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LOW IMPACT DEVELOPMENT (LID) MANUAL

Simple Solutions
to
Reduce Stormwater Impacts

LOW IMPACT DEVELOPMENT



ACKNOWLEDGEMENTS

FUNDING SOURCE

In 2010 the Town of Cedar Point received a Section 319 grant from the N.C. Department of Environment and Natural Resources to develop a Low Impact Development manual. The grant also provided resources to design and install a series of LID stormwater reduction measures at Cedar Point Town Hall and other locations around the community. This two year grant is part of a larger effort to reduce and prevent polluted stormwater runoff that is closing shellfish waters in the White Oak River. The Town of Cedar Point worked in partnership with the Town of Cape Carteret, the N.C. Coastal Federation, engineering consultants Withers & Ravenel, N.C. Division of Water Quality and the LID Technical Review Team to complete this project.



TABLE OF CONTENTS

Chapter 1	Project Background and Purpose
Chapter 2	What is LID?
Chapter 3	LID Fact Sheets
	Stormwater Solutions
	Site Fingerprinting
	Disconnect Impervious Surfaces
	Planter Boxes
	Permeable Paving
	Cisterns
	Simple Solutions
	Rain Gardens
	Disconnect Downspouts
	Native Landscaping and Tree Planting
	Rain Barrels
Chapter 4	Permitting and Maintaining LID Projects
	Glossary



CHAPTER 1

Project Background and Purpose

Local Considerations

STORMWATER IMPACTS ON THE WHITE OAK RIVER

Stormwater Management is a major issue for communities and developers. The way we develop and manage land dramatically increasing the flow of stormwater by creating pathways for the runoff to reach the water. Stormwater runoff flushes bacteria and other pollutants directly to our coastal creeks, rivers and sounds. The source of bacteria (wildlife and pet waste) has always been around but impervious surfaces such as roofs and parking lots can direct the polluted runoff into the water instead of it remaining on land where it can absorb into the ground or evaporate.

The secret to protecting and restoring water quality in the Towns of Cedar Point and Cape Carteret is to reduce the amount of stormwater runoff that flows off the land.

“Total Maximum Daily Loads (TMDLs) must be developed for each impaired water body. TMDLs are actions to restore clean water by examining water quality problems, identifying sources of pollutants, and specifying actions that create solutions. TMDLs define how much of a pollutant a water body can tolerate and still meet water quality standards.”
—Clean Estuary Partnership

EPA TOTAL MAXIMUM DAILY LOAD (TMDL) STUDY AND PLAN

A Total Maximum Daily Load (TMDL) study identifies how much pollution a water body can tolerate and still meet water quality standards. A recent TMDL study funded by the US Environmental Protection Agency analyzed portions of the lower White Oak River in Western Carteret County to determine the sources of pollution. The study found very high bacteria levels throughout the lower river and identified polluted stormwater as the primary culprit. State monitoring indicates that increased runoff from urbanization is a significant cause of the bacterial pollution.

Two-thirds of the White Oak River’s shellfish beds are now permanently off limits or close to shellfish harvest temporarily after a moderate rain.

The TMDL study and plan outlined a series of steps that should be taken to reduce the flow of stormwater runoff into the river. They include:



1. Reworking existing storm drains to infiltrate more runoff into the ground before it reaches the river;
2. Educating people about the effects of stormwater runoff;
3. Educating people about simple, effective and inexpensive steps they can take to reduce runoff; and
4. Encouraging developers to use more innovative techniques to control stormwater.

N.C. DEPARTMENT OF TRANSPORTATION

N.C. DOT was a project partner in developing the White Oak TMDL and restoration plan. N.C. DOT has committed to reduce the amount of stormwater runoff from N.C.24 that flows into the White Oak. They will use stormwater reduction measures to gain credit for compliance with their NPDES stormwater permit. This makes them a project partner in implementing LID in the community..

LID MANUAL AND PROJECT IMPACTS

This manual provides a tool for implementing recommendations from the 2008 Lower White Oak TMDL. It is also designed for use by neighboring coastal communities and project partners including the Town of Cape Carteret.

The manual provides techniques for reducing stormwater runoff from new development and for mitigating the impacts of runoff from existing development.

When used comprehensively, LID techniques can help local governments meet their water quality protection goals by creating landscapes that absorb and treat stormwater runoff.

The Town of Cedar Point and Town of Cape Carteret recognize that protecting water resources is a difficult challenge but are committed to balancing economic growth with coastal water quality protection. That is why the towns are joining other coastal communities from across the country to promote the use of LID.

MANUAL DEVELOPMENT

The Town of Cedar Point received a Section 319 grant from the N.C. Department of Environment and Natural Resources to develop this LID manual. The Town partnered with the Town of Cape Carteret, the North Carolina Coastal Federation, NC Division of Water Quality and Withers & Ravenel consulting engineers to develop this project.

The first task of the project was to form a team of dedicated professionals to guide the creation of the manual. The group consisted of developers, engi-



neers, realtors, surveyors and staff from Cedar Point and Cape Carteret. The Technical Review Team met several times over the course of a year to draft the LID manual. The N. C. Coastal Federation and Withers & Ravenel provided staff support and technical support for developing the manual and resolution.

TRT MEMBERS

- Alan Bell – Bell & Phillips Surveying, PLLC
- Keith Buck, Sr.- Prestige Land Surveying, PA
- Les Fredeen – Marsh Harbour
- Chuck Jordan – Jordan Building Company
- Kerry Moles – Coastal Landscaping, Inc.
- John Odom – Prestige Land Surveying, PA
- Mike Randall – N.C. Division of Water Quality
- Alan Redfearn – Redfearn’s Nursery
- David Reif – Town of Cape Carteret
- Diane Ritchie – Ritchie Commercial Developers, Inc.
- Chris Seaberg – Town of Cedar Point
- Teresa Smith – Bluewater Real Estate
- Maria Tart – Jordan Building Company
- With contributions from John McLean, John McLean Engineering and Brian Lassiter, Jones Masonic Campus.

APPLICATION OF MANUAL

The information in this manual is intended as a starting point to provide guidance in the application of LID.

For new development and redevelopment requiring permits, this manual should be used in conjunction with applicable current local, state and federal laws, rules, codes, ordinances and standards.

However, existing property owners and community members play a vital role in protecting the health and welfare of coastal water quality and this manual provides simple solutions that can be implemented on a lot by lot basis. Projects of this nature will likely not require permits. Town staff can advise on these smaller scaled projects.



CHAPTER 2

WHAT IS LOW IMPACT DEVELOPMENT (LID)

LID is a stormwater management approach that uses a variety of techniques to replicate the natural hydrologic function of the landscape. These techniques include creative site planning and small, decentralized treatment and infiltration techniques that minimize stormwater runoff.

Watershed hydrology refers to a land area that drains water, sediment and dissolved materials by a network of tributaries that feed a main creek or series of creeks. It is water that drains off land from the highest point to the lowest point.

GOAL OF LID

The goal of LID is to mimic a site's natural hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain stormwater runoff close to its source. LID can help prevent runoff and minimize the flow of stormwater from existing development and land uses.

