

Soil erosion at a proposed lawn cemetery at Kingston

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Introduction

An earlier report (Leaman, 1974) outlined the geological and hydrological situation at the site of a proposed lawn cemetery at Kingston. Mention was made at that time of the early stages of erosion. In view of this and the obvious drainage restrictions, it was recommended that the area be inspected after soaking rains had fallen. The property was subsequently inspected on two occasions, once in early August and again some weeks later. On the first occasion, the visit was preceded by several days of light to moderate rainfall. In addition, in the time between the original investigation and the first visit, the Kingborough Council had dug several pits in area B (fig. 1) and attempted a drainage investigation (as a result of discussions between the writer and the municipal engineer).

The council pits were situated in two basic lines, one along the eastern margin of area B and the other in the centre of area B, trending approximately NNE–SSW. One pit was located on the western side of area B and one in area C. Filling of the pits with water showed that the permeability of the weathered Triassic materials was very low. Pits in weathered sandstone indicated a higher permeability due to a lesser clay fraction.

Hydrology

Low permeability soils and impermeable surface clays may be inferred from the presence of shallow-seated soaks, sags and springs. The need for many shallow drains on the slope shows that surface runoff and shallow soil flow is the predominant response to rainfall. Direct infiltration is minimal at the present time.

A low water table is normal, generally at a depth of more than two metres (in winter 1972 more than four metres).

Drilling in the region of the quarry at the north end of area B revealed alternations of clay, sand and sandy clay, and thus perched water tables could be present (see Longman, 1962). It is obvious from Longman's sections that vertical continuity is non-existent and that all water flow will be lateral through the material once an intake point has been found. In view of the probably patchy clay seal at the surface the irregular distribution of springs and soaks may be explained. Confined water situations could also be present. The water tables indicated by Leaman (1974) could well have been perched although breakage of seals will release lenses of confined water. The dug pits showed that most near-surface underflow occurred at the base of the loamy soil and clay within 500 mm of the surface.

Erosion

Several distinct lines of sub-surface collapse are evident across area B. In places the roof has fallen and surface scour is commencing. This is the beginning of badland erosion which is the last phase of an erosion cycle in these soils.

Erosion in the soils of the Lower Triassic rocks commences with breakdown of the binding clays, either by chemical action of salt removal or replacement or by piping. In either case clay particles combined at silt size are removed leaving an increased porosity. With passage of time and water more particles are removed until a series of pipes or tunnels is produced. The presence of such channels increases the capacity to accept and pass water and the channel is enlarged until the roof collapses. Direct surface erosion may then proceed and gullies are produced. Tunnels may also be instigated from rabbit burrows. Once the process reaches tunnel development it is very difficult to halt as the soil texture in the given region has broken down. Plowing only exacerbates the effect as well as increasing overall water intake.

In area B pipes up to 20 mm diameter are visible at a depth of 300–900 mm. Rapid water movement through the soil is thus being facilitated after rainfall. At the first visit water could be seen actively seeping from the surface at the various outlets and flowing from the pipes in those places where roof collapse had occurred. The exact extent of the tunnelling is unknown but it is likely that the whole area contains distributaries to the main pipes in the partially collapsed drainage areas.

Effect of use as a cemetery

Graves are basically holes dug to a depth of more than two metres through the impermeable surface material. The hole is then filled with the extracted material. However, it is now completely disturbed and does not again display the same hydrological characteristics. Its permeability and porosity are significantly increased. As a result infiltration is increased and runoff reduced. More water is transferred underground.

Case 1: Where the grave is dug in impermeable material.

Following rainfall the filled grave will be saturated with water. This effectively loads the walls of the grave, which have been disturbed in the digging process, with up to 2-3 m head of water. Initially creep from the grave may be very slow, but eventually due to rotting and 'weathering' of the walls, transmission will be increased and piping may then commence. In addition the local head of water is raised above the soil base leakage zone, previously the only active seepage zone, and then only immediately following intake, and thus continual seepage will occur from graves. Water above this level moves at varying rates depending on the properties of the material as displayed in the test pits.

Case 2: Where the material is permeable or slightly permeable

Presence of the grave will increase water flow at low levels. Direct outflow occurs with permeable walls and piping commences on slightly permeable walls. This case includes the situation where the hole cuts through perched aquifers. Permeable materials are to be found in the northeast corner of area B.

When such a cemetery is viewed as a whole it is seen to be a large porous sponge, a marked change from the present relatively impervious surface, with much water being transmitted to depth in material that will readily pipe. If a grave is dug in a zone containing pipes water flow from the hole will be immediate. Thus compounds from the decay process could be rapidly transferred underground to the nearby river or to the surface and then downslope. The time of transfer could be only a few hours, meaning that insufficient time would elapse for the death and filtration of pathogenic bacteria.

In those situations where graves do not intersect pipes water transfer may be very slow. In much of area B it could be expected that little drainage will occur for a long time, resulting in slow decomposition in reducing conditions. Ultimately, due to ground disturbance, wall collapse and pressurisation in any of the paths present, pipes will be produced and escape will occur. If or when a pipe, though small, from a grave interconnects with the main tunnel system then rapid transit to the river will occur.

