Article 76

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A Tale of Two Regional Wet Extended Detention Ponds

Why do some stormwater ponds work, and others don't? How can virtually identical ponds located just a few miles away from each other have dramatically different pollutant removal capability? Some interesting answers to these questions can be gleaned from recent research performed by Robert Borden and his colleagues at North Carolina State University.

The setting for their study is the rapidly growing North Carolina Piedmont. In response to concerns about development's influence on water quality in local water supply reservoirs, many communities employ large regional wet extended detention (ED) ponds to remove pollutants from stormwater runoff generated by new development. State stormwater regulations promote the use of these ponds, on the basis of prior national research that has generally demonstrated they are highly effective in removing many stormwater pollutants of concern (see article 64 for a review). Consequently, regional wet ED ponds were adopted as a central element of a protection strategy for the City Lake reservoir near High Point, North Carolina. Local officials are now implementing a network of 33 regional wet and dry extended detention ponds to remove stormwater pollutants from future development in the 31-square mile watershed that contributes runoff to the drinking water reservoir.

Borden and his colleagues conducted an intensive monitoring study to document the pollutant removal performance of the first two large regional ponds constructed to protect the reservoir. Each pond was a wet extended detention pond that served a watershed nearly two square miles in size, and was built in advance of anticipated watershed development. The first pond was known as Davis Pond and had a rural drainage area of some 1,258 acres, consisting mostly of dairy farms, crops and forest, that will ultimately be converted into low-density residential development. The second pond, called Piedmont, drained a partially developed 1,220-acre subwatershed that included a large petroleum tank farm, industrial development, highways and open land slated for further development.

Intensive sampling at major inflows and outflows to each pond during both baseflow and storm conditions allowed very accurate computation of the mass of pollutants entering and leaving each facility. Over a single year, 22 storms were sampled at Davis Pond and 25 storms sampled at the Piedmont Pond, as well as 12 samples of baseflow conditions. The suite of pollutants measured included sediment, nutrients, carbon, coliform bacteria, and metals. In addition, researchers also intensively sampled water quality conditions occurring within each pond, taking monthly samples of dissolved oxygen, temperature, nutrients, chlorophyll, secchi depth and other parameters at various depths in the pond water column throughout the growing season. Lastly, the research team sought to understand the nutrient and sediment dynamics of the ponds using a series of simple and complex models.

At first glance, the Davis and Piedmont ponds were very similar (Table 1). Both drained about the same drainage area, and were located just a few short miles from each other. Their subwatersheds both had the same fine-grained clay soils for which the region is known. Both ponds had about the same surface area and depth, and had desirable length to width ratios. Both ponds had a similar permanent pool volume, and provided considerable additional extended detention volume. Both ponds stratified during the summer months, and experienced moderate sediment inputs.

At second glance, however, the two ponds could hardly be more different. As noted earlier, Davis pond was rural while Piedmont pond was primarily industrial (and had twice as much impervious cover). Average drawdown time for Davis Pond was nearly 60 hours, while Piedmont had an average drawdown time of less than eight hours. Algal conditions in Davis Pond were hypereutrophic, whereas Piedmont Pond barely registered as eutrophic at all. Incoming phosphorus concentrations were typically three times higher in Davis Pond than Piedmont. And whereas no stormwater practices were located upstream of Davis Pond, nearly half of the total drainage area to the Piedmont Pond (48%) was subject to prior treatment from an upstream stormwater pond at an industrial site. Lastly, the year in which Davis Pond was monitored was a dry year (rainfall only 78% of normal), compared to the relatively normal year monitored at Piedmont (93% of normal rainfall).

The pollutant removal performance observed at the two North Carolina ponds was considerably different (Table 2). On one hand, Davis Pond was found to have an overall pollutant removal just slightly below the national median for stormwater ponds. Davis Pond removed an estimated 60% of incoming sediment, 45 to 60% of phos-