Further report on the stability of a proposed subdivision near Lilydale.

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Abstract

In a previous report, this area was classified as a potential landslip zone on the basis of the thickness, irregularity and distribution of Quaternary talus gravel. This gravel was tilted when a landslide occurred in the underlying Triassic sediments, forming two benches on the top of a spur. Diamond drilling was undertaken in an attempt to locate a possible shear zone within the Triassic sediments; this was located at a depth of 9.3 m. Water table measurements in this hole indicated that water could rise to within the gravel. Further shear testing on clay from a nearby auger hole confirms that movement is a possibility when the watertable is above the slip plane. With this possibility, the area remains a potential landslip zone in which one house site is possible, provided certain recommended conditions are accepted to reduce the risk.

INTRODUCTION

In a previous report on the proposed subdivision at Underwood [EQ182294] the area around two flat benches on the top of a spur was classified as a potential landslip zone (Moore, 1978). Further investigations, comprising diamond drilling and shear testing of clay samples collected from auger drilling, have now been completed.

DRILLING

One diamond drill hole was drilled on the most likely home site in the area. The hole was located in the middle of the lower bench, away from the steeply sloping edge (fig. 1). The upper bench may have been a more stable area, but its closeness to the high scarp region and lack of winter sun make it unattractive as a home site. It also lacks the commanding view of the lower bench area.

The diamond drill hole was drilled to 23.8 m depth, passing through 7.1 m of Quaternary talus gravel with a low percentage of dark brown clay matrix, then yellow clay, grey and dark grey Triassic mudstone and grey and white feldspathic sandstone of Triassic age. The clay underlying the talus gravel at 7.5 m is 300 mm thick and grades into weathered mudstone and then to unweathered mudstone to a depth of 9.0 m. There is no evidence of any shearing in this clay. Below 9.0 m depth is 300 mm of broken mudstone core where weathering and drilling breakage has occurred along the intersection of joints. This is followed by what is considered to be an old shear zone of clay and soft grey mudstone from 9.3 m to 10.3 m depth. In this soft zone, core loss was high and recovery fell to 50%. Evidence of past movement is seen in the shear polish and slickensides in the clay and mudstone.

Following this soft zone is a sequence of white feldspathic sandstone and mudstone; no further shear zones were encountered. The bedding in the mudstone above the shear zone has a dip at 45° whereas below the shear zone the dip is 25°. The significance of these dips must be minimised because cross bedding is present in the sandstone sections of the core and is also possible in the mudstone. The log of the diamond drill hole is given in Appendix 1.

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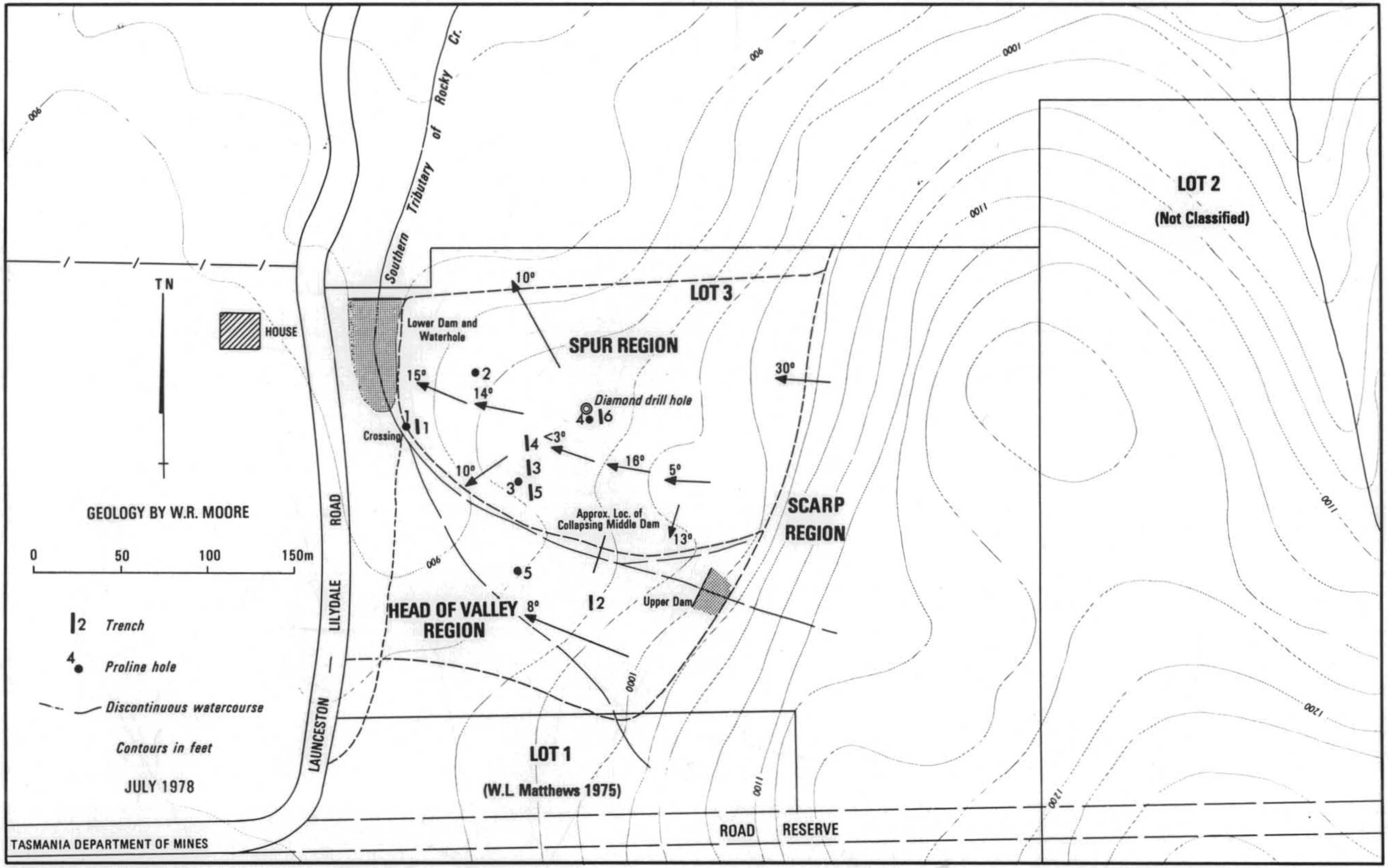

