

1976/16. Ground movements at Casuarina Crescent, Glenorchy.

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The Department of Mines was requested by the Glenorchy Council to report on apparent earth movements at Casuarina Crescent [EN209608].

The geological field work was done on various occasions between 16 January and 14 March 1976. Casuarina Crescent, containing about 25 blocks, runs along the centre of a small peninsula about 200 m wide projecting the same distance eastward into the River Derwent as McCarthys Point.

The peninsula rises to about 23 m above sea level, and slopes down to cliffs which are up to 10 m high on its south side. Elsewhere slopes are merely convex, resulting in steep slopes close to the shore. The flat-topped area has become a residential settlement over the last 20 years, having previously been open lightly wooded country. Aerial photographs taken before settlement show irregular hummocky slopes on the north side of the peninsula.

The bedrock of the area is Lower Triassic fine- and medium-grained quartz sandstone with minor mudstone. These rocks are soft, weathered, dip gently toward the west and crop out mainly in the cliffs mentioned above.

The bedrock is overlain by a variable thickness up to perhaps 10 m of mixed sediments. This deposit has not been previously studied but consists of boulders and smaller fragments of Triassic sandstone, dolerite, Permian mudstone and basalt dispersed in a mottled brown and grey sandy clay matrix. The deposit lies draped over the Triassic sandstone bedrock and has the form of an old eroded river terrace. The materials are all deeply weathered and the proportion of clay is probably greater than 50%. The soils found in this terrace deposit are light and sandy but have sufficient clay to shrink and crack in dry weather.

The ground surface has been disturbed by mass movement or landslip over nine house blocks. A general account of the ground surface features is given in Figure 1.

The surface on which the houses stand slopes at 4-11° with occasional steeper areas, as at No. 14. Evidence for deformation ('stretch marks') can be seen on this surface at Nos. 10, 12, 14, 16 and 18 but the ground does not appear to have been affected significantly at Nos. 20, 22, 24 and 26.

Below this surface is a break of slope and a steep bank often now at 25°, but becoming less steep at No. 14 and more so at No. 12. This steep slope is visible on aerial photographs taken in 1946, but has been emphasised by terracing, filling and by ground movement since then.

Below the steep bank a more gently sloping area is well marked at Nos 16, 18 and 20. Here the ground is extensively cracked but these cracks are due to drying and should not be confused with the 'stretch marks' mentioned above. Another steep bank is situated below this area. Between it and the shore the slope becomes confused and this has been so since 1946 although it has again been complicated by the installation of the sewer, cutting and filling, the erosion along the foot path and the cutting of the bank at the high tide mark by wave action.

The most prominent feature when assessing the present and possible future damage to the houses is the large tension crack, evidence for which can be seen on blocks of Nos 14, 16, 18, 20, 22, 24 and 26. The crack was seen open at No. 14 and can be inferred from the movement of paving slabs,

fencing, walling or other artefacts.

Where seen at Nos 20, 22 and 24 the crack crosses the upper flat surface and so has not caused a steep bank to form but at Nos 14, 16 and 18 the crack has been accompanied by slumping on the lower side with the production of a steep bank.

The ground movement can be pictured (see inset, fig. 1) as a series of slices, curved in profile and in plan slowly sliding successively down on curved fracture surfaces. That this process has been continuing for some years is plain and it is to be feared that it will continue if nothing is done. The process seems to have been active before 1946 for the slopes appear quite disturbed in the photographs, but such a process is intermittent and may be active only at intervals of 20 or 30 years or longer.

Any ground movement of this kind requires the presence of three factors; there must be:

- (1) a slope so that potential energy is available to break the material and move it downhill;
- (2) material that will lose strength easily, that is clay; and
- (3) water present to soften the clay, increase its weight and cause it to slide readily on the fractures.

All these factors are present at Casuarina Crescent.

