1987/20. Subsurface examination of proposed lots, Pleasant Hills Subdivision, Rosevears.

B. D. Weldon

Abstract

Subsurface investigation of proposed building lots at Pleasant Hills subdivision has been undertaken. Slickensided clays in several test pits indicate past mass movements. A sample taken from a pit was tested to provide parameters for stability analysis. The analysis indicates that the long term stability of the clay is suspect.

INTRODUCTION

Slope classification at the proposed extension of the Vos Nominees subdivision Grindelwald (Weldon, 1986) identified areas which are at risk with respect to slope instability. A suggested alteration to the subdivision layout would have minimised the lots affected by these areas. This suggestion was unacceptable to the developer as it was at the expense of jeopardising several good lots in favour of several which, in all likelihood, would not be as readily saleable.

Detailed investigation of the lots at risk (i.e. those where the natural slopes exceeded 8°) was requested by the developer. This report details the results of the investigation.

INVESTIGATION

Eleven test pits were excavated and logged on 12 December 1986. The pits were dug by a Domino DIG tracked mini-excavator. The locations of the test pits are shown on Figure 1. The engineering logs prepared from the exposures are attached as Appendix 1.

The test pits revealed that the near-surface materials consist of slope debris derived from the weathering and erosion of Tertiary age basalt mixed with Tertiary age clayey sediments. The majority of the pits showed no evidence of disturbance nor the presence of weak materials, and do not give concern with respect to slope instability. The exceptions are test pits 1-4 which revealed fissured clays, often showing slickensides in many directions.

LABORATORY TESTING

A typical sample of the slickensided clay from 1.5-1.9 m depth in test pit 2 was submitted for laboratory tests. The results are detailed below:

Atterberg limits:	Liquid Limit (%)	112
	Plastic Limit (%)	24
	Linear shrinkage (%)	26
	Angle of internal friction (degrees)	18
	Residual cohesive strength (kPa)	1.4

The angle of friction and the residual cohesive strength were determined by cyclical shearing in a shear box. As the sample was already disturbed, it is appropriate to use these values in stability analysis.

