UR1986_41

1986/41. Investigation of a cracked house at Alanvale Road, Newnham, Launceston

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Abstract

The brick bungalow is extensively cracked; most severely at its south-east corner, at the rear of the house. Because of difficulties of access only three auger holes to investigate the foundation material could be drilled using a trailer-mounted rig.

At the south-east corner 5.2 m of highly plastic and expansive clay (24-27% linear shrinkage) was penetrated. Expansive clay (0.7 m) was also encountered in the two holes at the north-west and south-west corners at the front of the house. Below the clay was a non-expansive sandy clay and cemented clayey sand which could not be penetrated by the drill.

The lensing out of the sandy cemented layer results in a thick expansive clay at the rear of the house. With seasonal and prolonged drought periods differential movement in the clay is thought to cause the house to crack.

INTRODUCTION

An investigation of cracking of a house at 194 Alanvale was requested by Mr E. J. Stevens on 12 April. The house was inspected by the writer on 16 April and it was recommended that a subsurface investigation was required to establish the material on which the house is founded. Three auger holes were drilled on 29 and 30 April and the clay samples collected were tested by the Department of Mines soil laboratory.

LOCATION AND TOPOGRAPHY

Steven's block is located on the east side of the northern end of Alanvale Road [EQ091181]. The block is flat and situated on a low, 25 m, river terrace. A shallow depression and marshy poorly-drained area occurs immediately south of the block.

DEGREE AND HISTORY OF THE HOUSE CRACKING

The house is a rectangular, single-storied brick bungalow and was built in the mid 1950s. The house has concrete wall foundation (which is cracked) and sits upon piles.

The severest cracking occurs at the south-east corner and extends along the southern wall. A small porch near the south-east corner is extensively cracked and this section of the house would appear to require rebuilding.

Another badly cracked area is along the back (eastern) wall at the north-east corner of the house and the adjoining northern wall. This cracking can possibly be repaired by selective replacement of some of the bricks if future movements can be eliminated. The front of the house shows only minor cracking which is not considered excessive for a house of its age. Internal cracking of the plaster walls has also occurred particularly in the southern section of the house.

Stevens reported that the cracking was only minor until the Lilydale Council dug a very deep sewerage main across their block in the 1970s. This drain is very close to the north-east corner of the house. The drain position is still visible by a hollow in the lawn - in spite of frequent filling. Cracking occurred then at the north-east corner of the house by the drain, and along this eastern wall. The concrete driveway also cracked at this time and was repaired by the Council. Cracking has continued over the years but has increased noticeably since 1983 to its present condition.

SUBSURFACE INVESTIGATION

A Triefus trailer-mounted drill was used with 100 mm augers. Augers were withdrawn and samples collected at the end of each flight. All samples tested were disturbed auger samples.

The three auger holes were drilled as close as possible to the house at the south-east, north-west and south-west corners. Because of the concrete driveway along the northern wall and lack of room along the southern wall no holes could be drilled here. No drilling was possible at the north-east corner because of the sewer main.

Surface Geology

No outcrops were present on this block or in nearby area. The soil was a black organic highly plastic clay (CH). The river terrace area of Alanvale Road is shown on the 1 inch 1 mile geological map as being underlain by sediments of Launceston Beds of Tertiary age (Longman *et al.*, 1964, 1966).

Subsurface (Drilling Logs Hole 1, 2 and 3)

Hole 1. Of the three holes drilled, this hole, near the south-east corner of the house, was the deepest (5.2 m). Beneath the surface, black soil, clay of varying colours was penetrated until the drill refused to turn. This was not because of any hard pan, or gravel layer but because of the tightness of the clay. The surface clay was soft and moist. It continued to feel moist to 2.5 m depth and appeared to become drier as well as hard below this depth. This change in moisture was not confirmed by the laboratory tests. Below 3.4 m the clay was hard and difficult to drill.

Hole 2. This hole was drilled on the front lawn - south of front porch near the south-west corner of the house. Underneath the black clay-soil at the surface was a brown clay. At 0.7 m depth a yellow clayey sand with a cemented sand layer at 0.9 m depth was drilled. The hard-pan of cemented sand could not be penetrated by the drill.

