Low-Impact Development and Bioretention Systems

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Low-Impact Development

- **Low-Impact Development** originally started as a stormwater management approach that relied on integrated site specific bioretention basins that replicate predevelopment hydrologic conditions.

- **Bioretention Systems** incorporate natural land features and natural physical, chemical, and biological processes to manage stormwater quantity and quality more efficiently than conventional end-of-pipe best management practices, or BMPs.

- **Also known as Rain Gardens**, bioretention basins are attractive landscape features that treat stormwater as a resource rather than a waste product.
What is a Bioretention Basin

- **A Garden** designed and placed at a low spot of developed land, full of native ferns, grasses, trees, and shrubs that thrive in wet conditions.

- **A Basin** that can control water quantity, much like conventional BMPs such as detention basins, to reduce and delay the peak of stormwater discharge.

- **Infiltration or Drainage**, depending on the design of the system, allows stormwater management close to the source and a large reduction of non point source pollution.
What is a Bioretention Basin
How Does it Work?

Physical Processes

- **Filtration, Infiltration, Ponding, and Evaporation** are all incorporated into managing stormwater by bioretention basins, using multiple layers of media. (Physical Processes)
- **A Mulch Layer** that does an effective job as a filter of sediment, a weed blocker, and a suitable home for microbial populations.
- **Bioretention Media** that has a mixture of clay, sand, and organic matter that allows for filtration and pollutant removal.
- **Sand Bed and Underdrain** that filter and remove excess water from a large storm.
How Does it Work?

Chemical Processes

- **Adsorption** removes many pollutants gathered from impervious surfaces and well manicured lawns from stormwater, such as metals, phosphorus, and hydrocarbons, where clay is the adsorbent.

- **Cation Exchange** again uses the clay to remove positively charged ions from stormwater such as $K^+$, $Ca^{2+}$, and $Mg^{2+}$, as well as $NH_4^+$ and micronutrient trace metals like $Zn^{2+}$, $Mn^{2+}$, and $Cu^{2+}$.
How Does it Work?

Biological Principles

- **Nutrient Uptake** of the native plants can use nutrients that become available from infiltrating stormwater, such as nitrogen and phosphorus, both of which can cause harmful eutrophication in streams and lakes.

- **Evapotranspiration** is a major source of loss in a watershed and occurs when water is taken up by the plant and transpired out of the leaves.

- **Microbial Soil Processes** can metabolize phosphorus and iron bonds and mineralize nutrients, while at the same time, improve soil structure.
Schematic

Grass Strip intercepts stormwater and filters out larger particles that prevent clogging of the basin

Evapotranspiration

Nutrient Uptake

Microbial Processes

Recharge

Sand Layer filters

Underdrain in a gravel bed

Adsorption and Cation Exchange
Case Study

Somerset in Maryland’s Prince George’s County

- A subdivision of 80 acres that has 200 homes, each on 10,000 square feet
- Developed in the early 90’s, with houses of a starting price of $160,000
- The development implemented half conventional BMPs and half LID BMPs to manage stormwater
Case Study

Convetional BMPs

- Part of the subdivision used curb-and-pipe controls leading to a detention pond for stormwater management
- Total cost to implement does not include curbs, gutters, and sidewalks
- Total Cost = $400,000
Case Study

Low-Impact Design BMPs

- Most of the lots have a bioretention basin installed at the low point.
- The basins are somewhere between 300-400 square feet each.
- Each basin cost around $500- $350 for vegetation and $150 for construction
- Total Cost = $100,000
Case Study

Savings

- $300,000 dollars in installing bioretention basins over conventional BMPs.
- Immeasurable environmental savings and benefits due to water quantity control and pollutant removal from stormwater.
- Elimination of the need for a stormwater pond allowed the development of six extra lots and resulted in a cost savings of more than $4,000 per lot.
Case Study

Benefits

- Preliminary monitoring has shown that the LID section has 20% less runoff
- Runoff has 36%, 21%, and 37% lower for copper, lead, and zinc
- Nitrogen and Phosphorus are the same in both, attributed to unstable media and the relative newness of the basins
- Residents have taken enthusiasm to the rain gardens
Bioretention Basins

- Act as a BMP to control stormwater quality and quantity while also being an attractive landscape feature
- Residents enjoy their basins as gardens and are willing to maintain them
- Cost cheaper per lot and do a better job at managing stormwater
- Couple with other LID techniques to reduce costs and improve water quality
- Water is a resource, not a waste