TR17-139-143

33. Proposed lawn cemetery, Kingston

D.E. Leaman

A private lawn cemetery has been proposed for a property north of Browns River, which is owned by W.C. Hodgman of Kingston. Peacock, Darcey and Anderson, surveyors, acting on behlf of the development company, requested a study of the area in order to determine its suitability for the purpose. Information was required on the depth of soil general bedrock conditions, the depth of the water table and the nature of drainage.

The area was visited in dry conditions in early May 1972 and again in wet conditions in early August 1972.

GEOLOGY AND RELIEF

The area to be developed as a lawn cemetery comprises areas A, B and C shown in Figure 36.

Area A

The alluvial plain: The plain has two distinct levels indicated by zones 1 and 2 in Figure 36, with zone 2 being 50-70 cm higher than zone 1. The geological profile is 75-150 cm of alluvial soil, silt and sand overlying an unknown thickness of dolerite boulders. The boulders range in size up to 40 cm across.

Areas B and C

Cleared hillside: The hillside areas have a gentle slope of about 10° and a variable but commonly thick weathering profile developed in quartz sandstone. Exposures of the sandstone can be seen north of Area A, west of Area B and south of Areas A and C. An indication of the nature of weathering in the area can be seen in the quarry north-east of Area B. Typically however there is up to one metre of light grey sandy soil overlying fairly soft, friable and often micaceous sandstone. There is much softening and decomposition with some clays developed. Some evidence of soil creep is also apparent.

Other Areas

The regions external to Areas A, B and C tend to be rocky and have much steeper slopes. The slope on which Areas B and C are situated is atypical and unexpected in the incised valley of Browns River.

HYDROLOGY

On the first visit several shallow holes were excavated and the water levels, if any, recorded. The coverage although not complete, does give an indication of possible problems and the approximate depth of the water table in dry conditions. Figure 36 presents a summary of the water level information. In Area A the greatest depth to the water table is on the western side of zone 2 at 2.5-3 m whereas in the centre of zone 2 it is 2-2.5 m but less than 1.3 m in the centre of zone 1.

In Area B the evidence indicates a high level water table. Areas of surface or near surface water are shown in Figure 36 and several permanent and intermittent springs are present. Drainage is variable but generally not good which is reflected by sag ponds, the effect stock have had on the soil and the early stages of badland erosion.

In the interim period between the first visit and the second investigation, the Kingborough Municipal Council excavated several pits in Area B and

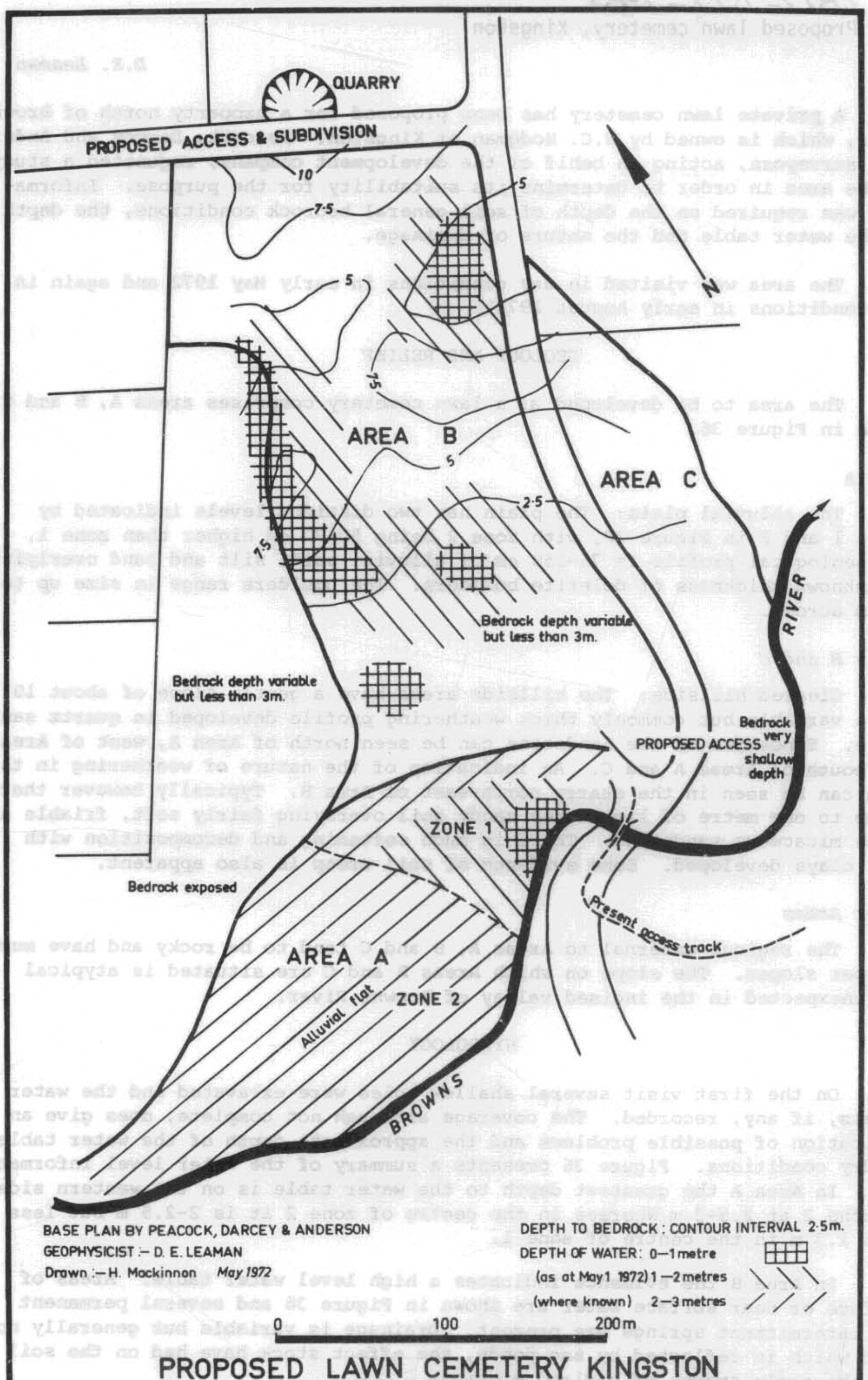
QUARRY
PROPOSED ACCESS & SUBDIVISION
10
7·5
5
5
N
7·5
AREA B
5
AREA C
2·5
7·5
RIVER
Bedrock depth variable but less than 3m.
Bedrock depth variable but less than 3m.
Bedrock very shallow depth
PROPOSED ACCESS
ZONE 1
Bedrock exposed
Present access track
AREA A
ZONE 2
Alluvial flat
BROWNS
BASE PLAN BY PEACOCK, DARCEY & ANDERSON
GEOPHYSICIST :– D. E. LEAMAN
Drawn :– H. Mackinnon May 1972
DEPTH TO BEDROCK : CONTOUR INTERVAL 2·5m.
DEPTH OF WATER: 0–1 metre
(as at May 1 1972) 1 –2 metres
(where known) 2–3 metres
0
100
200m
PROPOSED LAWN CEMETERY KINGSTON

