NEW21W-2348-S12
Issue No: 1

Shrink Swell Index Report

Client: Thornton Brentwood Pty Limited
28 Bolton Street
Newcastle NSW 2300

Project No.: NEW19P-0018H
Project Name: Proposed Subdivision, Thornton Brentwood - Stage 3.1

Accredited for compliance with ISO/IEC 17025-Testing.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Results provided relate only to the items tested or sampled.

Approved Signatory: Brent Cullen
(Senior Geotechnician)
NATA Accredited Laboratory Number: 18686
Date of Issue: 22/06/2021

Sample Details

Sample ID: NEW21W-2348-S12
Sampling Method: The results outlined below apply to the sample as received
Material: CLAY
Source: On-Site Insitu
Specification: No Specification
Project Location: Raymond Terrace Road, Thornton
Sample Location: TP510 - (0.7 - 0.9m)
Date Tested: 10/06/2021
Date Sampled: 25/05/2021
Date Submitted: 26/05/2021

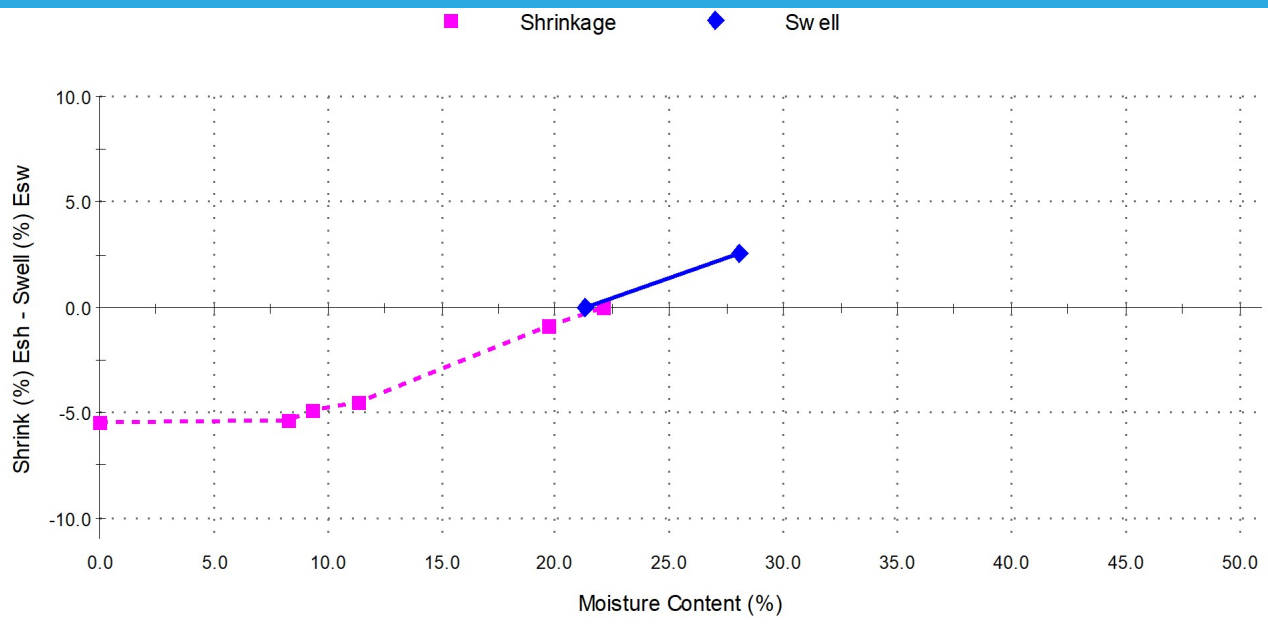
Swell Test AS 1289.7.1.1

Swell on Saturation (%):	2.5
Moisture Content before (%):	21.3
Moisture Content after (%):	28.1
Est. Unc. Comp. Strength before (kPa):	290
Est. Unc. Comp. Strength after (kPa):	130

Shrink Test AS 1289.7.1.1

Shrink on drying (%):	5.5
Shrinkage Moisture Content (%):	22.1
Est. inert material (%):	5%
Crumbling during shrinkage:	Nil
Cracking during shrinkage:	Nil

Shrink Swell



Shrink Swell Index - Iss (%): 3.7

Comments

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.

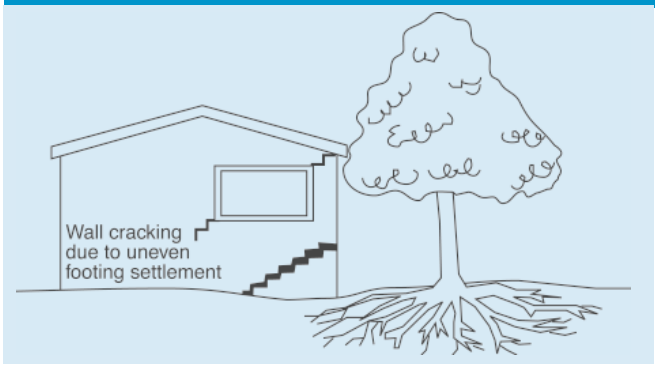
Seasonal swelling/shrinkage in clay

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.

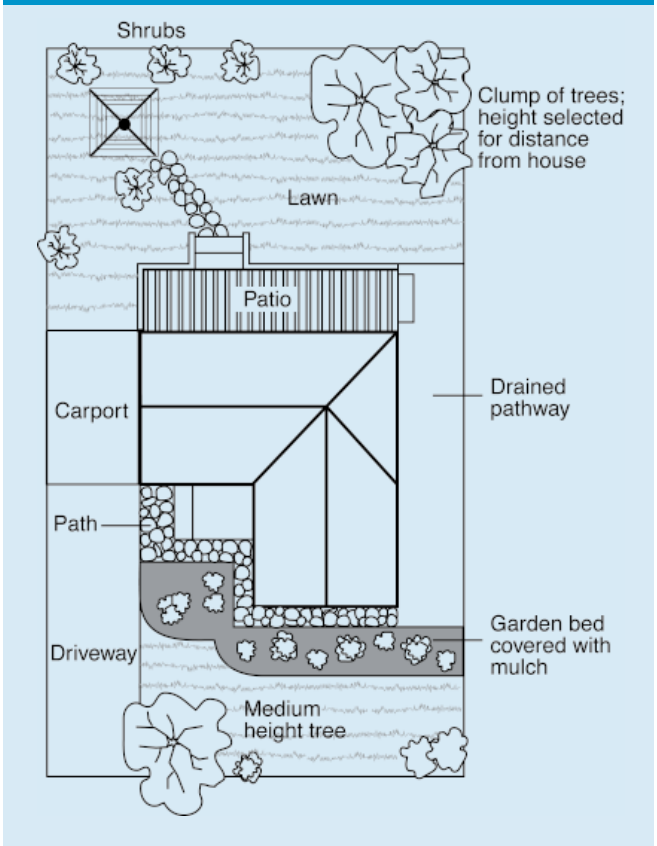
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

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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