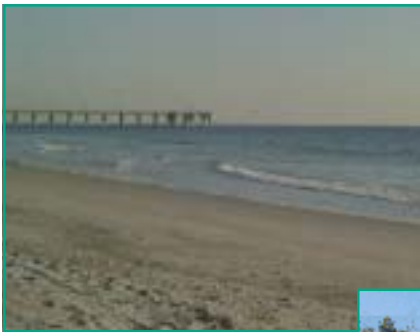


A Citizen's Guide To Protecting Local Water Quality

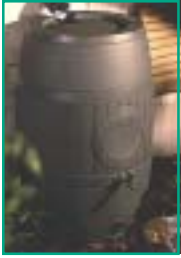
Includes
extensive plant
list, color
photos & a
glossary!

How to beautify your landscape & protect Wilmington water quality at the same time.



This guide made possible by a US Environmental Protection Agency Clean Water Act Section 319(h) Federal Grant & the City of Wilmington. Oversight by the NC Division of Water Quality.





INTRODUCTION

When rain falls on natural areas, it is slowed down and filtered by soil and plants. In contrast, when rain falls on hard surfaces such as rooftops, roads and parking lots, storm water runoff is created. This runoff picks up pollution such as pet waste, fertilizer, litter and lawn clippings on the way to local creeks, streams and waterways. In Wilmington, runoff does not go to a treatment plant- it eventually flows into the Cape Fear River or Intracoastal Waterway.

Washing your car on the grass, picking up pet waste, using minimal fertilizers and pesticides, and throwing litter in the trash are just a few simple ways you can prevent water pollution. In addition, there are several other things you can do on your own property to protect local water quality. A “Best Management Practice” (BMP) is a landscape addition or technique that reduces pollution in storm water runoff. Examples of BMPs include rain barrels, habitat gardens, shade trees, and shoreline buffers.

There are many benefits to installing BMP’s on your home or commercial property. Some BMPs prevent water pollution by capturing polluted runoff and allowing it to soak back into the ground naturally, while other BMPs simply act as natural barriers between polluted runoff and waterways. In addition to protecting water quality, many BMPs also reduce flooding, prevent soil erosion, conserve water, and provide wildlife habitat.

This guide takes you step-by-step through nine different BMPs explaining what they are, how they protect Wilmington water quality, and how you can easily install one on your own property. Descriptive pictures and website resources also accompany each section. The Appendix lists suggested plants for BMPs, drought & disease-resistant plants for NC, and a glossary. All of the BMPs listed in this guide are available for viewing at the Storm Water Demonstration Site in Anne McCrary Park next to Randall Pond. For more information or to obtain a guide, call the City of Wilmington Storm Water Services, (910) 343-4777.

Make the connection - you are the solution to water pollution!

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RAIN BARREL

During a typical storm of 1 inch of rain over a 24-hour period, over 700 gallons of water runs off an average-sized roof (about 1,200 square feet). Since your roof can't absorb rainwater, it flows into the gutters, drops through the downspout and onto the ground. Once the water makes it to the ground, it moves quickly toward its drainage destination (a storm drain, ditch, creek, etc.), but not before picking up pollutants such as fertilizers from the yard and oil from the driveway.

What is a Rain Barrel?

Rain barrels are simply containers that collect and store rainwater from a roof; the collected water is used to water your landscape. Rain barrels are usually positioned below the downspout of a roof gutter.



Position a rain barrel under a roof downspout.



Most rain barrels are equipped with a screen to keep debris & mosquitoes out and a spigot to attach a garden hose.

Benefits of Using a Rain Barrel

- » **Reduce runoff leaving your property**
Rain barrels reduce the amount of storm water runoff leaving your property by collecting and storing rainwater.
- » **Water your landscape**
Water that is collected in rain barrels is ideal for plants because it is has no added chemicals and is warmer than well or tap water. Most rain barrels are designed with a spigot to attach a garden hose or drip irrigation system.
- » **Conserve water during times of drought**
Rain barrels help to conserve water during times of drought or water shortages. Using water from a rain barrel may be the only way to water your garden during a drought.
- » **Save Money**
Using a rain barrel (or two) can save you money on your water bill since you are using rainwater to irrigate your landscape.

Types of Rain Barrels

There are endless varieties of rain barrels; everything from instructions on how to build your own rain barrel to designer rain barrels that cost hundreds of dollars and come in a wide range of colors and sizes. The most important thing to remember is that an efficient rain barrel, whether it is homemade or store-bought, makes a significant difference in controlling water pollution in your community.

Installing a Rain Barrel

Rain barrels should be placed directly under gutter downspouts as shown in the picture to the right. Since most downspouts run straight to the ground, you may need to modify your's a bit by cutting or sawing it to make it shorter.

Generally, gutter downspouts consist of a series of aluminum or plastic tubes with ends that are tucked inside each other and nailed or screwed to a building with brackets. Follow these steps to detach and reattach gutter tubes as necessary:

- » Use a hammer or screwdriver to undo the brackets that are holding the tubes against the house or building.
- » Remove the bottom section of the downspout.
- » Place your rain barrel underneath the downspout. A flexible plastic tube (from a hardware store) can be attached to the spout to help direct the flow of water into the barrel if needed.
- » Using a hammer or screwdriver, reattach the downspout to the building.



Some Things to Consider About Rain Barrels

- » Rainwater collected in rain barrels is not safe to drink, cook with or bathe in.
- » Buy a rain barrel with an overflow hose to divert excess water away from your house in case the rain barrel fills to capacity.
- » Make sure your rain barrel has a tight lid or screen so children or animals can't fall in and mosquitoes can't breed.
- » If you are converting an old storage barrel into a rain barrel, make sure you know what type of material the barrel contained before you got it. Some barrels may have contained toxic materials, and you don't want to pass these substances on to your lawn or garden.

Sources for This Section & Additional Rain Barrel Info:

<http://www.therainking.org>

http://www.yougrowgirl.com/garden/rain_barrel.php

<http://www.rainbarrelsandmore.com>

<http://www.urbangardencenter.com>

<http://www.sprucecreekrainsaver.com>

<http://www.rainsaverusa.com/>

<http://www.cityofbremerton.com/website1/html%20pages/makebarrel.html>



RAIN GARDEN

A rain garden is a fun and inexpensive way for you to help improve local water quality while enhancing the beauty of your yard. Rain gardens are perennial gardens planted with locally-adapted plants and flowers that are positioned between storm water runoff sources (roofs, driveways, parking lots) and runoff destinations (storm drains, streets, creeks, etc). Rain gardens are designed to capture storm water runoff and allow it soak back into the ground naturally, while the plants and flowers remove pollutants from the runoff.



Benefits of Building a Rain Garden

- » **Improve local water quality**
Rain gardens capture and treat polluted runoff before it flows into local creeks, streams and waterways.
- » **Enhance the beauty of your yard**
Rain gardens contain a wide variety of beautiful plants and flowers. You can plant specific plants that will attract birds and butterflies to your rain garden as well.
- » **Reduce flooding and recharge groundwater**
Instead of running into the streets where it can cause flooding, rain gardens allow storm water runoff to soak into the soil and recharge the groundwater.
- » **Protect area wildlife and wetlands**
Polluted runoff is harmful to fish, birds and other wildlife that depend on clean water for survival.

Designing a Rain Garden

Consider these things before designing a rain garden:

Location

To be effective, a rain garden must be planted between the source of storm water runoff (roof downspouts, driveway, etc.) and the destination of runoff (storm drain, creek, street, ditch, etc). To install a rain garden on your property,



look for low areas, areas that easily flood, areas where water ponds after a rain or an area where erosion is already occurring.

Drainage

The soil in a rain garden needs to be a well-drained soil such as sandy or sandy loam soil. All water should drain from the rain garden within 6-12 hours after the rain ends.

