Residential Subdivision The Gardens - Stage 1 Site Classification

Medowie Road, Medowie

NEW19P-0143-AC 1 July 2020



GEOTECHNICAL I LABORATORY I EARTHWORKS I QUARRY I CONSTRUCTION MATERIAL TESTING

1 July 2020

McCloy Project Management Pty Ltd Suite 2, Ground Floor, 317 Hunter Street NEWCASTLE NSW 2300

Attention: Mr Rylan Gibson

Dear Sir,

RE: RESIDENTIAL SUBDIVISION – THE GARDENS – STAGE 1 MEDOWIE ROAD, MEDOWIE SITE CLASSIFICATION (LOTS 101 TO 124)

Please find enclosed our geotechnical report for Stage 1 of "The Gardens" residential subdivision, located at Nos. 688 to 730 Medowie Road, Medowie.

The report provides site classification with respect to reactive soils, in accordance with the requirements of AS2870-2011 '*Residential Slabs and Footings*', for Stage 1 (Lots 101 to 124), following completion of site regrade works.

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

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

Jason Lee Principal Geotechnical Engineer

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- Figure AC1: Site Plan and Approximate Test Locations
- Appendix A: Engineering Logs of Test Pits
- Appendix B: Results of Laboratory Testing
- Appendix C: CSIRO Sheet BTF 18 Foundation Maintenance and Footing Performance

1.0 Introduction

Qualtest Laboratory NSW Pty Ltd (Qualtest) is pleased to present this geotechnical report on behalf of McCloy Development Management Pty Ltd (McCloy), for Stage 1 of 'The Gardens' residential subdivision, located at Nos. 688 to 730 Medowie Road, Medowie.

Based on the brief and drawing provided by the client, Stage 1 is understood to include 24 residential allotments (Lots 101 to 124).

The scope of work for the geotechnical investigation included providing site classification with respect to reactive soils, in accordance with the requirements of AS2870-2011 'Residential Slabs and Footings', for Stage 1 following completion of site regrade works which included controlled filling of Lots 101 to 107.

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

2.0 Desktop Study

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

- Geotechnical Assessment, 'Proposed Residential Subdivision, Medowie Gardens, 688 to 730 Medowie Road, Medowie, (Report Reference: NEW19P-00143-AA, dated 27 November 2019); and,
- Level 1 Site Re-grade Assessment Report, 'The Gardens Subdivision Stage 1, Medowie Road, Medowie, (Qualtest Report Reference: NEW20P-0022-AA, dated 29 June 2020).

This report includes a summary of selected results from the previous reports where applicable.

3.0 Field Work

Field work investigations were carried out on 25 May 2020, comprising of:

- Excavation of 14 test pits (TP101 to TP114) using a 2.7 tonne excavator with a 0.45m wide toothed bucket, to depths of between 1.60m and 2.00m;
- Undisturbed samples (U50 tubes) were taken for subsequent laboratory testing; and,
- 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.

Approximate test pit locations are shown on the attached Figure AC1. Engineering logs of the test pits are presented in Appendix A.

4.0 Site Description

4.1 Site Regrade Works

Site re-grading works were conducted between 20 February 2020 and 5 June 2020. Re-grade works included filling within Lots 101 to 107, along with cut / fill works performed for the foundation of a proposed retaining wall, located along the full length of Lot 101 to 103 adjacent to Medowie Road.

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

Filling was performed using site stockpiled material won from excavations cut from around the site. The fill material could generally be described as mixtures of residual (CI-CH) Sandy CLAY, medium to high plasticity, brown / red in colour, with fine to coarse grained sand and gravel.

The approximate depth of fill placed ranged in the order of 0.1m to about 1.5m, with the deepest areas adjacent to the retaining wall along the front of Lots 101 to 103. 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.

As the geotechnical testing authority engaged for the project, Qualtest state that the filling performed for the re-grade areas within Stage 1, (i.e. the filling of lots 101 to 107), 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". Refer to site regrade letter referenced in Section 2.0 for further details.

At the time of the field investigations on 25 May 2020, regrade works had been mostly completed; however, a further 300mm of controlled fill was placed in some areas of Lots 101 to 107 as part of the controlled earthworks observed by Qualtest as described above. Some fill stockpiles (mostly topsoil) were still present on a number of lots. It is understood and expected that the remaining stockpiles will be removed prior to development on the lots.

The recommendations of this report are based on the understanding that any existing lot re-grade works are limited to the controlled earthworks works supervised by Qualtest, and placement of low reactivity topsoil material such that total topsoil depths do not exceed 0.4m. Qualtest should be informed without delay if additional earthworks are known to have been carried out.

4.2 Surface Conditions

The site is located east of Medowie Road, Medowie. The site comprises Stage 1 of the Medowie Gardens residential subdivision at 688 to 730 Medowie Rd, Medowie. The site comprises 24 proposed residential allotments and associated pavements, covering a total area of approximately 2.3ha. The site of the proposed development is shown on Figure AC1.

The lots are bounded to the north, east, and south by future stages of the Medowie Gardens residential subdivision currently comprising rural residential lots including sections of bushland, and to the west by Medowie Road.

Natural surface slopes are typically in the order of about 2° to 4° towards the west and northwest, with some locally steeper slopes on the edges of minor fill mounds. Filling has been carried out in the southwest corner of Stage 1 (Lots 101 to 107).

At the time of inspection, the site had been cleared of trees and grass coverage was only observed to be present in Lots 115 to 117, and 124.

On the day of the investigation, stormwater systems had been installed, and the site was judged to be reasonably well drained.

Site access was from Medowie Road, with trafficability judged to be good by way of 4WD.

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



Photograph 1: From northern boundary of Lot 102, facing east.



Photograph 3: From southern boundary of Lot 104, facing northeast.



Photograph 2: From northern boundary of Lot 102, facing south.



Photograph 4: From southern boundary of Lot 104, facing east.



Photograph 5: From near southern boundary of Lot 110, facing northwest.



Photograph 6: From near southern boundary of Lot 110, facing north.



Photograph 7: From near southern boundary of Lot 113, facing north.



Photograph 9: From near northern boundary of Photograph 10: From near northern boundary Lot 118, facing south.



Photograph 8: From near southern boundary of Lot 113, facing northeast.



of Lot 118, facing southwest.



Photograph 11: From near south-western boundary Lot 119, facing northeast.



Photograph 13: From near south-western boundary Lot 119, facing southwest.



Photograph 12: From near south-western boundary Lot 119, facing east.



Photograph 14: From near south-western boundary Lot 119, facing west.



Photograph 15: From near south-eastern corner of Lot 121, facing east.



Photograph 17: From near south-eastern corner of Lot 121, facing west.



Photograph 19: From near south-western corner of Lot 124, facing east.



Photograph 16: From near south-eastern corner of Lot 121, facing south.



Photograph 18: From near south-eastern corner of Lot 121, facing northwest.



Photograph 20: From near south-western corner of Lot 124, facing southeast.

4.3 Subsurface Conditions

Reference to the 1:100,000 Newcastle Coalfield Regional Geology Sheet 9231 indicates the site to be underlain by the Permian Aged Tomago Coal Measures, which are characterised by Siltstone, Sandstone, Coal, Tuff and Claystone rock types.

Table 1 presents a summary of the typical soil types encountered on site during the field investigations, divided into representative geotechnical units.

