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Bioretention as a Water Quality Best Management Practice

by Susan D. Bitter and J. Keith Bowers, Biohabitats, Towson, MD

To respond to the need for better stormwater practices in small commercial areas, the Prince George's County Department of Environmental Protection (DEP) sponsored a research project to design innovative practices based on the concept of *bioretention*. Bioretention is an innovative urban stormwater practice that uses native forest ecosystems and landscape processes to enhance stormwater quality. Bioretention areas capture sheet flow from impervious areas and treat the stormwater using a combination of microbial soil processes, infiltration, evapotranspiration, and plants.

In 1993, Biohabitats, Inc. and Engineering Technologies Associates (ETA) tested the bioretention concept and developed a practical manual to provide initial guidance in the design, preparation, and maintenance of experimental bioretention areas. The feasibility study included extensive research to develop specifications for the design of bioretention areas. Areas of research included soil absorption capacities and rates, plant absorption capacities and rates, water budgets, pollutant removal potential, and maintenance requirements.

The feasibility study assessed the use of bioretention practices for sites containing large areas of impervious surfaces typical of suburban and urban development in Prince George's County. The case study analysis assessed bioretention practices for three commercial and one residential site. Bioretention areas were then designed using the guidelines developed during the feasibility analysis and included grading requirements, soil amendments, plant material selection, maintenance requirements, and an evaluation procedures to determine pollutant removal effectiveness.

The analyses demonstrated that bioretention practices can be feasible and economical alternatives for providing treatment of the first half-inch of stormwater runoff from most impervious surfaces. In addition, it was found that bioretention may be an economically feasible alternative to other stormwater practices and offers benefits of improved aesthetics and minimal environmental impact.

How Bioretention Works

Bioretention areas are designed to be used in urban and suburban areas as off-line systems which treat the first flush of runoff from impervious surfaces (Figure 1). Median strips and parking lot islands are two prime areas where bioretention can be successfully applied to enhance stormwater runoff quality.

Bioretention works by directing stormwater runoff from the parking lot to a bioretention area as sheet flow or concentrated flow. Depending on site conditions, runoff may be guided into bioretention areas directly from an impervious surface or through a grass filter strip/swale. Using a grass buffer strip will reduce velocities and filter particulates from the runoff.

Runoff is then directed over a sand trench that separates the planting bed from the impervious surface. The sand trench augments the infiltration capacity of the planting bed, slows the velocity and evenly distributes incoming runoff, and facilitates the flushing of pollutants from the surrounding soil.

Once the sand trench reaches its infiltration capacity, runoff is directed into the planting bed. The planting bed is graded to pond runoff to a depth of six inches, allowing time for the ponded water to infiltrate through the organic topsoil/sub-soil and evaporate on the surface. Infiltrated runoff is stored in the planting soil where it may exfiltrate into the underlying subsoils in the bioretention area.

The organic topsoil layer provides a medium in which microorganisms degrade petroleum-based solvents and other hydrocarbons. The planting soil is designed to facilitate plant growth, infiltrate runoff, and absorb heavy metals, nutrients, and hydrocarbons.

The use of plant material in bioretention areas is modeled after the properties of a terrestrial forest community ecosystem. The terrestrial forest community was selected based on its documented ability to cycle and assimilate nutrients, pollutants, and metals through the interactions among plants, soil, and the organic layer. These components are the major elements of the bioretention concept. Specific plant species are selected based on their ability to assimilate pollutant runoff and tolerate urban stress, variable soil moisture regimes, and ponding fluctuations. A list of landscaping materials that meet these requirements can be found in a design manual produced by the Prince George's County DEP (1993).