Size

Rain gardens can be very small or very large. The size of your garden will depend on personal preference, yard space and the amount of money you want to spend. Keep in mind that any size rain garden will help reduce runoff & water pollution!

Plant and Flower Choices

It's important to plant locally-adapted flowers and plants to minimize the use of pesticides and fertilizers.

Tip: The key to having a rain garden that does not require fertilizers or pesticides is to choose plants that are adapted to your site conditions—sun/shade, sand/clay, etc. Most rain gardens are a combination of wildflowers, plants and shrubs, but grasses may also be used.



Budget

Of course, it is less expensive to build your own rain garden—the smaller the garden, the less expensive it will be. However, you may choose to hire a professional landscaper, build a larger garden or install more expensive plants. Therefore, the cost of building a rain garden may vary.

Overall Landscape

Rain gardens should be designed with the overall landscape in mind so that it is an integral part of the entire landscape. Rain gardens can serve as an ornamental hedge or a perennial border.

Follow These Steps to Build a Rain Garden:

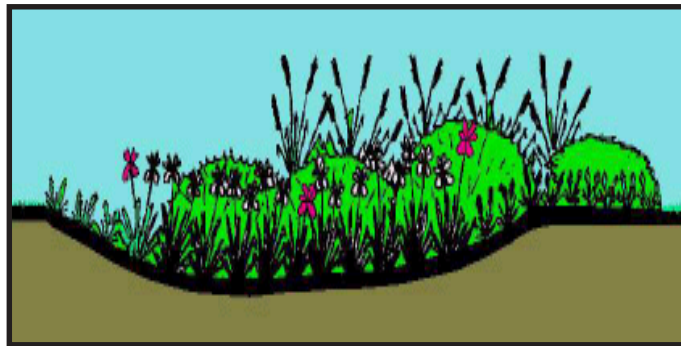
1. Determine runoff sources on your property (i.e. roof, driveway, etc.) and note where the runoff is going (i.e. storm drain, creek, etc.)- plant the garden somewhere in between. Ideal places to plant rain gardens are next to hard surfaces, such as roads, driveways or near roof gutter downspouts.

Tip: A great way to locate runoff sources & destinations is to walk your property when it's raining.

2. After deciding where to plant the rain garden, map out the area with string or lawn chalk.
3. Dig the garden 3 to 6 inches deeper than the lawn itself with a slight slope (or depression) in the center. Depending on your soil's ability to soak up water, you may need to add sand, gravel or mulch to improve infiltration. Hard, compacted soil will not soak up as much water as loose soil, gravel or sand. Make sure an absorbant layer of soil is in place before planting plants and flowers.
4. Use the dug out soil to create a berm along the bank of the rain garden—this will increase the amount of water that can be retained and allowed to soak into the ground.
5. Plant locally-adapted flowers, shrubs and plants. Plants should be able to withstand both periods of heavy water and times of drought. It is better to plant seedlings than seeds. Plants should be watered initially until they are established.



A rain garden contains 3 planting zones: the lowest part of the garden is going to be the wettest and should contain the most moisture-tolerant plants. A mixture of trees and shrubs native to local wetlands and streambanks are most suitable for the lower and middle zones, while perennials are most suited for the upper rim of the garden. Incorporate berry and nectar-producing plants to create a habitat for songbirds and butterflies. Plants in all zones will be subject to drought spells as well. Consult the Appendix for suggestions on suitable plants for rain gardens.



Rain gardens contain 3 distinct planting zones (see #5 above).

6. Mulch, mulch, mulch! Mulch plays a very important part in the pollution-removal process and in protecting plants, maintaining soil moisture and preventing erosion. However, not all mulches work in rain gardens. Lightweight mulch and flat wood chips will float when it rains. Use 2-3 inches of shredded hardwood mulch instead.
7. Enjoy the beauty of your rain garden! Be proud that you are making a difference in your community by reducing water pollution.

Frequently Asked Questions about Rain Gardens

- » ***Do I need to hire a professional landscaper to build a rain garden?***
Landscapers can probably get the job done faster, but they are not necessary to build or maintain a rain garden.
- » ***Are rain gardens hard to maintain?***
Maintaining a rain garden is similar to maintaining any other landscape bed; maintenance includes weeding, pruning and adding new mulch periodically.
- » ***Do rain gardens attract mosquitoes?***
Mosquitoes need about two to four days of standing water to reproduce. A well-designed rain garden will soak up excess water long before mosquitoes have a chance to breed.



Sources for This Section & Additional Rain Garden Information:

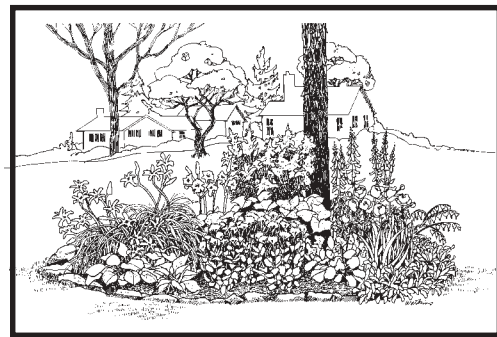
<http://clean-water.uwex.edu/pubs/raingarden/gardens.pdf>
www.mninter.net/~stack/rain/
www.mninter.net/~stack/bassett/raingard.pdf
[www.ci.maplewood.mn.us/Public Works/RainWater% 20Garden/RAINWATER% 20GARDENS.htm](http://www.ci.maplewood.mn.us/Public%20Works/RainWater%20Garden/RAINWATER%20GARDENS.htm)
<http://www.raingardens.org/>
www.dof.state.va.us/rfb/riparian/rain_gardens.htm
<http://natsci.edgewood.edu/wingra/management/raingardens/default.htm>

HABITAT GARDEN

A great way to bring nature to your doorstep is to plant a habitat garden. Unlike a common flower or rain garden, habitat gardens are planted specifically for the purpose of supporting and protecting wildlife. The best part about planting a habitat garden is that **you** decide what type of wildlife you want to attract and which plants you will use in the garden! Birds and butterflies are two of the most common species to attract to a habitat garden.



Hundreds of sulphur butterflies hover around the Cigar Plant in this habitat garden.



Habitat gardens can beautify your landscape as well as provide habitat for wildlife.



Landscaping for Birds

There are three things that will attract birds to your garden: water, food and shelter.

Water

Water, whether it is in the form of a large pond or small birdbath, will attract many bird species. Make sure the water source you choose provides clean water to prevent transmission of diseases.

Food

Use plants that produce berries, fruits, nuts or nectar to attract birds. Birds eat insects as a source of protein and also feed insects to their young. Therefore plants that attract insects will also attract birds.

Shelter

Birds need shelter from other animals as well as protection from weather conditions. Birdhouses and densely-planted shrubs serve as shelter from weather and predators. A shelter-friendly garden is sure to attract many bird species.

Plants

Visit the Appendix for a list of plants that will attract birds to your habitat garden.





Landscaping for Butterflies

To ensure a successful butterfly garden, your garden should have plants that support all phases of their lifecycle. Butterflies need a place to lay eggs, food plants for the caterpillars, a place to form a cocoon and nectar plants for the adults.

Food Plants

Food plants attract caterpillars that will eventually grow into butterflies. In a sense, you can grow your own butterflies by planting the right food plants.

Tip: Food plants may need to be located away from other landscape gardens because caterpillars have been known to chew leaves and flowers.

Nectar Flowers for Adults

Plant a diverse group of flowers and make sure something is in bloom from spring to late fall. See the Appendix for a list of plants that will attract butterflies to your garden.

Shelter

Butterflies love sunshine, so locate the garden in a sunny area. Butterflies are active on warm, windless, sunny days when temperatures are between 65°-95°F. Make sure the garden also provides shade; butterflies retreat to shaded areas when temperatures rise above 95°F.

