Low Impact Development

Promoting water quality through an integrated design approach

Virginia Natural Resources Leadership Institute — Session 3

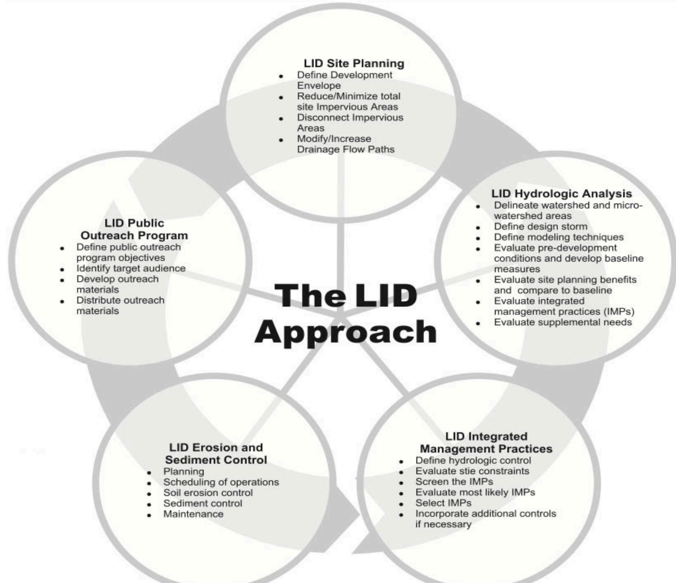
Introduction

Low impact development (LID) is a planning and engineering approach to stormwater management that emphasizes the conservation of natural resource function and on-site features. Within the urban context, the approach employs natural systems and processes to treat, detain and discharge stormwater. The goal of LID is to emulate a site's pre-development hydrologic conditions through the implementation of small scale, site-specific design and engineering techniques (typically known as integrated management practices, or IMPs), which allow the retention, detention, infiltration, filtering, storage and evaporation of stormwater runoff close to where the rain fell.[1] By allowing for water infiltration, filtering and storage, these LID applications increase water quality and reduce runoff quantity, preserving the integrity of runoff receiving waters.

Stormwater management is a critical aspect of the built environment. Proper management achieves two important results: prevention of floods and reduction of pollutants discharged to surface waters. Traditionally, stormwater management techniques have focused on capturing as much water into pipes as quickly as possible and transporting it to local receiving waters. In contrast, LID approaches focus on treating as much water on site as possible, mimicking the site's hydrologic functions that existed prior to construction. While specifics vary by site and climate, recharge of an area's groundwater table, reduction of pollutants entering surface waters, and habitat preservation typically accompany LID interventions.

LID design approaches were first developed and implemented in the early 1990's in Prince George's County, Maryland. Following both the fiscal and environmental success of this program, this strategy began to catch on throughout the country.[2] Public officials determined that traditional stormwater best management practices were not cost-effective and failed to meet specific water quality goals set forth by the county, and so a new paradigm was sought. Their approach of maximizing groundwater recharge, infiltration and natural filtering has proven successful both economically and hydrologically.

1 Storm Water Best Management Practice Design Guide, Ch 5 p.11
2 The Practice of Low Impact Development, p. 29



Prince George's County Maryland, Dept. of Environmental Resources; 1999

Goals of Low Impact Development

The primary goal of low impact development is to ensure the maximum protection of the ecological integrity of receiving waters while minimizing the risk of floods by maintaining the watershed's pre-development hydrology. In addition, LID seeks to:

- Provide improved technology for environmental protection of receiving waters
- Provide economic incentives that encourage environmentally sensitive development
- Help build communities based on environmental stewardship
- Reduce construction and maintenance costs of stormwater infrastructure
- Introduce new concepts, technologies and objectives for stormwater management
- Encourage flexibility in regulations that allow for innovative engineering and site planning

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Overview

LID stands in stark contrast to traditional stormwater runoff management systems, which seek to channelize any stormwater falling on-site as quickly as possible and move it to large concrete detention culverts or directly to receiving waters. Rather, it utilizes and augments the site's natural topography, hydrology and vegetation to treat the stormwater and encourage groundwater recharge. Viewed as a system, these conditions are described as the site's "green infrastructure." By incorporating LID into a development, its impact on the surrounding ecology can be greatly reduced while offering significant monetary rewards for both private developers and municipalities.