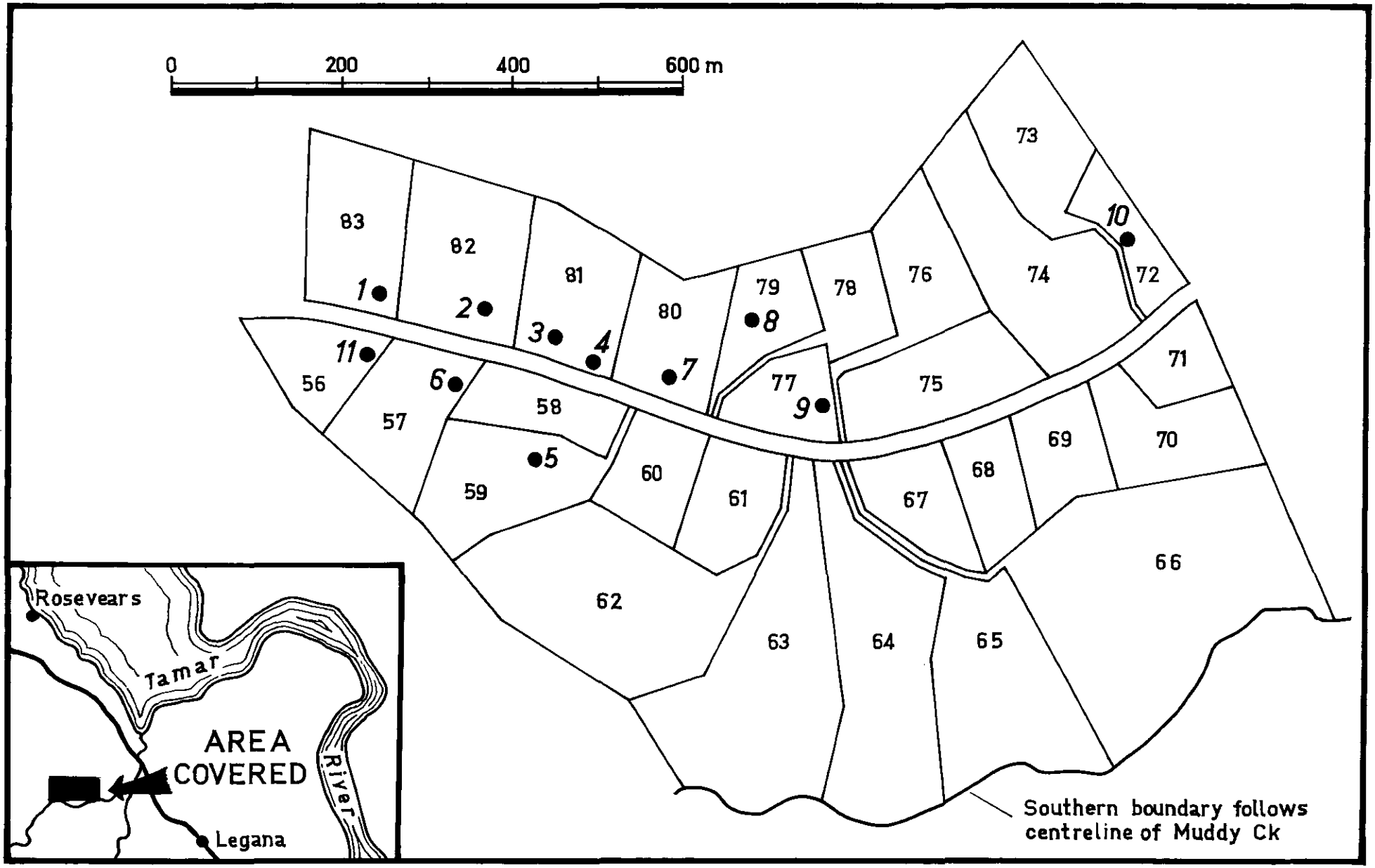

Figure 1. *Locations of test pits, Pleasant Hills subdivision.*

STABILITY ANALYSIS

A typical cross-section (fig. 2) in the vicinity of test pits 1-4 was selected for stability analysis using Bishop's method of slices (Bishop, 1955). The arbitrarily chosen end points of the circle were, on the downslope side, the outer edge of the roadway through the subdivision and, on the upslope side, the change in slope between the steep escarpment of the basalt plateau and the slope on which development is proposed.

An initial slope stability analysis was made for a dry slope with the residual cohesive strength and angle of internal friction as determined in the laboratory tests. A density (expressed in kN/cm^3) of 20 was selected for the soil and the effect of varying the radius of the slip circle was determined (fig. 3). As the radius increases, i.e. as the thickness of the sliding body actually decreases, the factor of safety decreases to a low point over a large range of radii (Yc between 210-300 metres).

A value of Yc=210 was adopted for subsequent slope stability analysis to determine the sensitivity of the factor of safety to density, cohesion and angle of internal friction. It was found that the stability analysis was relatively insensitive to variations in density (fig. 4) but sensitive to variations in cohesion (fig. 5) and most sensitive to changes in the angle of internal friction (fig. 6). The effect of pore water pressure ratios (Ru) is seen in Figures 5 and 6 where Ru of 0.0 indicates dry ground and Ru of 0.5 indicates virtually saturated ground.

INTERPRETATION

In stability analysis, a factor of safety equal to unity indicates a slope in delicate equilibrium, for failure is deemed to have occurred when the factor of safety falls below one. Stability analyses can, at best, only approximate actual ground conditions and require that certain assumptions be made. It is thus possible to obtain a factor of safety less than unity for slopes which have not yet failed. Conversely it is possible to obtain a factor of safety in excess of 1.0 for slopes which have actually failed.

It is generally accepted that slopes which yield a factor of safety between 1.0 and 1.3 during stability analysis have a high risk of slope failure. Moderate risks are associated with slopes where the factor of safety is determined between 1.3 and 1.5. Where the factor of safety exceeds 1.5, the slope has a low risk of slope failure.

At Pleasant Hills the factor of safety of a slope which contains slickensided clay consistently falls below 1.3 over a range of conditions when dry. The factor of safety is reduced even further should the clay be allowed to wet up.

CONCLUSIONS AND RECOMMENDATIONS

The subsurface materials on the majority of lots examined at the Pleasant Hills proposed subdivision for Vos Nominees show no evidence of disturbed or weak materials and are suitable for subdivision.

Slickensided clays encountered on lots 81-83 are evidence of past mass movement. Laboratory tests reveal low values of residual cohesive strength and angle of internal friction. A slope stability analysis of these lots indicates that a high risk of slope failure is associated with these lots. It is concluded that these lots are not suitable for development.

It is recommended that approval be given for subdivision of lots 56 to 80 at the Vos Nominees subdivision, Grindelwald.

It is recommended that approval not be given for subdivision of lots 81-83 at the Vos Nominees subdivision, Grindelwald.

REFERENCES

BISHOP, A. W. 1955. The use of the slip circle in the stability analysis of slopes. *Geotechnique* 5(1):7-117.

WELDON, B. D. 1986. Slope stability at a proposed subdivision at Rosevears. *Unpubl. Rep. Dep. Mines Tasm.* 1986/76.

