A Department of Ecology
Discussion Paper
Water Quality Program
Development Services' Section

Proposed Flow Control Standard for Highly Urbanized Drainage Basins

Introduction: This discussion paper provides the justification for the proposal to allow use of the high flow durations estimated for the existing project site land cover as the flow control target to match within drainage basins that have had at least 40% Total Impervious Area (TIA) for the last 20 years. Currently, the 2001 stormwater manual requires matching the high flow durations estimated for the historic (pre-European settlement) land cover.

Background: The following statements are excerpts from Booth and Henshaw, 2000.

"We found that channel restabilization generally does occur within one or two decades of constant watershed land use, but it is not universal."

"The level of urbanization in a watershed exerts at most a coarse effect on the likelihood that the stream channel will be stable, and the rate at which urban development is occurring shows no systematic influence at all."

"There is no generalizable formula for channel restabilization. When and if, an individual channel will restabilize depends on a combination of hydrologic and geomorphic characteristics of the channel and its watershed, beyond simply the magnitude or rate of urban development. The hydrologic regime and geologic setting appear to be important controlling factors…"

"Only a case-by-case evaluation of watershed and stream conditions can show whether a 10-year to 20-year interval is appropriate for a given site, and any simple prediction of channel response based on watershed urbanization is guaranteed to yield spurious results."

The following statements are excerpts from Finkenbine, Atwater, and Mavinic, 2000.

"Although stream equilibrium may be delayed for several decades following urbanization, a stream will eventually enlarge until the velocity drops to a stable level (Morisawa and LaFlure 1979), and bankfull (up to the top of the easily defined stream channel) flows again occur every one to two years. At this point, shear stresses return to pre-development levels (Millar and Quick, 1998) and channel erosion no longer delivers an excess of fine material to the bed. There is some disagreement, however, as to the time required to reach equilibrium."

"The lack of fine material in the urban streams studied indicates that they have adjusted to urbanization 20 years after their watersheds were developed. Since these streams appear to be in equilibrium with the new flow regime, the implementation of stormwater detention ponds to mitigate peak flows is not likely to improve their condition."

Scientists with local expertise, Hartley, Jackson, and Lucchetti (2001) published the following response to the paper by Finkenbine et al (2000).

"From a stream velocity, depth, sediment transport, and fish habitat perspective, a decades-long waiting period following urbanization does not return a stream to the same hydraulics and functional habitat or a wider, scale

model thereof. Rather, significant urbanization causes a shift from a natural geomorphological disturbance regime to a radically altered one with not only increased magnitude, frequency, and duration of peak flows and velocities, but also increased flow oscillations, and exotic flow events such as out-of-season stream rises. These are altered states to which most pre-development native aquatic biota are not likely to be adapted."

Discussion:

Most stream channels change their form as a result of urbanization of their watershed. Typically, they widen and downcut in response to more frequent, higher, and longer lasting extreme runoff events. Streams that have been highly urbanized for an extended period of time almost certainly have changed their form unless the stream bed and banks are in solid rock or extremely cemented deposits. Therefore, assuming a predevelopment land cover condition of "forested," which will exert substantially less erosive forces on the channel than the present land cover (assuming it is something other than forested), is likely more conservative than is necessary to prevent the existing channel from accelerated, destabilizing erosive forces.

The purpose of the flow control requirement is to protect stream channels, whatever their current condition, from erosive forces that keep them destabilized. Without basin-specific studies it is very difficult to estimate what level of flow control is appropriate to establish a dynamic equilibrium that is more stable. In the vast majority of cases, a land cover condition that is somewhere between the existing condition and the historic condition could produce flows which would place the channel in a relatively stable, but dynamic, equilibrium.