Hole 3. This hole was drilled on the front lawn near the north-west corner of the house a similar sequence to hole 2 was drilled. The refusal depth in the yellow sandy clay was deeper, at 1.2 m.

LABORATORY RESULTS (table 1)

The clays encountered in all three holes were tested and classified as highly plastic (plasticity index ranging from 64-143). They all have high linear shrinkage (24-27%).

Table 1
SOIL LABORATORY RESULTS ON CLAY FROM 194 ALANVALE ROAD, NEWNHAM, LAUNCESTON

Hole No.	1						2		3
Sample No.	1	2a	2	3	4	5	1	2	1
Depth (m)	0.6	1.4	1.6	2.5	3.4	4.3	0.6	0.7	0.5
Moisture content (m)	41	47	44	40	39	38	27	30	43
Plastic limit	29	33	34	32	28	26	20	-	32
Liquid limit	140	176	162	105	97	93	84	37	139
Plastic index	111	143	128	73	69	67	64	-	107
Linear Shrinkage (%)	25	27	26	24	25	24	25	-	25
XRD - CLAY FRACTION									
Montmorillonite	70-75	75-80	75-80	50-55	60-65	65-70	50-55	-	55-60
Kaolinite	20-25	20-25	20-25	40-45	35-40	30-35	45-50	-	35-40
Lepidocrosite	5-10	-	-	-	-	-	-	-	0-5
Goethite	-	-	-	5-10	-	-	-	-	-
Quartz	-	-	-	-	-	-	25-30	-	-

Analyst: R. N. Woolley.

In the only thick sequence of clay drilled (hole 1) the plasticity of the clay increases with depth from the surface to a grey clay layered at a depth of 1.4-1.6 m, with the plasticity index rising from 111 to 143 and the liquid limit rising from 140 to 176 both peaking in the grey clay. Below 1.6 m the plasticity of the clay declines and the liquid limit falls from 105 to 93 and the plasticity index falls to 65 in sample 5 at a depth of 4.3 m (fig. 1).

The moisture content in samples collected from hole 1 showed similar changes with depth. The range of difference in the moisture contents is very small, increasing from 41 to 47% at 1.4 m depth and then declining to 38% at 4.3 m (fig. 1).

The linear shrinkages are very high from all clay samples of hole 1 (24-27%). This reflects the composition of these clays which are dominantly montmorillonite (60-80%). No quartz was present in the clay samples of hole 1.

The clay sample from hole 2, collected at 0.6 m depth, had a high quartz content (25-30% of the total volume). The clay fraction of this sample is classified as highly plastic but its plasticity index (64) is lower than any sample collected from hole 1. The composition of this clay was still dominantly montmorillonite (50-55%) and as a result the clay possesses a high linear shrinkage of 25%. The clay fraction of the sandy clay sample at 0.7 m has a low plasticity and is non-expansive.

