

Surface Roughness Impacts – Arid Zones

Recent experiences have further contributed to Landloch’s perspective on the impacts of surface roughness on rehabilitated areas.

Effects on runoff

In arid zones with 200-400 mm rain per year, average annual runoff may be in the order of 10-50 mm. A significant proportion of years may not run off at all, so the actual runoff events will typically be larger than the long-term average suggests. Daily runoff volumes are, however, still relatively small. Consequently, there is potential for surface roughness to pond rain that does not infiltrate immediately, and to prevent any development of overland flows on rehabilitated slopes. Therefore, it is not surprising that some minesite rehabilitation practices and strategies involve large emphasis on creating surface roughness.

Unfortunately, the reality is often somewhat different. Despite best efforts, the roughness created inevitably has imperfections, so that flow ponds at low points, overtops the roughness, and creates concentrated overland flows. In erodible materials, roughness – once overtopped – is eroded away and the value of the roughness is lost. The point of overtopping often initiates gullies or large rills.

However, where the surface material is rocky, overtopping does not necessarily mean that surface roughness is rendered ineffective. In these situations, if the rock resists erosion, the roughness will persist and can continue to reduce runoff over the long term.

Recent simulations using the WEPP model for a site near Kalgoorlie considered rip lines on a batter slope where topsoil was ripped into underlying rock. Based on rip line dimensions, the impact of ponding depth in the consolidated rip lines was considered and found to have dramatic effects on predicted runoff (Table 1). Zero depth of ponding effectively describes a situation where all rip lines have been overtopped and broken.

Table 1: Predicted effects of ponding in rip lines on annual runoff and erosion predicted for 27 m high slopes on 11 degree gradient – site near Kalgoorlie.

Ponding Depth In Rip Line (mm)	Predicted Average Annual Runoff (mm/y)	Predicted Average Annual Erosion (t/ha/y)
100	2.9	0.6
50	14.7	4.5
0	40.3	21.2

For erodible materials, the benefits of roughness shown in Table 1 will be short-lived and illusory – lasting only until the roughness is overtopped and eroded. But for rockier, erosion-resistant materials, the benefits may persist for much longer. Consequently, one of the benefits of using rocky, erosion-resistant materials on batter slopes is that they enable surface roughness to become a viable option for long-term reduction of runoff and erosion.

Impacts on plant growth

Where large surface roughness elements are created, considerable proportions of the land surface are too steep to support vegetation in the short to medium term. This may be of benefit in arid landscapes if runoff from the steep areas is collected in low areas, creating wetter zones that assist in seed germination and establishment. Some arid-zone plant communities rely on trapping runoff from water-shedding parts of the landscape.



Figure 1: *Good grass coverage in an area of moderate roughness contrasted with restricted coverage of an area of high roughness of similar age.*

However, on steeply sloping areas (particularly where conditions are less arid), where the development of surface vegetation is essential for erosion control¹, large surface roughness actually **reduces** the proportion of surface covered by vegetation, and **reduces or delays** the potential for the surface to become stable. In time, surface roughness is likely to reduce and the coverage by vegetation will increase, but the rate of change may be slower than is desirable.

In designing rehabilitation practices and strategies, it is essential that priorities and goals are very clearly understood, and that these goals consider both the short and long-term.



Figure 2: *Moonscaped area showing vegetation establishment largely limited to areas of ponding.*

¹ In drier areas, it is unlikely that the amounts of vegetation and contact cover produced will be sufficient to be a major factor in erosion control. It is often unrealistic (in such areas) to place heavy emphasis on vegetation growth for that purpose.