This EFH supplement has been developed to provide an alternative design procedure for grassed waterways with small drainage areas.

Background

Many grassed waterways built in Indiana have small drainage areas. Due to the size of the construction equipment used to build them and the need to cross them with farm equipment, many of these waterways are built with top widths (T) of about 30 to 40 feet and depths (D) of 1 to 1.5 feet.

To simplify the design procedure for this size of waterway, Figure 1 was developed to provide a direct solution. This figure has three (3) curves for design of an alternative grassed waterway. Curve A has a Bottom Width = 16', Side Slopes = 10:1, Depth = 1.2' (Top Width = 40 ft). Curve B has a Bottom Width = 10', Side Slopes = 10:1, Depth = 1.0' (Top Width = 30 ft.). Curve C has the following options for the cross section: Bottom Width = 12', Side Slopes = 8:1, Depth = 0.8' (Top Width = 25 ft.) or Bottom Width = 10', Side Slopes = 8:1, Depth = 0.8' (Top Width = 23 ft.). Several assumptions had to be made to generalize the situation. Indiana has hydrological characteristics that will result in similar peak discharges for the 10 year frequency, 24 hour design storm. Other considerations included were soil types, average watershed slopes, 10 year rainfall, and runoff curve numbers for the predominate land uses. These considerations were checked in a rounded watershed shape with average length added to the flow path. The values used for analysis are:

Runoff Curve Number (RCN)	82
Slope	Moderate (approximately 6%)
Rainfall, in.	4.25

This alternative procedure is based on using vegetal retardance C for capacity design, retardance D for stability evaluation and a maximum allowable velocity of 4.0 fps. This design procedure should not be used if the watershed hydrologic characteristics differ substantially from the above assumptions.

This simplified design may only be used where the drainage areas shown are not exceeded, and where the waterway slope is uniform enough to be determined with a clinometer, hand level or survey instrument. If a structure is required, this procedure may be used for the waterway, but the structure must be surveyed and designed as normally required by Chapter 6 of The Engineering Field Handbook.

Construction control requirements will be the same as for a conventionally designed waterway. Erosion Control Blanket (ECB) will be required for waterway designs which are above the appropriate 3 feet per second (fps) line in Figure 1.

Conventional design procedures should be used for waterway grades of less than 1% or more than 10% and for combinations of drainage areas and grades that plot above Curve A in Figure 1.

Procedure

The first step is to determine the contributing drainage area and the waterway grade to be constructed. The basis of this chart is waterway grade. It is imperative that appropriate methodology and judgement be used in grade determination. For waterways with greater than 3% grade, the use of a clinometer may be satisfactory. However, if the chart is to be used for grades between 1 and 2% and near the upper limit of drainage area, the grade shall be determined with a survey instrument. The two top curves are steep and a change of only a few tenths percent in grade makes a large difference in allowable drainage area. Both the expected maximum and minimum grades should be determined. Enter Figure 1 with the waterway grade, project a vertical line up to the appropriate curve and read horizontally left to the vertical axis. Curve A indicates the maximum number of acres that the Bottom Width = 16', Side Slopes = 10:1, Depth = 1.2' (Top Width = 40 ft) alternative design can carry at that waterway grade. Figure 1 can also be used to determine the maximum grade allowable for a given number of acres. The alternative design is adequate for any combination of drainage area and waterway grade that plots below the Curve A.

All drainage areas below Curve C with waterway grades from 1 to 10 percent can be designed using one of the following cross sections for the alternative design:
Bottom Width = 12', Side Slopes = 8:1, Depth = 0.8' (Top Width = 25 ft.) or
Bottom Width = 10', Side Slopes = 8:1, Depth = 0.8' (Top Width = 23 ft.)

Plans must show the required cross section and the limits of the waterway grade.

Examples:

A situation is encountered with a drainage area of 20 acres. The steepest waterway grade to be constructed is 3%. A BW = 10', SS = 10:1, Depth = 1.0' (Top Width = 30 ft.) alternative design is adequate. ECB will be required since the waterway design plots above the 3 fps line for Curve B. The flattest waterway grade for the same waterway to be constructed is 1.5%. A BW = 16', SS = 10:1, Depth = 1.2' (Top Width = 40 ft.) alternative design is adequate. ECB will not be required since the waterway design plots below the 3 fps line for Curve A. The latter dimensions should be used for the whole length of the alternative waterway.

A situation is encountered with a drainage area of 35 acres. The steepest waterway grade to be constructed is 3%. The alternative design is not adequate; conventional design procedures should be used.

A drainage area of 12 acres has a waterway grade of 2%. An alternative design of BW = 10', SS = 10:1, Depth = 1.0' (Top Width = 30 ft.) is adequate. ECB would not be required since the waterway design plots below the 3 fps line for Curve B. If the same size drainage area has a waterway grade of 4 %, then either of the Curve C alternative designs are adequate, but would require an ECB since the waterway design plots above the 3 fps line for Curve C.