1977/41. Foreshore instability near Taroona High School.

R.C. Donaldson

Abstract

Mass movement and cliff regression is prevalent along the foreshore area between the Taroona High School and Karingal Court [EN290455].

The cliffs on the foreshore below Karingal Court are slowly retreating. They consist of a relatively competent sequence of interbedded Tertiary conglomerates, sandstone and claystone dipping to the south-west. The regression is associated with marine erosion and the movement of groundwater through the sub-surface. The seepage of groundwater, together with the additional surface water infiltration connected with residential development has the potential to accelerate this slow natural process and, in time, create stability problems.

Slumping of the foreshore cliffs below the High School sports ground is actively extending by headward caving of the scarp. Fissures developed along the western edge of the sports ground have been traced for 120 m around to the foreshore. The sediments at this location are devoid of the coarser fractions, comprising largely of fissured plastic clays interbedded with sandstone. Movement is associated with the local build up of groundwater pressures and the low shearing strength of the fissured clay. The infiltration of surface run-off water into the sub-surface via existing tension fissures is further adding to the problem.

The overall stability of the area could be increased by the installation of a suitable drainage system which would reduce the ingress of surface run off waters into the sub-surface.

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The Kingborough Council requested an investigation of the stability of the foreshore area between the Taroona High School and the northern end of Karingal Court [EN290455]. Concern was expressed at the potential danger to waterfront properties resulting from mass movement processes.

GEOLOGY

The variable and rapidly changing nature of the Tertiary Sediments is well illustrated in the cliffed section of the foreshore between the Taroona High School and the creek to the north of Karingal Court.

A sequence of boulder beds, conglomerate, cemented gravel, grit, lithic sandstone and minor intercalations of clay crop out in the cliffs below Karingal Court, immediately north of the school's sports ground. These sediments dip to the south-west and represent reworked Permian sediments and dolerite.

In contrast, the Tertiary sequence seen in the cliff below the oval is devoid of the coarser fractions and consists largely of interbedded clay and sandstone. The clay, up to several metres in thickness, is typically fissured and behaves plastically. Considerable disturbance and deformation is evident, with relative movement having taken place along the incompetent clay horizons (plate 1). The whole area is draped by a thin surface veneer of brown/black dolerite-derived soil and clay.

FORESHORE STABILITY

Karingal Court

The properties fronting onto the foreshore at the northern end of Karingal Court are not considered to be in any immediate danger from massive failure of the 10 m high cliffs. The sediments forming the cliff represent a relatively competent sequence, despite the breakdown of certain horizons through the removal of matrix and clay components resulting from weathering. These sediments dip to the south-west, enhancing the natural stability of the cliff face.

Marine erosion with some minor cliff retreat is evident, but the rate appears to be so slow along this particular section of the foreshore that it is insignificant and represents no great hazard.

Ground water seepages, together with the increase in the amount of surface water infiltration associated with residential development may, in time, create stability problems and accelerate this slow natural process.

Further cliff retreat is inevitable; the movement of water through the sub-surface has the potential to reduce stability. It is recommended that the input of additional water into the system from residential development be reduced to an acceptable minimum. This can be achieved through an effective household drainage system which would direct water away from the cliff into stormwater drains.

Taroona High School sports ground

Evidence of active landslip activity is seen in the Taroona High School sports ground area. A series of fissures have developed in the base of the cut along the western edge of the lower oval and extend around the foreshore to the north (fig. 1). Horizontal and vertical displacements of between 0.15 m and 0.3 m are typical of the order of movement (plate 3).

Mass movement is also prevelant along the foreshore cliff section which forms the eastern boundary of the sports ground. Earthen material has slumped onto the beach over a distance of approximately 30 m, taking trees and scrub with it (plate 2). Further movement is imminent along this section of the foreshore; fissures in various stages of development have formed in the zone of tension behind the main head scarp (plate 4).