How to Plant a Habitat Garden

It's important to plant the proper vegetation for the wildlife you want to attract; otherwise, you may attract critters you hadn't bargained for. In fact, you may already have plants and trees that are home to different wildlife species and you not even know it. So take stock of the plants you already have because you may be closer to having a habitat garden than you think!



1. Decide what type of wildlife you want to attract and then decide which plants are appropriate for your garden.
2. Choose plants that are adapted to this region—they are beautiful and much easier to care for. The Appendix lists plants that are suitable for habitat gardens.
3. Let the garden grow! Do not use pesticides in your garden! Pesticides kill insects that will attract birds and other wildlife to the garden. Your garden should try to replicate a natural habitat as much as possible, so don't worry so much about keeping its appearance neat and tidy.

Sources for This Section & Additional Habitat Garden Info:

Habitat gardening: <http://www.nrcs.usda.gov/feature/backyard/WildHab.html>

Native plant database: http://www.wildflower.org/?nd=native_plants_database

Native plant search: http://www.enature.com/guides/select_lbjnative.asp?

Butterflies: <http://www.nwf.org/backyardwildlifehabitat/attractbutterflies.cfm>

Butterfly guide: <http://www.nwf.org/backyardwildlifehabitat/pdfs/butterflies.pdf>

Butterfly site: <http://www.thebutterflysite.com/gardening.shtml#gardening>

Insect-eating birds: http://www.enature.com/backyardwildlife/garden_patrol.asp



SHADE TREES



The City of Wilmington has grown tremendously over the past few years. New hotels, neighborhoods, restaurants and retail stores continue to replace acres of vegetated land—land that was at one time home to trees, plants and shrubs that provided the community with cleaner air and water.

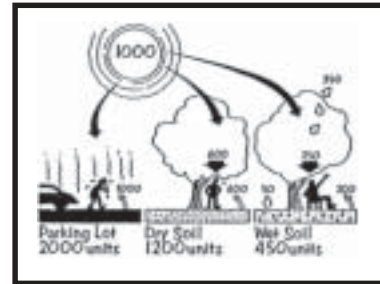
Trees are the environment’s natural solution to air and water pollution. Trees take carbon dioxide and convert it into oxygen and they absorb and filter polluted storm water runoff. Very simply, trees convert polluted air into clean air and polluted water into clean water.

As our community continues to grow and develop, water quality problems increase. Quite often, trees are cut down for construction and not enough are replanted. One of the most important things you can do to help the environment and reduce pollution is to plant a tree. Shade trees are especially important because they benefit homeowners and businesses as well as the environment.

Benefits of Planting Shade Trees

Prevent the “Heat Island Effect”

Unshaded pavement contributes to the “heat island effect.” The heat island effect occurs when plants and soil are replaced with pavement, concrete and rooftops. For instance, urban areas are hotter than the surrounding countryside due to a lack of trees and vegetation. Most US cities are heat islands, with temperatures between 2 and 10°F hotter than their surroundings. In addition, runoff from heated surfaces negatively impacts aquatic habitat and wildlife.



Reduce Energy Costs

In the hot summer months, the heat island effect can cause surface temperatures to increase as much as 20 degrees. Unshaded pavement also radiates heat back into the atmosphere and can cause air temperatures to rise as much as 12 degrees; this causes home cooling costs to be higher.



Planting trees next to a house can reduce heating & cooling costs.

On the other hand, shade trees shield pavement from direct sunlight, thereby lowering the surface temperature of the pavement. In the hot summer months, trees absorb heat from the atmosphere. In the colder months, trees provide protection for your house from winter winds, which reduces heating costs.

Fact: The US Forest Service reports that when trees are properly placed around buildings, they can reduce the need for air conditioning by 30 % and can save 20-50 % in energy used for heating.

Improve Water Quality and Reduce Flooding

Tree root systems absorb and filter nutrients and pollutants found in storm water runoff. Tree roots hold soil in place that might otherwise wash into local streams and waterways during storms. When soil washes into waterways they become more shallow, are more likely to flood and adversely affect aquatic habitat and wildlife.

Improve Air Quality

Trees absorb carbon dioxide and convert it into oxygen; they also filter the air we breathe by removing dust and other particles. High carbon levels in the atmosphere are a major contributor to global warming.

Fact: The US Department of Agriculture reports that one acre of forest absorbs six tons of carbon dioxide and releases four tons of oxygen, which is enough to provide 18 people with oxygen for an entire year.

Increase Property Value

Studies show that landscaping, especially with trees, can increase property values by as much as 20%.



In this picture, trees shade the house, walkway and landscape.



Trees shade & cool this residential street, cooling runoff before it enters our waterways.

Choosing Shade Trees

Some things to consider before choosing shade trees:

- » Make sure to avoid trees that are susceptible to storm damage, host destructive insects or diseases or produce an abundance of tree fruit.
- » Choose locally-adapted (native) trees. They will be more suited to local weather and soil conditions and be more beneficial to wildlife than non-native trees. (See page 15 for shade tree suggestions).

Planting Shade Trees: Right Tree, Right Spot

Placement of a tree is critical. Know the maximum size the tree will grow to be and assume that it will get bigger! Learn how large the canopy and root systems will grow to be and how

they will affect the existing landscape. For example, make sure the tree won't shade flowers or bushes that need sunlight to grow and be sure that the canopy won't cover utility lines.

Evergreen trees will provide cover and shade year round. They may also be more effective barriers for wind and noise. Deciduous trees will give you summer shade but allow the winter sun to shine in. This may be a considerations for where to place the tree in your yard.

When to Plant

Most bare root or packaged plants should be planted in fall or early spring. Other than seedling-sized evergreens, only deciduous trees can be transplanted with bare roots and only when dormant or leafless. See the following sources for more information on planting trees and seedlings.



Trees provide houses with protection from winter winds and summer sun. Trees also provide habitat for wildlife, shade for paved surfaces and rooftops, aesthetic qualities and increased property values.

Deciduous trees planted on the south and west sides of a building provide shade and can lower air conditioning costs dramatically.

Digging & Planting a Tree

To plant a tree, dig a hole 2-3 times as wide and only as deep as the root ball. Place the tree in the hole, then fill the hole with a generous mixture of native topsoil and compost to allow the roots a place to grow.

Water the newly-planted tree, but do not overwater! Overwatering is the #1 reason for plant death. Water deeply and infrequently. Do not fertilize until the next growing season so that the tree can deal with the winter and the shock of being planted before beginning to grow.

Sources for This Section & Additional Shade Tree Info:

<http://www.ct.nrcs.usda.gov/landscp/treep11.htm>

<http://www.arborday.org>

http://www.coolcommunities.org/urban_shade_trees.htm

<http://www.ces.uga.edu/pubcd/B1073.htm#Planning>

<http://www.epa.gov/globalwarming/actions/local/heatisland/>

<http://muextension.missouri.edu/xplor/agguides/hort/g06800.htm#choose>

<http://www.handrlawn.com/1-16-02/oct2001.html>

<http://www.austinutilities.com/Energytips/landscaping.html>

http://www.coronaclipper.com/shade_trees.htm

<http://www.ces.ncsu.edu/depts/hort/consumer/factsheets/trees-new/index.html>

<http://plantfacts.osu.edu/>

Shade Tree Suggestions for Southeastern North Carolina

The following chart lists shade trees that are large, native to the coastal plains of North Carolina, and require sun exposure. Make sure to note the “Special Considerations” column on the far right of the chart before choosing a tree.