The use of LID techniques can reduce the volume of runoff that is generated, and maximize the treatment capabilities of the landscape, while controlling runoff as close to the source as possible.

APPLICATIONS OF LID

LID is versatile and can be applied to all types of land use and development including commercial, residential subdivisions, mixed use development, individual lots, public lands, roads and parking facilities, and other areas.

LID PRINCIPLES

Successful application of LID requires consideration of the following core site planning and design principles and objectives:

1. Focus on prevention

Protect streams, wetlands, floodplains and coastal habitats. Maintain slopes and flow paths; minimize grading and tree clearing.

2. Work with the landscape

On new development projects, identify environmentally sensitive areas then outline a development plan that protects those areas. Natural hydrologic features of the site can be some of the most efficient and effective stormwater treatment practices for new development.



3. Keep It Simple

Before resorting to expensive piped systems, use lower-cost approaches to decentralize and micromanage stormwater close to where it falls. Direct runoff from impervious surfaces to landscaped areas and other small scaled devices for infiltration.

4. Practice Multi-tasking

Create a multifunctional landscape that can provide open space, wildlife habitat and stormwater treatment. Such landscapes can provide filtration, treatment, and infiltration while also providing curb appeal. The distribution and small scaled nature of LID practices means that multiple devices are working as a team to reduce the impacts of stormwater runoff.

5. Maintain and Sustain

The effectiveness of LID relies not only on design and installation but also on management. Whether LID practices are required by permit or purely a voluntary effort, the long term success of the system requires upkeep and care.

LID FOR NEW DEVELOPMENT

LID site design for new development includes identifying important natural features, strategic placement of buildings, roads and parking areas, and designing a stormwater management system that works with the site to maintain or mimic the predevelopment hydrology. The attention to natural hydrology, stormwater “micromanagement,” and integrated use of the landscape results in a more attractive, multifunctional landscape. Unlike conventional strategies that treat stormwater as a secondary component of site design, LID incorporates the natural slope, soils and hydrology as an integrating framework for site design starting at the project concept level.

SIMPLE SOLUTIONS FOR EXISTING DEVELOPMENT

The volume of stormwater runoff from existing land uses can also be reduced by installing LID stormwater reduction measures. When stormwater volume is reduced, so is the amount of bacteria and pollution reaching surface waters.

The goal of simple stormwater reduction measures is to utilize the capacity of the soil, plants or technique to collect stormwater before it has a chance to become polluted runoff. Some techniques such as rain gardens absorb the runoff. Others such as rain barrels catch the runoff for later use.



Stormwater retrofits are strategically placed to more closely mimic a watershed's hydrology. The result is a hydrologically functional landscape that generates less surface runoff, less pollution, less erosion, and less overall damage to coastal waters.

Over time, as areas are redeveloped and rebuilt using LID, the impact from those existing developments on water quality is greatly reduced. The cumulative impact of retrofitting existing flows of stormwater runoff can have a significant impact and are a part of the towns' overall strategy for managing stormwater.

LID retrofits can be used on individual lots, throughout residential subdivisions, on commercial and institutional facilities, and incorporated into capital improvement projects, roads and parking areas.

FACT SHEETS FOR LID TECHNIQUES

See stormwater solutions fact sheets and simple solutions fact sheets for LID techniques to prevent and reduce polluted stormwater runoff.



CHAPTER 3

Use of Manual Fact Sheets

Instead of including page upon page of difficult to follow text, the developers of this manual intend to provide users with several stand-alone fact sheets on how to implement LID. This manual contains fact sheets for incorporating LID into new development designs and for using LID techniques to retrofit existing development.

STORMWATER SOLUTIONS AND SIMPLE SOLUTIONS

These fact sheets are intended for use by developers, engineers, contractors, local government planners, permitting officers, state permitting agencies, and local property owners.

The first series of fact sheets, Stormwater Solutions #1-#5, are generally more suited for use when considering incorporating LID into new development projects. These techniques include Site Fingerprinting, Cisterns, Disconnect Impervious Surfaces, Planter Boxes, and Permeable Pavements.

Simple Solutions #6-#9 are fact sheets focused on LID techniques that can be incorporated into a new development site but also can be applied to fix an existing stormwater problem on an individual site. These techniques are referred to as Simple Solutions and are entitled Rain Gardens, Disconnect Downspout, Rain Barrels, and Native Landscaping.

All fact sheets can be used individually or together to help create a stormwater management strategy for a given project and to get local stakeholders on board with watershed management approaches that reduce the flow of stormwater runoff.

FACT SHEET CONTENTS

Each fact sheet contains a brief overview of the LID technique and benefit provided. In addition, the fact sheets provide information on the siting, installation and maintenance of each technique. Fact sheets include photos of local practices illustrating the technique and includes references and resource links.

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Simple Solutions: Rain Barrel



What is a Rain Barrel?

A rain barrel is a container that collects and stores rainwater from your roof that would otherwise be lost to runoff. Rain barrels come in all shapes and sizes. They typically include the drum, a vinyl hose, PVC couplings and a screen to keep debris and insects out. A rain barrel is relatively simple and inexpensive to construct and can sit conveniently under any residential gutter down spout.

*Rainwater is free!
All you need to do
is collect it.*

Did you Know?

- ¼" of rain produces enough runoff to fill a typical rain barrel hooked up to one downspout. If you and your neighbors all added just one rain barrel, it would have a significant impact on flooding and pollution in your community.
- One 55 gallon rain barrel holds a full week's worth of water for a 10' x 10' garden

Benefits

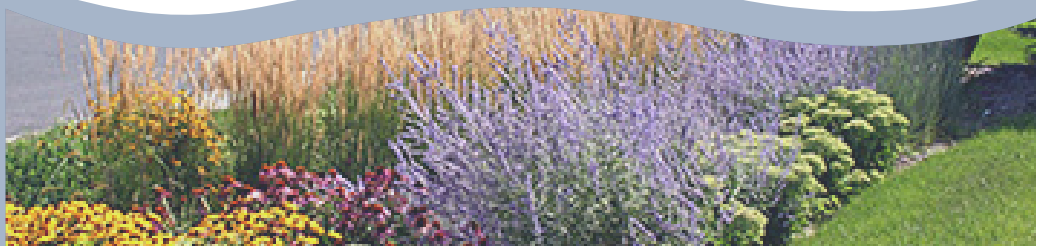
- Lower water bills
- Reduced runoff and stormwater pollution
- Available water for watering plants during drought
- Rainwater contains natural nutrients needed for healthy plants

Helpful Hints

Always keep the lid to your barrel tightly secured to avoid any accidents involving children or animals. Please do not ever consume water collected in barrel!