DRAINAGE HISTORY

The record of testing of drains held by the Glenorchy Council is instructive. Nos 14, 16, 18, 20 and 22 have had at least one additional test since installation, and Nos 16, 18 and 20 have had cast iron sewerage pipes installed after fracture. This work has been done in the years 1962, 1963, 1968, 1969, 1970 and 1971.

Fracturing and replacement of drains has therefore been commonplace for over twelve years and there is no reason to suppose that even cast iron pipes will resist movement for long. Indeed the writer saw evidence for drain failure at No. 20 during the present survey. This history indicates that slow movements have occurred over this period, and of course the fracture of drains will provide one of the essentials for ground failure, the presence of abundant water. This has been augmented during 1973-1976 by unusually heavy rainfall; 1973 was 13%, 1974 was 36% and 1975 was 51% above average at Glenorchy.

Another source of water is the disposal of stormwater. This is collected into downpipes from roofs and the Council's records show that it is then taken downslope nominally to high water mark. An examination will show that little or none of this water does in fact reach the river in pipes, and broken or displaced pipes can be seen at several places. Additionally, several gardens have water taps installed for watering purposes, and the supply pipes to these have either fractured, or have been so severely displaced by ground movement that this is imminent.

Pipes designed to carry away water not only suffer badly in an area of ground movement, but contribute very greatly to the process of movement by introducing water directly into the ground fractures where it can do most harm.

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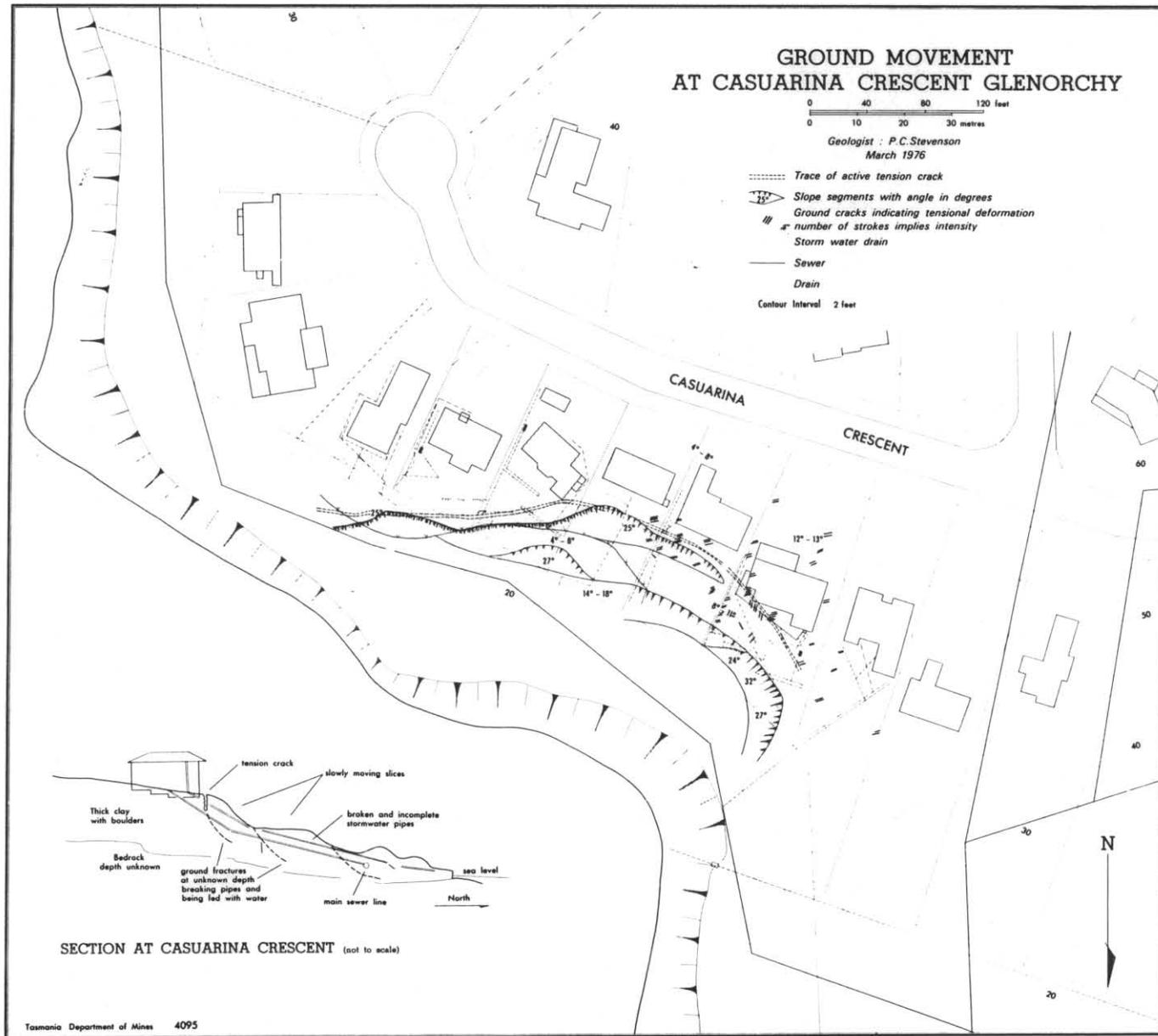


