Soil conservation waterways – planning and design

Constructed waterways are used to collect runoff from contour banks for erosion control in cropping lands. They convey runoff at a safe velocity to a drainage line or creek. A well grassed and stable waterway filters sediment, nutrients and pesticides from runoff.

This fact sheet provides information about the planning and design of waterways and should be read in conjunction with the fact sheets listed under *Further information.*

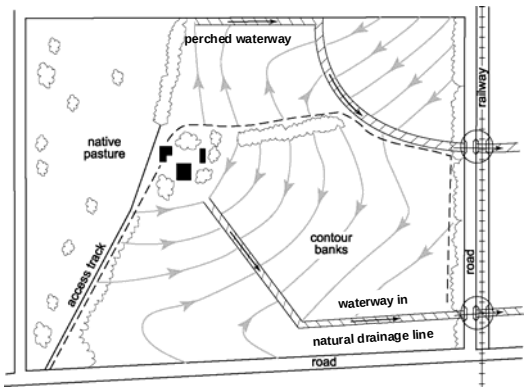

Figure 1: A contour bank and waterway layout for erosion control in a cultivated paddock

Location for waterways

Where possible, waterways in cultivated paddocks should be located in natural drainage lines. Here the slopes are usually lower than the adjacent land, and the topography tends to confine the flow to the waterway. It is best to avoid 'straightening' watercourses by removing the natural meanders. Such action leads to higher construction costs and inhibits the natural inclination for water to flow in a meandering pattern. However, there are many situations where there is no natural drainage line in a paddock. In these cases a straight waterway, often following a fence line, will usually be the best option. Such waterways are referred to as 'perched waterways'. Waterways should be planned and coordinated on a catchment basis in conjunction with neighbours and agencies responsible for adjacent infrastructure such as roads or railway lines.

Waterway cross–sections

Waterways for soil conservation purposes are normally constructed to a trapezoidal (Figure 2) or parabolic (Figure 3) shape. The batters on the retaining banks usually have a 1:3 (vertical:horizontal) slope.

Figure 2: Trapezoidal waterway

Figure 3: Parabolic or dish-shaped waterway

Parabolic cross–sections most closely resemble those found in natural waterways and small flows will be carried with less meandering than a flat-bottomed channel. However, flat bottomed channels generally perform well and are easier to construct. Construction of the 'dish' in a parabolic shape will add an extra 10 cm depth to the waterway. This would expose more subsoil and create greater flow velocities because of the extra depth of flow.

Retaining banks are essential to ensure that the flow remains in the waterway. Without these banks, runoff will follow the least line of resistance and flow along the cultivation. This may lead to gullying on one or both sides of the grassed drainage line (Figure 4).

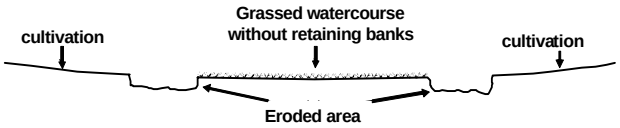

Figure 4: Waterways without retaining banks are likely to erode on either side of the grass strip

In situations with highly erodible subsoils, or where a good stand of suitable vegetation already exists, waterways can be constructed by excavating the retaining banks from the outside so that the section for water flow is left undisturbed (Figure 5).

Figure 5: Waterway with banks built from the outside

Subsurface waterways

In horticultural situations, subsurface waterways (similar to a spoon drain) are often used (Figure 6). Batter slopes on subsurface waterways should be 1:4 or flatter. Row crops can readily discharge into subsurface waterways (Figure 7). They can be crossed by tractors and

machinery to improve workability of the paddock. Care needs to be taken not to expose erodible subsoils during construction.

Figure 6: Subsurface waterway

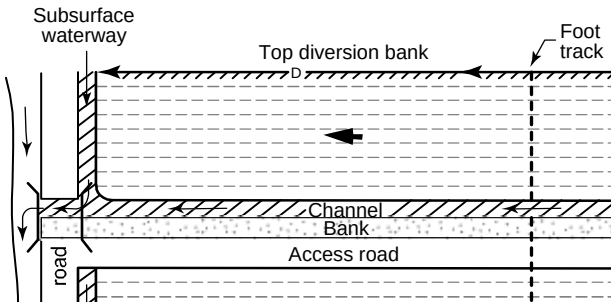

Figure 7: Row crops draining into a subsurface waterway

Perched waterways

In some paddocks there may be no suitable natural depression available and it can be convenient to construct a waterway adjacent to a fence or other suitable location. Such waterways will have some degree of side slope unless the waterway runs directly up and down the slope. A perched waterway will only need a bank on one side if there is significant side-slope.

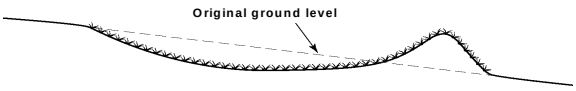

Figure 8: Perched waterway

Perched waterways generally require a significant amount of earthworks to produce a relatively flat channel. They should be avoided where highly erodible subsoils would be exposed by the construction. Unlike waterways in natural drainage lines, perched waterways do not receive runoff until contour banks are constructed into them. This provides an opportunity to ensure they are well grassed before the banks are built. Figure 9 is a plan view showing two perched waterways in fenced paddocks. For waterway A1–A2, the orientation of the contours would require a retaining bank against the fence. Waterway A3–A4 would require a bank on the side of the waterway away from the fence.

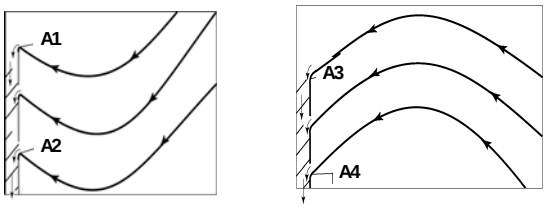

Figure 9: Plan view showing perched waterways

Design

There are two steps involved in the design of a waterway; determining the rate of runoff that the waterway needs to carry and calculating the channel dimensions to accommodate this runoff. More detailed information on waterway design is provided in the online Department of Environment and Resource Management publication *Soil conservation measures – A design manual for Queensland.* A waterway is usually designed to handle the rate of runoff (cubic metres/second) expected to occur in a one in 10–year event. If failure of the waterway was likely to cause significant problems, then it might be designed for a return period of one in 20, 50 or even 100 years. To determine the design runoff rate, the catchment area, rainfall intensity and the conditions in the catchment that affect the generation of runoff are considered.

The channel is designed to handle the estimated runoff at non-erodible velocities. The dimensions are determined using the Manning formula, which considers velocity, land slope, the shape of the waterway and the amount of 'retardance' provided by the vegetation in the channel. Sparse cover provides low retardance with high velocities and erosion risk. Dense stands of long grass provide high retardance and a potential for overtopping.

Further information

Refer to the online publication *Soil conservation measures – A design manual for Queensland* and the following fact sheets on the department's website at <www.derm.qld.gov.au>:

- L13—Erosion control in cropping lands
- L35—Runoff control measures for erosion in cropping land
- L83—Soil conservation planning in cropping lands
- L270—Soil conservation waterways – construction and management
- L271—Soil conservation waterways – plants for stabilisation.

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