



## Subsurface investigation of land at Leam Road

by B. D. WELDON

A subsurface investigation of a property at Leam Road, Hillwood, was undertaken in relation to a proposed subdivision of the property. The investigation involved sinking three test pits and laboratory tests on a sample of clay taken from one of the test pits. A stability analysis was performed using the results of the laboratory tests.

The analysis indicates that as the ground becomes fully saturated, the risk of a landslide developing increases. However as this condition is unlikely to arise, given the clayey nature of the soils encountered, no objection was raised to the proposed subdivision.

It was recommended that development on the proposed lot with a frontage to Leam Road be restricted to the flatter lying country such as near the site of the test pit. Excavations into the slopes on this proposed lot should not exceed one metre in depth.

### Test pits

The owner indicated that he wished to subdivide his property to produce three additional lots which could be built upon. A detailed plan of the proposal was not available, but the owner indicated roughly the lot boundaries he was considering and a potential house site was selected for each proposed lot. A test pit was dug at each of these sites under the supervision of engineering geologist B. Weldon.

The approximate location of the test pits is shown on Figure 1. The engineering logs of the test pits are presented in Appendix 1.

Test pits 1 and 2 were located on uniformly sloping ground and encountered stiff to very stiff clays. Spheroidally, extremely weathered boulders of dolerite were encountered at 1.4 m in test pit 1, while a cemented gravel and sand occurred at 1.55 m in test pit 2. These sites do not show anything extraordinarily suggestive of a high landslide risk.

Test pit 3 was located in an area where the morphology suggested past landslide movement.

### Stability analysis

Samples from test pit 3 were submitted for shear box testing to provide parameters for use in a stability analysis. The shear box test (cyclic reversed) provided the following soil parameters:

apparent cohesion             $c' = 2 \text{ kPa}$   
angle of internal friction        $= 19 \text{ degrees}$

A soil density of 20 kN/cubic metre was assumed.

Several lines of section were trialled for slip circle analysis and the line of section indicated on Figure 1 (A-A') was selected for detailed analysis.

Initially, an analysis was performed using the parameters detailed on Figure 2. The radius of the slip circle was increased until the Factor of Safety approached a minimum. A radius for the slip circle of 160 m was chosen for subsequent analysis where the apparent cohesion ( $c'$ ) varied from 0 to 6 kPa, angle of internal friction ( $\phi$ ) varied from  $16^\circ$  to  $22^\circ$ , and where the pore pressure ratio ( $r_u$ ) ranged from 0 (a completely dry slope) to 0.5 (a completely saturated slope for soil density = 20 kN/cubic metre).

For the conditions of the analysis, a Factor of Safety of unity indicates a slope in delicate equilibrium. A Factor of Safety below this indicates that failure will occur or has occurred. A Factor of Safety above one indicates that the conditions for which the analysis was performed produce a stable slope. It is stressed here that in a numerical analysis of this kind, only when the Factor of Safety exceeds 1.3 is the slope considered stable for building upon.