Figure 1. *Location of diamond drill hole*

5 cm

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WATER TABLE LEVELS

After drilling had finished, the hole was thoroughly flushed and then bailed dry and the water table level measured. After two tests, the water table level became stabilised in 24 hours at 4.7 m.

SHEAR TESTING OF CLAY SAMPLES

Unfortunately the amount of clay recovered from the diamond drilling in the suspected shear zone was insufficient to conduct a shear box test. Consequently, all the samples collected from the only deep auger hole drilled on this site in the previous investigation (Hole 3) were tested. These samples were collected at 1.8 m intervals down to a depth of 7.3 m. The sample from 7.3 m gave the lowest cohesion angle (22°) of the samples tested.

Using this friction angle and varying the slope angle between 10° and 22° and water table conditions from below the slip plane to a completely saturated slab, the factor of safety was calculated using the formula of Bishop and Morgenstern (1960). With the water table below the slip plane, the factor of safety was 1.0 for a slope of 22°. With a completely saturated slab the factor of safety was 1.05 for a 10° slope and 0.65 for a 15° slope. With the water table 2/3 of the distance between the ground surface and slip plane and with the slope angle at 15°, the factor of safety was 0.94 and 1.46 for a 10° slope. With the water table 1/3 of the distance between the ground surface and slip plane, the factor of safety for a 15° slope was 1.22 and 1.88 for a 10° slope.

CONCLUSIONS

From the drilling and water table measurements, it is now known that an old slip plane exists at a depth of 9.3 m. This slip plane is likely to be below the water table for much of the year, but it is unlikely that the groundwater level is ever likely to reach the surface of the bench of the spur. Consequently, the extreme conditions of complete saturation and containing no groundwater for the above factor of safety calculations do not apply. On the sides of the benches where slopes of 10° - 15° are measured and water table conditions of 1/3 to 2/3 saturation level are likely, landslips have occurred. Although these are small local parasitic slides and are not related to the deep seated slip plane found by the diamond drilling, the possibility of remobilising this old slip cannot be ignored. This danger is indicated in the factor of safety calculations from the shear tests from the clay from 7.3 m depth in the nearby auger hole.

The conclusion that this two bench spur area should be considered as a potential landslip area is correct and close subdivision in this area is not recommended. Several houses on these benches would only artificially increase the water table level and would accelerate the erosion by small landslips occuring around the margins and could possibly reactivate the larger old slip on the 9.3 m slip plane.

RECOMMENDATIONS

When this area is zoned, it is recommended that the two bench spur be proclaimed as a potential landslip zone in which only one house would be permitted to be built on either the top or lower bench of the spur. This house site must be located in the centre of the bench as far away from edges as is practicable.

The septic tank should not be dug on the bench but located off the spur on the western section of the head of the valley area. All stormwater drains and soakage pits should also be located off the benches.

It is recommended that the house be constructed according to the regulations set out in the Building Amendment Regulations (No. 5) 1974 for landslip areas. The access track to the house site should follow the route recommended in the previous report (Moore, 1978).

REFERENCES

BISHOP, A.W.; MORGENSTERN, N.R. 1960. Stability coefficients for earth slopes. *Geotechnique* 10: 129-147.