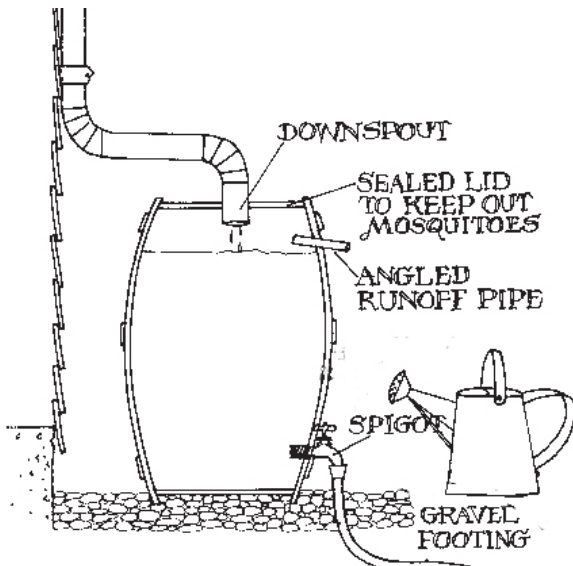


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Simple Solutions: Rain Barrel



How to size and install your rain barrel

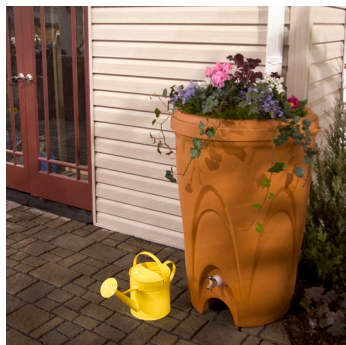
Most rain barrels are easy to install; however, actual installation methods may vary depending on the type of rain barrel. Installation of a typical barrel will involve disconnecting your downspout, cutting off a portion of the downspout and redirecting it into the top of the barrel. Most rain barrels have an overflow pipe that redirects the rainwater back into the downspout or onto your lawn or other surface in the event the barrel becomes full. Some rain barrels include safety features, spigots, connector barrels, mosquito proofing, and even water filters.

Care

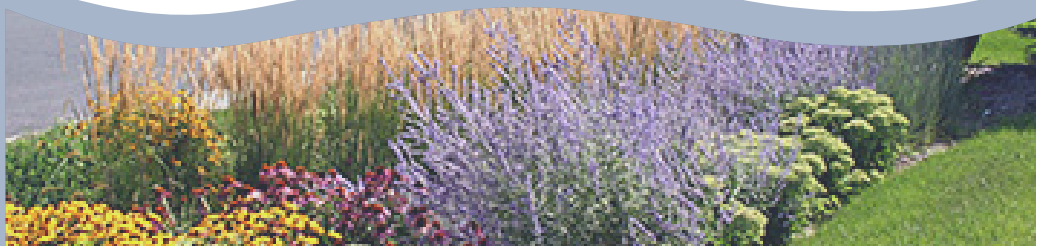
- Use the water between rain events, or empty the barrel monthly
- Once a year, tip over the rain barrel and wash it out with a hose
- Clean your gutters regularly to prevent debris
- If you start to see algae, add one cap of chlorine bleach to a full barrel of water – this small amount won't hurt plants

References and Resources

- NC Cooperative Extension: www.ces.ncsu.edu
- NC Community Conservation Assistance Program: www.enr.state.nc.us
- NC State University: www.bae.ncsu.edu/topic/waterharvesting
- NC Coastal Federation: www.nccoast.org



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Simple Solutions: Native Landscaping and Tree Planting



Native Landscaping and Tree Planting

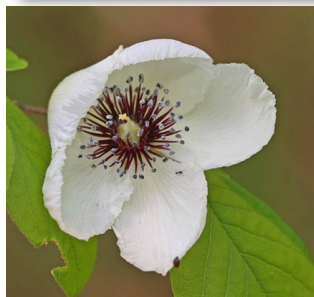
Native landscaping includes the use of native plants that occur naturally in the central coastal region, having not been introduced by human action. Native plants have adapted to the geography, hydrology, and climate of the region. Planting trees can help reduce stormwater by intercepting it and allowing it to evaporate, as well as dissipating the energy of runoff.

They also provide shade, which helps keep surface temperatures lower, and they facilitate stormwater infiltration and groundwater recharge.



Did you Know?

- Native trees and plants are hardy and well suited to our soils and climate
- Require little care once established as compared to non-natives
- Absorb and slow the flow of stormwater runoff
- Prevent erosion and increase soil permeability
- Are part of our coastal natural heritage



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Simple Solutions:

Native Landscaping and Tree Planting



Benefits

Native plants provide beautiful, hardy, drought resistant and low maintenance landscapes while benefiting the environment. Native plants, once established, save time and money by eliminating or significantly reducing the need for fertilizers, pesticides, irrigation and lawn maintenance equipment. It is estimated that one hundred large mature trees intercept 1.2 million gallons of rainfall per year, and for every 5 percent tree cover added to a community, stormwater runoff is estimated to be reduced by approximately 2 percent. Properties with trees are estimated to be valued 5 to 15 percent higher than comparable properties without trees.

Helpful Hints

Direct runoff to a native landscaped feature such as a rain garden to capture stormwater and create beautiful habitats. Rain gardens are designed landscape features that include depressions with native plants (see *rain garden fact sheet*).

Build and Plant

- Use the landscape to help keep rain water on site. Incorporate the following actions into your landscaping plan build a rain garden, plant native trees, use natives shrubs and flowers, install a rain barrel to irrigate, direct downspouts to landscaped areas to absorb stormwater.
- Plant trees that maximize interception of rain
- Plant trees in groves if possible
- Plant native trees with high growth rates



References and Resources

- For native landscaping design ideas and plant lists applicable to your community go to: www.ncsu.edu/goingnative/howto/index.html
- Carteret Cooperative Extension: www.carteret.ces.ncsu.edu
- NC Coastal Federation: www.nccoast.org
- Water Forestry Resource Guide: www.forestsforwatersheds.org
- Local Nurseries and Landscape Professionals



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Simple Solutions: Disconnect Downspouts



What are disconnected downspouts?

Downspouts directed to driveways, sidewalks or parking lots increase the amount of polluted runoff by an average of 50 percent or more. Instead of contributing to stormwater pollution you can put rain water to good use.



Did you Know?

- During the summer months it is estimated that nearly 40 percent of household water is used for lawn and garden maintenance. Rainwater from the roofs of houses picks up very little contamination, and is very healthy for plants

Benefits

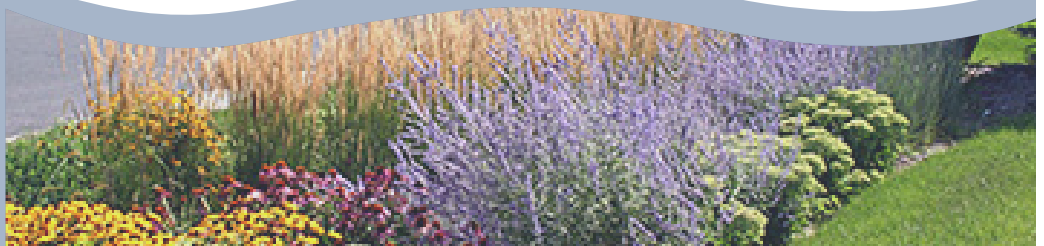
- Reduced runoff volume
- Reduced pollutants
- Reduced flooding

Helpful Hints

- Make the most out of the rain and help protect water quality too. Redirecting roof runoff is cost effective, easy to do and virtually maintenance free.