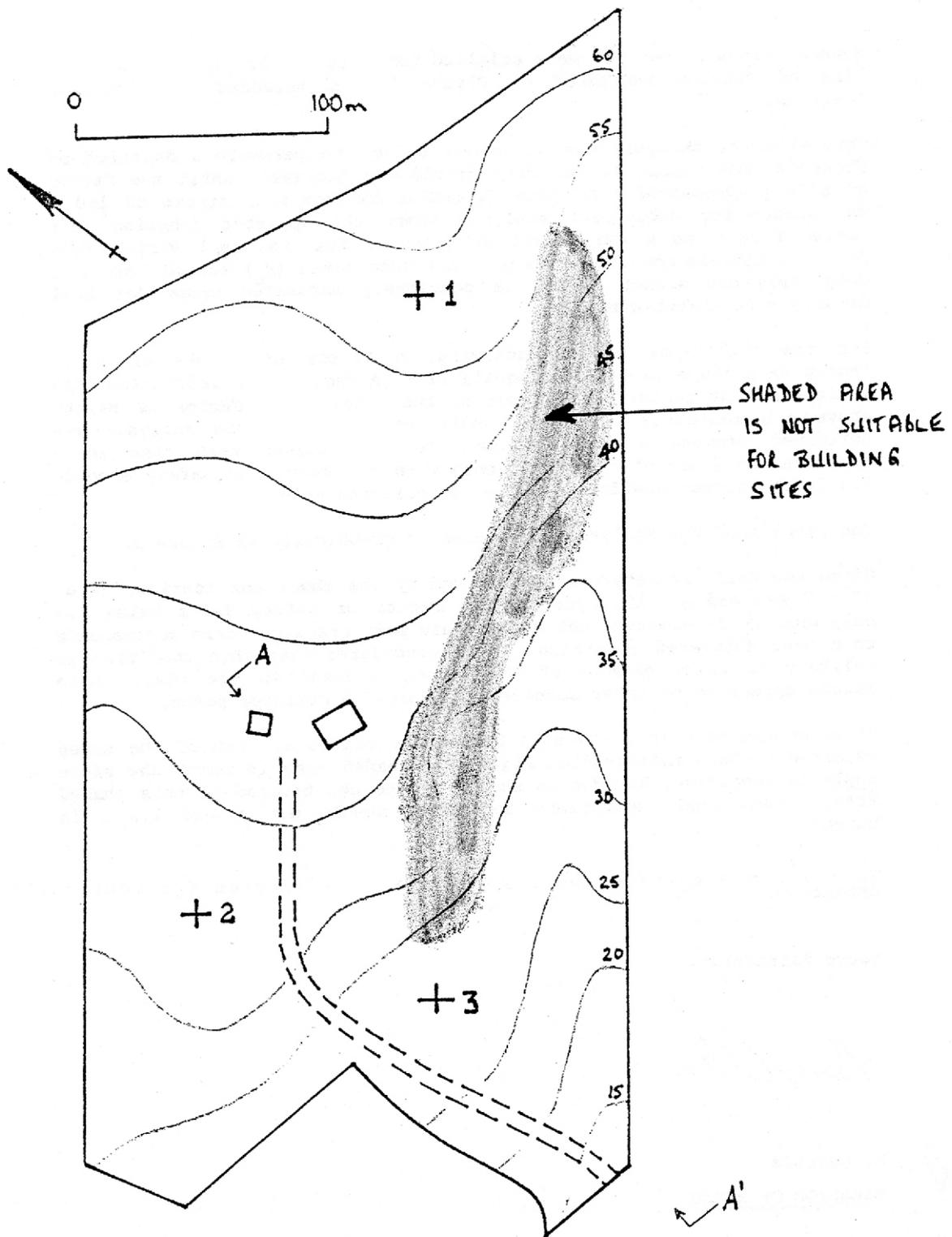
The results of the analysis are presented graphically as Figure 3.

Given the soil parameters as determined by the shear box testing, (i.e.  $c' = 2 \text{ kPa}$  and  $\phi = 19 \text{ degrees}$ ), the Factor of Safety falls below 1.3 only when  $r_u$  is greater than 0.473. This pore pressure ratio corresponds to a near saturated condition. It is considered that this condition is unlikely to arise because of the lenses of sand in the clay. These lenses appear to be interconnected and provide drainage paths.

### Conclusions

It is concluded that a suitable house site exists at each of the sites examined. Figure 1 shows a shaded area in which the slope angle is excessive, and residences should not be constructed in this shaded area. Unsupported excavations and fills should not exceed 1.5 m in height.

[21 February 1989]



T. BISSETT LEAM RD HILLWOOD

+ approx position of test pit  
 A-A' line of section for stability analysis

Figure 1

Location of test pits and section line

# SLOPE STABILITY ANALYSIS - COMPUTATIONS SHEET 1 OF 1.

NAME OF SLIP ..... BISSETT ..... MAP REF. ....

ANALYSIS BY: B.W.  
 DATE .....  
 CHECKED BY: .....