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

Unit	Soil Type	Description					
1A	UNCONTROLLED FILL	Not Encountered in current investigation.					
18	CONTROLLED FILL	CLAY / Sandy CLAY – medium to high plasticity, red-brown, brown, fine to medium/coarse grained sand. Trace fine to medium grained angular gravel in some locations. Gravelly Sandy CLAY - low to medium plasticity, brown, fine to coarse grained (mostly fine to medium grained) sand, fine to medium grained angular gravel.					
2	TOPSOILSandy CLAY – low plasticity, grey-brown, fine grained sand, affected.						
3	COLLUVIUM Sandy CLAY / CLAY – medium plasticity, pale brown, fine grained sand.						
4	RESIDUAL SOIL	CLAY / Sandy CLAY – medium to high plasticity, mixtures of red- brown, orange-brown and pale grey to grey, with some fine to medium grained (mostly fine grained) sand. Trace fine grained angular gravel and relict rock structure with depth in some locations.					
		Gravelly CLAY – medium to high plasticity, pale brown and red- brown with some pale grey, fine to medium grained (mostly fine grained) angular gravel, with some relict rock structure.					
5	EXTREMELY WEATHERED (XW) ROCK with soil properties	Siltstone, Sandstone; breaks down into CLAY – medium to high plasticity, pale orange-brown and red-brown / pale brown with some pale grey to white, trace fine grained angular gravel.					

TABLE 1 – SUMMARY OF GEOTECHNICAL UNITS AND SOIL TYPES

Location	Unit 1A Uncontrolled Fill	Unit 1B Controlled Fill	Unit 2 Topsoil	Unit 3 Colluvium	Unit 4 Residual Soil	Unit 5 XW Rock							
	Depth in metres												
	T	Cur	rent Investiga	tion	I								
TP101	-	0.00 - 1.70	-	-	1.70 - 2.00	-							
TP102	-	0.00 - 0.70	-	0.70 - 0.90	0.90 - 2.00	-							
TP103	-	-	-	0.00 - 0.40	0.40 - 1.60	-							
TP104	-	0.00 - 0.60	-	-	0.60 - 2.00	-							
TP105	-	-	0.00 - 0.35	0.35 - 0.60	0.60 - 2.00	-							
TP106	-	-	0.00 - 0.40	0.40 - 0.80	0.80 - 1.90	1.90 - 2.00							
TP107	-	-	0.00 - 0.30	0.30 - 0.70	0.70 - 2.00	-							
TP108	-	-	0.00 - 0.40	0.40 - 0.80	0.80 - 1.50	1.50 - 2.00							
TP109	-	-	0.00 - 0.30	0.30 - 0.80	0.80 - 1.40	1.40 - 2.00							
TP110	-	-	0.00 - 0.25	0.25 - 0.80	0.80 - 1.80	1.80 - 2.00							
TP111	-	-	0.00 - 0.20	0.20 - 0.50	0.50 - 2.00	-							
TP112	-	-	0.00 - 0.20	0.20 - 0.60	0.60 - 2.00	-							
TP113	-	-	0.00 - 0.25	-	0.25 - 2.00	-							
TP114	-	-	0.00 - 0.30	-	0.30 - 2.00	-							
	Previous Inve	stigation (NEW	/19P-0143-AA,	dated 27 Nov	ember, 2019)								
TP14	-	-	0.00 - 0.15	0.15 - 0.30	0.30 - 2.00	-							
TP15	-	-	0.00 - 0.20	0.20 - 0.50	0.50 - 2.00	-							
TP16	-	-	0.00 - 0.25	0.25 - 0.70	0.70 - 2.00	-							
TP17	-	-	0.00 - 0.20	0.20 - 0.70	0.70 - 2.00	-							
TP23	0.00 - 0.25	-	0.25 - 0.60	0.60 - 0.80	0.80 - 2.00	-							

No groundwater was 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.

5.0 Laboratory Testing

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

- (11 no.) Shrink / Swell tests; and,
- (3 no.) Atterberg Limits tests.

Results of the laboratory testing are included in Appendix B, with a summary of the Shrink/Swell test and Atterberg Limits test results presented in Table 3 and Table 4, respectively.

Location	Depth (m)	Material Description	I _{ss} (%)
TP101	0.70 - 0.80	FILL: (CH) Sandy CLAY	1.0
TP102	0.05 - 0.20	FILL: (CH) CLAY	1.8
TP103	0.20 - 0.35	(CH) CLAY	1.7
TP104	1.10 - 1.35	(CH) CLAY	2.4
TP106	1.10 - 1.25	(CI) Sandy CLAY	1.9
TP108	0.50 - 0.75	(CI) Sandy CLAY	1.7
TP109	0.80 - 1.00	(CH) CLAY	2.0
TP110	0.90 - 1.05	(CH) CLAY	1.9
TP111	0.30 - 0.50	(CI) Sandy CLAY	1.4
TP112	0.70 - 1.00	(CH) CLAY	2.2
TP113	0.80 - 1.00	(CH) CLAY	2.1
F	Previous Investigo	tion (NEW19P-0143-AA, dated 27 November 20)19)
TP14	1.10 - 1.30	(CH) CLAY	1.9
TP15	0.60 - 0.80	(CH) CLAY	2.2
TP16	0.50 - 0.70	(CL) CLAY	1.1
TP17	0.80 - 1.00	(CH) CLAY	1.4
TP23	0.80 - 1.15	(CH) CLAY	2.3

TABLE 3 -	SUMMARY	OF SHRINK	/ SWELL	TESTING RESULTS
	••••••		,	

TABLE 4 – SUMMARY OF ATTERBERG LIMITS TESTING RESULTS

Location	Sample Depth (m)	Material Description	Liquid Limit (%)	Plastic limit (%)	Plasticity Index (%)	Linear Shrinkage (%)
TP104	0.05 - 0.15	FILL: (CH) CLAY	59	23	36	15.0
TP105	0.40 - 0.55	(CI) Sandy CLAY	45	22	23	12.0
TP114	0.40 - 0.50	(CH) CLAY	47	20	27	11.0

6.0 Site Classification to AS2870-2011

Based on the results of the field work and laboratory testing, residential lots located within Stage 1 of The Gardens residential subdivision located at 688 to 730 Medowie Road, Medowie, as shown on Figure AC1, are classified in their current condition in accordance with AS2870-2011 'Residential Slabs and Footings', as shown in Table 5.

Stage	Lot Numbers	Site Classification
1	101 to 107	H1
I	108 to 124	м

TABLE 5 – SITE CLASSIFICATION TO AS2870-2011

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

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

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.

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 natural 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*, *H*1, *H*2 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 regardless of their site classification should be supported on footings founded beneath all uncontrolled fill, layers of inadequate bearing capacity, soft/loose, or other potentially deleterious material.

If any 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.

7.0 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 Shannon Kelly or the undersigned.

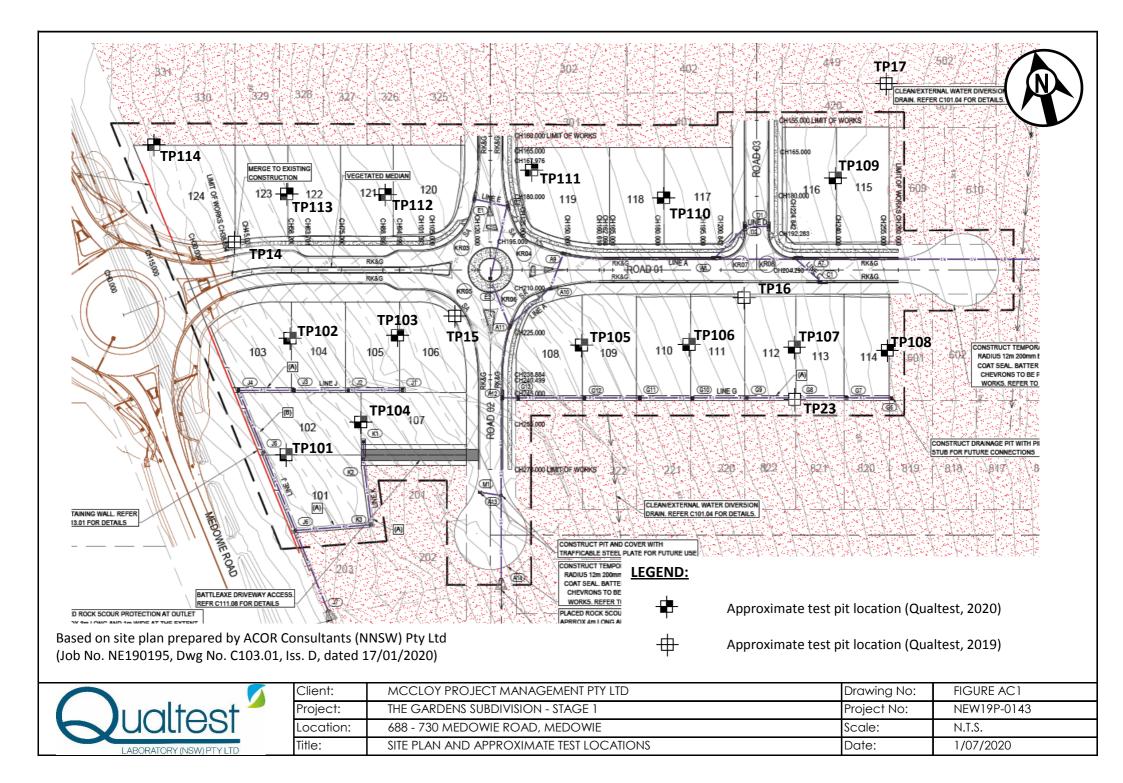
For and on behalf of Qualtest Laboratory (NSW) Pty Ltd.

