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Bioretention as a Water Quality Best Management Practice

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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).