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Potential effects of forestry operations on slope stability and springs in the Mt Koonya area

by B. D. Weldon

Abstract

Forestry operations are proposed in the Mt Clark–Mt Koonya State Forest above the 250 m contour. Numerous springs, which are relied upon by the local community, issue below this contour.

The Forestry Commission has proposed cautious management guidelines for the Koonya block. The effect of these guidelines on spring quality and quantity, as well as slope instability, is assessed as negligible.

INTRODUCTION

The Forestry Commisssion (Triabunna District Office) requested an assessment of the effects of forestry operations on spring waters and slope instability in the Koonya block. The Koonya block study area is the State Forest above the 250 m contour (refer fig. 1). The area is known locally as the "plateau". The 250 m contour is significant in that below this contour are numerous springs which are relied upon by the local population. The local community has expressed concern that logging operations on the plateau may affect water quality and quantity.

Sloane (1987) commented on the potential effect of forestry operations on slope stability and springs in the Mt Clark–Mt Koonya area. Re-examination of aerial photographs and reinterpretation of the local geomorphological, hydrological and geological conditions were undertaken by Sloane as an office-based assessment of the area for the present study. The route of the proposed logging access road was walked by the author with Forestry Commission and local community representatives during November.

GEOLOGY

The main Mt Clark–Mt Koonya plateau is underlain by Jurassic age dolerite. This was intruded as a sheet or sill into Triassic age sandstone and mudstone sediments. A major escarpment marks the present day extent of the dolerite sheet. Dolerite talus and scree deposits often mantle the escarpment slopes, covering the lower boundary between the dolerite and the Triassic age sediments into which the dolerite was intruded.

The dominant geological structures are NNE-SSW trending defects (joints/faults) with subordinate ESE-WNW trending defects. The main streams in the area have a similar trend, and the defects may also play an important role in spring development.

Soils observed along the proposed road route were dominantly medium to high plasticity clays. In places the clays were sandy. The sand is fine grained, suggesting an aeolian origin, possibly from the sand sheet to the north in the valley of Newmans Creek (Cromer *et al.*, 1979). On the plateau, areas of poor drainage were indicated by the presence of gleyed clays where the local slopes are very low. Outcrop or near-outcrop of slightly weathered, jointed dolerite was also observed in places on the plateau (less than 10% of the length of the proposed road route). The joints vary from open to tight, with spacings from about 50 mm to in excess of 1000 millimetres. The joints are usually clean but clay linings were observed as thin films on some joint surfaces.

GROUNDWATER

The source of spring water in the Koonya area has not been equivocally established. This is unlikely to be achieved without a lengthy, detailed study. The spring water may be groundwater derived from a fractured rock aquifer, or groundwater travelling along an interface between an essentially impermeable barrier (e.g. clay) and overlying materials comprised of boulders with little or a no-fines matrix between the boulders (e.g. talus or scree), or on the interface between the talus and the underlying rock. In reality it is probable that seepage from a fractured rock aquifer supplies the majority of the groundwater seepage. This is probably supplemented by water moving along a less permeable interface in the soil profile or talus–bedrock interface to the springs.

FRACTURED-ROCK AQUIFERS

Essentially, a fractured-rock aquifer is a body of rock which is fractured and in which groundwater is stored in the fractures. The fractures may be joints, crushed seams, shear zones or faults which are sufficiently open to allow water to pass through them or collect within them. The network and width of the fractures greatly influences the quantity of the water supply. For sustainable outflow, the

