TURFCOMMS

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PURPOSE: To pass on what we learn willingly and happily to others in the profession so as to improve turf conditions around the country.

STREAM CHANNEL DESIGN: For many years now I've searched for a simple method of designing stream channels that worked and did not involve a lot of mathematics. I've concluded there is only one - let nature take its course. Most golf courses are not happy with this approach - when letting nature take its course means letting the stream take the golf course or at least the "sixth green and the seventh tee".

For a little over a year and a half I've had a letter and partial article on my desk from a hydrologic engineer with at least 17 years experience in channel geometry. I thought his material was too technical but after reading it over for the fourth or fifth time have decided to go with it.

The channel he designed for Dick Stuntz, superintendent at Alvamar, works. Except for the drawings included the work here with only very minor editing is that of: Mr. Bob Hedman, 3407 Tam O'Shanter Drive, Lawrence, Kansas 66046 (913) 842-4378.

OPEN-CHANNEL DESIGN

by

Mr. Bob Hedman

Managers of golf courses need a reliable method for designing the waterways. The channel should carry the excess water, but not damage the course during periods of high flow. The channels should be easily maintained, not interfere with play, and have a

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pleasing appearance. All natural streams are "authors of their own channels" and are continually adjusting their channels to obtain the right geometry. Many problems can develop from improperly designed channels. If a channel is too wide at the base the low flow will meander, deposit silt, and form island and point bars as it attempts to narrow its width.

If a channel is too narrow the water will scour the banks attempting to widen its width. If the longitudinal slope of a channel is too steep, the stream will attempt to adjust its slope by meandering, and if the longitudinal slope is too flat the velocity will be reduced, silt will be deposited, and the flow will eventually be forced over the banks. If the bed and banks are too rough due to large boulders and/or vegetation, the velocity is also reduced with the same detrimental results. So, it is extremely important that channels are designed with the proper width, slope, and roughness. They must then be maintained free of trees and shrubs if designed with a grass cover.

The following described method was developed from proven hydrologic and geomorphic techniques. The Channel Geometry Method was used to design the active or pilot channel and the Manning equation to design the flood capacity of the channel. The object is to design the channel with a stable, properly sized channel. A channel that will not have to continually struggle to maintain equilibrium.

In a natural channel, the active channel is the lower part of the channel entrenchment that is actively involved in the transportation of water and sediment. Depostitional features within the active channel are altered regularly during the normal fluctuation of streamflow. The sides of the active channel, which contain the discharge of average stages, are formed by relatively steep sloped banks.

The reference level used to measure the geometry of the active channel of a natural stream is selected where the banks abruptly change to a more gently sloping surface. Hence, the break in slope that identifies the active-channel reference level is generally coincident with the lower limit of permanent vegetation. Beyond the boundaries of the active channel the geomorphic features are generally permanent and vegetated.

In the following example of a channel design, the flood discharge with a recurrence interval of 10 years was used for the design flood.

The channel geometry relation selected for designing this channel was for a 10-year flood in northeast Kansas. The object was to design the main channel so the combined active channel and grass-lined main channel would convey the design discharge. Side slopes of the active channel can be nearly vertical as in a natural channel. Main channel slopes should be gentle enough that they can be grass lined and easily maintained with conventional mowers. A channel with smooth, well maintained grassy side slopes will be much more efficient. Large boulders, trees, shrubs, etc., can double the roughness coefficient and reduce the channel conveyance by one half.

In this described example, the elevation of the upstream end of the reconstructed channel is controlled by a large over-designed corrugated pipe arch under a city street. The downstream end of the channel is controlled by the elevation of the existing channel. These two elevations permitted a longitudinal slope of .006 feet per foot (0.6 foot per 100 feet) and a maximum channel depth of 5 feet. A few trial computations were made with the Manning equation using the parameters that were proposed and adjusting the side slopes to obtain a conveyance that would carry the design flood. The final dimensions used were:

Width of active channel	6 feet
Depth of active channel	1 foot
Top width of main channel	40 feet
Total depth of main channel	5 feet
Longitudinal slope of channel	.006 feet/foot
Roughness coefficient	.020

The solution for the Manning equation is: $Q_{10} = 1.486/n \; A \; R^{2/3} \; S \; 1/2 = 74.3 \times 98 \times 1.74 \times .077 = 980$ cubic feet per second.

It was necessary to use a side slope approximately 4:1 (see Figure 1) to obtain the necessary cross-sectional area with the constricting upstream and downstream elevations. It may have been more desirable to have the side slopes closer to 2:1 slope if the elevations would have permitted.

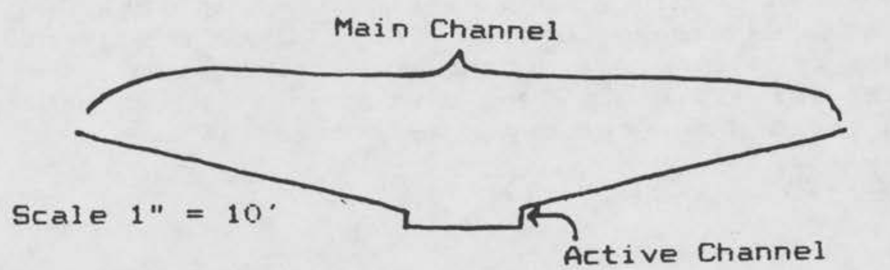

Figure 1: Stream channel as designed for Alvamar.

SELECTED REFERENCES

Hedman, E. R., Kastner, W. M., and Hejl, H. R., 1974. Kansas streamflow characteristics - part 10, selected streamflow characteristics as related to active-channel geometry of streams in Kansas: Kansas Water Resources Board Technical Report No. 10, 21 p.

Hedman, E. R. and Osterkamp, W. R., 1982. Streamflow characteristics related to channel geometry of streams in western United States: U. S. Geological Survey Water-Supply Paper 2193, 17 p.

Jordan, P. R. and Irza, T. J., 1975. Magnitude and frequency of floods in Kansas: Kansas Water Resources Board Technical Report No. 11, 20p.

EDITORS Addendum: Dick Stuntz has built some nice low water crossings in the active channels. It did this by concreting over four or five 12" corrugated plastic drain lines laid side by side in the active channel. (see Figure 2) This makes it possible to get around the course without expensive bridges, except during floods.

The above four or five corrugated drain lines were each fifteen feet long. They were first laid on sewer rock. Several cubic yards of concrete were then added to give a six inch cover. In 1985 thru 1987 when the work was done the cost was two to four thousand dollars per crossing. What do your bridges cost? Could the next time they need repair be a time to replace them with a low water crossing?

The low water crossing need extensive footings on both the upstream and downstream ends. They also need rock work or several gabion mattresses on the downstream side. The low water crossings definitely cause some disturbance in the otherwise very smooth flow of this channel during flood conditions.

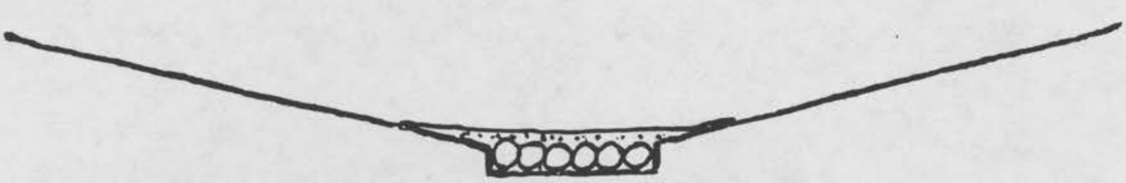

Figure 2: Stream channel with low water crossing in active channel.

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