Conclusion

This particular property is unsuitable for use as a cemetery based on the following soil properties:

1. Its unpredictable permeability and tendency to pipe, erode, collapse and suffer wall alteration and instability, even when backfilled.
2. The soil structure, partly layered and confined, produces disrupted water table situations.
3. Some graves will directly intersect tunnels and thereby permit immediate pollution of nearby surface drainage. It is not possible to predict where all present tunnels may be found or where others are likely to develop.
4. Over much of area B decomposition will be very slow due to water filling graves in almost impervious areas, which is most of area B as shown by filling of trial pits.
5. The entire hydrological situation will be altered and great quantities of water now running off will pass either into, or through, graves causing pressure situations or accelerated erosion depending on the initial permeability.
6. Any tendency for tunnel or pipe production will ultimately result in surface water pollution as it may be expected that the cemetery will be in use over many years and decomposition will be slow.
7. Remedial measures are not likely to be economic or successful. Attempts to lower the water table by pumping cannot be effective as it is water within the upper three metres which is critical and this will be ponded in graves or passing in channels. Planting of trees or pumping to remove water from pipes will not be successful in general due to the erratic, restricted nature of the flow system as well as its high capacity.

The above comments may be regarded as general for soils derived from mixed sandstone-mudstone successions of Triassic rocks.

References

- LEAMAN, D. E. 1974. Proposed lawn cemetery, Kingston. *Tech. Rep. Dep. Mines Tasm.* 17:139-143.
- LONGMAN, M. J. 1962. Brickmaking materials at 'Bowenwood', Kingston. *Tech. Rep. Dep. Mines Tasm.* 6:40-43.

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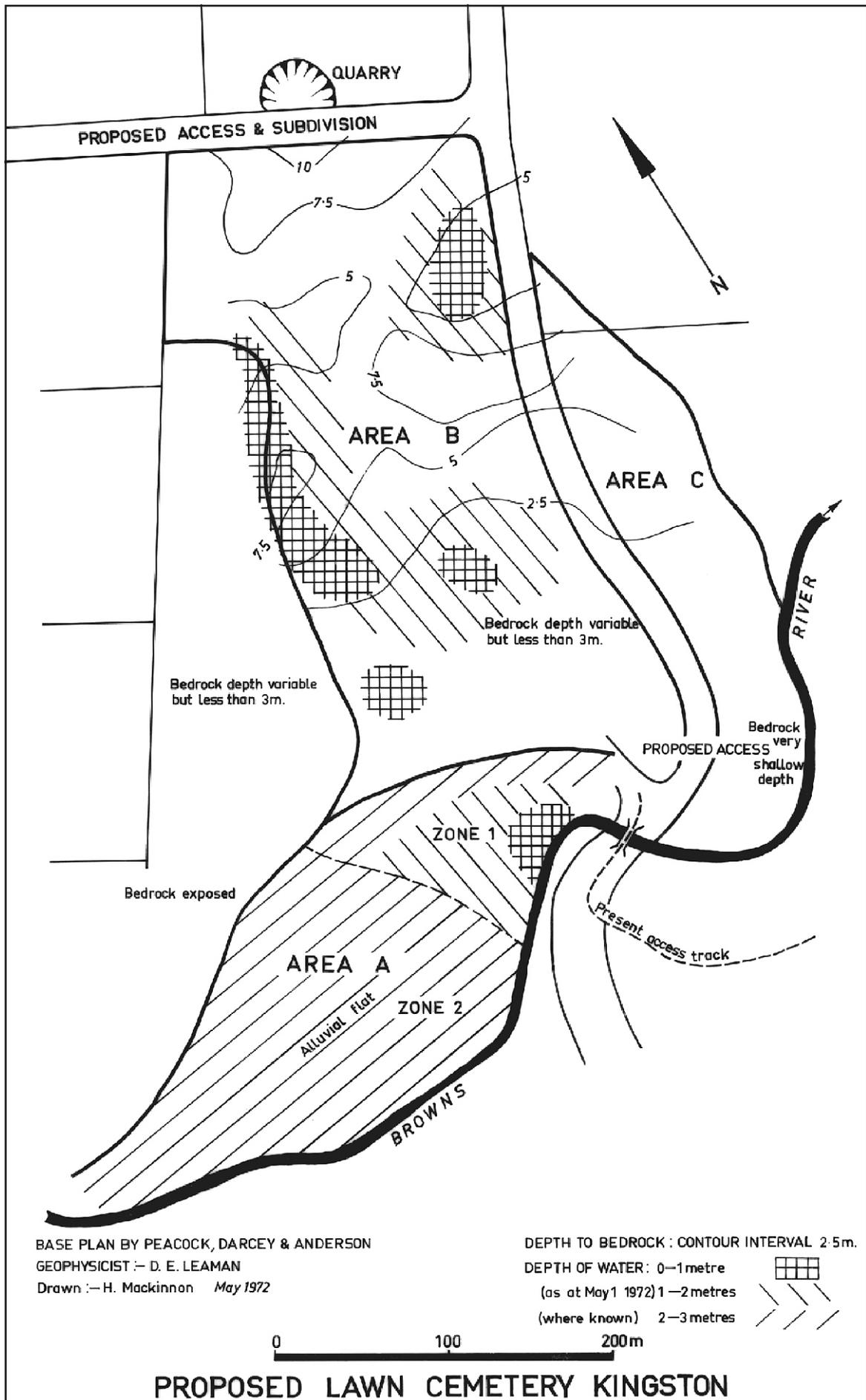


Figure 1