Technical Note #64 from Watershed Protection Techniques. 1(4): 210-213

Performance of Gravel-Based Wetland in a Cold, High Altitude Climate

A recent study by John Reuter and his colleagues provides new insights about the performance of stormwater wetlands in tough climates. The study team investigated the nutrient removal capability of a small wetland in the high altitudes of the Lake Tahoe Basin of California. The average precipitation in this mountainous region is a scant 20 inches a year, much of which is in the form of snowfall. The spring melt of the snowpack produces a sharp increase in runoff. The summers are hot and dry, and produce little runoff during the short growing season. Fall rainstorms are also important part of the water balance.

The mountainous region has granititic soils that are very poor in nutrients. Consequently, the region's exceptionally clear mountain lakes are highly oligotrophic, and are very sensitive to nutrient enrichment. As a result, communities have taken stringent measures to limit nutrient inputs into their sensitive lakes, including stormwater treatment options. Prior studies have shown that the ability of stormwater wetlands to remove nutrients can decline in the winter months especially when runoff is dominated by snowmelt (Oberts, 1994). The climate of the Lake Tahoe region presents a difficult challenge for removing nutrients through conventional stormwater wetland designs.

The study is intriguing not only for its location, but for its design. Most stormwater wetland designs have followed the traditional "impoundment" model. In this model, a site is excavated to form a very shallow pool, and emergent wetlands are rooted in the sediment. The primary pollutant removal mechanisms involve settling, and the adsorption of pollutants to sediments, detritus or plant stems. Actual pollutant uptake by the wetland plants themselves is incidental. In the Tahoe study, the stormwater wetland was designed using the "underground" model, which has been extensively used for the treatment of wastewater. In this design, runoff is directed into a gravel layer in which the wetland plants are rooted. Consequently, the wetland plants can directly take up pollutants from their roots, and the gravel medium also acts as an effective filtering mechanism (Figure 1).

The Tahoe stormwater wetland treated the runoff produced from a 2.5 acre recreational area, most of which was a fertilized ballfield (i.e., no impervious cover). The wetland was rather small (0.16 acres in size), composed of transplanted cattails that had not become fully established during the course of study. The bottom of the wetland was sealed with a liner, and filled with a three foot deep layer of fine gravel. Runoff was introduced into the gravel layer in a perforated pipe; outflow were collected by means of perforated pipe located in a standing well. Thus, runoff had to pass through the entire gravel filter before leaving the wetland. In general, the gravel layer was anaerobic (no oxygen), except for the top few inches. The bottom of the gravel layer was "inoculated" with muck from an adjacent wetland to introduce denitrifying bacteria into the system.

The stormwater wetland was monitored over a 18-month period, which included two winters. Most of the flow during the sampling period was generated by snowmelt, although the largest single runoff event was associated with a Fall thunderstorm. Incoming nutrient concentrations were fairly low in comparison with other urban runoff datasets-averaging 0.05 to 0.30 mg/l for nitrate, 0.5 to 1.5 mg/l for TKN, and 0.15 to 0.25 for total phosphorus. The sampling design did not permit the

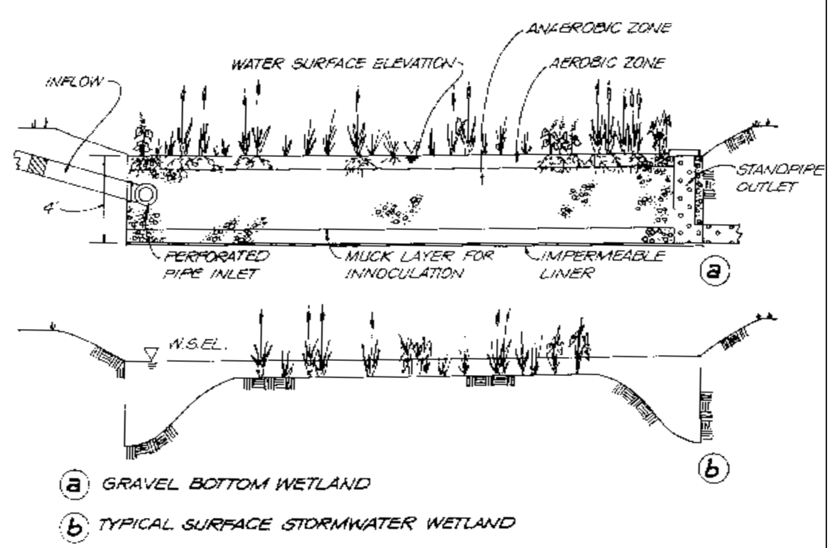

Figure 1: Comparison of Gravel-Based and Surface Stormwater Wetlands