INITIAL INPUT				SHAPE *			
STORE	ITEM		STORE	ITEM		STORE	ITEM
00	X L.H.S.	0 m	20	Y <sub>1</sub>	17.5	31	Y <sub>12</sub>
01	Y L.H.S.	15 m	21	Y <sub>2</sub>	22	32	Y <sub>13</sub>
02	X R.H.S.	100 m	22	Y <sub>3</sub>	25.5	33	Y <sub>14</sub>
03	Y R.H.S.	32 m	23	Y <sub>4</sub>	27.5	34	Y <sub>15</sub>
04	SLICE#	5	24	Y <sub>5</sub>	30	35	Y <sub>16</sub>
06	GAMMA	20 kN/m <sup>3</sup>	25	Y <sub>6</sub>		36	Y <sub>17</sub>
07	C	2 kPa	26	Y <sub>7</sub>		37	Y <sub>18</sub>
08	PHI	19 degrees	27	Y <sub>8</sub>		38	Y <sub>19</sub>
09	r <sub>u</sub>	0	28	Y <sub>9</sub>		39	Y <sub>20</sub>
10	Y <sub>CIRCLE</sub>	112 m	29	Y <sub>10</sub>			
11	F <sub>1</sub>	f	30	Y <sub>11</sub>			

\* Only enter No specified

### CALCULATIONS

Given .....  
 .....  
 Find .....

Given .....  
 .....  
 Find .....