Eden Len

Jason Lee Principal Geotechnical Engineer

FIGURE AC1:

Site Plan and Approximate Test Locations



APPENDIX A:

Engineering Logs of Test Pits



CLIENT:MCCLOY PROJECT MANAGEMENT PTY LTDPROJECT:THE GARDENS SUBDIVISION - STAGE 1LOCATION:No. 688 - 730 MEDOWIE ROAD, MEDOWIE

TEST PIT NO:

PAGE:

DATE:

JOB NO:

LOGGED BY:

TP101

1 OF 1 NEW19P-0143

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		T LENGTH:		2.0 m	VV	DTH:		DATUM:	F	HD		ا. _ד ړ	
	Drill	ing and Samp	ling			7	Material description and profile infor	nation			Fiel	d Test	
MEIHOU	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, characteristics,colour,minor co	plasticity/particle nponents	MOISTURE	CONSISTENCY DENSITY	Test Type	Result	Structure and additiona observations
		0.05m U50				СН	FILL: CLAY - medium to high plast with some fine to medium grained fine to medium grained angular gra	sand, with some	M ~ W		HP	>600	FILL - CONTROLLED
		<u>0.15m</u> , 0.70m		- - 0.5_ -		CL	0.15m FILL: Gravelly Sandy CLAY - low to plasticity, brown, fine to coarse gra to medium grained) sand, fine to mangular gravel. 0.60m FILL: Sandy CLAY - medium to hig and red-brown, fine to coarse grain medium grained) sand.	ned (mostly fine edium grained			HP	>600	
ш	Not Encountered	U50 <u>0.80m</u>		- 1. <u>0</u> - -		СН				VSt - H	HP	>600	
				- 1. <u>5</u> - -		СН	1.70m CLAY - medium to high plasticity, r some fine to medium grained sand		- W	VSt	HP		RESIDUAL SOIL
				2.0			2.00m Hole Terminated at 2.00 m						
				-									
	Wat (Dat Wat Wat	er Level te and time sho er Inflow er Outflow anges	wn)	Notes, Sar U₅₀ CBR E ASS B	50mm Bulk s Enviro (Glass Acid S	Diame ample f nmenta jar, sea ulfate S c bag, a	ter tube sample for CBR testing al sample aled and chilled on site) Soil Sample air expelled, chilled)	S S F F St S VSt V H F	ency /ery Soft Firm Stiff /ery Stiff Hard Friable		<2	 <u>CS (kPa)</u> 25 5 - 50 0 - 100 00 - 200 00 - 200 00 - 400 400	Moisture Condition D Dry M Moist W Wet W _p Plastic Limit W _L Liquid Limit
	Gi tra De	radational or ansitional strata efinitive or distic rata change		Field Test PID DCP(x-y) HP	<u>s</u> Photoi Dynan	onisatio	on detector reading (ppm) etrometer test (test depth interval shown) meter test (UCS kPa)	Density	V L ME D	Lo D M	ery Lo bose lediun ense	oose n Dense	Density Index <15% Density Index 15 - 35% Density Index 35 - 65% Density Index 65 - 85%



CLIENT: MCCLOY PROJECT MANAGEMENT PTY LTD **PROJECT:** THE GARDENS SUBDIVISION - STAGE 1 LOCATION: No. 688 - 730 MEDOWIE ROAD, MEDOWIE

TEST PIT NO:

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TP102

1 OF 1 NEW19P-0143

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		IENT TYPE		2.7 TC 2.0 m		EXCA'		SURFACE RL: DATUM:	Δ	HD			
		ling and Samp					Material description and profile inform	ation			Fiel	d Test	
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, p characteristics,colour,minor com	plasticity/particle	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
		0.05m U50 0.20m		- - - 0. <u>5</u> -		СН	FILL: CLAY - medium to high plastic orange-brown, with some fine to coa sand, with some fine to medium grai gravel.	rse grained ned angular	_	VSt - H	HP	>600 >600	FILL - CONTROLLED
	Not Encountered			- 1. <u>0</u> - - 1. <u>5</u> - - - -		СІ	grained sand. 0.90m CLAY - medium to high plasticity, red some fine grained sand.	d-brown, with	M ~ Wp	VSt	HP	300 380 370	RESIDUAL SOIL
	 (Da 4 Wat <u>ata Ch</u> G	ter Level te and time sho ter Inflow ter Outflow	own) <u> </u>	2.0 	50mm Bulk s Enviro (Glass Acid S (Plasti Bulk S s Photoi	Diamel ample fo nmenta jar, sea culfate S c bag, a c bag, a c bag, a	Be the sample of CBR testing sample sample sample sample ir expelled, chilled)	S S F F St S VSt V H F	ncy /ery Soft Soft /ery Stiff łard /riable V L M	Ve	22 25 50 20 20 20 20 20 20 20 20 20 20 20 20 20	5 - 50 0 - 100 00 - 200 00 - 400 400	D Dry M Moist W Wet Wp Plastic Limit WL Liquid Limit Density Index <15% Density Index 15 - 35%



CLIENT:MCCLOY PROJECT MANAGEMENT PTY LTDPROJECT:THE GARDENS SUBDIVISION - STAGE 1LOCATION:No. 688 - 730 MEDOWIE ROAD, MEDOWIE

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TP103

1 OF 1 NEW19P-0143

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		MENT TYP IT LENGTI		2.7 TC 2.0 m		EXCA IDTH:		SURFACE RL: DATUM:		\HD			
	Dril	ling and San	npling				Material description and profile information	ation			Fiel	d Test	
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, p characteristics,colour,minor com	lasticity/particle ponents	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
		0.20m U50 0.35m		-		CI	CLAY - medium plasticity, pale brown grained sand.	n, with some fine	M > Wp		HP	330	COLLUVIUM
Ш	Not Encountered			- 0. <u>5</u> -			CLAY - medium plasticity, red-brown grained sand.	, with some fine		VSt	HP	380	RESIDUAL SOIL — — — —
	Not			- 1. <u>0</u> -		CI			M > w _P		HP	350	
e>> 01/01/2020 11:56 10.0.000 Datgel Lab and In Situ 100				- - 1. <u>5</u>			Pale brown and red-brown. 1.60m Hole Terminated at 1.60 m				HP	320	
	. Wa (Da - Wa ■ Wa ■ Ca tr C tr D	ter Level te and time sl ter Inflow ter Outflow anges radational or ansitional stra efinitive or dia rata change	ata	Notes, Sa U ₅₀ CBR E ASS B Field Test PID DCP(x-y) HP	50mm Bulk s Enviro (Glass Acid S (Plast Bulk S Bulk S Photo Dynar	I Diame ample f onmenta s jar, sea Gulfate S ic bag, a Sample ionisatic nic pene	E ter tube sample or CBR testing I sample aled and chilled on site) ioil Sample iir expelled, chilled) on detector reading (ppm) etrometer test (test depth interval shown) meter test (UCS kPa)	S S F F St S VSt N H F	ency Very Soft Soft Firm Stiff Very Stiff Hard Friable V L ME D V V	Vi La D M	22 25 50 20 20 20 20 20 20 20 20 20 20 20 20 20	5 - 50) - 100)0 - 200)0 - 400 00 - 400 pose n Dense	D Dry M Moist W Wet Wp, Plastic Limit WL Liquid Limit Density Index <15%