While LID strategies must be individually tailored for each site, several key characteristics form the core of natural stormwater management. The most pertinent approaches include preserving the site's natural ecology, reducing impervious cover (including rooftops), minimizing grading and clustering buildings to retain the infiltration capacity of soil on the site, and directing excess water to on-site components that filter, treat and maximize infiltration.[3] These interventions form the core of LID, and when strung together, enable a developed site's hydrological footprint to mimic pre-development conditions.

A strong case for the widespread implementation of LID methods is made clear by juxtaposing these techniques against traditional stormwater management approaches. In the conventional approach, stormwater picks up pollutants such as oil, nitrogen, trash and heavy metals by nature of the surfaces it runs across. This pollution significantly degrades local water quality, negatively impacting the health of humans drinking from or recreating within the watershed as well as plant and animal species in connected riparian systems. As a result of entire systems being encased in impervious materials, the traditional stormwater management process does not contribute to the recharge of local groundwater tables. This can cause significant environmental and economic impacts as reduced local recharge could result in importing water across significant distances at great costs. When these conditions are endemic across the entire built form they endanger the long-term viability of the entire region. Furthermore, the sea of impermeable surfaces resulting from traditional development practices significantly increases the likelihood for erosion, which is detrimental to remaining natural environments as well as adjacent sites. Finally, utilization of Low Impact Development aids municipalities in attaining water quality benchmarks and helps to ensure the vitality of the region's ecology. Implementation of LID practices greatly reduces these negative consequences of traditional approaches to urban stormwater management. If implemented at city-scale, LID practices have the potential to radically alter the current hydrologic functions of urban regions for the better.

Obstacles

Though LID has largely proved successful and is often looked upon favorably by city planners, several common hindrances have limited widespread adaptation. The first roadblock to widespread incorporation of LID is that most local zoning ordinances were written decades ago and as a result, are restrictive of such new water management techniques. Many of these codes are very descriptive about the stormwater strategies implemented on new sites and leave little room for experimentation or deviation from the norm.[4] The reasons for this hindrance are twofold: first, as is the standard for most ordinances, proven strategies with long track records of use are heavily favored by developers and creditors over new approaches; and second, because LID is relatively new, there are few existing ordinances other municipalities may refer to, learn from and emulate.

If a developer is interested in LID despite the ordinances standing in their way, they must invest substantial effort to work with their local planning authority to obtain a variance allowing them to perform such actions. Securing such variances, however is very time consuming and can delay the entire development's permitting process, resulting in large costs to the developer. To combat this, the US Department of Housing and Urban Development has suggested creating a database of successful LID zoning ordinances from around the nation, both for

3 Low Impact Development by Law, p. 7

4 The Practice of Low Impact Development, p. 18

small towns and large metropolitan areas.[5] This resource, they argue, would be instrumental in facilitating change, as these sample ordinances would assist planners in creating legally sound and environmentally beneficial LID ordinances.

A third obstacle to widespread use facing LID is the externalization of stormwater costs by local governments so that land owners seldom have any incentive to reduce runoff volumes. Some municipalities have begun to seek to share the burden of excess stormwater more equitably, and hopefully, achieve more environmentally friendly results in the process.[6] Attempts to implement such changes may be met with strong legal pushback from affected landowners, as Richmond, Virginia is currently experiencing.[7] These stormwater taxes, which are assessed through a function of how much impervious surface is on the site in question, bring the appeal of LID to the front of the stage. The pushback from this breach of the status quo, however, is strong and the legality of such interventions continues to be tested in court.[8]

LID in Virginia

Despite these challenges, LID has gained visibility and accolades over the past decade and a half, and the movement for utilizing LID for stormwater management is growing. As illustrated above, many of the solutions to increasing LID's draw are quite basic. The transition from existing regulatory standards to new ones that permit and encourage LID is an uphill battle, but is beginning to take place.

Charlottesville, Va Greenleaf Park Rain Garden, 2005

5 The Practice of Low Impact Development, p. 15
6 Funding Stormwater Programs, p. 2
7 Southside Group in Opposition of Storm Water Utility Tax Is Organizing, 2010
8 Storm Water Lawsuit Ok'd Council Votes to Fight Rules to Purify Runoff, 2003

Stafford

In 2003, Stafford County amended its code to provide some incentives for LID techniques.[1] The following year, the County went even further, requiring LID implementation to the "maximum extent practicable".[2] Additionally, the County made exceptions in the curb and gutter requirements to accommodate water flowing into LID structures such as bioretention and tree box filters. Bioretention vegetated swales are permitted in lieu of curb and gutters along streets for the purposes of stormwater treatment and movement. Bioretention sites also count towards minimum landscaping requirements for parking lots, effectively addressing two development requirements at the same time.[3]