Tree Selections for the Coastal Plains of North Carolina

Species	Mature Ht/Wd, in feet	Exposure	Form	Special Considerations
Eastern Redcedar* <i>Juniperus virginiana</i>	40-60'/15-30'	Sun	Dense, evergreen	Grows in any soil type. Drought tolerant, good screening plant. Not suited for wet sites.
Southern Magnolia* <i>Magnolia grandiflora</i>	40-60'/25-30'	Sun	Symmetrical, sweeps to ground	Relatively problem-free. Wonderful bloom followed by interesting seedpods. Tree does best when lower limbs remain intact.
Black Gum* <i>Nyssa sylvatica</i>	40-60'/20-30'	Sun	Open, irregular	Spectacular fall color, no serious pests
Longleaf Pine* <i>Pinus palustris</i>	70-90'/30-40'	Sun	Horizontal with ascending branches; oval, rounded crown	Fairly drought resistant; relatively problem-free.
Oaks* <i>Quercus species+</i>	80-100'/50-80'	Sun	Broad crowns, thick trunks; Horizontal structure	Long-living tree, with majestic, spreading branches.
Bald Cypress* <i>Taxodium distichum</i>	50-100'/20-30'	Sun	Pyramidal in youth; broad, open crown at maturity.	No serious pests. Works well in wet to dry soils or poorly drained soils.
Lacebark Elm <i>Ulmus parvifolia</i>	40-50'/30-40'	Sun	Round-headed tree, pendulous branches	Excellent, tough tree. Beautiful mottled bark.
Atlantic White Cedar* <i>Chamaecyaris thyoides</i>	40-85'/25-35'	Sun	Tall, pyramidal tree	Relatively problem-free. Prefers moist soils; freshwater, not saltwater.
River Birch* <i>Betula nigra</i>	60-70'/30-50'	Sun	Single or multi-stemmed; pyramidal in youth, rounded at maturity	Early defoliator when leaf spot is a problem. Keep away from house and drains or drain fields.
American Beech* <i>Fagus grandiflora</i>	60-80'/40-60'	Sun	Dense, low spreading	Beech bark disease, bleeding center, beech scale; no pests are particularly serious. Holds leaves on juvenile wood in winter.

PERVIOUS WALKWAY & PAVEMENT

Typical roads, parking lots and driveways are paved with impervious materials, which means water can't soak through them. As a result, most of the pollution gathered on these surfaces (motor oil, pet waste, litter, etc.) will be carried by runoff to storm drains and local waterways.

Pervious materials, such as pervious pavement, walkway stones or gravel are a great way to improve local water quality and reduce the amount of storm water runoff leaving your property. This section contains information about a variety of different pervious materials including materials that are suitable for homeowners and materials that are best suited for commercial property.

Benefits of Pervious Materials

- » The quantity of storm water runoff is significantly reduced.
- » The quality of storm water runoff is improved.
- » Groundwater is recharged.
- » Reduces the need for more expensive retention ponds.
- » Pervious materials absorb much less heat than traditional pavement or concrete.



Semi-Pervious Walkway



Ornamental Walkway



Natural Garden Path

For Homeowners: Using Pervious Materials

To reduce storm water runoff at home, build sidewalks, walkways and other paths using pervious materials. Mulch, gravel, grid pavers or stepping stones are a great alternative to concrete because they allow water to soak into the ground.

For Commercial Property: Installing Pervious Pavement

Pervious materials can be used to pave sidewalks, driveways or overflow parking lots. Pervious pavement is made up of a mixture of materials that contain "void spaces." These void spaces are holes or cracks in the pavement that allow water to seep through and into the ground.

Pervious Material

Pervious pavement can be made of concrete, asphalt, open-celled stones or gravel, but must be mixed in a way that creates an open-cell structure (15% to 25% void spaces) so that water and air can pass through.

Pre-paving Considerations

Pervious pavement is not ideal for every situation. Pervious pavement is suitable for low-traffic parking lots, over-flow parking lots, fire lanes, driveways and other areas that have low levels of fast-moving traffic and little or no traffic from heavy machinery. The reason for this is because the pores (or void spaces) in pervious pavement can get clogged, which reduces its ability to filter water.

Tip: Pervious pavement is a little more expensive than typical paving materials; but for commercial purposes, it is much less expensive than retention ponds and does not waste land space.



Two pervious pavement options: pervious pavement or gridblock pavement.

Constructing Pervious Pavement

Follow these steps to construct a pervious sidewalk, driveway or parking lot:

- 1. Determine whether your soil is suitable for pervious pavement.**
Soils that contain significant amounts of clay or silt may not be suitable for pervious pavement. If needed, have your soil tested for permeability.
- 2. Prepare the base area.**
Use a vibratory roller or other suitable equipment to compact the base area to a minimum density of 90% to 95%. The base area must also be moist (no standing water) before you pour the pervious material.
- 3. Pour the mixture over the base.**
The material should be unloaded and leveled as quickly as possible. The area must be rolled again immediately after leveling with paving equipment.



4. **Allow the pavement time to set properly.**

After the pavement is rolled it should be covered with polyethylene film, which should be held down securely. The area should be traffic-free for at least seven days.

Maintaining Pervious Pavement

Proper maintenance of pervious pavement is critical to its operation, but it is relatively easy. There are two main problems that may arise as a result of poor maintenance:

The void spaces get clogged with sand or debris:

- » Remove debris often to prevent clogging.
- » Pressure-washing clogged pavement can restore 80%-90% of its permeability.
- » Vacuum the pavement with a Hi-Vac truck 2 to 3 times a year to reduce clogging.



The soil below the pavement becomes compacted:

- » Large, heavy vehicles cause the soil below pervious pavement to become compacted—that is why pervious pavement is not recommended for high-traffic roads.
- » Place signs around pervious areas to warn large trucks to stay off.

Sources for This Section & Additional Pervious Materials Info:

<http://www.perviousconcrete.com/perviousconcrete.htm>

http://www.coolcommunities.org/cool_pavements.htm

<http://www.mississippiconcrete.com/pervious.cfm>

http://www.gcpa.org/pervious_concrete_pavement.htm

http://www.forester.net/sw_0203_green.html

<http://www.bbc.co.uk/gardening/design/inspiration/surfaces/paths/>

<http://houseandhome.msn.com/garden/gardenpathandwalkwayideagallery0.aspx>

Make your own stepping stones:

<http://www.homestore.com/HomeGarden/gardening/crafts/SteppingStones.asp>

<http://www.squiglyplayhouse.com/ArtsAndCrafts/Crafts/GardenStone.html>

STREAMBANK RESTORATION

When stream banks erode, they carry soil and other debris into the water. A stream may fill in and become so shallow that it can no longer provide habitat for fish and other wildlife that depend on its water for survival. Stream bank erosion also causes flooding and poor water quality.

Bank restoration is the process of building or rebuilding the banks of streams, creeks or rivers to prevent erosion and filter polluted storm water runoff. Buffers, or strips of vegetation located along the banks of creeks and streams, are designed to stabilize banks, prevent soil erosion and act as a pollution/sediment barrier between land and waterways.

The following pictures show the same stream before and after bank restoration:



Before Bank Restoration



After Bank Restoration

Before Bank Restoration

In this photo, there is no vegetation to prevent the creek banks from eroding into the stream. As a result, sediment is washing into the creek and trees are falling into the water - which is a sure sign that the soil is unstable.

After Bank Restoration

The eroded bank has been graded and plants and grass have been planted to anchor the soil and prevent future erosion.

Benefits of Bank Restoration

- » **Improve local water quality**
Restoring banks enables plants, shrubs and grasses to trap and remove sediment and pollution from storm water runoff.
- » **Save your property**
Bank restoration reduces the risk of losing property to erosion.
- » **Control flooding**
Buffers help control the speed and amount of runoff and sediment entering our waterways - which reduces the risk of flooding and erosion.