The surface water drainage system is virtually non-existent, adding considerably to the landslip problem. The rear of the sports ground is ill-drained; surface run-off water has been seen flowing directly into the fissures during a recent downpour. In addition, water was being channelled into the head region of the landslip on the foreshore.

A short drilling programme was carried out to determine the nature and cause of movement. Considerable ground water pressure was encountered in Hole 6 (fig. 1). Water was struck at 10.0 m; this rose rapidly and is currently at 4.40 m. Regular monitoring will be continued and variations noted. Unfortunately, water was not encountered in Holes 4 and 5, due to an insufficient number of auger lengths to enable drilling to continue to greater depths.

It is not the intention or purpose of this report to discuss in detail the mechanism causing failure. However, in brief, the mass movement is associated with three factors:

- the surface water run-off and infiltration
- the local build up of groundwater pressures
- the low shear strength of the fissured clay.

It is also important to note that deformation increases significantly with increasing pore water pressure.

In principle, a decrease in pore water pressure gives rise to increased stability. This is usually accomplished by drainage. The fissured clay and permeable sand beneath the sports ground could be drained, but an effective drainage system could not be easily installed at a realistic cost. The concept that the most permeable materials should be drained requires that all water bearing beds should be crossed. This is not often feasible in disturbed ground where beds have sagged, or fractured, as evidenced in the cliff section (plate 1).

As an economic compromise, it is recommended that an effective drainage system be constructed to divert all surface run-off water away from the area, and preferably into the creek to the south of the sports ground. It is not anticipated that this will completely stabilise movement, but it will considerably reduce the potential for future mass movement. Existing fissures which allow the ingress of water into the sub-surface should either be plugged or the ground re-modelled by earth moving equipment to an even gradient, especially to the north of the sports ground. Natural vegetation should remain along the foreshore.