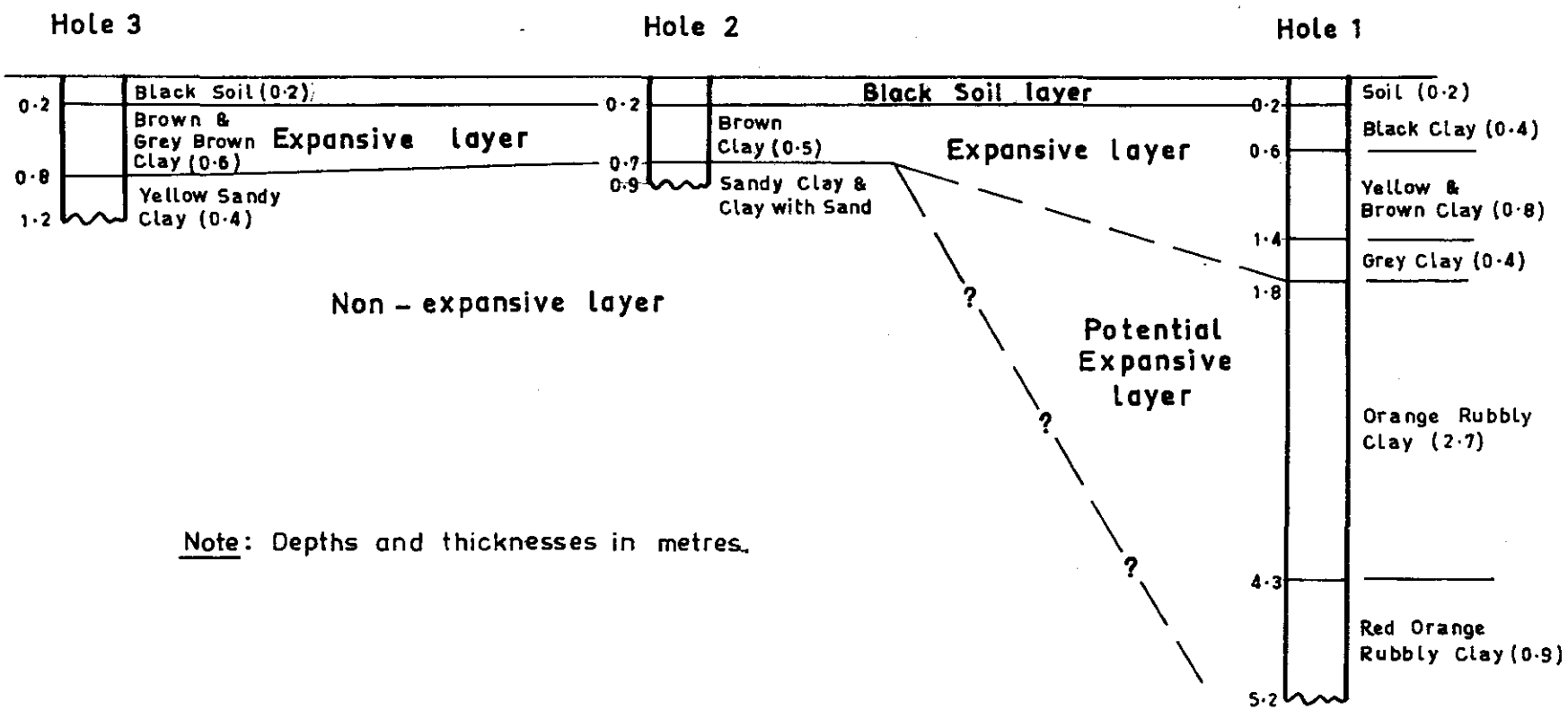


Figure 1. Section showing expansive and non-expansive layers.