[16 March 1987]

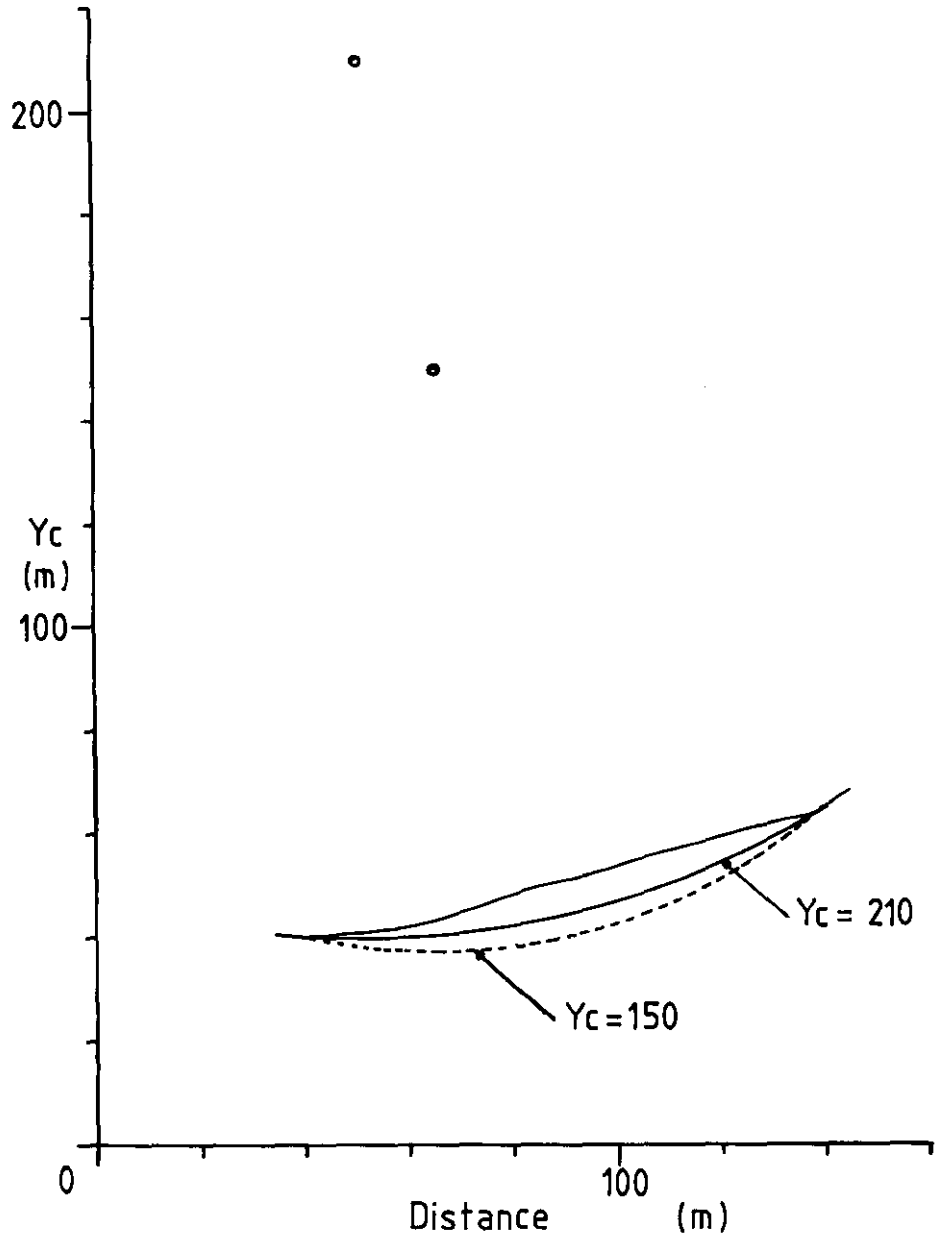

Figure 2. *Cross-section