

# Changing Landscape of Stormwater with Low Impact Design

Stormwater runoff is considered a problem in many urban environments. It occurs when precipitation flows over the ground and impervious surfaces, such as concrete and asphalt, prevent the stormwater from naturally soaking into the ground. Traditional design principles utilize large detention or retention ponds to contain and treat stormwater runoff on project sites, concentrating flow to one area or part of the site. Runoff must be controlled to prevent property damage, flooding, erosion and sediment deposits, and loss of healthy vegetation, and to encourage the recharge of groundwater. However, in recent years, regulations and perception have evolved to include low impact design principles that focus on preventing concentrated flows of stormwater from leaving a site and on improving water quality.

## What is Low Impact Design?

Low impact design, also referred to as green infrastructure, can be described as many things. It is an engineering and land planning approach that is tailored to treating stormwater by utilizing the natural environment. Green infrastructure is a concerted effort to minimize or prevent concentrated flows of stormwater from leaving a site and to allow for infiltration to recharge the groundwater table. It can improve water quality through natural filtration. In some instances, traditional components of a development, such as inlets, curbs and gutters, and piping can be eliminated through the use of low impact design practices. Green infrastructure can provide recreational opportunities or wildlife habitat through the incorporation of natural areas into the stormwater design. Examples of low impact design are bioretention areas, naturalized basins, vegetated swales, underground detention, infiltration trenches, green roofs, and tree boxes with infiltration.

## State and Municipal Regulations are Evolving

Municipal and State regulations have been evolving over the last 10 years to incorporate low impact design principles.

From stay-on-volumes, to infiltration and water quality, different jurisdictions have varying criteria that are being implemented, at times on a case-by-case basis. For instance, Metro Nashville implemented a voluntary low impact design program in August of 2012. During this voluntary period, 23 percent of all grading permits were issued to projects utilizing low impact design principles. When Metro's mandatory program came online in February 2016, the development and engineering communities were ready for the changes. Rebecca Dohn, with Metro Water Services Stormwater Division, indicated that the voluntary period seemed to provide a smooth transition from the traditional methods of stormwater design to incorporation of low impact design methodologies.

While Metro Nashville voluntarily implemented their program, the City of Chattanooga was placed under a consent decree from TDEC and the EPA to implement a stormwater ordinance utilizing green infrastructure. The new stormwater ordinance was implemented in December of 2015 and required the first one-inch of rainfall to be held on-site with infiltration utilizing green infrastructure. Even though the City conducted training for the engineering and development communities, there was some resistance and, in some cases, a misunderstanding of the ordinance requirements. Tony Kinder, City of Chattanooga Stormwater Manager, has indicated that the City stormwater ordinance is now better understood by the development community as a whole and implementation, both through design and construction, has gone well.

## Cost and Construction of Green Infrastructure

In some circles, low impact design and the term green infrastructure are still considered taboo. Change is hard, especially if it is enforced by a regulation or the individual does not have the training or adequate information to understand the potential benefits of low impact design.

Developers look at their bottom line



A bioretention area in a commercial office complex



Fairfax County, Va., roadway with vegetated swales



StormTech System by ADS. - Photo from the ADS website

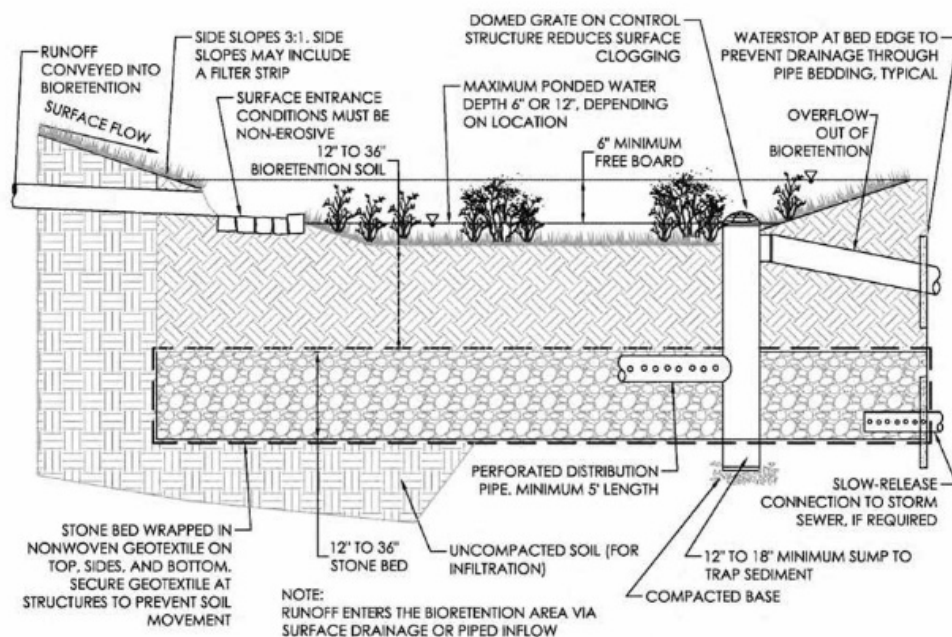
for pre-development costs, which consist of any cost they incur during the land purchase, due diligence, design, permitting and construction phases. These costs are passed along to the consumer in various ways, depending on the type of development. They know how much pre-development costs can be incurred and still meet