CLIENT:MCCLOY PROJECT MANAGEMENT PTY LTDPROJECT:THE GARDENS SUBDIVISION - STAGE 1LOCATION:No. 688 - 730 MEDOWIE ROAD, MEDOWIE

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TP104

1 OF 1 NEW19P-0143

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TE		T LENGTH:		2.0 m	W	DTH:	0.5 m	DATUM:	A	HD			
	Drill	ing and Sampl	ing				Material description and profile	information		1	Fiel	d Test	
METHOD	WATER			EPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soi characteristics,colour,mir	type, plasticity/particle or components	MOISTURE	CONSISTENCY DENSITY	Test Type	Result	Structure and additiona observations
		0.05m			***	0	FILL: CLAY - medium to high with some fine to medium gra						FILL - CONTROLLED
		U50 0.15m		0.5		СН	0.60m	ined sand.		VSt - H	HP	500 >600	
ш	Not Encountered					сн	CLAY - medium to high plast to red-brown, with some fine	gràined sand.	- W _P		HP	270	RESIDUAL SOIL
	Not	1.10m U50 1.35m		- - 1. <u>5</u>		СН	some fine grained sand.	city, red-brown, with	Σ	VSt	HP	300	
							2.00m				HP	350	
				_			Hole Terminated at 2.00 m						
				-									
	SEND:	<u> </u>	Not U	tes, Sar			<u>s</u> ter tube sample	Consist VS	ency Very Soft	<u>. </u>		CS (kPa) 25) Moisture Condition D Dry
	Wat (Dat - Wat	er Level te and time show er Inflow er Outflow	CB	R S	Bulk sa Enviro (Glass Acid S	ample f nmenta jar, se ulfate S c bag, a	la cube sample or CBR testing I sample aled and chilled on site) ioil Sample air expelled, chilled)	S F St VSt H	Soft Firm Stiff Very Stiff Hard Friable		25 50 10 20	25 5 - 50 0 - 100 00 - 200 00 - 400 400	M Moist W Wet W _p Plastic Limit W _L Liquid Limit
<u>ətra</u>	tra D	<u>anges</u> radational or ansitional strata efinitive or distic rata change	t DC	<mark>Id Tests</mark> PID P(x-y) IP	<u>s</u> Photoi Dynan	onisatio	n detector reading (ppm) etrometer test (test depth interval show meter test (UCS kPa)	Density		Lo D D	ense	oose n Dense ense	Density Index <15% Density Index 15 - 35% Density Index 35 - 65% Density Index 65 - 85% Density Index 85 - 100%



CLIENT:MCCLOY PROJECT MANAGEMENT PTY LTDPROJECT:THE GARDENS SUBDIVISION - STAGE 1LOCATION:No. 688 - 730 MEDOWIE ROAD, MEDOWIE

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BB

TE	ST P	T LENGTH	4:	2.0 m		IDTH:	VATOR SURF 0.5 m DATU	JM:	A	HD	1		
	Drill	ing and San	npling				Material description and profile information		_		Fiel	d Test	
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticit characteristics,colour,minor componen	y/particle ts	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additiona observations
				-		CL	TOPSOIL: Sandy CLAY - low plasticity, gre fine grained sand, root affected.	y-brown,					TOPSOIL
		0.40m U50 0.55m		0.5		сı	0.35mSandy CLAY - medium plasticity, pale yello fine grained sand.		_		HP	220	
	untered			-			Sandy CLAY - medium plasticity, red-brown some pale orange-brown, fine to medium g (mostly fine grained) sand.	n with grained		VSt	HP	350	RESIDUAL SOIL
ш	Not Encountered			1. <u>0</u> - -		CI			$M \sim W_P$		HP	350	
				- 1. <u>5</u> -		сн	1.40m CLAY - medium to high plasticity, pale orar and red-brown, with some fine to medium g sand, trace fine grained angular, with some rock structure. Pockets of Extremely Weathered Siltstone.	grained e relict	_	Н	HP	500	
				2.0			2.00m Hole Terminated at 2.00 m						
				-									
<u>Wat</u> ▼	Wat (Dat	er Level e and time sh er Inflow er Outflow	nown)	Notes, Sa U ₅₀ CBR E ASS B	50mm Bulk s Enviro (Glass Acid S (Plasti	i Diame ample f onmenta s jar, se Sulfate \$	ts ter tube sample for CBR testing al sample aled and chilled on site) Soil Sample air expelled, chilled)	S S F F St S VSt N H H	ency Very Soft Soft Firm Stiff Very Stiff Hard Friable		<2 2 50 10 20	CS (kPa) 25 5 - 50 0 - 100 00 - 200 00 - 400 400	Moisture Condition D Dry M Moist W Wet W _p Plastic Limit W _L Liquid Limit
	G tra D	radational or ansitional stra efinitive or dis rata change		Field Test PID DCP(x-y) HP	<u>s</u> Photo Dynar	ionisatio nic pen	on detector reading (ppm) etrometer test (test depth interval shown) meter test (UCS kPa)	<u>Density</u>	V L MC D VD	L N D	ery Lo bose lediun ense ery D	n Dense	Density Index <15% Density Index 15 - 35% Density Index 35 - 65% Density Index 65 - 85% Density Index 85 - 100%



CLIENT:MCCLOY PROJECT MANAGEMENT PTY LTDPROJECT:THE GARDENS SUBDIVISION - STAGE 1LOCATION:No. 688 - 730 MEDOWIE ROAD, MEDOWIE

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		MENT TYPE		2.7 TC 2.0 m		EXCA I DTH :		ACE RL:	A	HD			
	Dril	ling and Samp	pling				Material description and profile information				Fiel	d Test	
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity characteristics,colour,minor component		MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
				-		CL	TOPSOIL: Sandy CLAY - low plasticity, gre fine grained sand, root affected.	y-brown,	M M				TOPSOIL
				- 0.5		 CI	0.40m Sandy CLAY - medium plasticity, pale yellor fine grained sand.	 w-brown,	M > w _P	VSt	HP	250	
IL SIU 100	Not Encountered	<u>1.10m</u> U50		- 1.0_ -			<u>0.80m</u> Sandy CLAY - medium plasticity, red-browr orange-brown, fine to medium grained (mos grained) sand.		M < w _p	VSt - Fb	HP	380	RESIDUAL SOIL — — — —
		<u>1.25m</u>		- - 1. <u>5</u> -		CI	With some relict rock structure. Pockets of Extremely Weathered Siltstone.		dw ~	н	HP	500 >600	
0143 LOGS - STAGE 1.6FU << Drawngrille>> U1/0				2.0		сн	1.90m Extremely weathered Siltstone; breaks dow 2.00m CLAY - medium to high plasticity, pale oran and red-brown with some pale grey-white, t grained angular gravel. Hole Terminated at 2.00 m	ge-brown	-			-	EXTREMELY WEATHERED ROCK / RESIDUAL SOIL
	Wat (Da –_ Wat ■ G G D	ter Level te and time sho ter Inflow ter Outflow	own) a	Notes, Sau U ₅₀ CBR E ASS B Field Test PID DCP(x-y) HP	50mm Bulk s Enviro (Glass Acid S (Plasti Bulk S S Photo Dynar	Diame ample f onmenta s jar, se Sulfate S ic bag, a Sample ionisationis ationis and the second nic pende	ts ter tube sample or CBR testing al sample aled and chilled on site) Soil Sample air expelled, chilled) on detector reading (ppm) etrometer test (test depth interval shown) meter test (UCS kPa)	S S F F St S VSt V H F	Incy /ery Soft Soft Firm Stiff /ery Stiff Hard -riable V L ME D V V	V Lu D D	22 25 50 20 20 20 20 20 20 20 20 20 20 20 20 20	5 - 50) - 100)0 - 200)0 - 400 400 pose n Dense	D Dry M Moist W Wet W _p Plastic Limit W _L Liquid Limit Density Index <15%