- » **Prevent soil erosion**
Roots from trees, shrubs and grasses anchor soil in place making it less likely to wash away during heavy rains.
- » **Provide habitat for wildlife**
Restoring a bank and adding a buffer helps to shade and cool waterways in the summer months. Cooler water has more oxygen and shade is especially important for fish in shallow bodies of water.
- » **Aesthetic values**
Bank restoration preserves the natural character of a shoreline, blocks views of nearby development and can provide privacy for waterfront homeowners.

Planting a Buffer

Bank restoration involves building a buffer. To perform bank restoration, see pages 20-23 for information on how to build a buffer and page 24 for buffer plant suggestions.



Before stream bank restoration.



After stream bank restoration.

This local streambank restoration project is located on the Pine Valley Golf Course in Wilmington.

Sources for This Section & Additional Bank Restoration Info:

<http://www.cayuganet.org/owl/riparian/>

http://www.co.gaston.nc.us/natural_resources/projects/PerkinsReachLongCreekRestoration.htm

http://www.ncwildlife.org/pg07_WildlifeSpeciesCon/pg7c3_2.htm

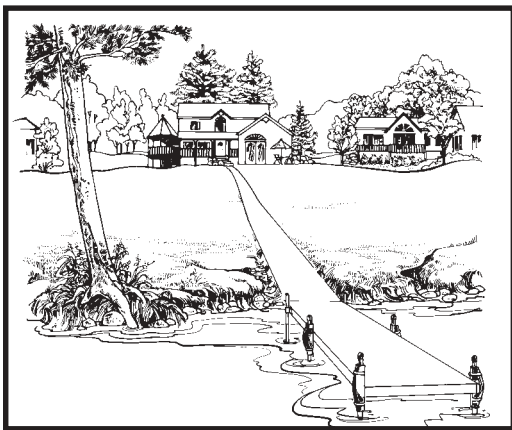
http://www.usda.gov/stream_restoration/

<http://www.rmi.org/sitepages/pid277.php>

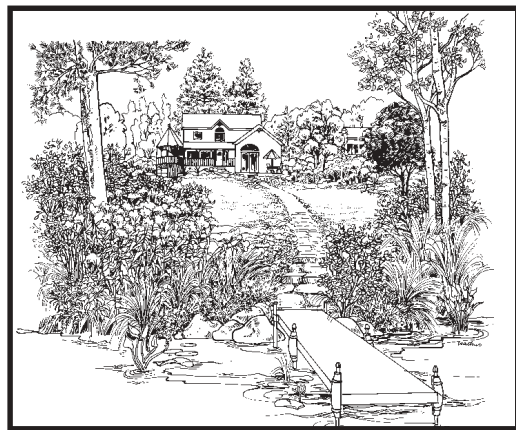
BUFFER

Commercial and residential development has replaced much of our community's natural means for reducing water pollution. Without natural filters like trees and shrubs, polluted storm water runoff flows directly into our local creeks, streams and rivers.

A buffer is an area of native trees, shrubs, and plants located adjacent to a waterbody and designed to protect the receiving waterbody from sediment and pollutants contained in storm water runoff. Buffers stabilize banks, remove sediment and pollution from runoff, provide habitat and shelter for wildlife and act as a barrier between water and developed land. Buffers are best planted with locally-adapted (native) plants, trees, and shrubs.



Before planting a buffer.....



.....after planting a buffer.

Benefits of Buffers

- » **Filter storm water runoff**
Buffers trap and remove sediment, nutrients, chemicals and bacteria from storm water runoff.
- » **Helps control flooding & recharges groundwater supplies**
Buffers help control the speed and amount of water that flows into waterways, which reduces the risk of flooding and keeps property from eroding away. Buffers also allow runoff to soak back into the ground and recharge groundwater supplies.
- » **Helps prevent soil erosion**
Roots from trees and shrubs anchor soil in place making it less likely to wash away during heavy rains.
- » **Wildlife habitat**
Buffers provide habitat for migratory birds and aquatic and terrestrial wildlife. Buffers shade waterways and help keep the water cool in summer months which is especially important for fish in shallow bodies of water. Buffers are also excellent wildlife corridors.

» **Save time, money and views**

Buffers increase property values and decrease yard work. Buffers also block views of nearby development, preserve the natural character of the shoreline and provide privacy for waterfront homeowners.

Buffer Recommendations

- » **Buffer Size**—Size depends on what you want the buffer to do; the state minimum width is 30 ft., but the New Hanover Soil and Water Conservation District prefers a buffer width of at least 35ft. See Table 1 (below) for more information about buffer widths.
- » **Slope**—For the buffer to filter water effectively, water must be allowed to flow through it slowly and evenly. The North Carolina National Estuarine Research Reserve reports that slopes less than 15% are ideal for buffers. Steep slopes carry water too quickly for the water to be absorbed efficiently. Fast-moving water can also cause soil erosion.
- » **Plants Selection**—Buffers contain a variety of locally-adapted trees, shrubs, and grasses that will survive easily in our climate without the use of fertilizers and pesticides. Plants should also be selected to provide habitat for wildlife. See page 24 for buffer plant suggestions.



Before Buffer



After Buffer



Buffer protects waterway

Table 1. Effectiveness of Vegetated Buffers based on Width

Buffer Width	Pollutant Removal Effectiveness	Wildlife Habitat Value
15 ft.	50% or greater sediment and pollutant removal	Poor habitat; good for temporary wildlife activities.
35 ft.	60% or greater sediment and pollutant removal	Minimally protects stream habitat. Good for temporary wildlife activities.
50 ft.	70% or greater sediment and pollutant removal	Minimal general wildlife and avian (bird) habitat.
65 ft.	70% or greater sediment and pollutant removal	Minimal general wildlife habitat. Some value as avian habitat.
100 ft.	70% or greater sediment and pollutant removal	May have use as a wildlife travel corridor and avian habitat.
165 ft.	75% or greater sediment and pollutant removal	General wildlife and avian habitat value
245 ft.	80% or greater sediment and pollutant removal	Fair to good general wildlife and avian habitat value.
330 ft.	80% or greater sediment and pollutant removal	Good wildlife habitat value. May protect significant wildlife.
660 ft.	90% or greater sediment and pollutant removal	Excellent wildlife value. May support a diverse community.
2000 ft.	99% or greater sediment and pollutant removal	Excellent wildlife value. Supports a diverse community. Protection of significant wildlife.

Planting a Buffer

1. Deciding when to plant a buffer will depend on the type of plants you want to use. Trees and shrubs should be planted when they are dormant—either in early spring after the ground thaws or in autumn after the leaves fall.
2. Know where your property & utility lines are (make sure you have permits if needed.)
3. Decide on the width of your buffer and how many plants you'll need.
4. Arrange plants so they create a gradual buffer instead of an abrupt one. Guidelines for planting widths are:

Shrubs	3-6 feet apart,
Small trees	5-8 feet apart,
Large trees	8-12 feet apart,
Groundcovers	1-3 feet apart.
5. Rooted plants should be put in holes that are 2-3 times as wide as the root ball but only as deep as the root ball. Fill in the hole with the original soil, then water to settle the soil.
6. Water once a week for the first growing season, but make sure not to overwater, which could cause the soil to erode. Use only lime or wood ash to fertilize the buffer zone.
7. Mulch the buffer with organic mulch such as leaf humus, wood chips, pine mulch or other shredded bark; avoid redwood and cedar mulch. Mulch controls weed growth, helps the soil retain moisture and prevents erosion.
8. If necessary, build a temporary barrier to keep out unwanted visitors. Chicken wire is effective to keep small animals away from seedlings until they become established.