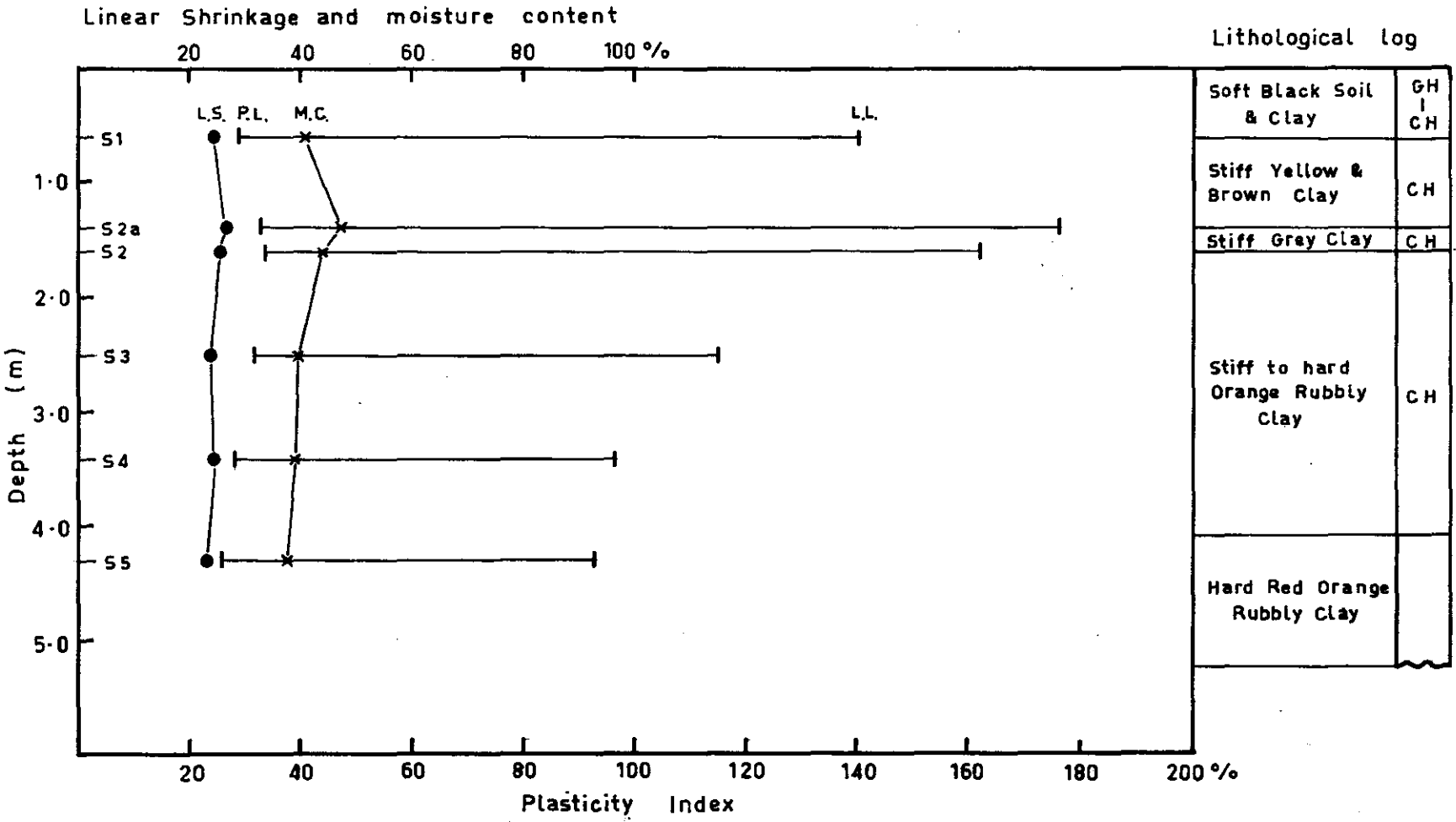
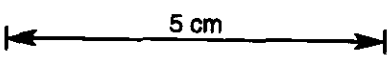


Figure 2. Soil testing results and log of hole 1.



Sample 1 collected at 0.5 m depth in hole 3, the brown clay has similar properties to the subsurface clay of hole 1 at 0.6 m depth, with high liquid limits of 139, plasticity index of 107 and linear shrinkage of 25%/. Its composition with montmorillonite at 55-60%, kaolinite 45-50% and lepidocrosite 0-5%, is also very similar to sample 1, hole 1.

INVESTIGATION RESULTS

(1) The clay at 194 Alanvale Road is highly expansive and has the potential to cause movement in the house foundations.

(2) Drilling shows a considerable variation in the thickness of the clay between holes 1, at the rear of the house, compared with holes 2 and 3 in front of the house (fig. 2).

(3) A cemented hard sandy clay and clayey sand lens underlies the front of the house (holes 2 and 3). This layer does not occur at the south-east corner of the house (hole 1). The position where this layer lenses out beneath the house is unknown and can only be ascertained by further drilling along the northern and southern walls of the house.

(4) House foundations supported by such a hard layer are unlikely to move.

(5) There were only minor variations in the properties and composition of the clay samples collected from the three holes drilled.

(6) The moisture contents in samples from hole 2 were lower than those from holes 1 and 3. No explanation for this was obvious from the locations of the drill holes.

(7) The moisture content of the clay from hole 1 showed little variation with depth, but when drilled felt drier as the clay became stiffer at 2.5 m. These clays had become very hard at 3.4 m in this hole.

CONCLUSIONS

(1) The severity of cracking of Stevens' house would appear to be directly related to the thickness of the expansive clay at the south-east corner of the house.

(2) Cracking is less severe along the front of the house, where the expansive clay is thin (0.7 m). This thin clay layer is underlain by yellow cemented sandy clay and sand layer. Unfortunately the foundations along the front of the house did not reach this distinctive horizon according to Mr Stevens.