Figure 1.

5 cm

DISCUSSION

Sufficient has been written to indicate the nature and gravity of the problem, but if further proof is needed, then this could be provided by several bore holes to provide samples of clay and to give water levels. These could further be used to calculate a stability analysis and give quantitative information.

At this stage however it is clear that some action is required urgently to try to stabilise the slope.

The three factors of slope, clay and water which are essential to this type of ground movement suggest remedies which may be able to restore stability to the slope.

If the slope could be reduced then less energy would be available. Such a solution is generally impractical, but some contribution could be made by removing terraces and fills which have been placed in the past to provide more flat ground. This would enable the steep slopes which have been created to be flattened, so reducing the load on the lower slopes. This could only provide a minor contribution to stability.

The nature of the clays in the slope is very difficult to modify although such a solution is possible but in this respect the best contribution can be made by retaining as many as possible of the trees and shrubs. These not only bind the surface to some extent but also abstract appreciable quantities of water.

The control of water is the easiest and also the most effective solution, but a concerted effort is required and the remedy is not permanent. As soon as control of the water, is lost, movements will be again initiated. In order to establish this control all pipes carrying water must be checked for leakage and those which are faulty must be replaced urgently. Thereafter during the life of the houses there must be some conscientious periodical check to insure that leakage does not restart. The stormwater for disposal is more likely to be ignored when leaking, but is also easier to deal with. Specific suggestions on the general control of effluent waters are given below.

The over watering of gardens is undesirable. The construction of swimming pools would be unwise as leakage is almost impossible to prevent and periodical emptying can endanger the stability of slope.

CONCLUSION

An active landslip condition exists at Casuarina Crescent.

RECOMMENDATIONS

It is important that houseowners are informed of the nature of the problem and, to this end it is recommended that a meeting be held attended by houseowners, Council staff and Department of Mines geologists. The actions of houseowners can have a great influence on the stability of the slope, and they should be informed directly of what actions are required. In return the geologists can often gain an insight into the detailed behaviour of the slope from the past experience of the houseowners.

The sewerage system of each house should be tested for leaks with the utmost care. This may involve excavation of the pipes as far as the sewer

and possibly the testing of the sewer itself. It may become clear that underground sewerage pipes are inadequate in the active area and it may become necessary to consider sewer pipes in conduits or installed above ground with crushed metal back filling .

The stormwater pipes must similarly be examined for leaks, defects strictly rectified, and the pipes extended to sea level. It may become easier to discharge stormwater to the gutter in Casuarina Crescent rather than to persevere with pipes across the active area.

A drilling programme to examine the subsurface materials, their moisture content and the position of movement planes should be planned. The above recommendations should take priority over it, but a long term solution to the stability of the area may be possible with adequate detailed knowledge derived from subsurface investigation.

[24 March 1976]