Article 19

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Dynamics of Urban Stream Channel Enlargement

It is widely accepted that urbanization can alter the geometry and stability of stream channels. Both anecdotal evidence and field research support the notion that the larger and more frequent discharges that accompany watershed development cause downstream channels to enlarge, whether by widening, downcutting, or a combination of both. Channel enlargement severely degrades the quality of instream habitat structure and sharply increases the annual sediment yield from the watershed. These two factors, in turn, are thought to be responsible for the sharp drop in aquatic diversity frequently observed in urban streams (EPA, 1997).

Despite the large body of research available, many questions about the channel enlargement process in urban streams remain to be answered. For example, exactly how much will a channel enlarge, and how many years will it take to do so? Can the degree of enlargement be predicted by watershed indicators, such as impervious cover, age of development, geology or stream gradient? Finally, what stormwater management strategies can engineers use to mitigate the amount of future channel enlargement?

In this article, we review past research on channel enlargement processes in urban streams and explore how long it takes streams to reach a "new" equilibrium once watershed development is completed. These concepts are illustrated with some recent and historical geomorphological data drawn from Watts Branch, an urban stream in the Maryland Piedmont that has been the subject of considerable development and study for more than 40 years.

Evidence of the Impacts of Watershed Development on Channel Enlargement

The first evidence that stream channels enlarge in response to watershed development can be found in the high bank erosion rates measured for urban streams. In a recent study, bank erosion accounted for an estimated two-thirds of the measured instream sediment load of an urban stream in California (Trimble, 1997). In contrast, most geomorphologists have found that bank erosion in rural streams comprises only 5% and 20% of the annual sediment budget (Walling and Woodward, 1995; Collins *et al.*, 1997). Evidently, channel enlargement can begin at a relatively low level of watershed development, as indicated by the amount of impervious cover. One study estimated that channel erosion rates were three to six times higher in a moderately urbanized watershed (14% impervious cover) than in a comparable rural one, with less than 2% impervious cover (Neller, 1998).

Further evidence that stream channels enlarge in response to watershed development lies in research studies that have tracked the change in the cross-sectional area of stream channels over time. The simplest way to quantify these changes is to define an "enlargement ratio," which represents the ratio of a stream's current cross-sectional area to its pre-development cross-sectional area (or, in some cases, a cross-section from an adjacent undeveloped stream of equivalent watershed area). The concept of the channel enlargement ratio can be easily grasped by examining past and current stream cross sections in Watts Branch (Figure 1).

Watts Branch was first studied by Luna Leopold and others in the early 1950s, when development first began to spread across what was a predominately rural watershed (less than 3% impervious cover). Since then, the watershed has been gradually, but continuously,

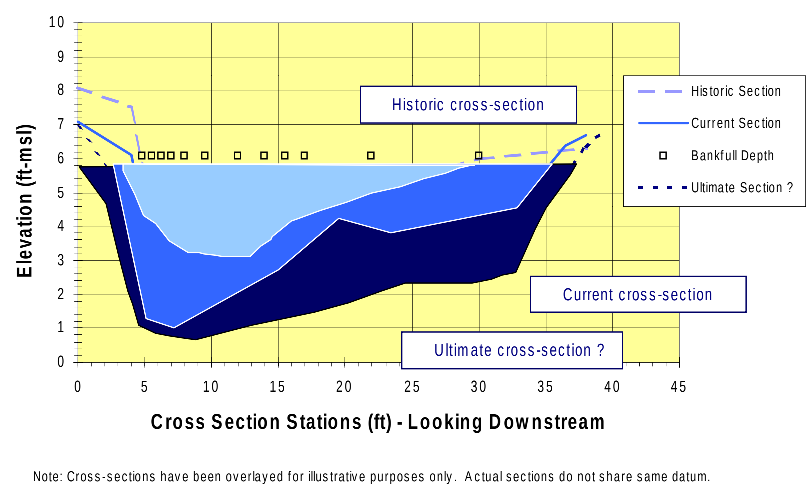

Figure 1: Change in a Stream Cross-Section of Watts Branch Over Time