Though not the specific goal of the stormwater manual's flow control requirement, it is a goal of the federal Clean Water Act and the State Water Pollution Control Act to protect the waters of the state and their beneficial uses. The anti-degradation provisions of the Clean Water Act and its implementing rules require the preservation of the beneficial uses that existed as of November, 1975. Though it may be possible to establish a basin-specific flow control standard that produces a flow regime that is compatible with the existing channel form, that channel form may not be compatible with the preservation or restoration of the existing beneficial uses that federal and state laws require.

In light of the realities of stream hydrogeology and federal water quality rules, wherever basin-specific studies were lacking (virtually all watersheds), Ecology initially decided to presume that matching the duration of high flows produced by a "forested" land cover condition would be an appropriate flow control target for land development projects. This target is intended to reduce the development site's incremental contribution of runoff that causes accelerated stream channel erosion. Lacking basin-specific information, it is viewed as necessary to not preclude the preservation and restoration of beneficial uses of streams – most notably fish resources.

Proposal:

Ecology is now proposing to allow the application of a less aggressive flow control target that is more likely appropriate for most of the existing stream channels in basins that have been highly urbanized for an extended period of time. Many, though not all (e.g., Thornton Creek; see Booth and Henshaw, 2000) of these stream channels have re-stabilized by adjusting form to accommodate flows from the existing land cover condition. Therefore, use of the existing land cover condition as the flow control target should be adequate to protect most streams in highly urbanized basins against increased erosive forces that destabilize the existing channel.

In these highly urbanized basins, requiring land development projects to match high flow durations produced by an historic land cover is not likely to appreciably benefit the geomorphology or hydrology of the stream, or the health of its beneficial uses. Conversely, allowing use of the existing land cover condition at the project site (which could be forested, partially developed, or fully developed) as the flow control target means that stormwater flow controls on new and redevelopment projects will not further damage the existing stream geomorphology and hydrologic condition. So, the purpose of the flow control standard is achieved. However, the overall land cover of these basins produce stream conditions that are likely hostile to the maintenance or restoration of beneficial uses such as fish resources. In these highly urbanized basins, more comprehensive rehabilitation strategies are necessary to address those conditions and other severe problems caused by past

development. Those strategies need to be based on agreed upon natural resource goals that have been adjusted in acknowledgement that significant ecosystem recovery is probably not possible (Booth, Hartley, and Jackson, 2002).

Until those rehabilitation strategies are developed, it is not a reasonable regulatory approach to apply the default (historic land cover) flow control requirement to land development projects when there are a host of other actions that are needed to achieve even modest resource management goals - especially since the default flow control requirement is likely more rigorous than necessary to achieve those modest goals.

Setting Basin Criteria:

The referenced studies provide a basis for generalizing that a basin that has not experienced significant land cover changes for many years will probably adjust to the new hydrologic regime associated with those changes. Thus, use of the existing land cover condition could be adequate for maintaining a dynamic equilibrium with the channel. But, use of that existing land cover as the flow control target should be restricted to basins for which there is little hope of restoring relatively robust beneficial uses (e.g., self-sustaining fish populations).

As a way to illustrate the point, take the example of a basin that has been at 10% + 2% TIA for over 20 years. This could happen in a watershed dominated by a public park, or in a rural watershed. Observations on Puget Sound streams (Booth, 1997) indicate that such a stream can have experienced significant hydrologic-related impacts such as a reduction in pools and large woody debris, and excessive bank erosion and channel downcutting at certain points within the channel. That could be particularly true if the basin has lost a significant percentage of forested land cover to pasture. The physical condition of the stream could easily be impacting the health and numbers of resident and anadromous fish populations. In this situation, though the channel may have re-stabilized, that condition is not conducive to maintaining or restoring a healthy biology, and may reduce other beneficial uses such as swimming. In this situation, improving the survivability of the existing populations, or possibly restoring those healthy populations is an achievable, and possibly a legally mandated goal. Using the existing land cover condition as the target for flow control in this basin will perpetuate a hydrologic condition that is detrimental to the existing fish populations and may prevent the restoration of those populations. Therefore, it is appropriate to use the historic land cover condition as the flow control target for all new and re-development project proposals within that basin.