ENGINEERING LOG - TEST PIT

CLIENT: MCCLOY PROJECT MANAGEMENT PTY LTD **PROJECT:** THE GARDENS SUBDIVISION - STAGE 1 LOCATION: No. 688 - 730 MEDOWIE ROAD, MEDOWIE

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BB

TE	ST PI	T LENGT	4:	2.0 m	w	IDTH:		FACE RL: UM:		HD			
	Drill	ing and San	npling	-		1	Material description and profile information			I	Fiel	d Test	
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plastic characteristics,colour,minor compone	ity/particle nts	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additiona observations
				-		CL	TOPSOIL: Sandy CLAY - low plasticity, gr fine grained sand, root affected.	ey-brown,					TOPSOIL
				- - 0. <u>5</u>			0.30m Sandy CLAY - medium plasticity, pale gre fine grained sand.	 y-brown,	-		HP	220	
ш	Not Encountered			- - - 1.0_			0.70m	inge-brown grained	~ M~	VSt	HP	350	RESIDUAL SOIL
F	Not E			- - 1. <u>5</u>		СН	With some relict rock structure.		W		HP	300	
							Pockets of Extremely Weathered rock.			н			
				2.0			Hole Terminated at 2.00 m						
				-									
<u>Wat</u> ▼	Wat (Dat Wat	er Level le and time si er Inflow er Outflow	nown)	Notes, Sa U ₅₀ CBR E ASS B	50mm Bulk s Enviro (Glass Acid S (Plasti	n Diame ample f onmenta s jar, se Sulfate \$	ter tube sample for CBR testing al sample valed and chilled on site) Soil Sample air expelled, chilled)	S S F F St S VSt N H F	Ancy Very Soft Soft Firm Stiff Very Stiff Hard Friable		<2 2 50 10 20	CS (kPa 25 5 - 50 0 - 100 00 - 200 00 - 400 400	D Dry M Moist W Wet W _p Plastic Limit
<u></u>	Gi tra De	anges radational or ansitional stra efinitive or dis rata change		Field Test PID DCP(x-y) HP	<u>ts</u> Photo Dynar	ionisati nic pen	on detector reading (ppm) etrometer test (test depth interval shown) ometer test (UCS kPa)	<u>Density</u>	V L ME D VD	L N D	ery Lo oose lediun ense	n Dense	Density Index <15% Density Index 15 - 35% Density Index 35 - 65% Density Index 65 - 85% Density Index 85 - 100%



CLIENT:MCCLOY PROJECT MANAGEMENT PTY LTDPROJECT:THE GARDENS SUBDIVISION - STAGE 1LOCATION:No. 688 - 730 MEDOWIE ROAD, MEDOWIE

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		MENT TYPE		2.7 TC 2.0 m		EXCA	VATOR 0.5 m	SURFACE RL: DATUM:		HD			
\square	Dril	ling and Samp	oling				Material description and profile in	ormation			Fiel	d Test	
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil ty characteristics,colour,minor	oe, plasticity/particle components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
				-		CL	TOPSOIL: Sandy CLAY - low pi fine grained sand, root affected		M ~ Wp				TOPSOIL
		0.50m U50 0.75m		0.5		CI	<u>0.40m</u> Sandy CLAY - medium plasticit grained sand.	, pale brown, fine			HP	220	
ш	Not Encountered			- - 1. <u>0</u> -			Sandy CLAY - medium plasticit and red-brown, fine to medium grained) sand.		M > W	VSt	HP	350	RESIDUAL SOIL
				- - 1. <u>5</u>			1.50m Extremely weathered Siltstone I CLAY - medium to high plasticit	reaks down into			HP	380 >600	EXTREMELY WEATHERED ROCK / RESIDUAL SOIL
						СН	and pale brown, with some pale fine grained angular gravel.	grey to white, trace	M < w _p	Н			
				-			2.00m Hole Terminated at 2.00 m						
	Wai (Da Wai	ter Level te and time sho ter Inflow ter Outflow <u>anges</u>	wn)	Notes, Sa U₅ CBR E ASS B	50mm Bulk s Enviro (Glass Acid S (Plasti Bulk S	Diame ample f nmenta jar, se sulfate \$	ts ter tube sample for CBR testing al sample aled and chilled on site) Soil Sample air expelled, chilled)	S F St VSt H Fb	Very Soft Soft Firm Stiff Very Stiff Hard Friable		<2 25 50 10 20 >4	5 - 50 0 - 100 00 - 200 00 - 400 400	D Dry M Moist W Wet W _p Plastic Limit W _L Liquid Limit
	tr D	radational or ansitional strata efinitive or disti trata change	a	Field Test PID DCP(x-y) HP	Photoi Dynan	nic pen	on detector reading (ppm) etrometer test (test depth interval shown) meter test (UCS kPa)	<u>Density</u>	V L D VC	La D M D	ery Lo bose ediun ense ery Do	n Dense	Density Index <15% Density Index 15 - 35% Density Index 35 - 65% Density Index 65 - 85% Density Index 85 - 100%



CLIENT: MCCLOY PROJECT MANAGEMENT PTY LTD **PROJECT:** THE GARDENS SUBDIVISION - STAGE 1 LOCATION: No. 688 - 730 MEDOWIE ROAD, MEDOWIE

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		IENT TYPI		2.7 TC 2.0 m		exca I dth :		RFACE RL: TUM:		HD			
	Dril	ling and Sam	npling				Material description and profile information	า			Fiel	d Test	
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plast characteristics,colour,minor compon		MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
				-		CL	TOPSOIL: Sandy CLAY - low plasticity, grey-brown, fine grained sand, root affect	:ted.	_		_		
		0.80m		- 0.5_ -		СН	fine grained sand.		M > W _P	VSt	HP	350 280	
Lab and In Situ Tool E	Not Encountered	U50 1.00m		- 1. <u>0</u> -		сн	CLAY - medium to high plasticity, pale or and red-brown, with some fine grained s fine grained angular gravel.		M ~ W _P		HP	550	RESIDUAL SOIL
이 내 B 1.1.G.B Log NON-CORED BORHOLE - TEST PIT NEW19P-0143 LOGS - STAGE 1.GPJ < <drawing-he>> 01/07/2020 11:56 10.0000 Dagget Lab and In Situ Too</drawing-he>				- 1. <u>5</u> - - -		сн	1.40m Extremely weathered Siltstone; breaks d CLAY - medium to high plasticity, red-bro some pale grey and pale brown, with so medium grained angular gravel.	own with	M < W _P	Н	HP	>600	EXTREMELY WEATHERED ROCK
				2.0			2.00m Hole Terminated at 2.00 m						
	(Da – Wa ⊲ Wa • <u>ata Ch</u> – G tr	ter Level te and time sh ter Inflow ter Outflow	hown) ita	I Notes, Sa U ₅₀ CBR E ASS B Field Test PID DCP(x-y) HP	50mm Bulk s Enviro (Glass Acid S (Plast Bulk S S Photo Dynar	n Diame sample f ponmenta s jar, se Sulfate S sic bag, a Sample ionisationic pene	Is ter tube sample or CBR testing al sample aled and chilled on site) Soil Sample air expelled, chilled) on detector reading (ppm) etrometer test (test depth interval shown) meter test (UCS kPa)	S S F F St S VSt V H F	/ /ery Soft Soft Firm Stiff /ery Stiff Hard Friable V L ME D VD	Vi La D M	22 25 50 20 20 20 20 20 20 20 20 20 20 20 20 20	5 - 50 0 - 100 00 - 200 00 - 400 400 pose n Dense	D Dry M Moist W Wet Wp, Plastic Limit WL Liquid Limit Density Index <15%