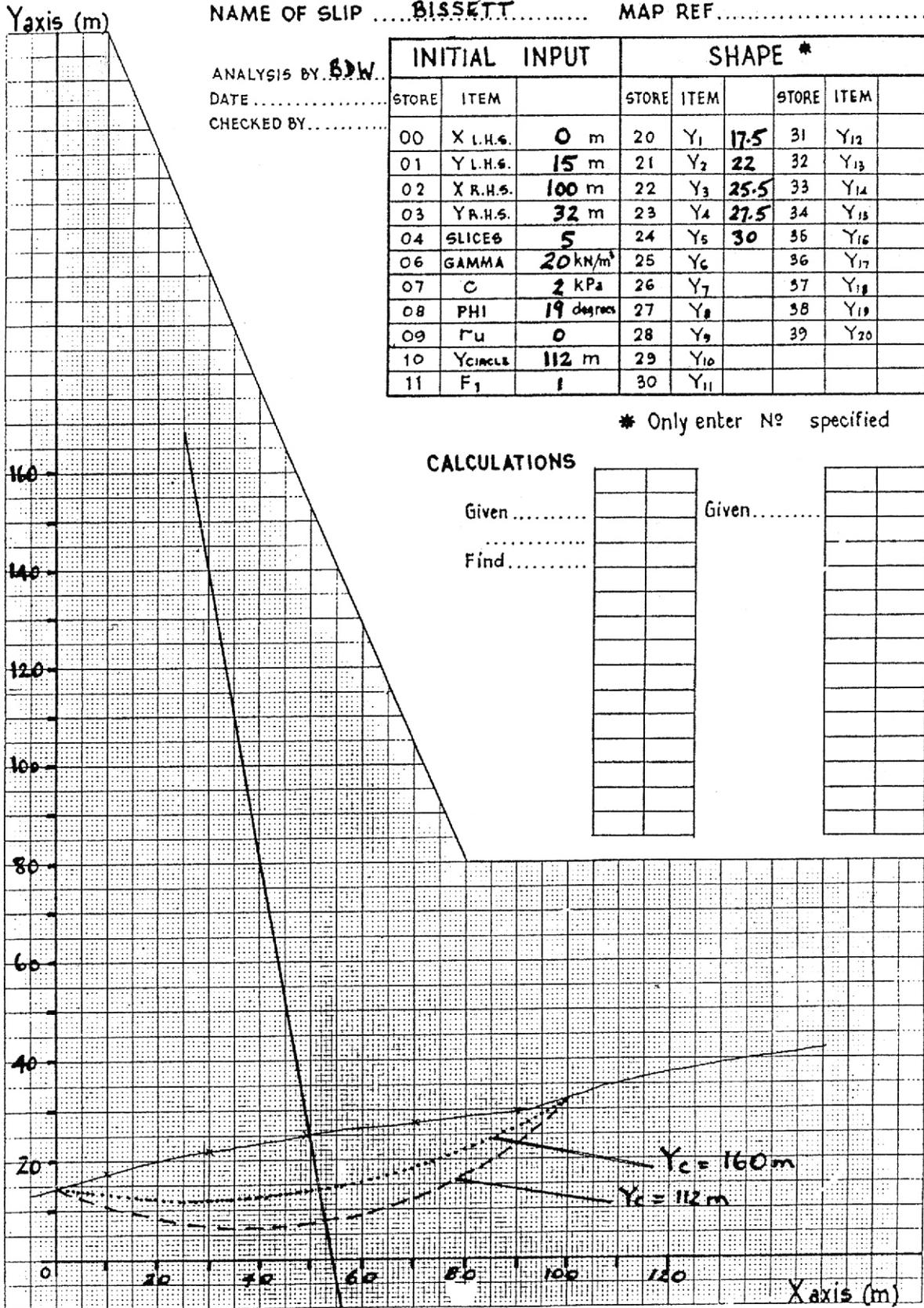



Figure 2  
 Cross section analysed for slope stability

# STABILITY ANALYSIS: T BISSETT, LEAM

$Y_{circ}=160m$ ,  $C'=0$  kPa,  $\Gamma=20$  kN/cub m

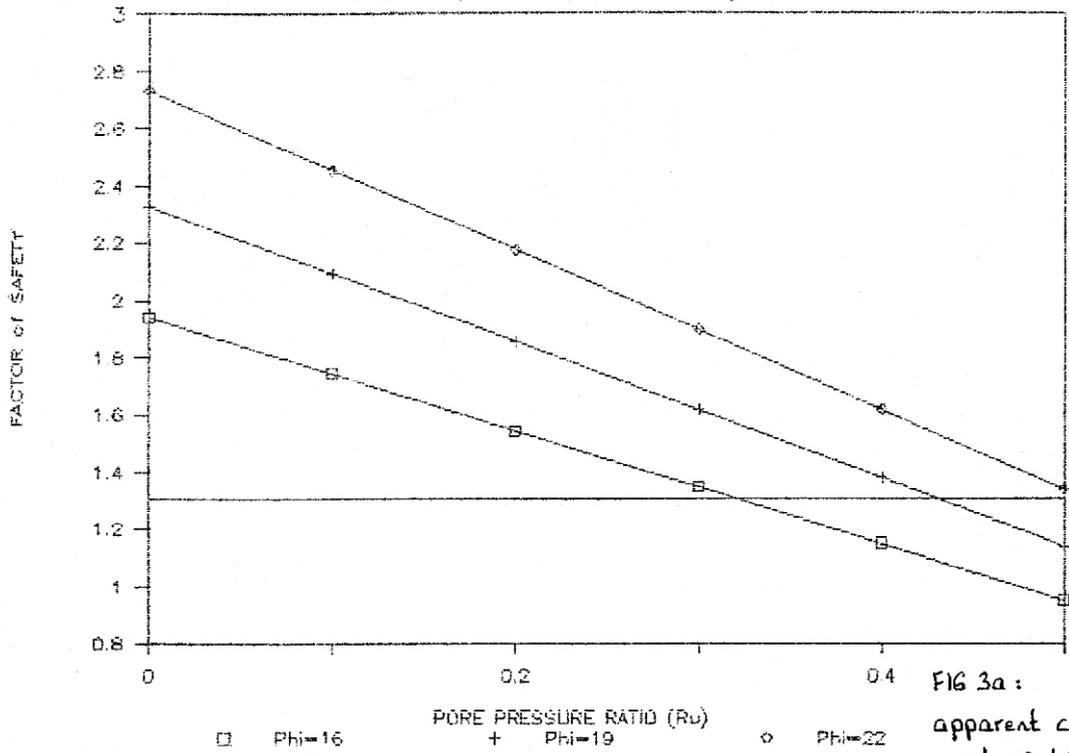