This leads to the question of where to draw the line between basins in which application of the historic land cover condition will likely help maintain and possibly help restore beneficial uses (as may be required by the antidegradation provisions of the Clean Water Act implementing rules), and those basins in which restoration is likely not possible or not required. Referring to the available literature yields recommendations for reasonable natural resource objectives and how to achieve them based upon the level of basin urbanization (May, 1997; Center for Watershed Protection, 1998; Booth et al, unpublished). These recommendations seem to be based upon applying best professional judgment to the likely conditions of the habitat and natural resource status and to the challenges and limitations of environmental restoration without regard to statutory requirements. They also tend to not establish definitive thresholds for different levels of resource management objectives. Generally though, the greater the existing urbanization, the lower the natural resource objective.

We have but one local example of an urbanized watershed where a stream-specific target has been established as a result of extensive field studies and hydrologic modeling. The Des Moines Creek basin plan identified a strategy for improving the creek characteristics in order to improve the creek's habitat for native anadromous and resident fish survival. Because of the changes in the stream channel, the strategy included controlling high flows to an extent that was substantially less than would be indicated assuming a forested land cover condition, but substantially more than what the existing land cover produces. In other words, the plan identified that high flow durations produced by the existing land cover condition would continue to produce a de-stabilizing condition that put the remaining fish resources at risk. The Des Moines Creek basin has an estimated TIA of 35%.

Based on the above information, Ecology is proposing to use a 40% total impervious area land cover, coupled with a 20-year time frame, as the criteria for allowing use of the existing land cover condition as the flow control target. This is a relatively conservative rule of thumb to use as part of the presumptive approach to stormwater management that the manual represents.

Conclusion:

Ecology encourages local governments to do basin-specific studies for all of their basins. Using best available science to tailor rehabilitation and protection strategies that address land use, year-round stream flows, stormwater quality and quantity, and riparian and channel improvements to achieve jointly agreed upon natural resource goals should be more cost efficient and have a greater chance of success than a strategy that relies on new and re-development projects to apply default, generic strategies. Where local governments continue to choose not to perform such studies in highly urbanized basins that meet the proposed criteria, Ecology does not consider it appropriate to require new and re-development projects to assume that the duration of high flows should be controlled to those that occurred under an historic land cover condition.

Implementation Issues:

In order to implement this new requirement consistently, Ecology would have to establish a default method of estimating %TIA. Within a few months, Ecology may have %TIA's computed for basins of all sizes within western Washington by using a method to interpret satellite images. However, specific data on basins will only go back to 1990 land cover conditions. We will need some method, such as historical references to land development permits, or orthographic photos from 1985 that provide a weight of evidence that land cover did not change appreciably from 1985 to 1990. Alternatively, the proposal could be changed to use a 15-year criterion, dating back to 1990 – the earliest available satellite images.

As an indication of the types of basins that may qualify for use of the existing land cover condition as the flow control target, the following is a listing of basins in the King, Snohomish, and Pierce County areas that are estimated to have over 40% TIA. These data were provided by local governments which used various methods and assumptions. Ecology does not mean to imply that there aren't other basins that could meet the proposed criteria. Nor is Ecology guaranteeing that these basins will meet the proposed criteria when a standard technique for estimating TIA is used. The basin names and boundaries were set by the local governments.

Snohomish County:

Snohomish Estuary	North Creek	Juanita Creek
Puget Sound Drainage	Lower Sammamish	N. Lake Washington
Swamp Creek	McAleer Creek	Lyon Creek

King County:

Juanita Creek	Salmon Creek	Seola Creek
Miller Creek		

Seattle:

Longfellow Creek	Pipers Creek

Bellevue

Kelsey/Mercer Creek

Tacoma:

Flett Creek	Mason Creek	Joe's Creek
Puget Creek	Swan Creek	Leach Creek

Pierce County:

Brown's/Dash Point	Chambers Bay

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For more information

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