CLIENT:MCCLOY PROJECT MANAGEMENT PTY LTDPROJECT:THE GARDENS SUBDIVISION - STAGE 1LOCATION:No. 688 - 730 MEDOWIE ROAD, MEDOWIE

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BB

		IENT TYP		2.7 TC 2.0 m		EXCA		URFACE RL: ATUM:	A	HD			
	Dril	ling and San	npling				Material description and profile informati	on			Fiel	d Test	
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, pla characteristics,colour,minor compo	sticity/particle nents	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
				-		CL	TOPSOIL: Sandy CLAY - low plasticity brown, fine grained sand, root affected	, dark grey					TOPSOIL
				- 0.5_ -		СІ	<u>0.25m</u> Sandy CLAY - medium plasticity, pale medium grained (mostly fine grained) s		M < W _P	VSt	HP	250 300	COLLUVIUM — — — — — — —
	Not Encountered	0.90m U50 1.05m		- 1.0_ -			O.80m CLAY - medium to high plasticity, pale and red-brown, with some fine to medi sand.	orange-brown um grained	4P		HP	500	RESIDUAL SOIL
				- 1. <u>5</u> -		СН			$M \sim W_P$	Н	HP	>600	
				- 2.0		СН	1.80m Extremely weathered Sandstone; brea CLAY - medium to high plasticity, pale and red-brown, with some fine to medi sand, with some fine grained angular g	orange-brown um grained	M M M M				EXTREMELY WEATHERED ROCK
				-			Hole Terminated at 2.00 m						
	(Da – Wa ∎ Wa Tata Ch	ter Level te and time sl ter Inflow ter Outflow anges	hown)	Notes, Sar U₅ CBR E ASS B Field Test	50mm Bulk s Enviro (Glass Acid S (Plasti Bulk S	Diame ample f nmenta jar, se sulfate S	ts ter tube sample or CBR testing al sample aled and chilled on site) soil Sample air expelled, chilled)	S S F F St S VSt N H F	n cy /ery Soft Soft Firm Stiff /ery Stiff lard Friable V		<2 25 50 10 20	CS (kPa 25 5 - 50 0 - 100 00 - 200 00 - 400 400	D Dry M Moist W Wet W _p Plastic Limit
	tr D	ansitional or ansitional stra efinitive or dis trata change	ata	PID DCP(x-y) HP	Photo Dynar	nic pene	on detector reading (ppm) etrometer test (test depth interval shown) meter test (UCS kPa)		V L D VD	Lo M D	oose	n Dense	Density Index 15 - 35%



QT LIB 1.1.GLB Log NON-CORED BOREHOLE - TEST PT NEW19P-0143 LOGS - STAGE 1.6PJ <cDrawingFile>> 01/07/2020 11:56 10.0000 Datgel Lab and in Situ Tool

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BB

		MENT TYPI		2.7 TC 2.0 m		EXCA		JRFACE RL:	Д	HD			
		ling and San					Material description and profile information				Field	d Test	
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plas characteristics,colour,minor compo	ticity/particle nents	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
				-		CL	TOPSOIL: Sandy CLAY - low plasticity, fine grained sand, root affected.	grey-brown,	$M\sim W_P$				TOPSOIL
		0.30m U50		-		CI	Sandy CLAY - medium plasticity, pale t orange-brown, fine to medium grained grained) sand.	mostly fine		VSt	HP	230	COLLUVIUM
		0.50m		0.5			0.50m				HP	350	RESIDUAL SOIL
ш	Not Encountered			- 1. <u>0</u> - - - 1.5_		СН			M > W _P	VSt	HP	380	
,							Relict rock structure.		$M \sim W_{P}$	Н	HP	>600	
				-			Hole Terminated at 2.00 m						
<u>Wat</u> ▼	Wat (Dat Wat Wat Wat	ter Level te and time sh ter Inflow ter Outflow anges radational or	· · · ·	Notes, Sa U ₅₀ CBR E ASS B Field Test	50mm Bulk s Enviro (Glass Acid s (Plast Bulk s	n Diame sample f onmenta s jar, se Sulfate \$	ter tube sample for CBR testing al sample aled and chilled on site) Soil Sample air expelled, chilled)	S S F F St S VSt V H F	ncy /ery Soft Soft Stiff /ery Stiff lard <u>riable</u> V		<2 25 50 10 20	5 - 50 0 - 100 00 - 200 00 - 400 400	D Dry M Moist W Wet W _p Plastic Limit
	tra D	radational or ansitional stra efinitive or dis rata change		PID DCP(x-y) HP	Photo Dynai	nic pen	on detector reading (ppm) etrometer test (test depth interval shown) meter test (UCS kPa)		L MC D VD	Lo M D	oose	n Dense	Density Index 15 - 35%



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BB

		IENT TYPE T LENGTH		2.7 TO 2.0 m		EXCA IDTH:		FACE RL: UM:		HD			
	Drill	ing and Sam	pling			i	Material description and profile information			1	Fiel	d Test	
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plastic characteristics,colour,minor compone		MOISTURE	CONSISTENCY DENSITY	Test Type	Result	Structure and additiona observations
						CL	TOPSOIL: Sandy CLAY - low plasticiy, gre fine to medium grained (mostly fine graine with some broken ceramic pipe in top 0.1r	d) sand,					TOPSOIL / POSSIBLE FIL
				-			0.20m Sandy CLAY - medium plasticity, red-brov grained sand.	 vn, fine	~ ~		-		
				0.5		СІ			Σ		ΗP	280	
		0.70					0.60m CLAY - medium to high plasticity, pale bro some fine to medium grained (mostly fine	 wm, with grained)		VSt			RESIDUAL SOIL
	pe	0.70m U50					sand.	<u> </u>			HP	350	
ш	Not Encountered	1.00m		- 1. <u>0</u>									
	Not										HP	>600	
				_		СН			$M\sim W_{\rm P}$				
				- 1. <u>5</u>						н	HP	580	
				-			Red-brown and orange-brown with some structure.	relict rock					
				2.0			2.00m						
				-			Hole Terminated at 2.00 m						
				-									
Wate		er Level		<u>Notes, Sar</u> U₅₀ CBR E	50mm Bulk s	i Diame ample f	ts ter tube sample or CBR testing al sample	S S	ency Very Soft Soft Firm		<2 25	<u>CS (kPa</u> 25 5 - 50 0 - 100) <u>Moisture Condition</u> D Dry M Moist W Wet
► _	· Wat Wat	e and time sh er Inflow er Outflow	í í	ASS	(Glass Acid S (Plast	s jar, se Sulfate S ic bag, a	aled and chilled on site) Soil Sample air expelled, chilled)	St St VSt H	Stiff Very Stiff Hard		10 20	0 - 100 00 - 200 00 - 400 400	W _p Plastic Limit
<u>Stra</u>	tra	anges radational or ansitional stra efinitive or dis	ta	B Field Test PID DCP(x-y) HP	<u>s</u> Photo Dynar	nic pen	on detector reading (ppm) etrometer test (test depth interval shown) meter test (UCS kPa)	Fb I Density	Friable V L ME D	Lo D M	ery Lo bose lediun ense	oose n Dense	Density Index <15% Density Index 15 - 35% Density Index 35 - 65% Density Index 65 - 85%