for stability analysis.*

5 cm

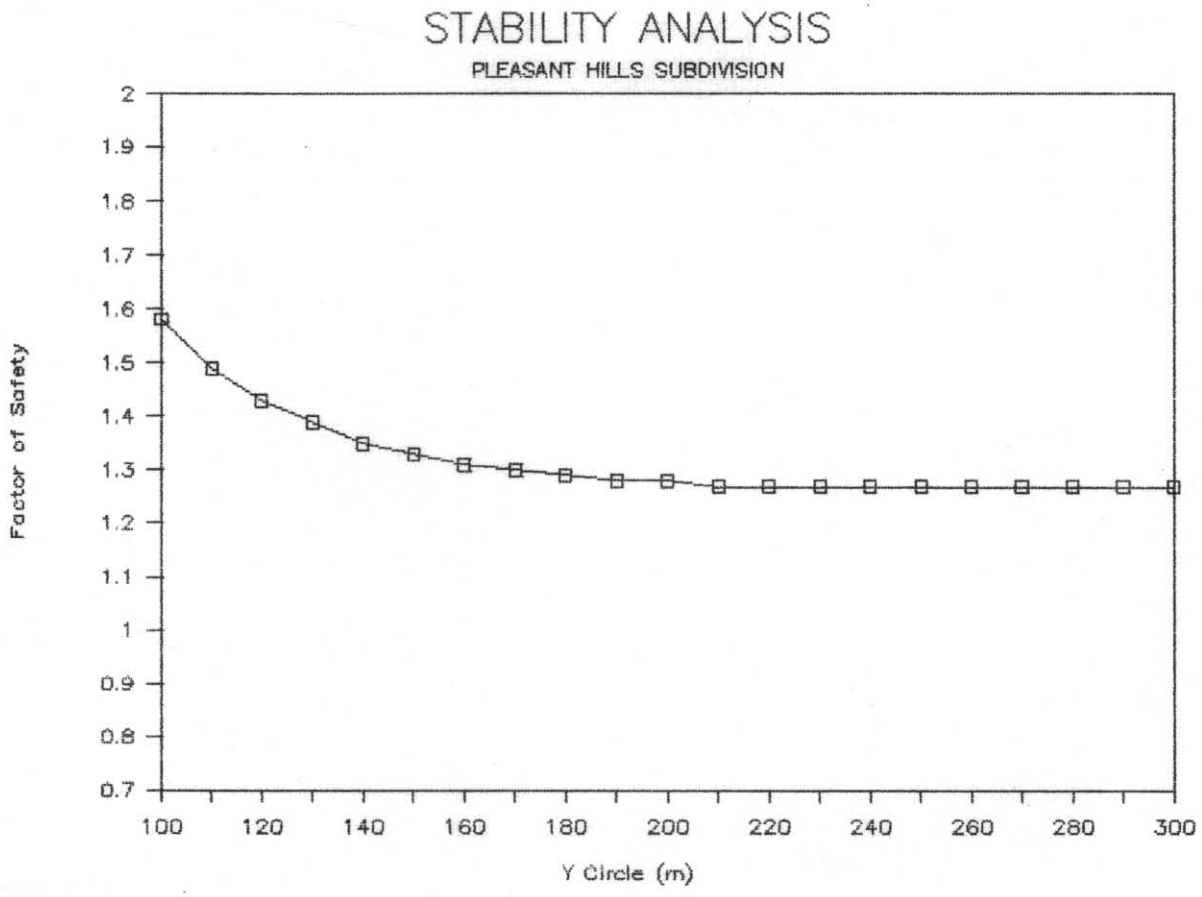

Figure 3.

