Design Methodology for Stormwater Quality

Everyone who has dealt with stormwater issues is familiar with the term "first flush". What does the phrase actually mean? It depends.

"First flush" is defined by some as the first ½ (13 mm) of runoff, or the runoff from the first inch (25 mm) of rain, this may make sense in some areas, but almost none in others. Is it realistic that this definition of a first flush would equally apply for Washington State as it would for Florida where the rainfall patterns are completely different? Probably not.

When a first flush occurs, its effects can be deceiving unless we define whether we are talking about pollutant concentration or load. For small areas, a first flush may refer to pollutant concentrations but not necessarily to load. High concentrations during the rising limb of the hydrograph combined with the lower flow rates result in attenuated loads. By the same token, lower concentrations during peak rates produce similar loading. Chang (1992) found this to be true in a study of first flush and pollutant loading in Texas.

The following positions have been raised while debating stormwater run-off:

- Higher pollutant concentrations during the rising limb of the hydrograph pose a greater threat to aquatic health than does an assessment of overall pollutant loading.
- Long term cumulative effects of total pollutant loading are more important than peak pollutant concentrations.
- A first flush does not occur for all pollutants and may not occur for specific pollutants all the time. The first flush is related to factors such as the distribution of intensities during a storm, the number of antecedent dry days and pollutant build up characteristics.

Is stormwater quality really this complex? In a word…yes.

In spite of this, many jurisdictions throughout North America base their design criteria for stormwater quality facilities on a single hypothetical storm with a certain infrequency of occurrence. This single storm is obviously a poor substitute compared to a continuous analysis of long-term precipitation records.

So why is the design storm event still used in stormwater quality design? For two reasons:

1. It is easy. Engineers are familiar with design events, and have decades of experience using them for flood and erosion control. They are extremely simple to define and reflect local rainfall statistics.
2. The cause and effect relationship between stormwater and ecosystem health is complex and ill defined. Accordingly many agencies adopt simple criteria that are easily understood and relate to accepted methodologies (peak flow design) for storm drainage design. The adoption of simple criteria is generally accepted since many people still question the basic need for stormwater quality control, let alone how to design stormwater quality facilities.

Unfortunately, a real danger exists when simple criteria are applied to complex problems.

Simple criteria such as the design event have been demonstrated to be ineffective (cumulative watershed effects of peak flow shaving) or capable of actually exacerbating problems (increased erosion due to near peak flows of peak flow shaving) if used incorrectly.

While a water quality volume or peak flow from a design storm may be a simple concept to grasp it is a poor substitute for BMP specific criteria. Flow related criteria only address the volume of water treated and not the expected water quality enhancement (performance).

For these reasons the design criteria for a stormwater quality measure should be based on the annual performance of the measure for the pollutants of interest.