1 Stafford, Stormwater, Erosion and Sediment Control Plan
2 Ibid.
3 Stafford County Stormwater Management Design Manual

Staunton

In late 2009, the city of Staunton, Virginia enacted a stormwater ordinance that is very supportive of LID principles. Staunton's approach is a particularly well-defined model, and can serve as an exemplar for other planning agencies to follow. The crux of the new stormwater ordinance can be found it its requirement of all new developments affected by the ordinance to maintain "predevelopment runoff characteristics."[1] This stipulation gets to the heart of LID's goals, and recognizes that they are not incompatible with development.

1 Staunton, Stormwater Ordinance, p. 3

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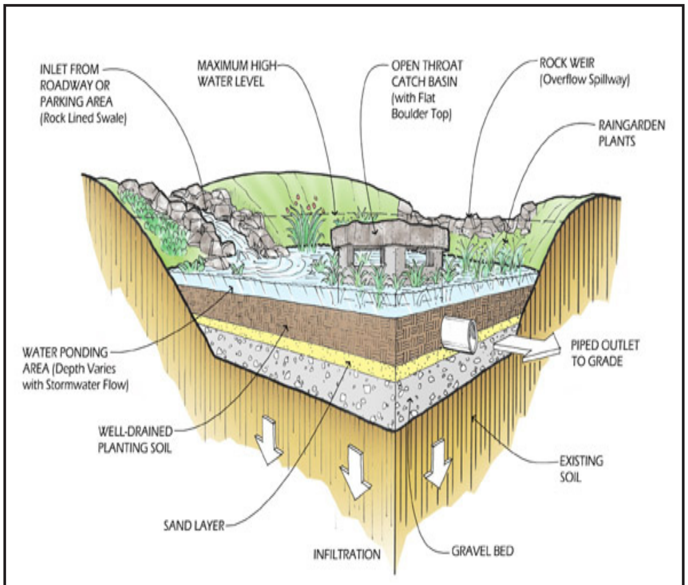
Common LID Techniques

Bioretention

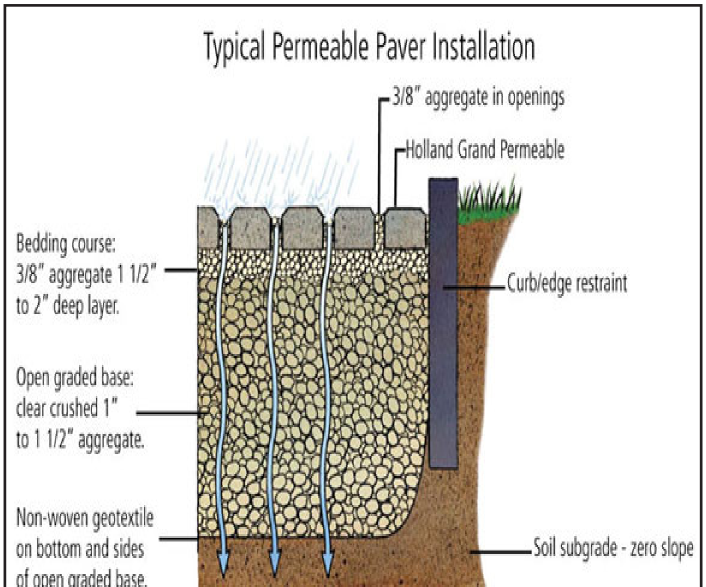
Bioretention is designed to manage stormwater by imitating pre-development hydrologic conditions in a concentrated area. Bioretention has the ability to manage and clean stormwater at or near the source. Often, bioretention cells are placed in the path of stormwater flows over pavements, such as at the edge of a parking lot. A bioretention cell is made up of a mix of porous soil, sand, topsoil, and compost. Cells are typically located in a shallow depression in the earth (often called a swale). The area above and around the cell is planted with low shrubs and grasses that thrive in wet soil. Larger trees and bushes are often planted at the periphery of the bioretention site. The cell absorbs stormwater runoff, filtering and slowing it in the process. By keeping the rainwater on site, bioretention also helps to recharge groundwater tables.