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Simple Solutions: Disconnect Downspouts



Disconnecting your Downspout

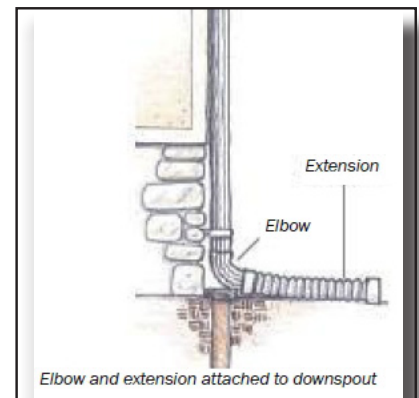
Re-route your downspout with these few simple techniques:

- Direct downspouts to areas where water can soak into the ground
- Turn downspouts away from sidewalks and driveways into yards and other vegetated areas by using extension gutters to “disconnect” the impervious surfaces
- Route downspouts to landscaped areas such as rain gardens
- Link downspouts to rain barrels
- Use extension gutters or splash blocks to help direct the flow of water
- Re-route all stormwater at least five feet from your foundation
- Avoid routing downspouts to neighboring property or directly over a septic system or drain field

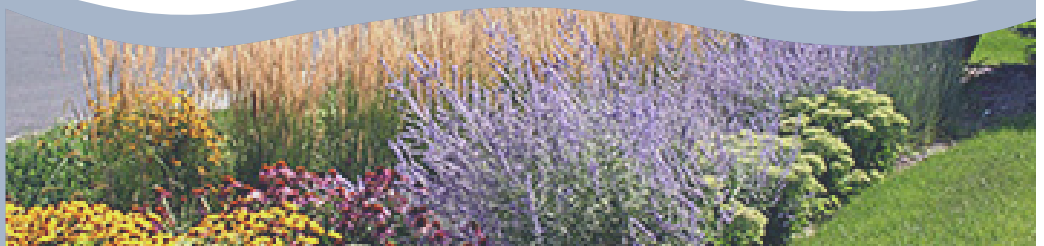


References and Resources

- Mid-America Regional Council: www.marc.org
- North Carolina Coastal Federation: www.nccoast.org
- City of Portland Stormwater Solutions Handbook: www.portlandonline.com
- River Smart Homes: www.ddoe.dc.gov



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Simple Solutions: Rain Garden



What is a Rain Garden?

Rain Gardens are small, shallow, vegetated areas where rainwater collects during storms. Rain gardens are typically 4-8 inches lower than the surrounding lawn and act as a bowl that collects runoff. The plants and soil soak up the rain water before it becomes polluted runoff.

Did you Know?

- Rain Gardens can reduce stormwater runoff by 90% or more
- Over 25% of the population lists gardening as a hobby

Benefits

- Reduced stormwater runoff
- Reduced pollutants
- Reduced flooding
- Natural stormwater treatment
- Enhance the curb appeal of your yard

Helpful Hints

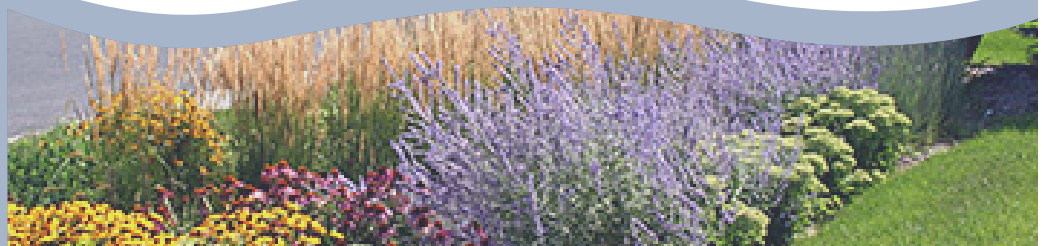
- Observe water flow patterns during rains to determine potential areas for rain gardens
- Use native plants or grasses for lower maintenance
- Rain Gardens may not be suitable in areas of standing water
- Make sure water from rooftops or driveways is directed into the garden.

Installation

- Easy to moderate



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Simple Solutions: Rain Garden



Build and Plant!

Location

- Select an area that will capture and absorb runoff based on how water flows across your land
- Site the garden at least 10' from your house, and 25' from wells or septic fields
- Make sure the soil will drain
- Gardens can contain flowers, shrubs or grasses, or even turf

Equipment

- Small rain gardens can be built by hand in a weekend, but, contact Town staff or a local contractor for additional assistance if needed

Planting

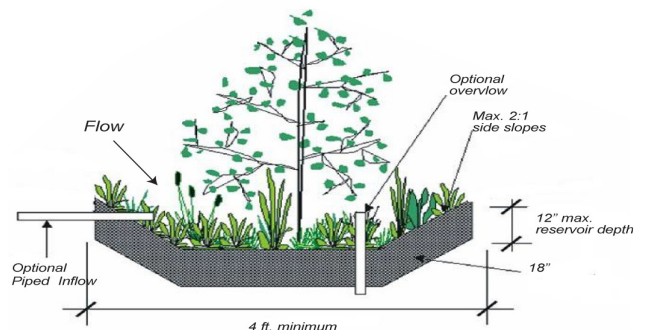
- Heavy double or triple shredded hardwood mulch works best because it won't float away. It also helps retain moisture for the plants
- Choose native vegetation when possible

Care

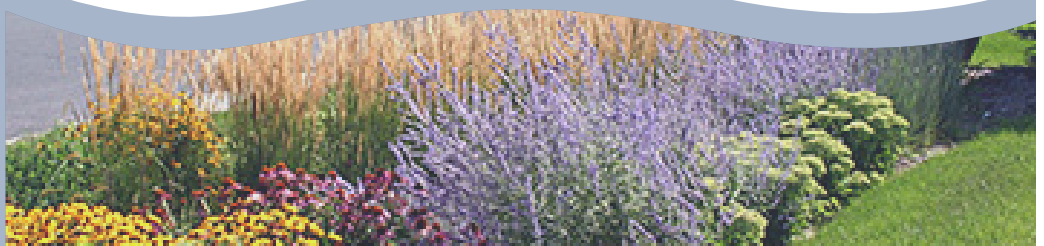
- Periodically water your garden until established
- Mulch annually

References and Resources

- See the "Simple Solutions: Native Landscaping" sheet for more help, or contact your local nursery or Town staff for more assistance.
- www.raingardennetwork.com/raingardens.htm
- NC Coastal Federation: www.nccoast.org
- NC Cooperative Extension: www.ces.ncsu.edu
- NC State University Rain Garden Guide: www.bae.ncsu.edu



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Stormwater Solutions: Cisterns



What is a Cistern?

Cisterns are large water harvesting systems which collect rain water and store it for future use. In contrast to a rain barrel, which only stores a small volume of water, cisterns are sized to capture larger volumes of water and can be installed above or below ground. This water can then be reused for larger scale irrigation, industrial processes, and/or commercial reuse among other options.



Did you Know?

- For every inch of rain that falls on a 1,200 square foot area, approximately 748 gallons of stormwater runoff is produced.
- For high water consumption users, cisterns can be a financially profitable investment, paying for themselves by reducing, or even eliminating water bills for non-potable uses.