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		MENT TYPE		2.7 TC 2.0 m		EXCA IDTH:		SURFACE RL: DATUM:		HD			
	Dril	ling and Sam	npling				Material description and profile informa	tion			Fiel	d Test	
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, pla characteristics,colour,minor comp		MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
				-		CL	TOPSOIL: Sandy CLAY - low plasticit grey-brown, fine to medium grained (i grained) sand, root affected.		M > W _P				TOPSOIL
						СН	CLAY - medium to high plasticity, red- orange-brown, with some fine to med (mostly fine grained) sand.				HP	420	RESIDUAL SOIL
				-			0.50m CLAY - medium to high plasticity, red- Some fine grained sand.	 brown, with			ΗP	>600	
ш	t Encountered	0.80m U50 1.00m		- 1. <u>0</u>							HP	>600	
	Not			-		СН			M < W _P	н			
,				- 1. <u>5</u> - -							HP	>600	
				2.0			2.00m Hole Terminated at 2.00 m						
LEC Wat				-									
LEG	SEND:			Notes, Sa				Consiste				CS (kPa)	
	Wat (Da Wat	ter Level te and time sh ter Inflow ter Outflow	iown)	U ₅₀ CBR E ASS B	Bulk s Enviro (Glass Acid s (Plast	ample f onmenta s jar, sea Sulfate S	ter tube sample or CBR testing I sample aled and chilled on site) soil Sample air expelled, chilled)	S F St VSt H	Very Soft Soft Firm Stiff Very Stiff Hard Friable		25 50 10 20	25 5 - 50 0 - 100 00 - 200 00 - 400 400	$\begin{array}{llllllllllllllllllllllllllllllllllll$
<u>ətra</u>	G tr D	anges iradational or ansitional stra efinitive or dis irata change		Field Test PID DCP(x-y) HP	<u>:s</u> Photo Dynar	ionisatio	n detector reading (ppm) etrometer test (test depth interval shown) meter test (UCS kPa)	Density	V L ME D VD	La D M D	ery Lo bose lediun ense ery D	n Dense	Density Index <15% Density Index 15 - 35% Density Index 35 - 65% Density Index 65 - 85% Density Index 85 - 100%



ENGINEERING LOG - TEST PIT

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BB

		IENT TYP		2.7 TC 2.0 m		EXCA IDTH:		FACE RL: JM:		HD			
	Drill	ing and San	npling				Material description and profile information				Fiel	d Test	
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticit characteristics,colour,minor componer	ty/particle Its	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
				-		CL	TOSPOIL: Sandy CLAY - low plasticity, dai grey-brown, fine to medium grained (mosti grained) sand, with some fine grained angi sub-angular gravel, trace rootlets and root	y fine ular to	M < Wp				TOPSOIL / POSSIBLE FIL
		0.40m U50 0.50m		0.5			CLAY - medium to high plasticity, red-brow some fine to medium grained (mostly fine o sand.				HP		RESIDUAL SOIL
	Not Encountered			-							HP	490	
ш	Not End			1. <u>0</u> - - - - 1.5		СН			M ~ W	н	HP	500	
							2.00m				HP	>600	
							Hole Terminated at 2.00 m						
				-									
Wat	Wat	er Level		Notes, Sa U ₅₀ CBR E	50mm Bulk s	i Diame ample t	ts ter tube sample for CBR testing al sample	s :	ency Very Soft Soft Firm		<: 2!	CS (kPa) 25 5 - 50 0 - 100) Moisture Condition D Dry M Moist W Wet
	- Wat Wat	te and time sl er Inflow er Outflow	hown)	ASS B	(Glass Acid S (Plasti	s jar, se Sulfate \$	aled and chilled on site) Soil Sample air expelled, chilled)	St St VSt V	Stiff Very Stiff Hard Friable		10 20	00 - 200 00 - 400 400	W _p Plastic Limit W _L Liquid Limit
<u>ətrê</u> — -	tra D	anges radational or ansitional stra efinitive or dis rata change		Field Test PID DCP(x-y) HP	<u>s</u> Photo Dynar	ionisati nic pen	on detector reading (ppm) etrometer test (test depth interval shown) ometer test (UCS kPa)	<u>Density</u>	V L ME D VE	La D M D	ense	n Dense	Density Index <15% Density Index 15 - 35% Density Index 35 - 65% Density Index 65 - 85% Density Index 85 - 100%

APPENDIX B:

Results of Laboratory Testing



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lient:	PC	Cloy Project I Box 2214 ngar NSW 2	· ·	ent Pty Ltd					Accredited for complian The results of the tests his document are trace Results provided relate This report shall not be	 calibrations and/or i eable to Australian/na only to the items test 	measurements include ational standards. ted or sampled.
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roject na	me. Fit	oposed Subdi		e Galuelis	, staye i			DITATION	Senior Geotechr NATA Accredited Date of Issue: 3/0	Laboratory Nur	mber: 18686
ample		S									
mple ID:		NEW20W-19	991S01			Client Sar	-	-			
st Reque	est No.:	-				Sampling		Sampled	by Engineer	ring Departn	nent
aterial:		Sandy Clay				Date Sam	pled:	25/05/20	20		
ource:		On-Site				Date Subr	nitted:	25/05/20	20		
pecification		No Specifica									
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orehole N		TP101): 0.7 - 0.8									
	ehtii (iii). 0.7 - 0.8									
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vell on Sa bisture C	aturatioi ontent b	efore (%):	18	9.6 3.5	89.7.1.1	Shrink or Shrinkage	n drying (% e Moisture	Content	: (%): 18.3	AS	1289.7.1
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Report No: MAT:NEW20W-1991--S04 Issue No: 1 **Material Test Report** 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 provider letale only to the items tested or sampled. This report shall not be reproduced except in full. McCloy Project Management Pty Ltd PO Box 2214 Client: Dangar NSW 2309 ΝΑΤΑ Principal: 2.00 Project No.: NEW19P-0143 Approved Signatory: Dane Cullen (Senior Geotechnician) Project Name: Proposed Subdivision - The Gardens, Stage 1 WORLD RECOGNISED NATA Accredited Laboratory Number: 18686 Date of Issue: 3/06/2020

Sample Details

-	
Sample ID:	NEW20W-1991S04
Client Sample ID:	-
Sampling Method:	Sampled by Engineering Department
Date Sampled:	25/05/2020
Source:	On-Site
Material:	Clay
Specification:	No Specification
Project Location:	688 - 730 Medowie Road, Medowie
Lot. No	-
TRN	-
Sample Location:	TP104 - (0.05 - 0.15m)

Test Results

Description	Mathad	Becult	Limite
Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	15.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	59	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	23	
Plasticity Index (%)	AS 1289.3.3.1	36	



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ample l	Details										
ample ID:		NEW20W-1	991S05			Client San	-	-			
est Reque	st No.:	-				Sampling	Method:	Sampled	by Enginee	ring Departn	nent
aterial:		Clay				Date Sam	pled:	25/05/202	20		
ource:		On-Site				Date Subr	nitted:	25/05/202	20		
pecificatio	on:	No Specifica	ation								
roject Loc		•	ledowie Road	d, Medowie							
ample Loo		TP104 - (1.1	1 - 1.35m)								
orehole N	umber:	TP104	-								
orehole D	epth (m): 1.1 - 1.35									
well Te	st			AS 12	89.7.1.1	Shrink	Test			AS	1289.7.1
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oisture C	ontent a	fter (%):	33	3.9		Shrinkage Est. inert	material (%	%):	2%		
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Report No: MAT:NEW20W-1991--S06 Issue No: 1 **Material Test Report** 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 provider letale only to the items tested or sampled. This report shall not be reproduced except in full. McCloy Project Management Pty Ltd PO Box 2214 Client: Dangar NSW 2309 ΝΑΤΑ Principal: Cull B Project No.: NEW19P-0143 Approved Signatory: Brent Cullen Project Name: Proposed Subdivision - The Gardens, Stage 1 WORLD RECOGNISED (Senior Geotechnician) NATA Accredited Laboratory Number: 18686 Date of Issue: 3/06/2020