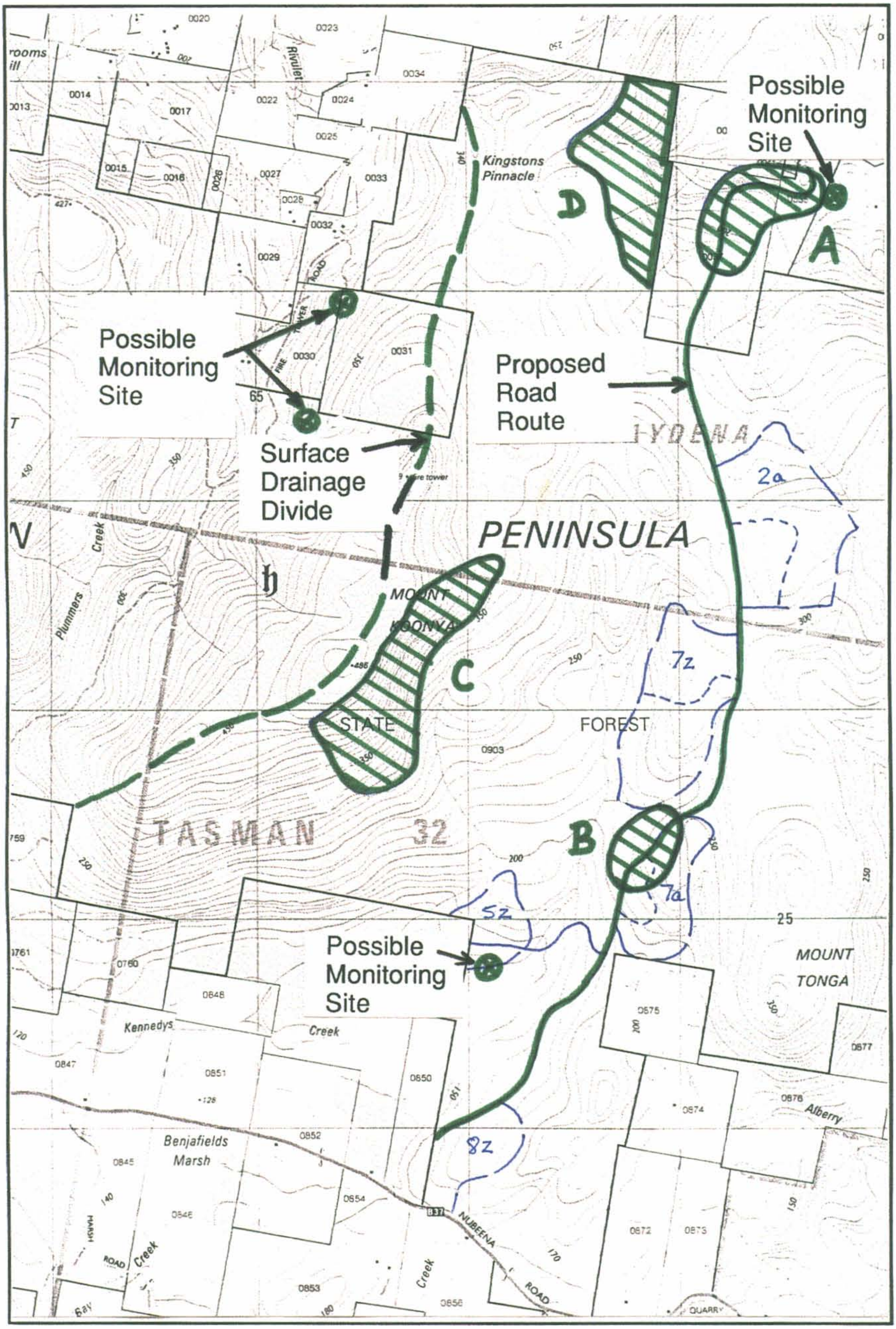
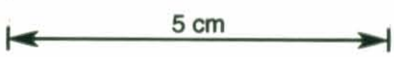

Possible Monitoring Site
Possible Monitoring Site
Possible Monitoring Site
Proposed Road Route
Surface Drainage Divide
Kingstons Pinnacle
PENINSULA
TASMAN
STATE
FOREST
MOUNT KOONYA
MOUNT TONGA
Benjafields Marsh
Kennedys
Creek
Plummers
A
B
C
D
2a
7z
7a
5z
8z
NUBEENA
ROAD
QUARRY

Figure 1


5 cm

interconnected fractures must have access to an area where recharge (i.e. water inflow) is possible. This may occur where fractures are exposed at the surface, in stream beds, or by infiltration through the soil profile which becomes saturated and allows water to infiltrate into the rock defects.