Benefits

- Lower water bills
- Reduced runoff and stormwater pollution
- Available water for use during drought conditions

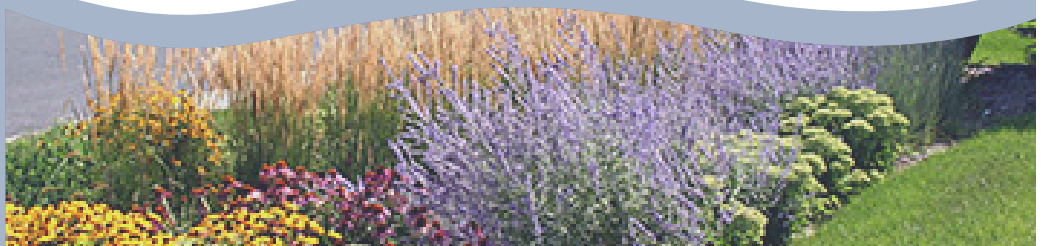


Helpful Hints:

- Check local building codes for allowable uses
- Computerized water management systems can optimize performance
- Cisterns are often some of the most visible green elements of a property and many aesthetic options are available.
- Low cost filters are available to prevent clogging and reduce long term maintenance needs
- A cistern system that minimizes sunlight penetration can help prevent bacteria and mosquito growth



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Stormwater Solutions: Cisterns



How to size and install your cistern

Location

- Look for ways to connect multiple downspouts into a system
- For especially large systems, water can be stored underground in vaults or other engineered systems

Equipment

- Heavy construction equipment is often required, but most commercial contractors have the equipment which would be needed.
- There are a number of specialized rainwater harvesting contractors who offer comprehensive design and installation services.



Considerations

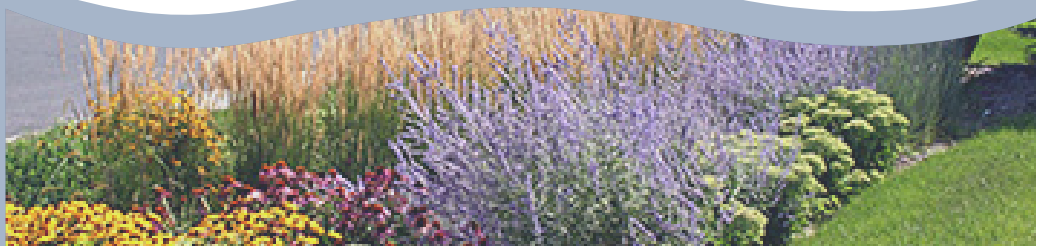
- Cisterns can be used on existing development or new construction
- A full cistern is heavy, and may require additional support, such as a concrete or gravel pad
- If rainwater is to be used inside a building for non-potable uses, dual plumbing systems will be required.

References and Resources

- NC Cooperative Extension—www.ces.ncsu.edu
- NC Community Conservation Assistance Program—www.enr.state.nc.us/dswc
- NC State University—www.bae.ncsu.edu/topic/waterharvesting
- NC DWQ BMP Manual



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Stormwater Solutions: Permeable Paving



What is Permeable Paving?

Permeable paving is any paving material that allows rainwater to soak through the pavement and infiltrate. Permeable paving comes in various forms – pervious concrete, pervious asphalt, and concrete paving are some of the most popular materials. The permeable paving system requires a washed stone base, which aids in adding runoff storage volume as well as structural support.

Did you Know?

- The concrete industry has data on the long term performance and cost-benefit of using pervious pavement systems.
- Town regulations may require pervious pavement in some parking areas.
- Permeable pavement has been used in many locations in coastal North Carolina.

Benefits

- Increased infiltration, reduced runoff
- Opportunity for artistic design if pavers are used
- Great way to reduce runoff without losing parking
- Great for retrofits

Helpful Hints

- Permeable pavements can be used in conjunction with underground detention or rainwater harvesting systems to gain additional stormwater benefits.
- There are thousands of paver and material options – contact your contractor for more information.



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Stormwater Solutions: Permeable Paving



Where to Start

Location

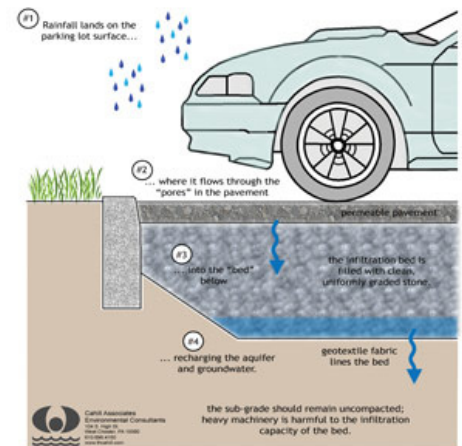
- Pervious pavement systems should be sited on generally flat areas
- A concrete edging may be necessary
- Obtain a soil test before installing pavements, an under drain might be needed
- Only install permeable systems where the water table is deep enough to allow the system to completely drain

Sizing

Unless a permit is required, there is no surface area requirement. Consider using a thicker washed stone base to increase storage capacity and further reduce runoff volumes.

Care

- The system should be checked regularly for proper drainage
- If infiltration rate decreases, clean debris and fines from surface layer
- If system loses infiltration capabilities, contact an engineer or qualified contractor.
- Potholes, cracks, or damaged pavers should be repaired or replaced immediately



References and Resources

- Carolinas Ready-Mix Concrete Association: www.crmca.com
- Pervious Pavement: www.perviouspavement.org/
- Concrete Network: www.concretenetwork.com/pervious/
- Low Impact Development Center: www.lowimpactdevelopment.org
- NC DWQ BMP Manual: www.portal.ncdenr.org/web/wq/ws/su/bmp-manual



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Stormwater Solutions: Planter Boxes



What is a Planter Box?

Planter boxes use high flow rate soil filtration media to control and treat runoff from small parking lots or roadways. Runoff flows through the sandy soil mix, which traps solids and pollutants. As their name suggests, planter boxes also use vegetation to help absorb the water trapped by the soil. In addition, the plants also create a mini living ecosystem within the soil, fostering healthy microbes which aid in breaking down oil and grease.

Did you Know?

- Planter Boxes can be integrated into the existing storm drainage system with minimal disturbance, making them an excellent retrofit
- Planter boxes are a great LID solution. They provide treatment at the source in a small footprint.