(Adapted from Connecticut River Joint Commissions: Riparian Buffers)



Maintenance

Water the buffer once a week during the first growing season. Periodically check for soil erosion, insect disease or storm damage. Do not use fertilizers or pesticides and leave the vegetation, leaf litter and undergrowth undisturbed. Lastly, make sure the buffer is doing what it was designed to do - if it's not, you may need to add more plants or build a larger buffer.



Sources for This Section & Additional Buffer Info:

<http://www.crjc.org/riparianbuffers.htm>
<http://www.nrcs.usda.gov/feature/buffers/#Anchor-WhatBuffer>
<http://www.epa.gov/owow/nps/ordinance/buffers.htm>
<http://www.ncnerr.org/>
<http://www.unl.edu/nac/riparian.html>
<http://www.buffercouncil.org/>
http://www.na.fs.fed.us/spfo/pubs/n_resource/buffer/cover.htm
www.dof.state.va.us/rfb/rimages/rfb-riparian-buffer-classic-photo.jpg
<http://www.chesapeakebay.net/info/forestbuff.cfm>

Buffer Plant Suggestions

For additional information on buffers and plant information, contact the New Hanover Soil & Water Conservation District at (910) 798-6032.



TREES

American Holly	<i>Ilex opaca</i>	(Female has red berries)
Bald Cypress	<i>Taxodium distichum</i>	(Wet to average moisture.)
Black gum	<i>Nyssa sylvatica</i>	(Dry. Fruits used by many birds and bees.)
Eastern Red Cedar	<i>Juniperus virginiana</i>	(Full sun. Dry soil. Birds love fruit.)
Green Ash	<i>Fraxinus pennsylvanica</i>	(Sun to shade. Tolerates salt. Fast growing.)
Bitternut Hickory	<i>Carya cordiformis</i>	
Hickory, Pignut	<i>Carya glabra</i>	(Recommended for dry sites. Birds use nuts)
Hickory, Shagbark	<i>Carya ovata</i>	(Moist to dry. Nuts eaten by wildlife and humans.)
Magnolia, Southern	<i>Magnolia grandiflora</i>	
Maple, Red	<i>Acer rubrum</i>	(Very adaptable, fast growing. Nesting and food.)
Oak, Cherrybark	<i>Quercus f. var. leucophylla</i>	(Var. of S. Red Oak. Dry to moist soil. Acorns used.)
Oak, Laurel	<i>Quercus hemisphaerica</i>	
Oak, Live	<i>Quercus Virginiana</i>	(Dry sandy sites. Full sun. Birds and mammals use.)
Oak, Southern Red	<i>Quercus falcata</i>	(Dry to moist. Good nesting and acorns.)
Oak, Willow/Water	<i>Quercus phellos</i>	(Needs some moisture. Wild ducks eat acorns.)
Palmetto	<i>Sabal palmetto</i>	(Wet to dry. Sun to shade. Salt tolerant. Monk butterfly.)
Pine, Loblolly	<i>Pinus taeda</i>	(Fast growing, full sun. Moist. Birds nest and eat seeds.)
Pine, Longleaf	<i>Pinus palustris</i>	(Sandy soil. Good with turkey oak, wax myrtle, yaupon.)
Pine, Pond	<i>Pinus serotina</i>	
Sweetgum	<i>Liquidambar styraciflua</i>	(Moist to wet. Seeds used by birds and mammals.)
Sycamore	<i>Plantanus occidentalis</i>	(Excellent nutrient scavenger. Fast growing. Tolerates salt.)

SMALL TREES

Carolina Ash	<i>Fraxinus caroliniana</i>	(Tolerates salt and some shade. Butterflies and birds use.)
Persimmon	<i>Diospyros virginia</i>	(Part shade to sun. Dry soil. Fruit for wildlife and humans.)
Redbay	<i>Persea borbonia</i>	(Birds use fruit. Sandy soil. Dry to moist. Part shade to full sun.)
Red Buckeye	<i>Aesculus Pavia</i>	(Spike of red flowers-early summer)
Sassafras	<i>Sassafras albidium</i>	(Aromatic stems)
Serviceberry	<i>Amelanchier obovalis</i>	(Early spring fruit for wildlife. Understory.)
Sparkleberry	<i>Vaccinium arboreum</i>	(Dry soil, tolerates salt. Shade to sun. Many birds and butterflies.)
Sweet Bay	<i>Magnolia virginiana</i>	
Turkey Oak	<i>Quercus laevis</i>	(Dry, sandy soil. Good fall color. Some birds use acorns.)
Wax Myrtle	<i>Myrica cerifera</i>	(Vigorous-tolerates dry, wet, sun & shade, Painted Bunting habitat)
Wild Olive	<i>Osmanthus americanus</i>	(Dry to moist sandy soil. Sun to light shade. Berries for birds.)
Yaupon Holly	<i>Ilex vomitoria</i>	(Amazingly adaptable, Painted Bunting habitat.)

SHRUBS

American Beautybush	<i>Callicarpa americana</i>	(Likes sun, tolerates shade and dry soil. Fall berries.)
Arrowwood Viburnum	<i>Viburnum dentatum</i>	(White flowers, blue berries. Sun to shade. Moist soil.)
Elderberry	<i>Sambucus canadensis</i>	(Handles dry-wet. Needs some sun. Birds love.)
Groundsel Tree	<i>Baccharis halimifolia</i>	(Quite salt tolerant, needs some moisture. Leaves poisonous)
Highbush Blueberry	<i>Vaccinium corymbosum</i>	(Tolerates shade, wet, dry but needs low pH.)
Inkberry	<i>Ilex glabra</i>	(Wet soils. Tolerates some shade, flooding, salt. Birds use.)
Possum-haw	<i>Viburnum nudum</i>	(purple to black fruits, tolerates wet and shade)
Marsh Mallow	<i>Hibiscus moscheutos</i>	(White specimen flowers)
Swamp Rose	<i>Rosa palustris</i>	(Attractive all year. Full sun or shade. Wildlife eats fruits)
Summersweet Clethera	<i>Clethera alnifolia</i>	(Fragrant. Tolerates shade, tough and beautiful. Wet soil.)
Titi	<i>Cyrilla racemiflora</i>	(Wet soils. Semi evergreen)
Virginia Sweetspire	<i>Itea virginica</i>	(White flowers. Tolerates shade, flooding, some drought. Very adaptable)
Winterberry	<i>Ilex verticillata</i>	(Red winter berries. Tolerates shade and wetness)

Source: New Hanover Soil & Water Conservation District

BIORETENTION AREA

Technically, bioretention areas are rain gardens - but on a much larger scale. They are generally more suitable for commercial properties, whereas rain gardens are more suitable for the homeowner's yard. (See pages 6-9 for a description of Rain Gardens.) Many commercial businesses are required to build some sort of storm water infiltration system to collect and treat storm water runoff - the most common system built is a bioretention area.



This bioretention area is located next to Randall Pond at the Storm Water Demonstration Site. It was planted with locally-adapted trees, plants and shrubs. Bioretention areas are designed to capture and filter polluted storm water runoff.

Similarities between Bioretention Areas & Rain Gardens

- » Both are designed to capture & filter polluted storm water runoff before it flows into storm drains and waterways.
- » Both allow water to soak into the ground naturally, recharging groundwater supplies.
- » Both are constructed with a slight depression in the center.
- » Both are planted with locally-adapted plants, trees, shrubs, grasses and flowers.
- » Both are aesthetically-pleasing additions to a landscape.

Differences between Bioretention Areas & Rain Gardens

- » Rain gardens are usually planted in a homeowner's yard, whereas bioretention areas are usually found on commercial property and next to roads or highways.
- » Bioretention areas are usually larger than rain gardens and are designed to capture and filter larger amounts of storm water runoff.

Building and Maintaining a Bioretention Area

Location

Size and location of a bioretention area will depend on site constraints such as utility lines and available land area.