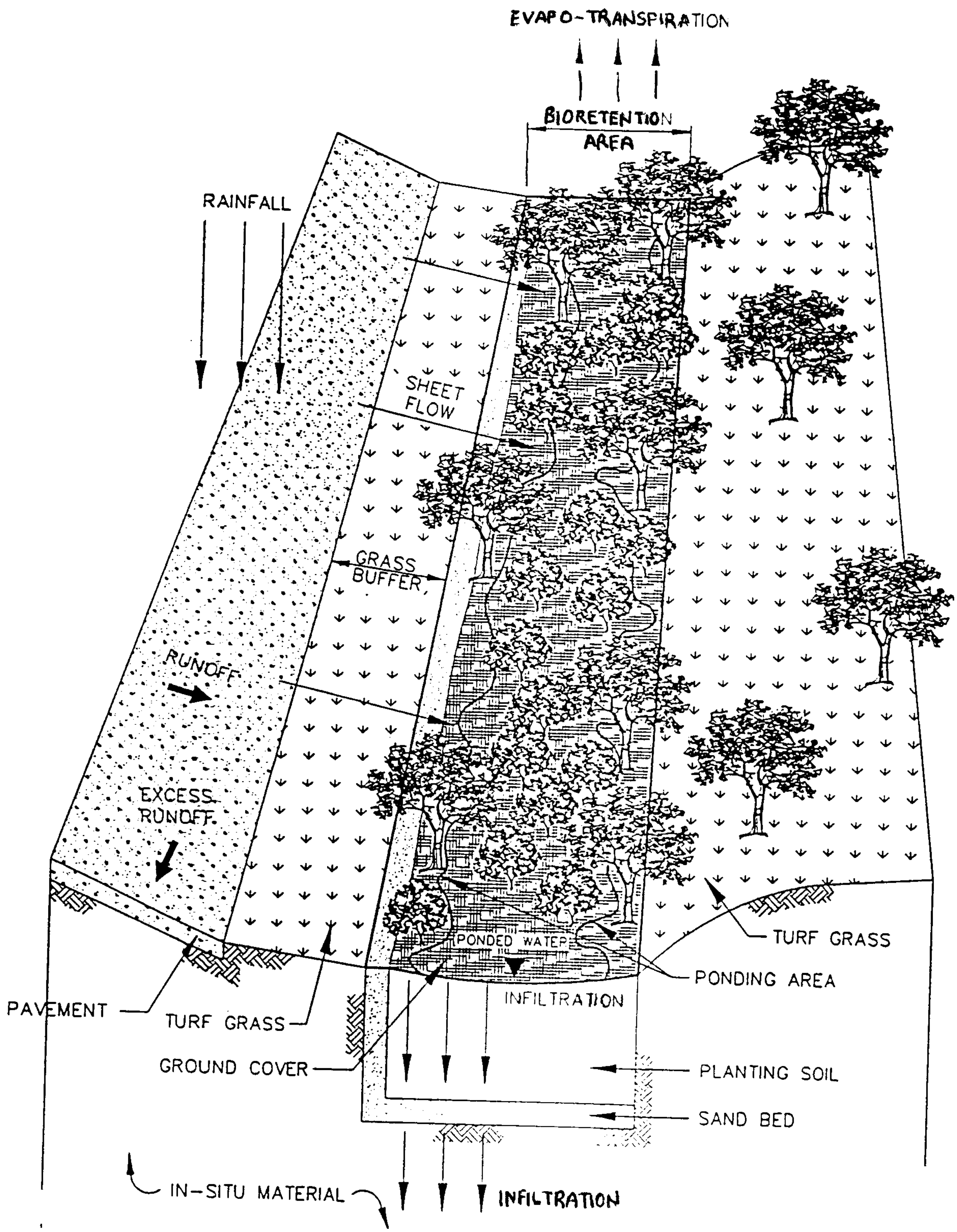

Figure 1: Schematic of a Bioretention Area Serving a Parking Lot (PGDER, 1993)

When designing bioretention areas, the following criteria need to be considered:

- Size of the drainage area to be treated
- Location of the bioretention areas
- Sizing guidelines
- Calculating water budgets and nutrient removal capabilities
- Grading and elevations
- Soil amendments
- Organic layer/mulch amendments
- Planting concept
- Plant species selection
- Surrounding land use and land cover
- Number and sizing of plant material
- Planting design
- Plant growth and soil fertility
- Maintenance

Bioretention areas also provide other benefits including the creation of shade and wind breaks, noise absorption, albedo reduction, creation of micro-habitats, and improved aesthetics. The primary application is for commercial parking lots. In many cases a bioretention area can be located within the required landscaping or open space in a commercial parking lot.

Reference

Prince George's County Dept. of Environmental Protection. 1993. *Design Manual for Use of Bioretention in Stormwater Management.* Landover, MD.

Table 1: Key Specifications for Bioretention Area (BA) Design (Prince George's County DEP, 1993)

Bioretention design element	Specification
Minimum width of BA	15 to 25 feet
Minimum length of BA	40 feet
Maximum ponding depth	6 inches
Minimum planting soil depth	4 feet
Maximum drainage area to BA	0.25 to 1 acre
Maximum slope within BA	20%
Maximum entry velocity	3 feet/second
BA as Percent of Total Site Area (100% imperv.)	5 to 7%
BA Landscaping, Trees and Shrub species	3 each
BA Landscaping, Plant Materials (Tolerant of pollution, ponding and periodic drying)	Tolerant species from approved list
Shredded Hardwood Mulch layer	3 inches
Planting Soil Texture (No more than 25% clay content)	sandy loam, loamy sand, or loam
Sand layer (bottom and one-side)	1 foot