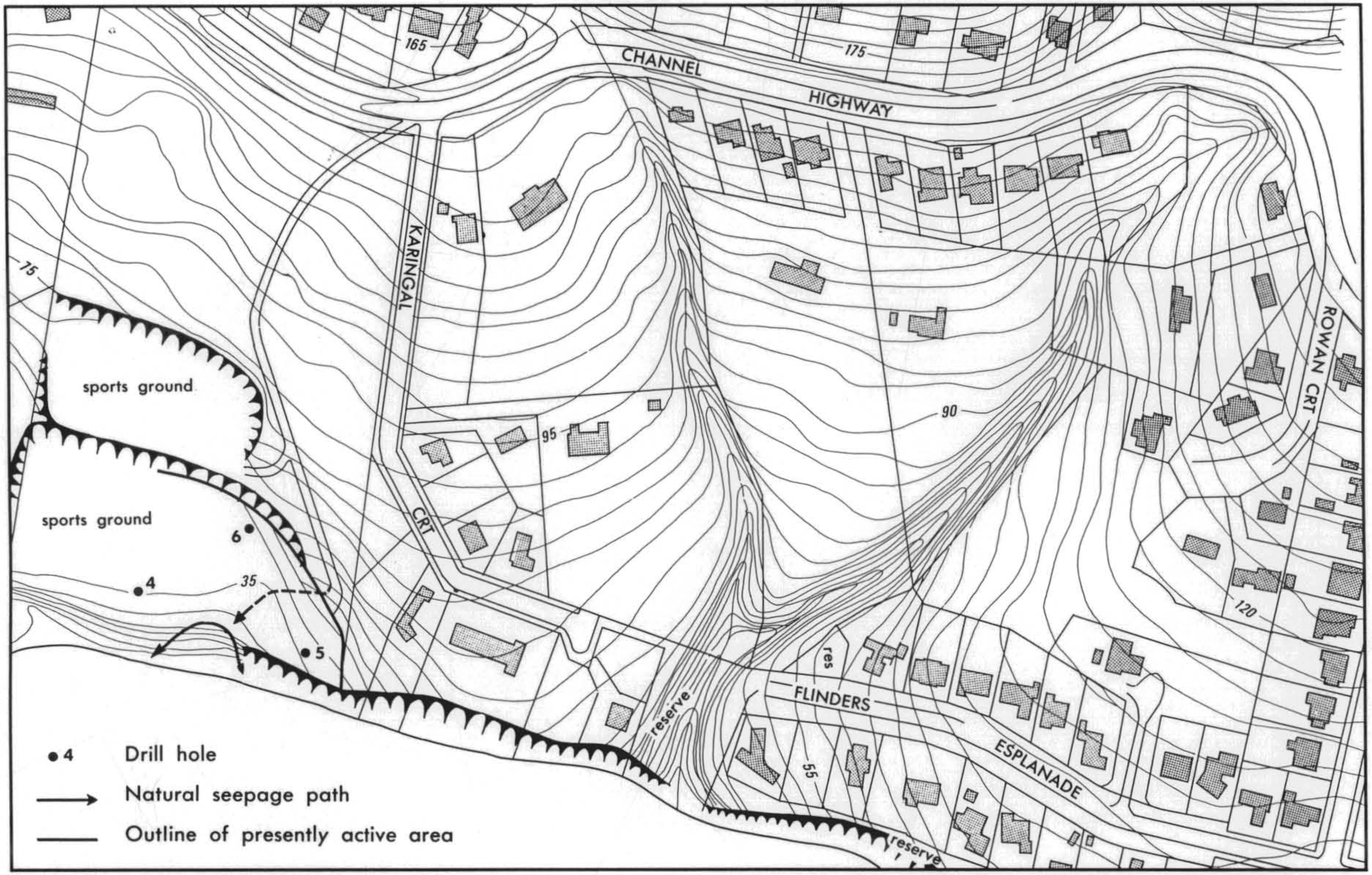

Figure 1. *Location of active areas.*

Plate 1. *Tertiary sediments exposed in foreshore cliffs north of Taroona High School. Note disturbance and movement associated with fissured clays.*

Plate 2. *Slumping of Tertiary sediments onto beach below sports ground.*

Plate 3. *Tension crack developed along western edge of sports ground.*

Plate 4. *Fissure in zone of tension behind main head scarp. Stretched tree roots indicate active movement.*

REFERENCES

STEVENSON, P.C. 1976. Ground stability at Taroona High School. *Unpubl.Rep.Dep.Mines Tasm.* 1976/12.

LEAMAN, D.E.; CROMER, W.C. 1976. Marine erosion at Taroona. *Unpubl.Rep.Dep.Mines Tasm.* 1976/68.

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APPENDIX 1

Summary of Proline auger logs

Hole No.	Depth (m)	Description
4	0-0.9	Topsoil over a stiff moist dark brown plastic clay.
	0.9-1.8	Very stiff dark brown clay containing quartz grains and fragments of sandstone.
	1.8-3.7	Mixed light brown/fawn friable clay intercalated with more gritty horizons containing fragments of sandstone.
	3.7-6.3	Slightly plastic laminated clays. Weathered sandstone fragments. Drill penetration rate suggests alternating bands of clay and sandstone.
	6.3-8.2	Similar to above - clay moist and more plastic.
5	0-0.9	Topsoil over a tough brown plastic clay.
	0.9-1.8	Soft crumbly brown clay.
	1.8-3.7	Soft moist reddish brown clay.
	3.7-8.2	Firm orange/brown clay, sandy fractions present.
6	0-0.9	Topsoil over a stiff green and brown clay. Very plastic, with oxidised patches.
	0.9-1.8	Stiff plastic light grey laminated clay, oxidised patches.
	1.8-2.7	Feldspathic clayey sands and clays.
	2.7-3.7	Dry clayey, silty, sandy material.
	3.7-4.6	Moist brown moderately plastic clay.
	4.6-5.5	Dry brown clay with 30-40% sandstone fragments.
	5.5-6.4	Similar to above - friable lithic sandstone horizon at 6 m.
	6.4-9.1	Grey plastic clays containing lithic sandstone fragments.
	9.1-10	Wet returns - similar to above, sandy grey clay.