Benefits

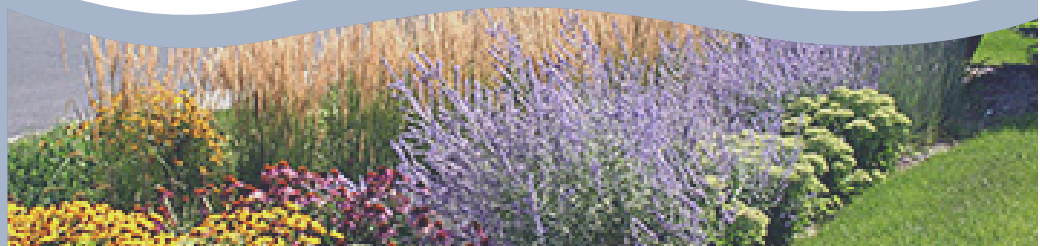
- More trees, flowers, and shrubs
- Reduced runoff volume and pollution
- Small footprint needs almost no land
- Great for retrofits

Helpful Hints

- Think about using the planter box upstream of any underground stormwater device– the water that gets into the underground device will be cleaner, and the cistern won't need as much maintenance
- Holes can be installed in the bottom of the box to encourage additional infiltration if the soil is suitable



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TOWN OF CEDAR POINT AND AND TOWN OF CAPE CARTERET



Stormwater Solutions: Planter Boxes

Where to start

Location

- Site the planter box in the curb line, immediately upstream of catch basin or inlet
- Typical boxes are 3' deep – make sure there is a suitable outfall to drain the box between storms
- Box should be oriented so flow comes across inlet throat, not directly at inlet opening
- Use plants that are native to coastal NC

Sizing

- The soil media should be at least 3' deep
- Minimum soil infiltration rate should be 10" per hour or greater.

Planter Box Size	Max Impervious Area (acres)	Max Impervious SF
4' x 6'	.14	
4' x 8'	.19	
4' x 12'	.28	
6' x 6'	.21	
6' x 8'	.28	
6' x 10'	.35	
6' x 12'	.42	
7' x 13'	.54	



Installation

- Contractor assistance will be required
- Many manufactured systems are available, contact a manufacturer for specific installation guidelines

References and Resources

- Portland, Oregon: www.portlandonline.com
- Low Impact Development Center: www.lowimpactdevelopment.org
- NC Soil and Water Conservation Service CCAP program: www.enr.state.nc.us



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Stormwater Solutions: Disconnected Impervious Surfaces



What is a disconnected impervious surface?

Roof tops, parking lots, and other impervious surfaces often drain directly to pipe systems or ditches, increasing runoff and preventing rainwater from soaking into the ground. Disconnected impervious areas are those which divert or direct stormwater to naturally vegetated areas. This reduces pollution by slowing down the runoff, increasing infiltration, and filtering flow through vegetation.



Did you Know?

- During small storms, disconnected impervious areas can reduce runoff volume by 30% to 100%
- Benefits include reduced need for irrigation, better aesthetics, and lower infrastructure costs
- Local soils can infiltrate over 5 inches of rainfall before becoming saturated

Benefits

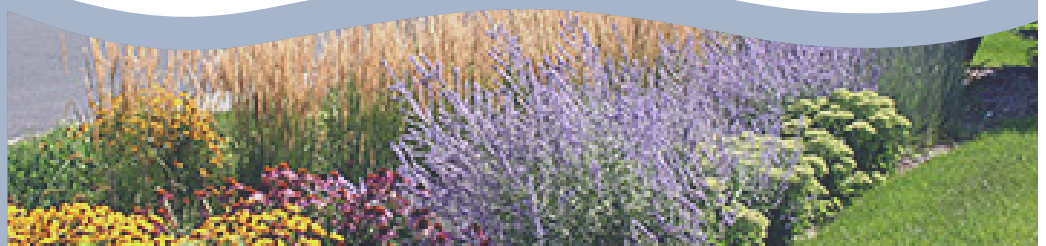
- Reduces stormwater runoff volumes discharged into our waterways
- Reduces infrastructure costs
- Reduces dependence on irrigation
- Healthier green space

Helpful Hints

- The native soils around Cedar Point and Cape Carteret often have incredible capacity to infiltrate stormwater runoff. A landscape specialist or soil scientist can help determine the capacity of the soils on your property.
- For the best effect, tie multiple practices together. Use disconnected impervious areas as part of a larger stormwater management strategy.



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Stormwater Solutions: Disconnected Impervious Surfaces



Where to start

Location

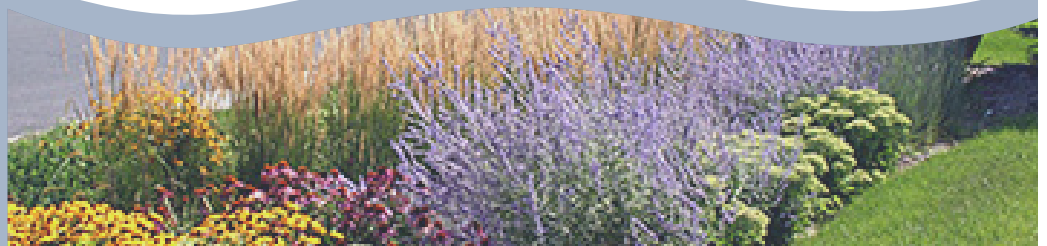
- As a retrofit, see if it's possible to add curb cuts in the edge of the parking lot to allow runoff flow into vegetated areas.
- On new or re-development sites, try to slope the parking lots, roofs, and sidewalks into landscaped areas, open spaces, or woods.
- Make sure water is directed away from buildings.
- Disconnect the building downspouts (see Simple Solutions sheets)

References and Resources

- See the "Simple Solutions: Downspout Disconnection" sheet for more help, Contact your local nursery or Town staff for more assistance
- NC Cooperative Extension: www.ces.ncsu.edu/
- Low Impact Development Center: www.lowimpactdevelopment.org
- NC Coastal Federation: www.nccoast.org



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Stormwater Solutions: Site Fingerprinting

What is a Site Fingerprinting?

Site Fingerprinting is a practice that uses the site design as a stormwater management tool by reducing land disturbance, preserving soil structure, and utilizing suitable natural areas (rather than expensive structural BMPs) for runoff management. Rather than grading land to fit a desired development type, the type of development is dictated by the existing conditions of the site, resulting in developed sites which use the land to maintain and protect the natural balance of the surrounding ecosystem.



Did you Know?

- Site Fingerprinting can be done during the planning process for no additional cost and can often lead to reduced infrastructure costs.
- The majority of soils of Cape Carteret and Cedar Point have natural infiltration rates of greater than 5 in/hr, making them well suited for natural stormwater filtration.
- By fitting the development to the land, it is often easier to preserve existing vegetation, giving a more established look to new developments
- A little preservation goes a long way toward effective stormwater management

Benefits

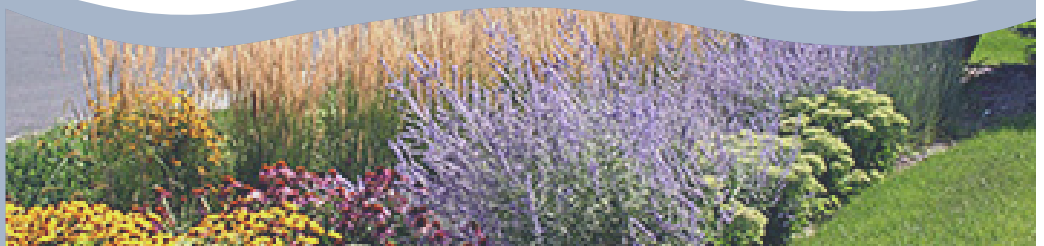
- Reduced stormwater runoff volumes discharged into our waterways
- Maintained natural drainage patterns
- Reduced infrastructure costs
- Healthier green space

Helpful Hints

- When trying to preserve the health of the local watershed, the best place to start is to enhance and preserve the natural stormwater treatment areas. These include marshes, wetlands, and coastal forests, which have great potential to control and treat stormwater runoff. By preserving these, less time and money will be spent trying to make up for the lost potential if they are impacted.