(3) Even though the moisture content of the clay when tested was constant throughout the entire depth of hole 1 at the south-east corner seasonal fluctuations of the moisture content are considered likely to occur around the outside foundations of the house. Larger scale fluctuations are most likely to occur in long drought periods such as 1982-1984.

(4) The opening of the deep drain by Lilydale Council resulted in exposing the clay allowing it to dry and contract. This movement resulted in the house being cracked as a drying front reached the clay beneath the house foundations. It seems logical that the further cracking would be from the seasonal or longer periods of wetting and drying of the clay causing it to expand and contract causing the present damage.

RECOMMENDATIONS

(1) Further clay samples should be collected from the northern end southern section of the house. Because of the access problem, a hand auger machine will be required. These holes should go to 2 m deep and try to establish the limits of yellow sandy clay. The clay samples should be collected and tested as were the samples from the drill holes.

(2) A foundation engineer should be consulted about the feasibility and cost of boring a pile and beam support for the foundations under the southern section of the house. Conventional under pinning to a depth of 2.5-3.0 m, as required here, is considered to be too expensive an operation. More important further cracking frequently occurs in the foundations where the underpinning ceases. Limited underpinning may be possible at the north-eastern section of the house. This will depend on results of the further investigation, especially the extent of the hard sandy clay layer.

(3) If underpinning or any other remedial measures are suggested by the engineer, then he should design and then supervise the work of the builder.

(4) When the remedial work is completed a concrete path (or border) be placed beside the house along its eastern and southern wall. This concrete should be underlain by thick plastic. This would help prevent seasonal moisture fluctuations in the clay from affecting the house foundations.

REFERENCES

LONGMAN, M. J. 1966. One mile geological map series. K/55-7-39. Launceston. *Explan. Rep. Dep. Mines Tasm.*

LONGMAN, M. J.; MATTHEWS, W. L.; ROWE, S. M. 1964. Geological atlas one mile series. Zone 7 Sheet 39. Launceston. *Department of Mines, Tasmania.*

[22 July 1986]

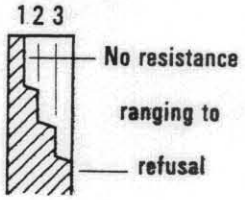
TASMANIA DEPARTMENT OF MINES

8/11

EXPLANATION SHEET FOR ENGINEERING LOGS

Borehole and excavation log

Penetration



Water

22 Jan, 80 Water level on date shown.

Water inflow.

Water outflow.

Notes - samples and tests

U50	Undisturbed sample 50mm diameter.
D	Disturbed sample.
N	Standard penetrometer blow count for 300mm.
N*	SPT + sample.

Material classification

Based on Unified Soil Classification System.

In Graphic Log materials are represented by clear contrasting symbols consistent for each project.

Moisture content

D	Dry, looks and feel dry.
M	Moist, no free water on hand when remoulding.
W	Wet, free water on hand when remoulding.
LL	Liquid limit.
PL	Plastic limit.
PI	Plasticity Index.

eg. M > PL – Moist, moisture content greater than the plastic limit.

Consistency

		hand penetrometer (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.	

Notes: X on log is test result

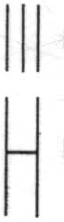
— is range of results.

Density index

		%
VL	Very loose.	0 - 15
L	Loose.	15 - 35
MD	Medium dense.	35 - 65
D	Dense.	65 - 85
VD	Very Dense	85 - 100

Cored borehole log

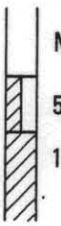
Case - lift



Casing used.

Barrel withdrawn.

Fluid loss



No loss

50% loss

100% loss.

Lugeons

Lugeon units (μL) are a measure of rock mass permeability. For a 46 to 74mm diameter borehole 1 Lugeon is defined as a rate of loss of 1 litre per metre per minute. 1 Lugeon is roughly equivalent to a permeability of 1×10^{-4} mm/sec.

Graphic log

No core.

Rock substances represented by clear, contrasting symbols consistent for each project.

Weathering

Fr	Fresh.
SW	Slightly weathered.
HW	Highly weathered.
EW	Extremely weathered.