Size

The size of a bioretention area will vary from site to site. Generally, the size should be about 5% of the impervious surface area draining to it.

Planting Soils

The right kind of soil is important for a bioretention area because it helps plants and flowers grow and remain healthy; it is also a major component of the pollution-filtering process.

- » Soils should be sandy, sandy loam, loamy sand or loam texture.
- » When planting the area, be sure to provide enough depth for plant root systems to become established and also to provide adequate moisture-holding capacity.

Plants

Plant locally-adapted flowers and plants. All plants should be able to withstand periods of heavy water along with times of drought. It is better to plant seedlings than seeds. Plants should be watered initially until they are established.

A bioretention area contains 3 planting zones: the lower part of the area is going to be the wettest and should contain the most moisture-tolerant plants. A mixture of trees and shrubs native to local wetlands and streambanks are most suitable for the lower and middle zones, while perennial plants are most suited for the upper rim of the garden. Incorporate berry and nectar-producing plants to create a habitat for songbirds and butterflies.



Mulch

Mulch should be added immediately after trees and shrubs are planted. Evenly spread 3-4 inches of shredded hardwood mulch or pine straw to protect the plants, retain moisture and help prevent erosion.

Maintenance

Plants should be inspected twice a year to evaluate their health. Remove any dead or diseased vegetation. Pruning and weeding may also be necessary to maintain the area's appearance.



This bioretention area is located in the Storm Water Demonstration Site next to Randall Pond in Wilmington.



Sources for This Section & Additional Bioretention Area Info:

<http://www.bae.ncsu.edu/people/faculty/hunt> (*bioretention area design factsheets, links and technical info*)

<http://epa.gov/owm/mtb/biortn.pdf>.)

<http://www.gsd.harvard.edu/news/conferences> (other pictures)

<http://www.stormwatercenter.net/Slideshows/filtering%20for%20smrc-dsc/sld052.htm>

<http://www.fxbrowne.com/html/gf-facts/gf-factsheet05v9.pdf>

http://www.lid-stormwater.net/bioretention/biocommind_specs.htm

GRASSY SWALE

Swales, which appear as long, shallow, grassy depressions alongside roads, are often confused with ditches. How can you tell the difference? Swales are much wider than they are deep; in fact, swales have only slight depressions (no steep sides) and are designed to hold and convey large amounts of storm water runoff.

Runoff from hard surfaces, such as roads and parking lots, is a main source of water pollution—that is why you will commonly find grassy swales along highways, streets, sidewalks and parking lots.

Swales manage storm water pollution by slowing down the speed of runoff to waterways. By doing this, grassy swales have time to allow water and pollutants to soak into the ground instead of running into local creeks, streams and waterways.



Grassy swales are designed to hold and convey storm water runoff. Swales slow the speed of runoff and allow the water and pollutants to soak into the ground.

Benefits of Grassy Swales

- » **Slows down & filters runoff**
Swales collect runoff from streets, roads and parking lots, and hold the water long enough for the water and pollutants to soak into the ground.
- » **Filters large amounts of water**
Because swales are large, wide areas, they can capture and filter a large amount of storm water runoff.
- » **Prevents erosion**—The grass root systems help keep soil in place to prevent erosion. Other materials may be used such as gravel or other vegetation (trees & plants) if necessary to help prevent erosion.
- » **Cost-effective**
Swales cost less to install than typical curb, gutter and underground pipe systems and maintenance costs are minimal.
- » **Easy to maintain**
Maintenance includes periodic mowing, watering and litter/debris removal.



Grassy swales are commonly found alongside roads, streets and parking lots.

Designing a Grassy Swale

Some things to consider when designing a swale:

- » The ability to remove large amounts of pollutants such as nitrogen and phosphorus is directly related to how well the grassy swale is designed. Swales should be much wider than they are deep so runoff can settle in the swale for an extended period of time. This way, the grass and soil can filter the pollutants out of the water. If the swale has a steep angle, water will flow too quickly through the swale and only a small amount of water will soak into the ground - where much of the pollutant removal process takes place.
- » While it is important to design swales to allow water to settle for a period of time, it is also important that they don't hold standing water long enough for mosquitoes to breed. Clay and sandy soils may require an underground drain or other adjustments to increase soil permeability. Swales should be constructed on permeable, non-compacted soils.
- » Swales should not be designed to receive construction or post-construction site runoff with high sediment content.
- » The speed of the water flowing through the swale should not exceed 1.5 feet per second. The slope of the swale should be between 1 and 4 % (1 to 2 % slopes are recommended by the EPA). Side slopes should not be steeper than 3:1 horizontal to vertical.
- » Length of the swale should be at least 100 feet per acre of drainage area.
- » A check dam is a small barrier within a swale that is used to retain excess water during heavy rains and to slow the speed of runoff. Check dams help to minimize erosion and allow sediment to settle. Check dams should be made of materials that will not erode such as lumber, rocks, logs, hay bales or concrete blocks (see below).



Maintenance

- » **Mowing**—Most maintenance includes mowing. It is suggested that the swale be mowed twice annually to a minimum height of 4" and grass clippings should be removed from the swale immediately.
- » **Remove sediment & debris**—Litter, pet waste and sediment may find their way into the swale. Make sure to remove them as often as possible.
- » **No fertilizers or pesticides**—Avoid using pesticides or fertilizers on the swale since they contribute to storm water pollution.
- » **Cleaning Check Dams**—Clogged check dams should be cleaned and maintained to ensure that water doesn't pond for more than 24 hours. Excess sediment should be removed. Water should be able to flow in a thin sheet through the swale.
- » **Beware of Erosion**—Make sure to check the swale for erosion. If significant erosion occurs, you may need to plant more grass or plants to anchor the soil in place.

Suggested Grasses for Swales

Common Name	Tolerant of Shade	Propagation	Green Foliage	When to Plant
Carpet Grass	Fair	Seed	Spring, Summer, Fall	May - July
Common Bermuda	Poor	Sprigs or Seed	Spring, Summer, Fall	May - July
Tifway (Tifgreen) Bermuda	Poor	Springs, Plugs, Sod	Summer, Fall	
Centipede	Fair	Sprigs, Seeds, Plugs, Sod	Summer, Fall	May - July
St. Augustine	Excellent	Springs, Plugs, Sod	Spring, Summer, Fall	May - July
Zoysia	Good	Springs, Plugs, Sod	Spring, Summer, Fall	May - July

Adapted from: http://www5.bae.ncsu.edu/programs/extension/publicat/wqwm/ag508_3/turf.html

Sources for This Section & Additional Grassy Swale Info:

<http://www.oaklandpw.com/creeks/pdf/swales.pdf>
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post_24.cfm
http://www5.bae.ncsu.edu/programs/extension/publicat/wqwm/ag508_3/turf.html
<http://www.greenworks.tv/stormwater/vegetatedswales.htm>
http://ci.ftlaud.fl.us/public_services/swales/sos.htm
http://www.uoregon.edu/~mattlamb/projects/BioSwale/body_bioswale.html