Sample Details

Sample ID:	NEW20W-1991S06
Client Sample ID:	-
Sampling Method:	Sampled by Engineering Department
Date Sampled:	25/05/2020
Source:	On-Site
Material:	Sandy Clay
Specification:	No Specification
Project Location:	688 - 730 Medowie Road, Medowie
Lot. No	-
TRN	-
Sample Location:	TP105 - (0.4 - 0.55m)

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	12.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	45	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	22	
Plasticity Index (%)	AS 1289.3.3.1	23	

Comments

The results outlined above apply to the sample as received



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ample ID:	l	NEW20W-1	991S07			Client San	nple ID:	-			
est Reque	est No.:	-				Sampling	Method:	Sampled	by Engineer	ring Departn	nent
aterial:		Sandy Clay				Date Sam	pled:	25/05/202	0		
ource:		On-Site				Date Subn	nitted:	25/05/202	0		
pecificati	on:	No Specifica	ation								
oject Loo	cation:	688 - 730 M	edowie Roac	l, Medowie							
ample Lo		TP106 - (1.1	- 1.25m)								
orehole N		TP106									
brehole D	Depth (m	: 1.1 - 1.25									
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						11					
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oisture C oisture C st. Unc. C st. Unc. C hrink S	Sontent b Sontent a Comp. St Comp. St Swell	efore (%): fter (%): rength befor	30 32 re (kPa): >6	.2 .9 600	Shrinkage	Shrinkage Est. inert Crumbling	e Moisture material (% g during s during shi	Content %): hrinkage:	2% Nil		
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Comments



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Principal:									0 (M_{\sim}		
Project No	.: NE	W19P-0143							Approved Signat	orv: Dane Culle	n
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laterial:		Sandy Clay				Date Sam	-	25/05/20			
ource:		On-Site				Date Subi	mitted:	25/05/20	20		
pecification		No Specifica		. 							
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Comments



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Report No: SSI:NEW20W-1991--S09 Issue No: 1 Shrink Swell Index Report 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. Client: McCloy Project Management Pty Ltd PO Box 2214 Dangar NSW 2309 This report shall not be reproduced except in full. NATA **Principal:** all Project No.: NEW19P-0143 Approved Signatory: Brent Cullen Project Name: Proposed Subdivision - The Gardens, Stage 1 WORLD RECOGNISED (Senior Geotechnician) NATA Accredited Laboratory Number: 18686 Date of Issue: 3/06/2020 Sample Details Sample ID: **Client Sample ID:** NEW20W-1991--S09 Test Request No.: Sampling Method: Sampled by Engineering Department Material: Clay **Date Sampled:** 25/05/2020 Source: **Date Submitted:** On-Site 25/05/2020 Specification: No Specification **Project Location:** 688 - 730 Medowie Road, Medowie Sample Location: TP109 - (0.8 - 1.0m) **Borehole Number:** TP109 Borehole Depth (m): 0.8 - 1.0 AS 1289.7.1.1 AS 1289.7.1.1 Swell Test Shrink Test Swell on Saturation (%): Shrink on drying (%): -1.1 3.5 Shrinkage Moisture Content (%): 29.4 Moisture Content before (%): 30.5 Moisture Content after (%): Est. inert material (%): 35.3 2% Est. Unc. Comp. Strength before (kPa): >600 Crumbling during shrinkage: Nil Est. Unc. Comp. Strength after (kPa): Cracking during shrinkage: 400 Nil Shrink Swell Shrinkage ٠ Sw ell 10.0 Shrink (%) Esh - Swell (%) Esw 5.0 0.0 -5.0 -10.0 0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 Moisture Content (%) Shrink Swell Index - Iss (%): 2.0

Comments



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Comments



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Comments



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Report No: SSI:NEW20W-1991--S12 Issue No: 1 Shrink Swell Index Report 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. Client: McCloy Project Management Pty Ltd PO Box 2214 Dangar NSW 2309 This report shall not be reproduced except in full. NATA **Principal:** all Project No.: NEW19P-0143 Approved Signatory: Brent Cullen Project Name: Proposed Subdivision - The Gardens, Stage 1 WORLD RECOGNISED (Senior Geotechnician) NATA Accredited Laboratory Number: 18686 Date of Issue: 3/06/2020 Sample Details Sample ID: **Client Sample ID:** NEW20W-1991--S12 Test Request No.: Sampling Method: Sampled by Engineering Department Material: Clay **Date Sampled:** 25/05/2020 Source: **Date Submitted:** On-Site 25/05/2020 Specification: No Specification **Project Location:** 688 - 730 Medowie Road, Medowie Sample Location: TP112 - (0.7 - 1.0m) **Borehole Number:** TP112 Borehole Depth (m): 0.7 - 1.0 AS 1289.7.1.1 AS 1289.7.1.1 Swell Test Shrink Test Swell on Saturation (%): Shrink on drying (%): -1.0 3.9 Shrinkage Moisture Content (%): 30.1 Moisture Content before (%): 30.0 Moisture Content after (%): Est. inert material (%): 32.9 1% Est. Unc. Comp. Strength before (kPa): >600 Crumbling during shrinkage: Nil Est. Unc. Comp. Strength after (kPa): Cracking during shrinkage: 500 Minor Shrink Swell Shrinkage ٠ Sw ell 10.0 Shrink (%) Esh - Swell (%) Esw 5.0 0.0 -5.0 -10.0 0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 Moisture Content (%) Shrink Swell Index - Iss (%): 2.2

Comments



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Comments



Material	Test Report	Report No: MAT:NEW20W-1991S14 Issue No: 1
Client:	McCloy Project Management Pty Ltd PO Box 2214 Dangar NSW 2309	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. This report shall not be reproduced except in full.
Principal: Project No.: Project Name:	NEW19P-0143 Proposed Subdivision - The Gardens, Stage 1	WORLD RECOGNISED ACCREDITATION BACK Senior Geotechnician) NATA Accredited Laboratory Number: 18686 Date of Issue: 3/06/2020

Sample Details

Sample ID: Client Sample ID:	NEW20W-1991S14 -
Sampling Method:	Sampled by Engineering Department
Date Sampled:	25/05/2020
Source:	On-Site
Material:	Clay
Specification:	No Specification
Project Location:	688 - 730 Medowie Road, Medowie
Lot. No	-
TRN	-
Sample Location:	TP114 - (0.4 - 0.5m)

Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	11.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	47	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	20	
Plasticity Index (%)	AS 1289.3.3.1	27	

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



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 boglike 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
А	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
М	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes
Н	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
Р	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.



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.

Trees can cause shrinkage and damage

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.

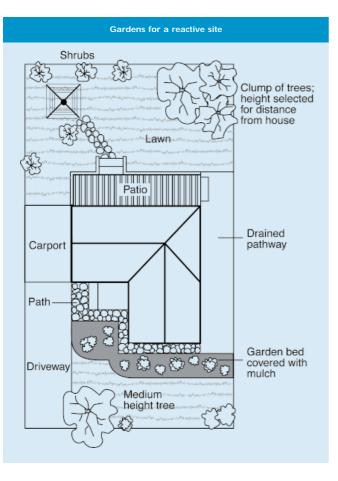
It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

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					



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.

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

The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

The information is advisory. It is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject.

Further professional advice needs to be obtained before taking any action based on the information provided.

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