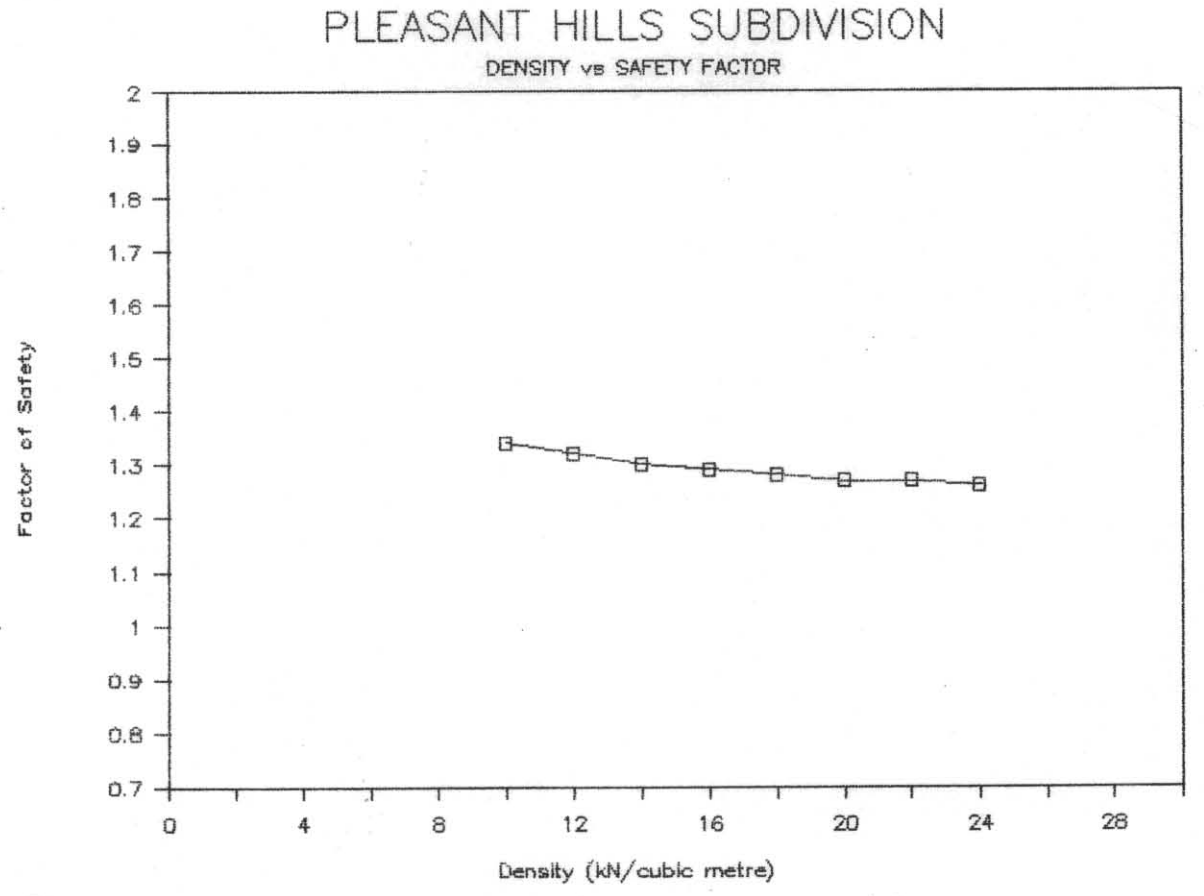

Figure 4.

5 cm

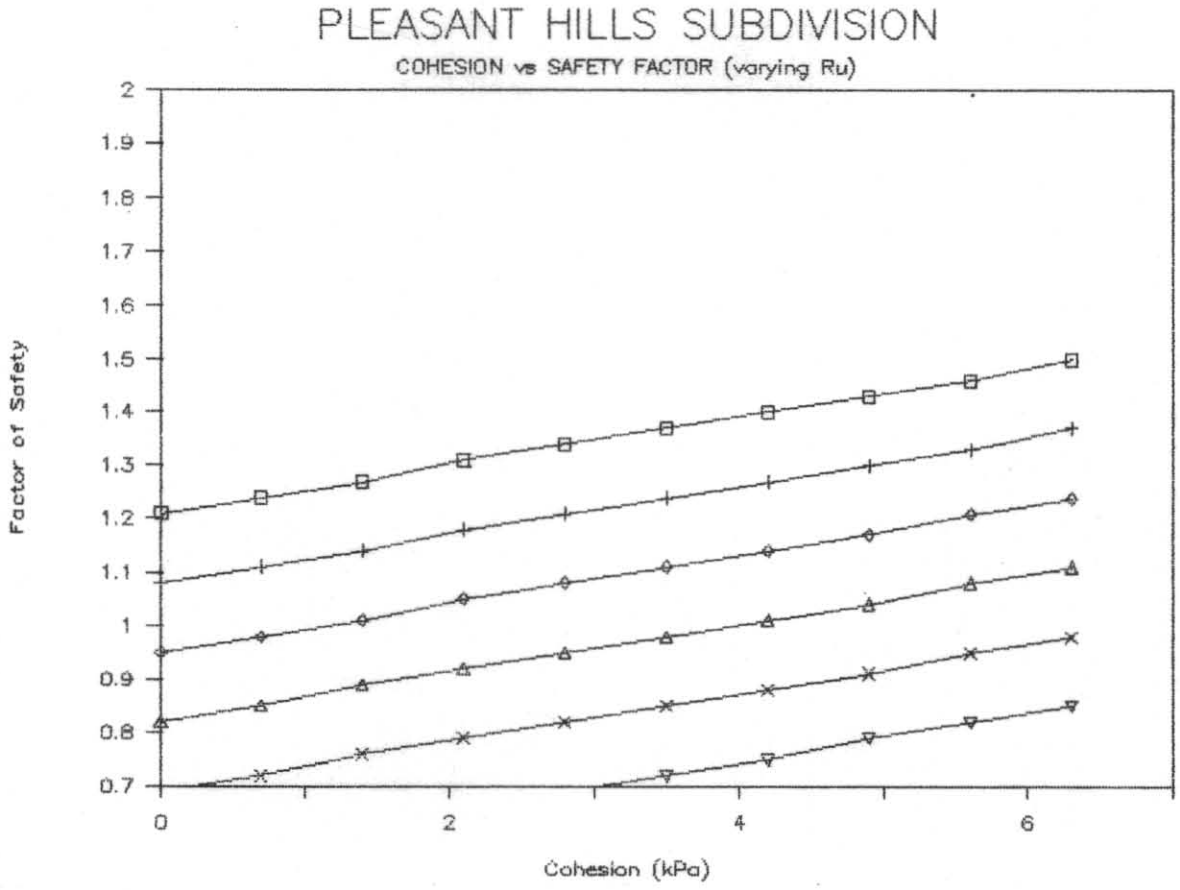

Figure 5.