FIG 3a:  
apparent cohesion  
 $c' = 0$  kPa

# STABILITY ANALYSIS: T BISSETT, LEAM

$Y_{circ}=160m$ ,  $C'=2$  kPa,  $\Gamma=20$  kN/cub m

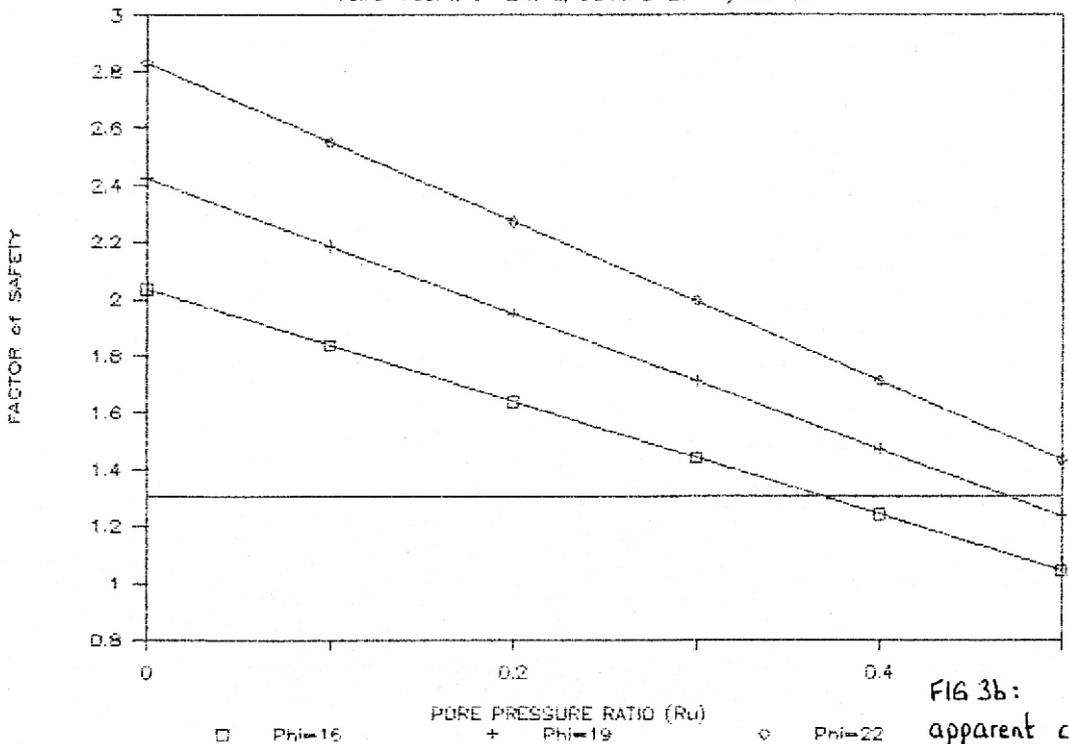


FIG 3b:  
apparent cohesion  
 $c' = 2$  kPa

Figure 3 (a, b)