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TOWN OF CEDAR POINT AND TOWN OF CAPE CARTERET

Stormwater Solutions: Site Fingerprinting

Where to Start?

Natural Resources Inventory

1. Start by identifying the natural characteristics of a site

- Wetlands
- Shoreline
- Floodplain
- Forests
- Flow patterns

2. Determine the site's potential for LID stormwater treatment

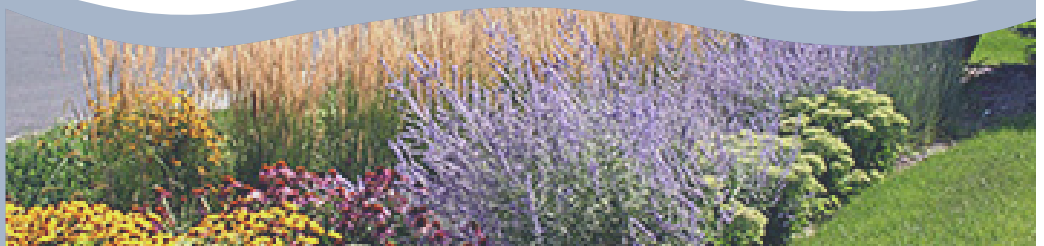
- Locate development on the least sensitive natural areas
- Protect the preservation areas during construction
- Use density where appropriate
- Minimize soil compaction during construction
- Use disconnected impervious areas to minimize runoff volumes
- Use the natural drainage patterns

References and Resources

- Low Impact Development Center: www.lowimpactdevelopment.org
- Green Growth Guidelines, Chapters 1-6, Site Fingerprinting Utilizing GIS/GPS Technology: www.crd.dnr.state.ga.us/assets/documents/GGG1.pdf
- Urban Land Institute: www.uli.org
- American Institute of Certified Planners (AICP): www.planning.org
- American Society of Landscape Architects (ASLA): www.asla.org
- Ladybird Johnson Wildflower Center: www.wildflower.org



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CHAPTER 4

Permitting and Maintaining LID Projects

INTRODUCTION

If town staff or project developer determines that a local or state stormwater permit is required, quantifying the benefits of LID practices is essential. Each LID practice requires careful planning and construction. Each LID practice has its own specific permitting and construction requirements. This chapter deals with general permitting procedures.

PERMITTING LID PROJECTS USING “LID-EZ”

The Town of Cedar Point in a collaborative effort with the Town of Cape Carteret, N.C. Coastal Federation, N.C. Division of Water Quality and Withers & Ravenel, have developed a stormwater management tool to aid engineers, planners, and developers with design and permitting of LID projects.

The tool, LID-EZ, quantifies the effect of the structural and non-structural BMPs on the overall hydrology of residential and commercial developments. LID-EZ requires the user to enter basic pre- and post-development information into the spreadsheet. Well established engineering equations pre-programmed into the spreadsheet then compute the various stormwater parameter of the site. The results include pre- and post-development runoff volumes, land use characteristics, and the impact of non structural practices such as pervious pavement or disconnected impervious surfaces. Additionally, the spreadsheet provides the basic results needed to determine if the site complies with applicable Town stormwater regulations. If structural BMPs are needed to demonstrate compliance, the spreadsheet reports the required storage volumes necessary to meet local and state stormwater regulations. The user then inputs all proposed structural storage devices and identifies the non-structural devices, such as disconnected impervious areas. The resulting calculations then quantify the effect of all LID components on the post development conditions as they relate to required water quality storage volumes and peak flow rates.

While small scale structural and non-structural BMPs can be used to meet many state and local regulations, often the engineer or developer may need to incorporate additional storage areas to fully comply with the regulations. The importance and benefit of the small scale LID devices cannot be overlooked. If a hybrid approach is used, LID-EZ should still be used to compute the effective post development curve numbers, which can then be used to determine actual volume requirements of the large scale detention structures. In many cases, the size of the large scale devices may be significantly reduced.



If the user chooses to use a hybrid approach to stormwater management and include large structural BMPs, such as a wetland or wet pond, additional detention system routings and analysis may be required.

LID-EZ is available free of charge from the Town of Cedar Point and Town of Cape Carteret. Please contact the Towns for more information.

CONSTRUCTING LID PROJECTS

TRAINING

It is very important that contractors, vendors and inspectors have been properly trained in the design specification and construction requirements for all LID practices employed. The success of many LID techniques depend on accurately following the grading plan; the use of proper materials and the appropriate location of practices. In some cases certification training may be appropriate. For example, the design and construction of permeable paving requires the knowledge of several disciplines including engineering, landscape architecture and soil science to ensure the proper design and construction of the project.

COMMUNICATION

LID uses innovative techniques, unique strategies and various combinations of practices. Consequently, each development results in a unique design with its own set of issues and challenges. It is vital that everyone involved in the LID project (contractors, vendors, design engineers and inspectors) understand the unique details of the LID project. A pre-construction meeting is the most useful approach to ensure that the project goals and issues are effectively communicated. Ideally the permit reviewer, contractor, vendor, design engineer and inspector should hold a meeting to go over the plans and discuss all aspects of the project. During the pre-construction meeting, the inspector may evaluate the proposed sequence of construction, sediment control requirements, and indicate when inspection points during construction of the LID practices are required as identified in the design manual.

Throughout the construction process, proper lines of communication must be in place between the general contractor, site engineer, inspector, and permit staff to ensure project success. After construction, a final inspection and walk-through of each LID practice is necessary to ensure its proper function.

MAINTENANCE

LID is a comprehensive approach that has built-in redundancy, which greatly reduces the possibility of failure. Many LID techniques have nothing to do with the actions or inaction of property owners. These include basic



subdivision and infrastructure design features such as reducing the use of pipes, ponds, curbs and gutters; grading strategies, and reducing impervious surfaces and disconnecting those that must be used; and conserving open space.

LID's long-term success has much more to do with the knowledge, skills, and creativity of the site designers than what the property owner does or doesn't do.

The key factor in the success of LID is to ensure that the landscape practices (such as rain gardens) are attractive and perceived by the property owner as adding value to the property. If these LID practices are viewed as assets, the primary motivation for their long-term maintenance is that of property owners protecting their vested economic interests.

Maintenance agreements can be used if a developer is uncomfortable about on-site landscaping features that also serve as stormwater controls.

Some sample landscaping agreements may include:

- Identify expected maintenance needs for all proposed stormwater facilities and BMPs
- Identify the party/parties responsible for maintenance and operation;
- Identify long-term funding for operation and maintenance
- Determine how operation and maintenance will be transferred with the property to the new owner; for public facilities, be retained in the appropriate department.
- Develop a maintenance log indicating the activity and actions taken shall be kept and be available for inspection.