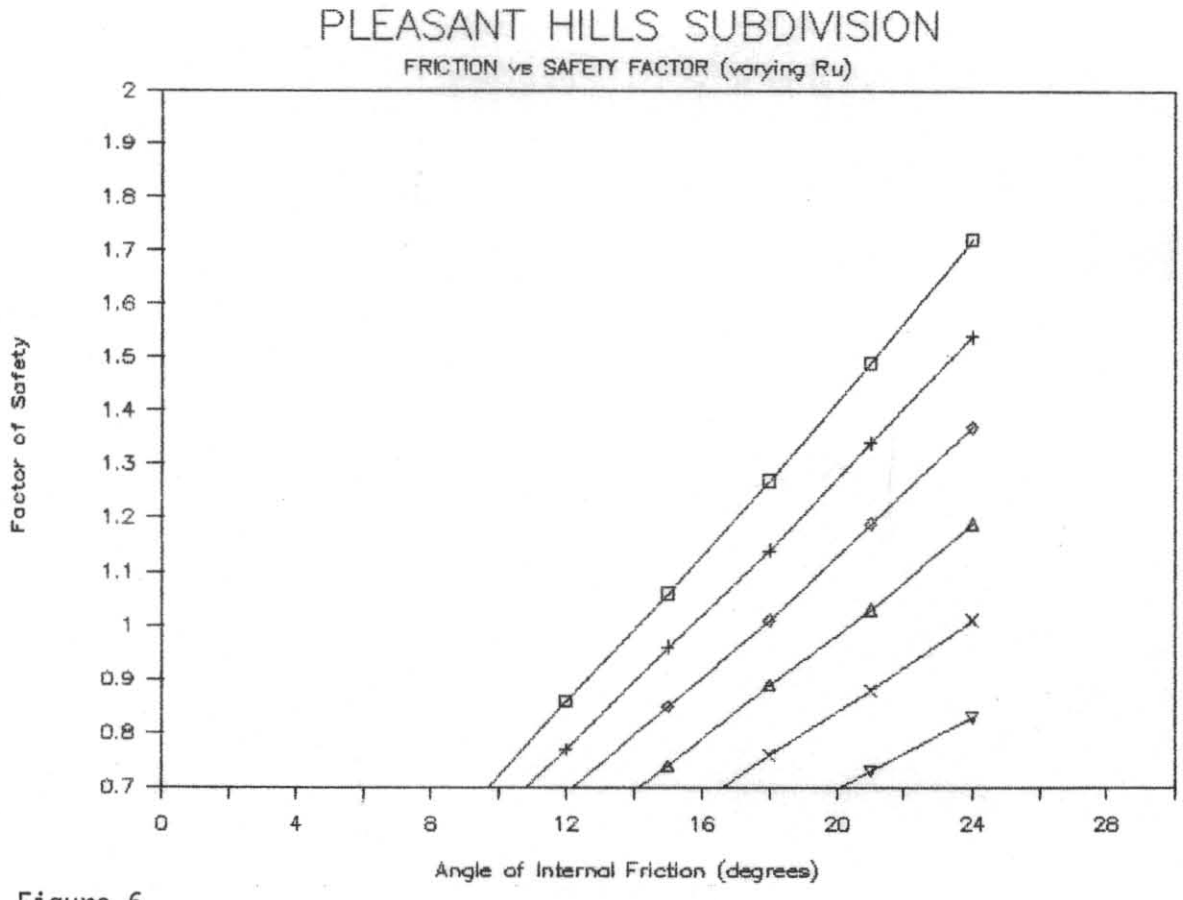

Figure 6.

5 cm

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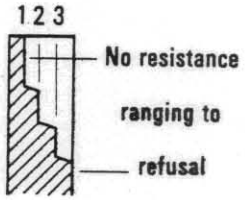
EXPLANATION SHEET FOR ENGINEERING LOGS

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.

