Open Channel Drains

The basic principles behind locating and sizing an open channel drain for normal depth flows are:

- determine the size of the catchment feeding into the base of the proposed section of drain. On reasonable size catchments, it is often worthwhile to separate the proposed drain into sections. By doing this it may be possible to have a smaller cross section in the upper section of the drain which only services the upper reaches of the catchment;
- for a suitable ARI (commonly 5 to 20 yrs) calculate the peak flow in each section of the drain as described in Fact Sheet No.2;
- calculate the slope of the drain. If it is not possible to achieve a uniform slope along the length of the drain it should again be separated into sections of similar average slope. *(Note: Wherever possible the slope of the drain should be in the range of 0.5% to 1.0% or to suit local soil conditions. This will drastically reduce the cost of erosion control measures. It is preferable to 'snake' drains down steep slopes rather than taking the shortest possible route;)* and
- having established the flows and slopes for the proposed section of drain, a cross section size can be calculated using the Manning's equation (shown below) with suitable roughness coefficients. *(Note: Roughness coefficients are determined by the type of lining there is in the drain, ie. a smooth bare earth channel will have a low roughness coefficient while a channel lined with large unevenly placed rocks or dense vegetation will have a high roughness coefficient.)* A freeboard of between 100 and 300 mm is added to the flow depth to give the design drain depth.

Manning's Equation:

$$Q = \frac{A.R^{2/3}S^{1/2}}{n}$$

where:

Q = Flow (m^3/s)

A = Cross sectional area of flow (m^2)
R = Hydraulic Radius (= A/WP)

WP = Wetted perimeter; length in m of wetted contact between water and the channel measured at right angles to the direction of flow

S = Slope of channel section (m/m)

n = Manning's roughness coefficient.

Typical values of Manning's n are:

Smooth concrete lining	0.014 - 0.018
Smooth graded earth	0.025 - 0.03
Grass cover	0.04 - 0.06
Rock lining	0.04 - 0.06

In uniform section open channels, regard for flow and hydraulic radius should be considered for Manning's n (refer Chow, 1973).

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The best method for using this equation is to trial different drain cross sections and flow depths until sufficient flow capacity is achieved.

- As an iterative procedure with the previous step, the type of erosion protection to be used in the drain should be decided at this stage. As described in Fact Sheet No.8, a different level of protection is required as the flow velocities increase; however the erosion protection method will also affect the flow velocity (Q/A) hence the need for iteration.
- The following tips should be followed for selecting a drain cross section:
  - steep side slopes should be avoided (2-3 H to 1 V recommended);
  - the cross fall of the natural ground will affect the actual slopes used;
  - v-shape drains are recommended for minor drains while trapezoidal shapes should be used for large drains. The base width of a trapezoidal drain should be sized to suit earth moving equipment to be used;
  - a contour drain should be cut into the cross slope sufficiently to provide a balance of cut to embankment fill; and
  - embankments should be compacted to a minimum 90% Standard Compaction.

Note: where large channels are required, expert advice should be sought due to the potential for backwater and downstream effects.