Strength

		point load strength index $I_{s\,(50)}$ (MPa)
EL	Extremely low.	< 0·03
VL	Very low.	0·03 - 0·1
L	Low.	0·1 - 0·3
M	Medium.	0·3 - 1
H	High	1 - 3
VH	Very high.	3 - 10
EH	Extremely high.	> 10

Note: X on log is test result.

Significant defects

Significant defects shown graphically.

Joint.

Sheared zone.

Crushed seam.

Infill seam.

Extremely weathered seam.

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – BOREHOLE

borehole no. 1

sheet 1 of 1

9/11

project: H. Stevens' cracked house
SE corner at back of house.

location: 194 Alanvale Road, Newnham

co-ordinates: EQ091181
R.L.: 25 m
inclination: vertical
bearing: --

drill type: Treifus
drill method: Auger
drill fluid: None

hole commenced: 29.4.86
hole completed: 29.4.86
drilled by: B.E. Cox
logged by: W.R.Moore
checked by: R.C.Donaldson

penetration 1 2 3	support	water	notes samples, tests	metres R.L. / depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa (25 50 100 200 400)	structure, geology
	None	None	S1			OH / CH	*Clay* - Black, organic, highly plastic.	M ≥ PL	S		Soil sub-soil
				1.0		CH	*Clay* - Yellow, highly plastic.	M ≥ PL	St / V St		Yellow and
			S2				*Clay* - Grey brown, highly plastic.	M ≥PL	St		Grey clay
				2.0			*Clay* - Orange rubbly -	M	V St / I		
			S3				Highly plastic.	< PI	H		Orange clay
				3.0		CH					
			S4					D	H		
				4.0							
			S5			CH	*Clay* - Red orange - rubbly, high plasticity.	D	H		Red-orange clay
				5.0							
							Drill reached refusal by clay gripping augers - not due to hard band or gravels etc.				
							Refusal depth 5.2 m.				
							N.B. Penetrometer measurements taken from disturbed auger samples.				

5 cm

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ENGINEERING LOG – BOREHOLE

borehole no. 2

sheet 1 of 1

10/11

project: H. Stevens' cracked house, SW corner (front) of house

location: 194 Alanvale Rd, Newnham

co-ordinates: EQ091181

R.L.: 25 m

inclination: vertical

bearing: --

drill type: Treifus

drill method: Auger

drill fluid: None

hole commenced: 30.4.86

hole completed: 30.4.86

drilled by: B.E. Cox

logged by: W.R. Moore

checked by: R.C.Donaldson

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
								Clay - Black organic. Highly plastic	M	S		Soil
	None	None	S1		0.5		CH	*Clay* - Brown, highly plastic. Small percentage of sand	M ≥ PL	St		Clay
			S2				SC	*Clayey sand* - Yellow clay, low plas-	M>>	S		Sandy clay
							SC	ticity. Sand fine 10%.	Pl	H		Hard sand
					1.0			*Sand with clay* - Yellow sand, fine, poorly graded well-sorted. Clay 10% approx. Non plastic.	D			(cemented)
								Hard cemented sand layer stopped drill.				
								Refusal depth 0.9 m.				

5 cm

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ENGINEERING LOG – BOREHOLE

borehole no. 3

sheet 1 of 1

11/11

project: H. Stevens' cracked house, NW (front) of house

location: 194 Alanvale Rd, Newnham

co-ordinates: EQ091181

R.L.: 25 m

inclination: vertical

bearing:

drill type: Treifus

drill method: Auger

drill fluid: None

hole commenced: 30.4.86

hole completed: 30.4.85

drilled by: B.W. Cox

logged by: W.R. Moore

checked by: R.C. Donaldson

penetration 1 2 3	support	water	notes samples, tests	metres R.L.	metres depth	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency density index	hand penetrometer kPa 25 50 100 200 400	structure, geology
							CH	*Clay* - Black organic. Highly plastic	M ≥Pl	S		Soil
	None	None	S1		0.5		CH	*Clay* - Brown. Highly plastic Grey brown.	M < Pl	St		Clay
			S2		1.0		SC	*Sandy clay* - Yellow. Sand fine. Poorly graded well sorted. Clay - plasticity low.	D	H		Sandy clay
								Drill refused at 1.2 m.				

5 cm