Obviously there is a delay between rain falling in the recharge area and discharge at any spring site. The author is not aware of any Tasmanian studies into dolerite fractured-rock aquifers which have attempted to quantify this delay. The literature suggests that for a well-fractured rock mass with good, clean fractures or defects, the rate of water movement may be in the order of 1–10 metres/day, decreasing to an order of 1–3 metres/year for a poorly-fractured rock mass with clay-lined defects.

The quality of fractured-rock aquifer groundwater is affected by the chemical composition of the rock mass and its weathering products. Where chemical analyses have been performed on water from bores drilled into dolerite fractured-rock aquifers, over 50% have total dissolved solids contents in excess of 1000 milligrams/litre (ppm).

NEAR-SURFACE GROUNDWATER

Water falling on the surface will move under gravity as either overland flow or infiltrate into the soil or rock profile until a less permeable interface (such as a clay layer or massive rock) is encountered. The materials above an impermeable soil layer will become saturated in time, and the thickness of the saturated zone will increase. Only a small fraction of the water reaching an impermeable clay layer will flow through it (typical rates of water movement through clays are 0.001 to 1 millimetre/day). The majority of water is deflected downslope as through flow but in areas of internal drainage (as occurs in some places on the "plateau"), some water will pond until an outlet is found and then be deflected downslope as through flow.

It is common in areas with many springs to observe holes or tunnels in the soil profile, particularly where the soils are dispersive. These holes or tunnels are conduits for water flow. Some talus deposits have large pore spaces between boulders which may also act as conduits. Water flowing through these conduits has the potential to erode the materials surrounding the conduits. It is possible that some turbidity observed at springs in the Koonya area is a result of this process.

EFFECTS OF FORESTRY OPERATIONS

Forestry operations in an area have a complex effect on the hydrological cycle. It is generally accepted that removal of vegetation results in an increase in runoff. Compaction of the soil results in an increase in runoff and decrease in infiltration. Ground disturbance results in an increase in surface roughness and therefore depression storage, which can lead to increased infiltration and/or reduced runoff. Ground disturbance also increases turbidity, with the increased suspended load having the potential to clog pores in the soil and thus diminish infiltration through surface sealing.

The net short-term effect of forestry operations is generally considered to be an increase in runoff in proportion to the area logged. Depending on local conditions, infiltration may also increase in the short term. The literature indicates that removing the vegetation from a catchment area for immediate regrowth appears to increase the runoff yield for up to five years following reseeding, after which time runoff has returned to the rate prior to vegetation removal.

Roading associated with forestry operations has a long term effect on the turbidity of road drainage waters. Studies have shown that the entire road system (including cut batters, fill embankments, roadside drains etc.) contributes the majority of sediment yield to streams. The entire road system is a constant source of fine-grained particles which become suspended in the surface runoff. The proper management of road drainage in catchment areas is therefore of prime importance.

IMPACT ON THE SPRINGS

The Mt Koonya ridge line is a surface drainage divide. Forestry operations west of the ridge line could directly impact on the spring water quality and quantity. Forestry operations east of the ridge line are assessed as having only a remote probability of affecting the spring water quality and quantity.

It is considered that any component of spring water derived from a fractured-rock aquifer system will be unaffected in quality by forestry operations east of the Mt Koonya ridge line. The ridge is some 500 m distant from the nearest known spring and any suspended load entering the aquifer in the logging area should have settled out before reaching the spring.

It has been indicated that the Commission is unlikely to conduct forestry operations west of the Mt Koonya surface drainage divide. This will preserve the quality of spring water derived from infiltration through the talus slope deposit (i.e. near-surface groundwater) on the west side of the divide. It has the additional benefit that forestry operations will not occur on a slope which, from aerial photograph interpretation, may have been subject to previous landslide activity.