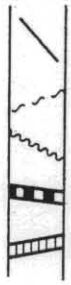
Strength

		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 – EXCAVATION

excavation no. 1
sheet 1 of 1

project PLEASANT HILLS SUBDIVISION location Atkinsons Rd Rosevears

co-ordinates
R.L.
excavation dimensions 4m x 0.6m

exposure type test pit
equipment DOMINO DIG
operator

pit commenced 18.12.86
pit completed 18.12.86
logged by B. Weldon
checked by

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
					0.15			TOPSOIL dark grey-brown silty clay, med-high plasticity, roots/rootlets				
					0.60		GC	GRAVELLY CLAY red-brown, medium-high plasticity, rounded medium size basalt gravel (≈ 40%). Moisture Content less than plastic limit	M			
							CH	CLAY red-brown, high plasticity, some medium to coarse size basalt gravel, Moisture Content (M.C.) approximately equals Plastic Limit (P.L.).	M	Fb		CLAY IS FISSURED with dark lustrous staining on some fissures. peds generally very small (<10mm)
			END		2.0							

sketch

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – EXCAVATION

excavation no. 2
sheet 1 of 1

project PLEASANT HILLS SUBDIVISION location Atkinsons Rd Rosevears

co-ordinates
R.L.
excavation dimensions 0·6m x 5·0m

exposure type test pit
equipment DOMINO DIG
operator

pit commenced 18·12·86
pit completed 18·12·86
logged by B. Weldon
checked by

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
				0.15			TOPSOIL dark brown, silty clay medium plasticity, roots / rootlets				
				0.60		GC	GRAVELLY CLAY red-brown, medium to high plasticity, rounded medium to coarse size basalt gravel M.C. < P.L.	M	Fb		
				0.90		CH	CLAY red-brown, becoming more yellow with depth, high plasticity, M.C. ≥ P.L. occassional rounded basalt gravel	M	St-VSt	•	CLAY is FISSURED with dark lustrous coatings on some fissures
				1		CH	CLAY yellow-red-brown, high plasticity Moisture Content (M.C.) greater than or equal to Plastic Limit; occassional rounded medium to coarse size basalt gravel	M	St-VSt	• • •	SLICKENSIDES are common
			END	1.90							
				2							

sketch

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – EXCAVATION

excavation no. 3
sheet 1 of 1

project PLEASANT HILLS SUBDIVISION location Atkinsons Rd Roseveats

co-ordinates
R.L.
excavation dimensions 4.5m x 0.6m

exposure type test pit
equipment DOMINO D16
operator

pit commenced 18.12.86
pit completed 18.12.86
logged by D L Weldon
checked by

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
				0			CLAY, yellow-brown, rounded basalt gravel, medium grain size, high plasticity, occasional boulder Moisture Content (M.C.) less than plastic limit (P.L.).	M	Fb		CLAYS ARE FISSURED with SHINY SURFACES
				0.70		CH					
				1			CLAY yellow-red-brown, high plasticity, moisture content ≈ or greater than P.L.	M	Fb		CLAYS ARE FISSURED with SHINY SURFACES being very common
			END	1.90		CH					
				2							

sketch

5 cm

11/18

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – EXCAVATION

excavation no. 4
sheet 1 of 1

project PLEASANT HILLS SUBDIVISION location Atkinsons Rd Roseveare

co-ordinates
R.L.
excavation dimensions 4.5m x 0.6m

exposure type test pit
equipment DOMINO DIG
operator

pit commenced 18.12.86
pit completed 18.12.86
logged by B. Weldon
checked by

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
					0.70		GC	GRAVELLY CLAY – red/brown, high plasticity clay, gravel is medium to coarse in size and composed of subrounded basalt.	M	VSt		
					0.90 1		CH	CLAY brown, high plasticity, M.C. > P.L., some coarse size basalt gravel with subrounded edges	M	St-VSt		clay fissured with shiny surfaces
					1.60		CH	CLAY yellow-red-brown, high plasticity M.C. < P.L.	M	VSt		
			END	2.0 2								

sketch

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – EXCAVATION

excavation no. 5
sheet 1 of 1

project PLEASANT HILLS SUBDIVISION location Atkinsons Rd Rosevears

co-ordinates
R.L.
excavation dimensions 4.5m x 0.6m

exposure type test pit
equipment DOMINO D16
operator

pit commenced 18.12.86
pit completed 18.12.86
logged by R. Waldon
checked by

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
							BOULDERS : subrounded basalt 250+ x 250+mm, often polygonal in silty clay matrix; roots/rootlets	M			
				0.60			GRAVELLY CLAY red-brown, medium-high plasticity MC. ≈ P.L., medium-coarse basalt gravel (to 30%)	M	VSt-H	x x	
				1.40		GC					
			END	1.60		GC	GRAVELLY CLAY yellow-brown otherwise as above	M	VSt-H	x x	

sketch

5 cm

13/18

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – EXCAVATION

excavation no. 6
sheet 1 of 1

project PLEASANT HILLS SUBDIVISION location Atkinsons Rd Rosevears

co-ordinates
R.L.
excavation dimensions 5m x 0.6m

exposure type test pit
equipment DOMINO DIG
operator

pit commenced 18-12-86
pit completed 18-12-86
logged by B. Weldon
checked by

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
				0.15			TOPSOIL brown clay, med plasticity				
				0.50		CH	CLAY brown-red, high plasticity, M.C. < P.L. ; some basalt gravel	M	VSt		
				1		CH	CLAY yellow-red-brown, high plasticity, MC ≥ P.L. ; occassional fragments of gravel (basalt)	M	St-VSt		
			END	1.70							
				2							