the business plan for the project. When a low impact design element is implemented on a site, it cannot be looked at as an “apple to apple” replacement for stormwater costs. A detention pond has different elements and costs than a bioretention area. Some green infrastructure can be expensive and labor-intensive to construct, while others are simple and cost effective. For instance, a subdivision can be designed without curbs and gutters, stormwater inlets, and piping with vegetated swales being utilized between the edge of pavement and the sidewalk to allow for infiltration and storage. The swales would direct the stormwater to a larger facility, such as a naturalized basin or bioretention area, for further treatment. Another example would be to utilize pervious pavement for sidewalks or streets to allow for stormwater storage underground. When comparing these construction costs, all aspects have to be taken into account individually before determining if there is a cost increase or savings on the stormwater component of the project.

Pre-fabricated stormwater storage units are available from several manufacturers for underground detention systems with infiltration, which are allowed in some municipalities to meet low impact design requirements. These can be a little more expensive to purchase; however, they are typically easier and cheaper to install. If the project site is land restricted, these units are great alternatives and space savers to meet stormwater ordinance requirements. Two examples are a stormwater management chamber system offered by ADS called “StormTech” or multiple underground storage options from Contech Engineered Solutions. Another green infrastructure option is installing a green roof on a structure, which utilizes space that is often times ignored and can assist in meeting LEED specifications and stormwater requirements.

### Low Impact Design Criteria

There are many options for low impact design depending on the location,



**Bioretention area typical section with stone bed and underdrain.** - Taken from the City of Chattanooga Resource Rain Guide Section 5.3.4 Bioretention.

project type, soil types, and jurisdiction. Depending on the low impact design element being utilized on a project, different components will be required. Each municipality or jurisdiction will have design criteria, and sometimes a design manual, for use during the stormwater design of a project. The City of Chattanooga Resource Rain Guide or the Metro Nashville Low Impact Design Manual are two examples of publications that provide information on various green infrastructure practices. Both of these publications include details and the required design criteria to assist the engineer in designing the system to meet the stormwater ordinances.

### Design Considerations

Several things must be considered when selecting low impact design practices for a project. Most importantly is soils information. A Geotechnical Engineer should provide detailed site information relative to rock seams or outcroppings, soil types and infiltration rates. Some soils are not suitable for infiltration. Another consideration is the size of the drainage area. Some practices are better suited for small drainage areas, in the two- to five-acre range, while others can treat larger areas. Landscaping plans with water-tolerant plants specified are required for some practices such as bioretention areas, rain gardens, or naturalized basins.

Practice performance is another con-

sideration. A bioretention area functions differently than a vegetated swale. Depending on the site and conditions some sites may require treatment trains, which are multiple practices which work together to store, treat and infiltrate the stormwater runoff to achieve improved water quality.

One important consideration in designing a stormwater system utilizing green infrastructure is long-term maintenance. If maintenance is not performed as required, the system can get clogged or stop functioning as designed. This can be detrimental to the site, or to an adjacent site. Each system will require specific maintenance with differing costs associated with that maintenance. Bioretention areas have high long-term maintenance costs, while vegetated swales have low long-term maintenance costs. This information should be relayed to the developer prior to design to ensure he/she adequately plans for the required maintenance.

### TSS Removal

One major benefit that is sometimes overlooked is the total suspended solids removal achieved when implementing green infrastructure. A traditional detention pond is assumed to achieve approximately 60 percent TSS removal. In many instances, low impact design practices are assumed to achieve 80 percent TSS removal without additional measures.

*Continued on page 11*

the trash. This protects the elderly or children from unintentionally taking a drug they should not, and keeps experimenting teens and other potential drug abusers from having access.

For 2017 alone, over 55,656 lbs. of pharmaceuticals have been collected through the drug take back collection bins, and nearly 255,337 lbs. cumulative since the origination of the take back program. There are 234 bins total in Tennessee. Specific bin locations for each county and further information about the state's Unwanted Pharmaceuticals Take Back Program can be found at <http://www.tennessee.gov/environment/article/sp-unwanted-pharmaceuticals>.

"Collection boxes are available in every Tennessee county, thanks to TDEC's program and partnership with local law enforcement," said TDEC Deputy Commissioner of the Bureau of Environment Shari Meghreblian. "The 200+ permanent bins offer residents a way to help us safeguard our natural water resources."