Resources – Low Impact Development Center, Brunswick County, NC LID Manual, NC State University



Glossary

Annual plant—A plant that completes its entire life cycle in a single growing season.

Base flow—The flow in a stream between storm events. The flow is supplied by groundwater.

Best Management Practice (BMP)—A practice or combination of practices that are the most effective and practicable means of controlling pollutants at levels compatible with environmental quality goals.

Bioretention Area—A water quality practice that utilizes landscaping and soils to treat stormwater by collecting it in shallow depressions and then filtering it through a planting soil media. (also see raingarden)

Buffer—An area of trees, shrubs and plants next to a waterbody designed to protect the receiving waterbody from sediment and pollutants contained in storm water runoff. Buffers also function as habitat for migratory birds and aquatic and terrestrial wildlife.

Check dam—A small barrier built across the direction of water flow in a swale to retain excess water during heavy rains and to slow the speed of runoff traveling through the swale.

Deciduous plant—A plant that sheds or loses its foliage at the end of each growing season.

Disconnected Impervious Surfaces—integration of treatment and management measures into developed areas to remove the links between hard-scaped areas such as driveways, walkways, parking areas with the strategic placement of distributed lot-level controls that can be customized to more closely mimic a watershed's hydrology.

Ecosystem—An interactive system that includes the organisms of a natural community together with their abiotic, physical, chemical and geochemical environment.

Easement—A right, such as a right-of-way, afforded a person to make limited use of another's real property.

Estuary—Brackish-water area influenced by the tides where the mouth of the river meets the sea.

Evergreen plant—A plant that remains green and retains its foliage throughout the year.

Fecal coliform bacteria—Bacteria that are present in the intestines or feces of warm-blooded animals. Often used as indicators of water quality.



Floodplain—Areas that are periodically flooded by lateral overflow, such as river.

Forebay—Stormwater design feature that uses a small basin to settle out incoming sediment delivered in runoff to a stormwater BMP.

Geographic information systems (GIS)—A computer system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data related to positions on the Earth's surface. Typically, GIS is used for handling maps of one kind or another. These might be represented as several different layers where each layer holds data about a particular kind of feature (ie roads, waterbodies, etc). Each feature is linked to a position on the graphical image of a map.

Groundwater—Water below the earth's surface, often between saturated soil and rock, that supplies drinking wells and springs. Runoff can seep into the soil and recharge groundwater supplies.

Habitat—The specific area or environment where a plant or animal lives. A habitat must provide all of the basic requirements for life (food, water, shelter) and should be free of harmful contaminants and pollution.

Hydrology—The science of dealing with properties, distribution and circulation of water.

Impervious surface—Any surface that water cannot penetrate into (i.e. parking lots, streets, sidewalks, rooftops).

Infiltration—the slow passage of a rainwater through the soil.

Low Impact Development—Low Impact Development (LID) is an innovative stormwater management approach with a basic principle that is modeled after nature: manage rainfall at the source using uniformly distributed decentralized micro-scale controls. LID's goal is to mimic a site's predevelopment hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to its source

Native plant—A plant that naturally occurred in an area before disturbance by humans. Native plants are adapted to the weather, temperature and soil conditions of this region. Native plants require less (if any) fertilizers, pesticides or irrigation and tend to be disease and drought-tolerant.

Nonpoint source pollution (NPS)—Pollution that comes from many different sources in a watershed and is carried by storm water runoff into local waterways. Sources of NPS pollution are difficult to identify and control. Typical NPS pollutants are pet waste, lawn fertilizer, pesticides, car washing detergents, litter and sediment.

Nutrient—A primary element necessary for the growth of living organisms. For example, nitrogen and phosphorous, are nutrients required for phytoplankton (algae) growth.



Outfall—Point where water flow from (i.e. conduit, stream, pipe, drain).

Perennial plant—A plant that grows and persists for more than one year. Perennial plants persist as vegetation from year to year or resprout from their rootstock annually.

Pervious materials—Pervious materials allow water to soak into the surface by virtue of their porous nature or by “void” spaces in the material.

Pervious Paving—Water-pervious materials such as gravel, crushed stone, open paving blocks or pervious paving blocks for driveways, parking areas, walkways, and patios that minimize runoff from those areas, as well as increase infiltration.

Point source pollution—Water pollution entering the environment from a single point (i.e. factory pipe).

Pollution—Any substance that exists in the environment that is undesirable or harmful for that environment.

Rain Garden—A rain garden is a shallow depression planted with native plants, flowers or grass that captures and infiltrates rain before it becomes polluted runoff.

Receiving waters—Creeks, streams, rivers,, lakes, estuaries and other bodies of water into which stormwater flows into.

River Basin—A river basin is the land that water flows across or under on its way to a river. As a bathtub catches all the water that falls within its sides, a river basin sends all the water falling on the surrounding land into a central river and out to an estuary or the sea.

Runoff Volume—The total volume of runoff (in cu m or cu km) is the amount of water that flows through the hydrometrically closed segment of a drainage basin. The total volume of runoff is usually determined graphically by constructing a hydrograph, that is, a diagram of change over time (t) of discharge (Q) for a year. Using the hydrograph it is possible to construct the integral curve of runoff, which gives a representation of the progressive accumulation of water volume (in a reservoir) with the passage of time. The modulus of runoff is the volume of runoff in a unit of time per unit of area of the watershed; it is usually expressed in //sec-km² or //sec-hectare.

Sediment—Soil or dirt that washes into a body of water and contributes additional nutrients to the water. Sediment often comes from construction sites or bare lawns. North Carolina’s #1 pollutant.

Storm drainage system—The system built to collect and transport runoff to prevent flooding. This system consists of storm drains, drainage ditches, pipes and culverts. Anything that flows into the storm drainage system flows directly into local creeks and waterways. (Storm water runoff is not



treated.) Storm drainage systems are completely separate from those that carry domestic and commercial wastewater (sanitary sewer system).

Storm water runoff—When rain falls on surfaces such as rooftops and parking lots it is not absorbed into the ground. Instead, it flows over these hard surfaces collecting pollutants along the way. This polluted stormwater runs into fragile coastal waters, degrading the health of creeks, rivers and sounds.

Surface water—The water that rests on top of the earth in streams, lakes, rivers, oceans and reservoirs and is open to the atmosphere (i.e. rivers, lakes, creeks, streams, etc).

TMDL—Total maximum daily load of the amount of pollutants that can flow into the water without violating water-quality standards. Reductions are assigned to various sources.

Tributary—A stream that flows into a larger stream or other body of water.

Watershed—The land area that drains water to a particular stream, lake or river.

Water quality—The biological, chemical and physical conditions of a waterbody; a measure of the ability of a waterbody to support beneficial uses.

Wetland—Land whose soil is saturated with moisture either permanently or seasonally. They are generally distinguished from other water bodies or landforms based on their water level and on the types of plants that thrive within them. Specifically, wetlands are characterized as having a water table that stands at or near the land surface for a long enough season each year to support aquatic plants.

Sources - City of Wilmington Stormwater Services stormwater glossary, Dictionary.com, Low Impact Development Center, NC Coastal Federation