sketch

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – EXCAVATION

excavation no. 7
sheet 1 of 1

project PLEASANT HILLS SUBDIVISION location Atkinsons Rd Rosevears

co-ordinates
R.L.
excavation dimensions 4.5m x 0.6m

exposure type test pit
equipment DOMINO DIG
operator

pit commenced 18.12.86
pit completed 18.12.86
logged by B. Weldon
checked by

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
				0.15			TOPSOIL dark grey/brown silty clay, roots / rootlets				
				0.70		GC	GRAVELLY CLAY with BOULDERS	M			
				1		CH	CLAY red-brown, high plasticity, moisture content ≈ plastic limit	M	St-VSt	x	
				1.20		CH	CLAY yellow-brown, high plasticity M.C. > P.L.	M	St-VSt	x x x	
			END	1.50							
				2							

sketch

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – EXCAVATION

excavation no. 8
sheet 1 of 1

project PLEASANT HILLS SUBDIVISION location Atkinsons Rd Roseneass

co-ordinates
R.L.
excavation dimensions 5m x 0.6m

exposure type test pit
equipment DOMINO DIG
operator

pit commenced 18.12.86
pit completed 18.12.86
logged by R. Weldon
checked by

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
				0.15			TOPSOIL brown silty clay, medium plasticity, roots/rootlets, some gravel				
				0.50		GC	GRAVELLY CLAY, brown, medium to high plasticity, fine-medium gravel size basalt M.C. < P.L.	M			
				1		CH	CLAY red-yellow-brown, medium to high plasticity, M.C. ≈ P.L., some basalt gravel	M	VSt-H		
				1.30							
			END	1.50		GC	GRAVELLY CLAY: clay as above but with coarse rounded basalt gravel	M	St-VSt		
				2							

sketch

5 cm

16/18

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – EXCAVATION

excavation no. 9
sheet 1 of 1

project PLEASANT HILLS SUBDIVISION location Atkinsons Rd Rosevears

co-ordinates
R.L.
excavation dimensions 5m x 0.6m

exposure type test pit
equipment DOMINO DIG
operator

pit commenced 18.12.86
pit completed 12.12.86
logged by B. Weldon
checked by

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
				0.20			TOPSOIL dark brown-grey, silty clay, roots, rootlets, medium plasticity				
				0.50		CH	CLAY red-brown, high plasticity, occassional basalt gravel, M.C. < P.L.	M			
				1		CH	CLAY as above but M.C. ≈ P.L.	M	VSt-H		
			END	1.50 / 1.60		CH	CLAY yellow brown, high plasticity	M	St-VSt		
				2							

sketch

5 cm

20-76

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – EXCAVATION

excavation no. 10
sheet 1 of 1

project PLEASANT HILLS SUBDIVISION location Atkinsons Rd Rosevears

co-ordinates
R.L.
excavation dimensions 5m x 0.6m

exposure type test pit
equipment DOMINO DIG
operator

pit commenced 18.12.86
pit completed 18.12.86
logged by B. Weldon
checked by

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
					0.20			TOPSOIL dark brown-grey, silty clay, med-high plasticity				
					0.50		CH	CLAY dark brown-red, high plasticity with some basalt gravel. Moisture Content less than plastic limit	M	St-VSt		
			END		1.50		CH	CLAY - as above but Moisture Content (M.C.) approximately equal to Plastic Limit (P.L.)	M			

sketch

5 cm

TASMANIA DEPARTMENT OF MINES

ENGINEERING LOG – EXCAVATION

excavation no. 11
sheet 1 of 1

project PLEASANT HILLS SUBDIVISION location Atkinsons Rd Rosevears

co-ordinates
R.L.
excavation dimensions 5m x 0.6m

exposure type test pit
equipment
operator

pit commenced 18.12.86
pit completed 18.12.86
logged by B. Weldon
checked by

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
				0.20			**TOPSOIL** dark grey-brown, med. plasticity, roots, rootlets, silty clay				
				0.60		GC	**GRAVELLY CLAY** red-brown, high plasticity, medium-coarse gravel (basalt), some boulders – elongated to 300mm. Moisture content less than plastic limit	M	St-VSt		
				1		GC	**GRAVELLY CLAY** yellow-red/brown otherwise as above. Moisture content approximately at plastic limit	M			
			END	1.50							
				2							

sketch

5 cm