Article 64

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Comparative Pollutant Removal Capability of Stormwater Treatment Practices

Over the last two decades, an impressive amount of research has been undertaken to document the pollutant removal capability of urban stormwater treatment practices. The Center has recently developed a national database that contains more than 135 individual stormwater practice performance studies. The goals for this project, were to generate national statistics about the pollutant removal capability of various groups of stormwater practices and to highlight gaps in our knowledge about pollutant removal.

The database was compiled after an exhaustive literature search of past monitoring studies from 1990 to the present. About 60 earlier monitoring studies had been collected in prior literature syntheses (Strecker *et al*., 1992; Schueler, 1994). To be included in the database, a performance monitoring study had to meet three minimum criteria: a) collect at least five storm samples, b) employ automated equipment that enabled taking flow or time-based composite samples, and c) have written documentation of the method used to compute removal efficiency. A total of 139 studies in the current phase of the project met these criteria.

Once in the database, a few general conventions were needed to facilitate the statistical analysis. First, related measurements of water quality parameters were lumped together in the pollutant removal analysis (e.g., "soluble phosphorus" included ortho-phosphorus, biologically available phosphorus, and soluble reactive phosphorus; "organic carbon" lumps biological oxygen demand, chemical oxygen demand and total organic carbon removals, "hydrocarbons" can refer to oil/grease or total petroleum hydrocarbons and "soluble nitrogen" refers to nitrate + nitrite or nitrate alone.

Second, if more than one method was used to calculate pollutant removal, methods that compared the input and output of mass rather than concentrations were used. Third, if the monitoring study only recorded removal in terms of "no significant difference" in concentrations, these were registered as zero removals. Similarly, studies that reported unspecified negative removals were entered as minus 25% (mean of negative values where specified). Finally, performance studies reporting negative removals greater than 100% were limited to minus 100% to prevent undue bias in the data set.

Each study was then assigned to one of five general stormwater practice groups: ponds, wetlands, open channels, filters, and infiltration practices. Each group was further subdivided according to design variations. For example, the pond group includes detention ponds, dry extended detention (ED) ponds, wet ponds and wet ED ponds. Medians were used as the measure of central tendency for all stormwater practice groups and design variations, and are only reported if sample size exceeded five monitoring studies. In general, pollutant removal rates should be considered as *initial* estimates of stormwater practice performance as studies occurred within three years of practice construction.

As always, extreme caution should be exercised when stormwater management performance studies are compared. Individual studies often differ in the number of storms sampled, the manner in which pollutant removal efficiency is computed (e.g., as a general rule, the concentration-based technique often results in slightly lower efficiency than the mass-based technique), the monitoring technique employed, the internal geometry and storage volume provided by the practice design, regional differences in soil type, rainfall, latitude, and the size and land use of the contributing catchment. In addition,

Table 1: Seldom-Monitored Stormwater Management Practices (National Urban BMP Database, 1997)

Number of Stormwater Practice Design	Monitoring Studies
Biofilter	0
Filter/Wetland Systems	0
Filter Strips	0
Infiltration Basins	0
Bioretention	1
Wet Swale	2
Gravel-based Wetlands	2
Infiltration Trench	3
Porous Pavement	3
Perimeter Sand Filter	3