### STABILITY ANALYSIS: T BISSETT, LEAM

$Y_{circ}=160m$ ,  $c'=4 kPa$ ,  $\Gamma=20 kN/cub\ m$

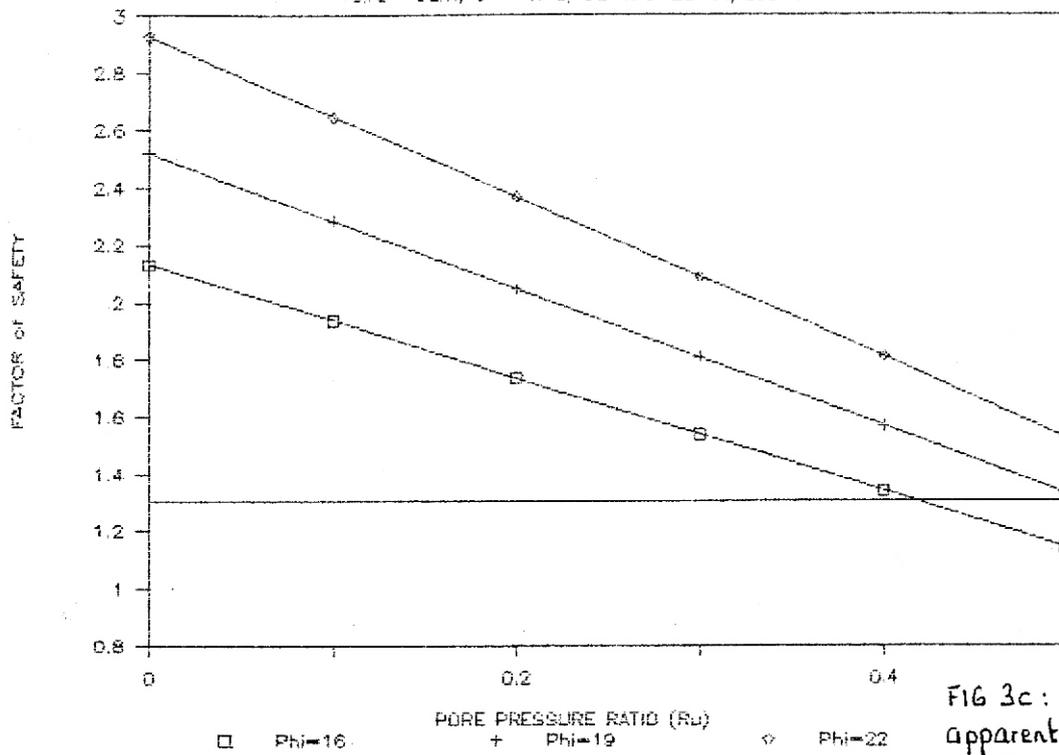


FIG 3c:  
apparent cohesion  
 $c' = 4 kPa$

### STABILITY ANALYSIS: T BISSETT, LEAM

$Y_{circ}=160m$ ,  $c'=6 kPa$ ,  $\Gamma=20 kN/cub\ m$

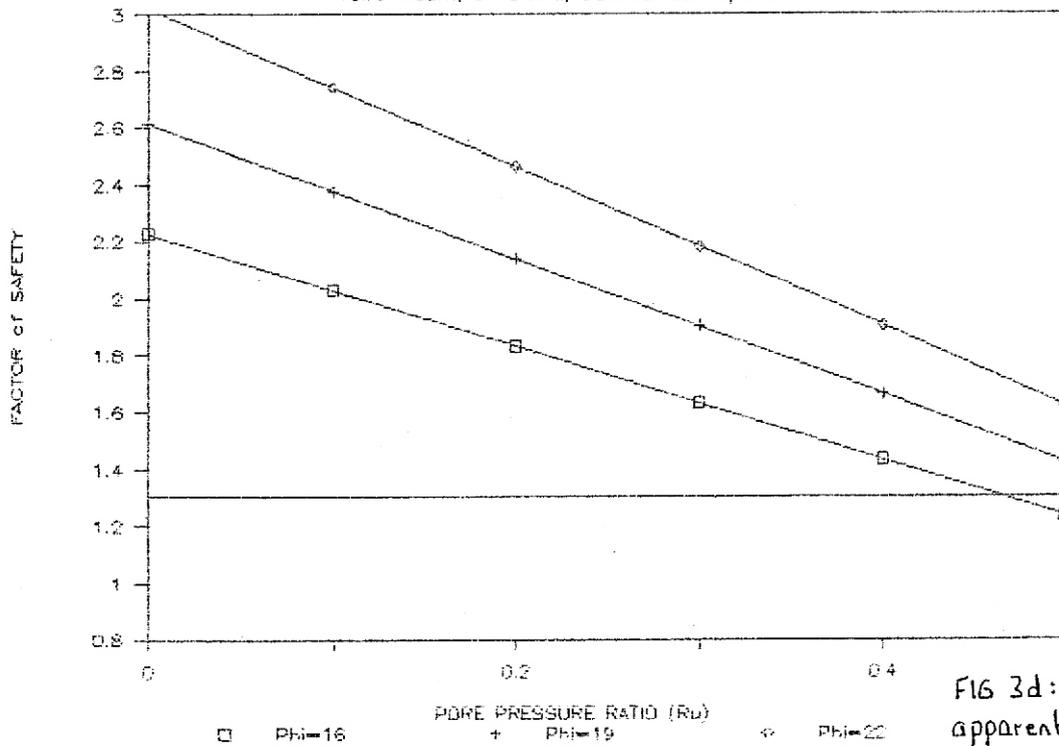


FIG 3d:  
apparent cohesion  
 $c' = 6 kPa$

Figure 3 (c, d)