So this year keep your cabinets cleaned out year-round and responsibly dispose of over-the-counter and prescription drugs at your local prescription take back bin, and help keep Tennessee's water clean and limit drug abuse. [UDW](#)

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The amended soils and vegetation assist in filtering the suspended solids and also prevent re-suspension. If the project is in an urban setting, this can be particularly helpful for "hotspot" runoff and treatment.

### The Contractor is a Part of the Team

Prior to construction of green infrastructure, it is important that the selected contractor understands the design, what is intended in the plans, and how to install and construct low impact design features per the local jurisdiction requirements. More and more contractors are learning about green infrastructure, including gaining an understanding of the different elements, proper installation practices, and how the various elements function together. This understanding improves the overall stormwater system being installed on a project site, and the more proficient a contractor is at installation, the lower the construction costs. Whether it is realized or not, the contractor is an important member of the team.

### Low Impact Design on a Large Scale

For many, green infrastructure is considered something that is applicable only in an urban setting on a small scale. However,

these same low impact design principles can be implemented on a larger scale, such as on roadway projects. A great example is in Fairfax County, Virginia, where a multi-lane roadway project utilizes a vegetated grass swale system with inlets for stormwater management.

### What Have We Learned

It is important to note that no one solution will fit every project or site when it comes to low impact design. Sometimes, it may take a combination of practices to make a site work, while on other sites it might not work at all. With municipalities and the development communities working together, the implementation of low impact design practices will assist in alleviating urban stormwater issues and improve water quality in our streams, rivers, and lakes. [UDW](#)

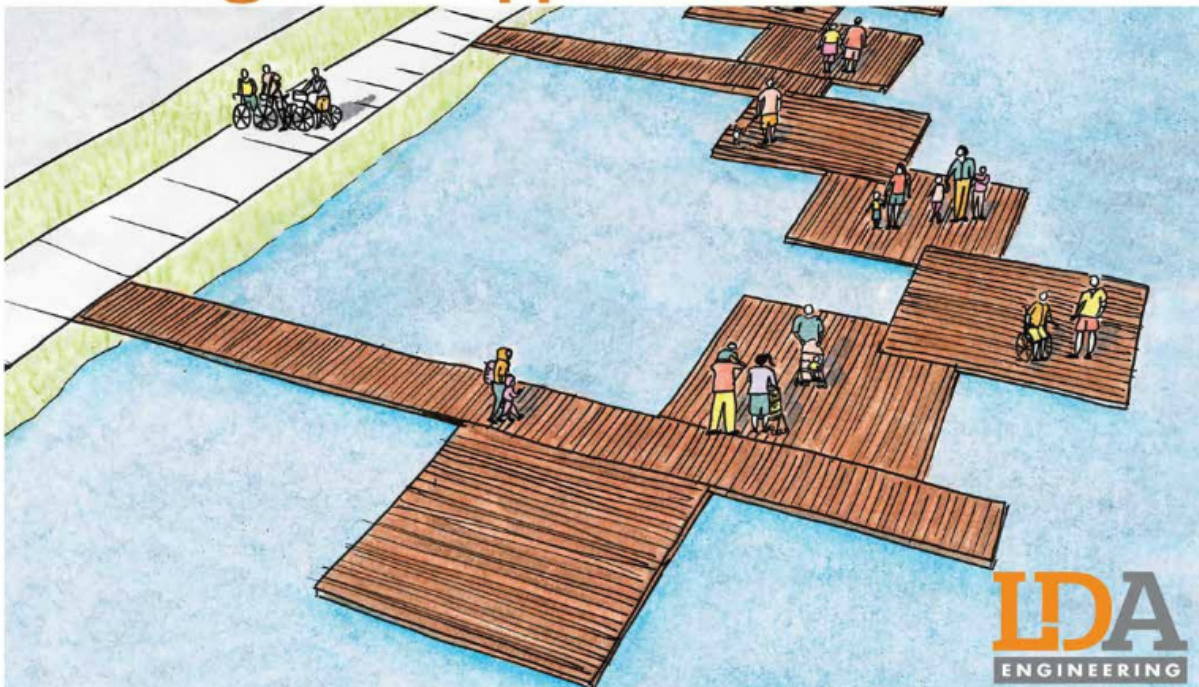
### Resources for Information on Green Infrastructure:

Environmental Protection Agency [www.epa.gov](http://www.epa.gov)

City of Chattanooga Resource Rain Guide  
<http://www.chattanooga.gov/public-works/44-public-works/989-resource-rain>

Metro Nashville Low Impact Design Manual  
<https://www.nashville.gov/Water-Services/Developers/Low-Impact-Development.aspx> U.S.

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November 7-9

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