As discussed earlier, the effect of forestry operations on water quantity is potentially complex. The literature indicates that the net effect initially is an increase in runoff. In areas immediately reseeded, after about five years growth, the runoff has returned to the rates prior to removal of the vegetation. The vigour of the new forest may result in a decrease in infiltration through increased evapotranspiration.

It is considered that the suggestion by the Commission to restrict the area of forestry operations to a small percentage per annum of the total area of the "plateau", in combination with a forestry practice of thinning with some clear-felling, will not impact on groundwater quantity issuing from the springs.

The local community and the Commission must be aware that there is a time lag between effecting a change in a potential recharge area of a groundwater system, and observations at the discharge area. Without detailed lengthy studies of the system it will not be possible to isolate the effects of the change from climatic variations.

IMPACT ON SLOPE INSTABILITY

Examination of aerial photographs, and topographical and geological maps, indicated four areas of possible concern regarding slope instability (refer to fig. 1). Two of these areas were viewed during the inspection of the proposed road route.

Access to the proposed road route is via a logging road on private property through area A. The road batters expose dolerite talus and scree apparently overlying dolerite rock (which is exposed in the quarry reserve). Some boulders of dolerite have spalled from the cut road batters, but no landslide failures were observed. Water was not observed seeping from the road batters at the time of the inspection. Forestry operations have already occurred on portions of the private land in area A, with no adverse effects on slope stability being reported. The risk of induced slope instability associated with forestry activities in area A is assessed as low.

During the inspection of the proposed road route, the steep slopes in area B were observed. There was some confusion regarding our position along the proposed road route near area B. It is the authors recollection that boulders of slightly to moderately weathered dolerite in a clayey matrix occurred in this area, along with some outcrop or near-outcrop of dolerite. The slope, as far as could be observed through the forest, was relatively uniform although some minor benches were associated with the areas of dolerite outcrop or near outcrop. On the observations made it is considered unlikely that the area has deep talus or scree deposits. The risk of induced slope instability associated with forestry activities in area B is assessed as low.

Areas C and D were not observed during the November inspection. These areas are not proposed for forestry operations in the Preliminary Logging Advice for the Koonya block but may be considered in the future. The slopes are steep and may be veneered by dolerite talus and scree deposits. For this reason, the areas should be assessed by a field inspection should they be considered in a future forestry program.

CONCLUSIONS

It is considered that forestry operations on the "plateau", if restricted to the east of the Mt Koonya surface drainage divide, would have a very low probability of affecting the quality of spring water in the surrounding district.

If, as suggested by the Commission, the area of forestry operations is restricted to a small (say 2.5) percentage of the total catchment area per annum, and the forestry practice is a combination of clear-felling and thinning, then any potential fluctuations in the spring water quantity are likely to be extremely minimal, if detectable. In these circumstances, the probability of forestry operations affecting the quantity of spring water in the surrounding district is assessed as very low.

Two areas with a possible potential for slope instability (areas A and B, fig. 1) were examined during the inspection of the proposed road route. The evidence available suggests that forestry operations in these areas will not result in slope instability. Should the proposed road be constructed, a re-examination of area B would be desirable.

Two other areas of potential concern with respect to slope instability (areas C and D, fig. 1) have been identified and should be inspected if future forestry operations are planned in or near these areas.

In areas of forestry operations, the road system gives the majority of sediment yield to streams. Stream beds may be potential recharge areas for fractured-rock aquifers. The Commission's suggestion to construct the road and monitor the effects on stream quality before proceeding with operations in designated coupes is fully endorsed. A monitoring program should be in place prior to road construction, and it would be desirable that one winter–spring cycle of observations be made between road construction and the commencement of forestry operations. Possible monitoring sites are indicated on Figure 1.

The Commission's proposed forestry management guidelines for the Koonya block are well reasoned. It is a cautious approach which should minimise the effect on stream and spring quality as well as slope instability. In reality, the effect is expected to be negligible.

REFERENCES

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