MOORE, W.R. 1978. Subsurface investigation and slope stability of Haack's subdivision at Underwood, Lilydale Municipality. *Unpubl.Rep.Dep.Mines Tasm.* 1978/19.

[26 September 1978]

APPENDIX 1

Log of diamond drill hole

Depth (m)	*Lithological description*	*Recovery*	*Age*
			Quaternary
0 - 3.6	Dolerite cobbles and pebbles with rubbly ironstone nodules and small pebbles with low percentage of clay as a matrix.	17%	
3.6 - 4.5	Rubbly iron-stained clay layer mixed with small pebbles with large dolerite cobbles and pebbles at its base, forming a gravel bed. Pebbles and cobbles angular.	77%	
4.5 - 5.5	Dolerite cobbles and pebbles with small percentage of clay matrix.	25%	
5.5 - 7.0	150 mm of red iron-stained clay 300 mm small angular dolerite pebbles and clay 250 mm angular dolerite pebbles. Pebbles unweathered overaging 50 mm in size.	46%	
			Triassic
7.0 - 8.5	150 mm massive grey-yellow clay with dolerite pebbles embedded in the clay. Pebbles angular and unweathered. 150 mm massive grey-yellow clay with one major joint dipping 45°. No shear polish or slickensides apparent. 200 mm broken core of deeply weathered, soft mudstone. Mudstone bedded with graphite grains on the bedding planes. 150 mm black to dark-brown micaceous mudstone. Mudstone deeply weathered with mica on bedding planes.	43%	
8.5 - 9.0	Bedded grey graphitic micaceous mudstone with cross bedding of small wisps of sandstone. Mudstone competent and unweathered. Bedding dips at 45°.	86%	
9.0 - 9.3	Broken core with weathering on two 45° joints. No clay present on the joints.		
9.3 - 10.0	Broken core of soft, black to dark grey mudstone and clay with inter-mixing of the bedded mudstone and clay. Incipient shear marks and shear polish seen on mudstone bedding. Thought to be the top of the slip zone.	Shear Zone	
10.0 - 11.5	100 mm massive grey-brown clay with shear plane marks present. 200 mm reported core loss. 100 mm grey		

Depth (m)	*Lithological description*	*Recovery*	*Age*
	mottled mudstone weathered with one joint with a dip of 45°. Slickensides on the joint faces. Thought to be the bottom of the slip zone. 500 mm dark grey bedded mudstone. 400 mm massive white feldspathic sandstone. 250 mm broken core of soft, white, fine-grained micaceous sandstone.	Shear Zone 60%	Triassic
11.5 - 13.0	50 mm feldspathic sandstone. 250 mm broken core of massive white sandstone and minor grey mudstone. Core broken on joints from drilling. 1.2 m massive to poorly bedded grey-white feldspathic sandstone.	100%	
13.0 - 14.5	800 mm massive to poorly bedded white micaceous sandstone. Two joints, dip 45°. Iron staining around joints. 600 mm of broken core of soft white fine-grained micaceous sandstone with one vertical joint. 100 mm massive grey to white sandstone.	100%	
14.5 - 16.0	Soft grey micaceous mudstone with carbonaceous and graphite grains. Mudstone closely bedded with dip of 25°. Two major joints with iron stained joint planes; one joint dips at 75° the other is horizontal.	100%	
16.0 - 17.5	300 mm dark grey mudstone with minor mudstone partings. Dip on mudstone 25°. 400 mm of broken core of white soft feldspathic sandstone. Sandstone massive to poorly bedded. Two joints dip at 70° and intersect causing broken core. Some rusting near the joints. 400 mm cross-bedded micaceous sandstone.	100%	
17.1 - 17.5	Grey-white bedded sandstone with graphite and mica on the bedding planes.	100%	
17.5 - 19.0	300 mm cross-bedded grey-white sandstone. 200 mm broken core of feldspathic sandstone. Vertical joint with iron-staining on joint. Bedding in sandstone horizontal. 1 m massive to poorly bedded feldspathic sandstone with iron-stained concretion. Graphite and mica on some bedding planes. Two 45° joints that intersect. No rusting of joint planes.	100%	

Depth (m)	Lithological description	Recovery	Age
19.0 - 20.5	1.0 m massive to poorly bedded felds-pathic sandstone. 500 mm grey and brown organic mudstone. Grades down to a massive fine grey sandstone.	100%	
20.5 - 22.0	Massive very fine-grained feldspathic sandstone with carbonaceous partings.	100%	
22.0 - 22.7	Fine-grained grey sandstone with rusty joint. One joint at 22.6 m with dip of 70°. 22.6 - 40 mm grey mud-stone bed weathered to soft mudstone.	100%	
22.7 - 23.5	Bedded medium-grained feldspathic sandstone with carbonaceous mudstone pellets and partings. Bedding dips at 23° with some rusting on bedding.	100%	
23.5 - 23.8	As above with broken core of sand-stone.	100%	