Figure 36.

attempted a drainage investigation. The council pits were located in two basic lines, one along the eastern margin of Area B and the other in the centre of Area B in a NNE-SSW direction. One pit was located on the western side of Area B and one in Area C. Filling of the pits with water showed that permeability of the weathered Triassic materials is very low. Pits excavated in sandstone showed a higher permeability due to a lesser clay fraction.

The need for many shallow drains on the slope shows that surface run off and shallow soil flow is the predominant response to rainfall. Direct infiltration is minimal in the high rainfall conditions encounted on the second visit to the area.

A low water table is normal, generally at a depth of more than 2 m, but in the winter of 1972 it was more than 4 m.

Drilling in the region of the quarry at the northern end of Area B revealed alternations of clay, sand and sandy clay and therefore perched water tables could be present (Longman, 1962). From Longman's sections it is obvious 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. Situations of confined water could also be present. The water tables found in the first visit to the area could be perched although breakage of seals will release lenses of confined water. The excavated pits indicated that most near surface underflow occurred at the base of the loamy soil and clay within 50 cm of the surface.

EROSION

Several distinct lines of sub-surface collapse are evident across Area B. In places the roofs of subsurface channels have collapsed 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 the 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 since 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 2 cm in diameter are visable at a depth of 30-90 cm in the soil. Rapid movement of water through the soil is thus facilitated after rainfall. On the second visit water could be seen actively seeping from the surface at 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 areas.

SEISMIC SURVEY

A seismic refraction survey was undertaken across the slope in Areas B and C to ascertain the bedrock depth and workability of the area.

The transmission velocities recorded were as follows:

Material	*Velocity (m/s)*
Soil	300 - 400
Weathered Rock	900 - 1100
Bedrock-sandstone	2600 - 4200

As abrupt changes in velocities were recorded, it may be concluded that there is only limited gradation in properties between soil and weathered rock, and weathered and fresh rock. Materials with a seismic velocity of less than 2000 m/s can be excavated with pick and shovel or by back-hoe methods. With materials of velocities in excess of 2000 m/s excavation requires picking and, or explosives expecially if velocities exceed 2750 m/s.

Contours on the depth to the bedrock (solid sandstone) interface are shown in Figure 36. The quality of the rock improves downslope and solid sandstone occurs at shallow depth in the western section of Area B.

EFFECT OF USE AS A CEMETERY

After excavation of a grave, the soil is completely disturbed and does not again display the same hydrologic characteristics. Its permeability and porosity are significantly increased with the result that infiltration is increased and runoff reduced. More water is transferred underground.

A number of considerations apply when graves are dug in impermeable and permeable material.

Impermeable material. Following rainfall the filled grave will be saturated with water effectively loading the walls of the grave, which have been disturbed in the digging process, with up to a 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.

Permeable material. Where the material is permeable or slightly permeable, the 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 includes the situation where the hole cuts through perched aquifers. Permeable materials are to be found in the north-east corner of Area B.

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.

CONCLUSIONS

The particular property is unsuitable for use as a cemetery because of the following soil properties:

(1) Its unpredictable permeability and tendency to pipe, erode, collapse and suffer wall alteration and instability even when back-filled.

(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 nor where others are likely to develop.

(4) Over much of Area B decomposition will be very slow due to water filling graves in the almost impervious areas.

(5) The entire hydrologic 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, since 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 since it is water within the upper 3 m 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 due to the erratic, restricted nature of the flow system as well as its high capacity.

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

REFERENCE

LONGMAN, M.J. 1962. Brickmaking materials at "Bowenwood", Kingston. *Tech. Rep. Dep. Mines, Tasm.* 6:40-43.