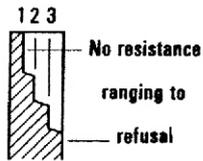
# APPENDIX 1

TASMANIA DEPARTMENT OF MINES

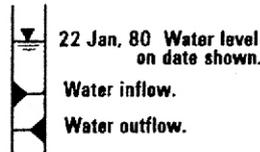
## EXPLANATION SHEET FOR ENGINEERING LOGS

### Borehole and excavation log

#### Penetration



#### Water



#### Notes - samples and tests

- U50 Undistributed 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

- VS Very soft.
- S Soft.
- F Firm.
- St Stiff.
- VSt Very stiff.
- H Hard.
- Fb Friable.

hand penetrometer (kPa)

- < 25
- 25 - 50
- 50 - 100
- 100 - 200
- 200 - 400
- > 400

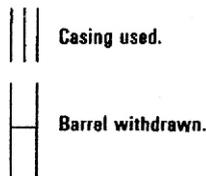
#### Density index

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

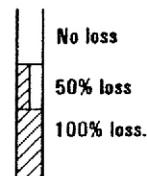
Notes: X on log is test result  
— is range of results.

### Cored borehole log

#### Case - lift



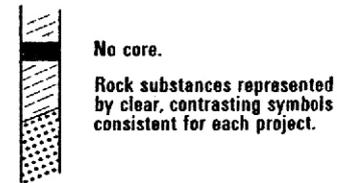
#### Fluid loss



#### Lugeons

Lugeon units (pL) 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  $1 \times 10^{-4}$  mm/sec.

#### Graphic log



#### Weathering

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

#### Strength

- EL Extremely low.
- VL Very low.
- L Low.
- M Medium.
- H High
- VH Very high.
- EH Extremely high.

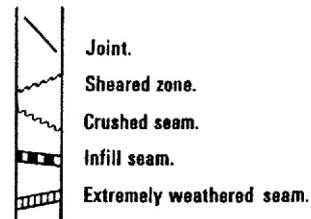
point load strength index  $I_{s(50)}$  (MPa)

- < 0.03
- 0.03 - 0.1
- 0.1 - 0.3
- 0.3 - 1
- 1 - 3
- 3 - 10
- > 10

Note: X on log is test result.

#### Significant defects

Significant defects shown graphically.





# ENGINEERING LOG - EXCAVATION

excavation no. **2**  
sheet **1** of **1**

project <b>Proposed Subdivision - T. Bissett</b>	location <b>LEAM</b>	
co-ordinates	exposure type <b>test pit</b>	pit commenced <b>29-6-88</b>
R.L.	equipment <b>JCB</b>	pit completed <b>29-6-88</b>
excavation dimensions <b>3.6 x 0.6 m</b>	operator	logged by <b>B. D. Weldon</b>
		checked by

penetration 1 2 3	support water	notes samples tests	metres		classification symbol	material soil type: plasticity or particle characteristics, colour secondary and minor components	moisture condition	consistency density index	hand penetr- ometer kPa			structure geology
			R.L.	depth					75	100	200	
			0.15	0.15	ML	SILTY CLAY: dark grey; rootlets; medium to low plasticity; fine-med size gravel (15%)	M	Fb				
					CH	CLAY: mottled yellow-grey; high plasticity; MC > P.L.; rootlets; blocky pedal structure (5mm cubes)	M	SE	x			
			1.00									
			1.25		CH	CLAY: yellow-grey and brown; layered to mottled; high plasticity; MC > P.L.	M	VSE	x			
			1.55		CH	CLAY: brown-orange-red; high plasticity; MC ~ P.L.	M	H	x			
			1.90			CONGLOMERATE: cemented fine to medium gravel with sandy matrix; dark brown-red, iron stained,	M	D				
			2.21		GC	GRAVELLY CLAY: brown; medium to high plasticity; sub rounded to rounded quartzite and limonite gravel	M	H	x			
						END OF EXCAVATION						

sketch