Permeable Pavers

Permeable Pavers are an alternative to concrete or asphalt in light-duty or residential settings, such as driveways, sidewalks, and parking areas. Pavers interlock or create a lattice grid over grassy areas and are typically inset into layers of sand and gravel to allow water to filter through to the underlying soils. By allowing infiltration to occur on site, runoff is reduced and groundwater recharge rates and water quality are improved.



Bioretention; Cloos Landscape Architecture; 2010



Permeable Paver; My Paver Driveway; 2010

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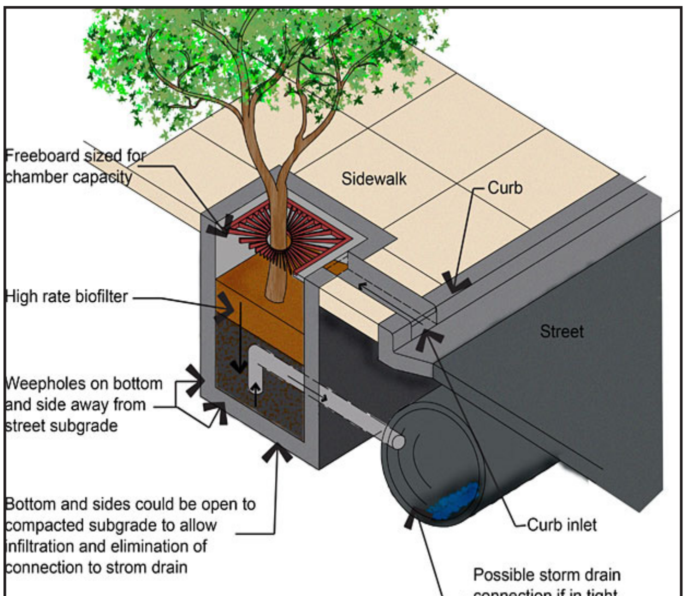
Common LID Techniques

Tree Box Filters

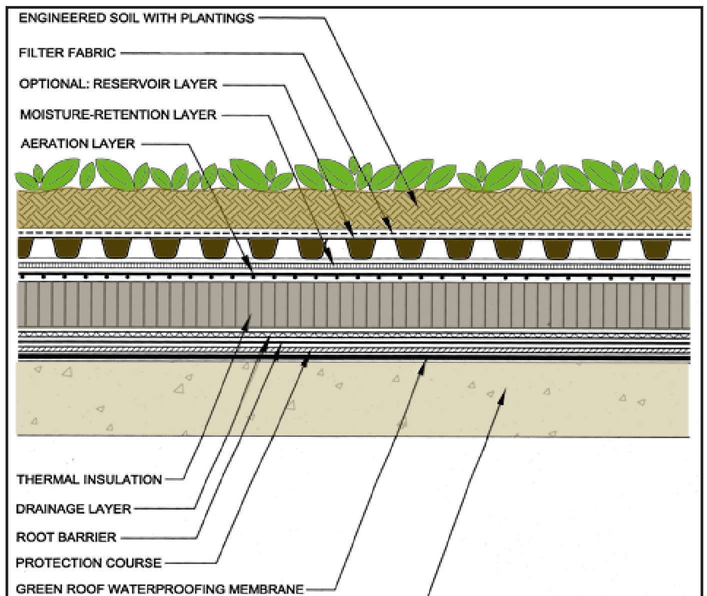
Tree Box Filters are essentially small-scale bioretention cells, and can typically be installed more easily than a full bioswale. When several are used in concert, they can achieve significant results. The bioretention soil is placed in a container beneath a tree box. Stormwater runoff flows into a curb cut in the tree box where it the filters through the bioretention soils. The filtered water flows through a pipe or sheet flows into an adjacent natural area.

Green Roofs

Green Roofs are designed to replicate the pre-development stormwater function of the site to the maximum extent possible by essentially moving the disturbed soil beneath the development to its roof. Typically, a green roof consists of a layer of vegetation and soil on the very top, which covers filter and drainage membranes, waterproof and root repellent layers, insulation, and structural support. These layers serve to prevent water damage and leakage while soaking up as much rainwater as possible. There are several economic and environmental benefits to installing green roofs, including lowering heating and cooling costs, maximizing the time between roof replacements, reducing exterior noise inside the building, improving local water quality by reducing stormwater runoff, and providing an aesthetically pleasing public space where roof access is possible.



Tree Box Filter; USAF Sustainability Toolkit; 2010



Green Roof; Eco Brooklyn; 2010

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Image Credits

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