APPENDIX

Suggested Plants for BMPs

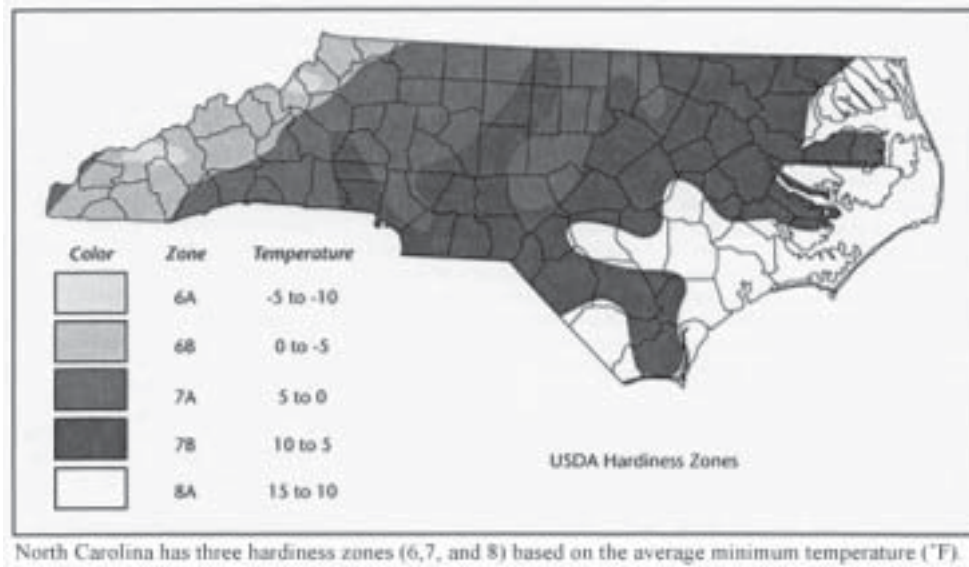
The plants listed below are adapted to this region (Southeastern NC) and are drought & disease-tolerant plants. Additional plants for BMPs can be found on the following pages.

Common Name	Botanical Name	Native Plant	Habitat Garden	Rain Garden	Bank Restoration	Buffer	Shade Tree	Bioretention Area
Autumn Sage (perennial plant)	<i>Salvia greggii</i>		Yes					
Bald Cypress (tree)	<i>Taxodium distichum</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Beautyberry Bush (deciduous shrub)	<i>Callicarpa americana</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Black-eyed Susan (perennial plant)	<i>Rudbeckia fulgida</i>	Yes	Yes	Yes				Yes
Butterflyweed (perennial plant)	<i>Asclepias tuberosa</i>	Yes	Yes					
Buttonbush (deciduous shrub)	<i>Cephalanthus occidentalis</i>	Yes	Yes	Yes	Yes	Yes		Yes
Carolina Cherry Laurel (tree)	<i>Prunus caroliniana</i>	Yes	Yes					
Inkberry (evergreen shrub)	<i>Ilex glabra</i>	Yes	Yes	Yes	Yes	Yes		Yes
Longleaf Pine (tree)	<i>Pinus palustris</i>	Yes	Yes	Yes			Yes	Yes
Purple Coneflower (perennial plant)	<i>Echinacea purpurea</i>		Yes	Yes				Yes
Red Cedar (tree)	<i>Juniperus virginiana</i>	Yes	Yes					
River Birch (tree)	<i>Betula nigra</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Seashore Mallow (perennial plant)	<i>Kosteletzkya virginica</i>	Yes	Yes					
Silky Dogwood (deciduous shrub)	<i>Cornus amomum</i>	Yes	Yes			Yes	Yes	
Southern Magnolia (tree)	<i>Magnolia grandiflora</i>	Yes	Yes	Yes			Yes	Yes
Sweet Pepperbush (deciduous shrub)	<i>Clethra alnifolia</i>	Yes	Yes	Yes	Yes	Yes		Yes
Threadleaf Coreopsis (perennial plant)	<i>Coreopsis verticillata</i>	Yes	Yes					
Virginia Sweetspire (deciduous shrub)	<i>Itea virginica</i>	Yes	Yes	Yes	Yes	Yes		Yes
Wax Myrtle (tree)	<i>Myrica cerifera</i>	Yes	Yes	Yes				Yes
Yaupon (evergreen shrub)	<i>Ilex vomitoria</i>	Yes	Yes	Yes				Yes

APPENDIX

Drought & Disease-Tolerant Plants for North Carolina

The following pages list drought & disease-tolerant plants for North Carolina. The plant tables make reference to “hardiness zones” and “water use zones” which are discussed in the information below. Additional information can be found on the web at: <http://www.bae.ncsu.edu/programs/extension/ag-env/publicat/turf.html> or http://www.ces.ncsu.edu/depts/hort/consumer/weather/hardiness_zones.html.



Water Use Zones

Water use zones refer to a plant’s water needs. Some plants need more water than others. By grouping plants together which have similar water needs, less water is wasted to irrigate mixed plantings when half the plants don’t need the extra water.

The philosophy is to only use high water use plants (most annuals, roses, some ornamentals) close to the house for impact. High water use plants need weekly irrigation throughout the growing season. ***It would be better to create a landscape of medium and low water use plants*** - medium use plants would need watering during drought, and low water use plants should thrive under natural rainfall except during times of extended drought. You create these water use zones in your yard.

The placement of plants is a key element in efficient water use. Native & locally-adapted plants, often require little supplemental water and maintenance once established. Many of our southern landscape plants can live through drought. Once they are established, plants such as Crape Myrtle, Elaeagnus, Cedar, Chinese and Japanese Hollies, Glossy Abelia, and Juniper can survive weeks without watering. ***Turf (grass) requires much more care than native plant landscaping.*** Turf is only practical in areas of the landscape where it serves a function, such as in recreational areas, on slopes to control erosion or where it lends aesthetic value.

When you begin planning your landscape, locate plants according to their water needs. Create these water use zones in your yard:

- high water use zones (1),
- moderate water use zones (2),
- low water use zones (3).

Remember, it is better to create a landscape using low (3) and medium (2) water use plants!

Water Use Zones: (1) high water use zone, (2) medium water use zone, (3) low water use zone.

VINES <i>(*Indicates an extremely drought-tolerant plant.)</i>						
Botanical Name & Common Name	Water Use Zone	NC Hardiness Zone	Flower Color/Time of Bloom	Growth Rate	Group	Exposure
<i>Akebia quinata</i> Fireleaf Akebia	1,2,3	6b to 8	Not showy	Fast	Deciduous	Sun/Shade
<i>* Campsis radicans</i> Trumpet Vine	1,2,3	6b to 8	Orange/Summer	Fast	Deciduous	Sun/Shade
<i>Clematis paniculata</i> Sweet Autumn Clematis	1,2,3	6b to 7	White/Summer	Medium	Deciduous	Sun/Semi-Shade
<i>Clematis hybrids</i> Large Flowered Clematis	1,2	6b to 8	Purple, pink, white/Spring	Medium	Deciduous	Sun/Semi-Shade
<i>Fatsyhedera lizei</i> Fatsyhedera	1,2	7to8	Not showy	Medium	Evergreen	Shade/Semi-Shade
<i>Ficus pumila</i> Climbing Fig	1,2	7b to8	Not showy	Slow	Evergreen	Sun/Shade
<i>Gelsemium sempervirens</i> Carolina Jessamine	1,2,3	6b to 8	Yellow/Spring	Medium	Evergreen	Sun/Semi-Shade
<i>Lonicera sempervirens</i> Trumpet Honeysuckle	1,2,3	7b to 8	Orange-Red-Yellow/Spring	Fast	Evergreen	Sun/Semi-Shade
<i>Parthenocissus quinquefolia</i> Virginia Creeper	1,2,3	6b to 8	Greenish white/Summer	Fast	Deciduous	Sun to Shade
<i>Parthenocissus tricuspidata</i> Boston Ivy	1,2,3	7b to 8	Not showy	Fast	Deciduous	Sun/Shade
<i>Rosa banksiae</i> Banks Rose	1,2,3	6b to 8	White/Spring	Fast	Semi-Evergreen	Sun
<i>Rosa species</i> Climbing Rose	1,2	6b to 8	Many colors/Spring	Fast	Deciduous	Sun/Semi-Shade
<i>Trachelospermum jasminoides</i> Star or Confederate Jasmine	1,2,3	7 to 8	White/Summer	Medium	Evergreen	Sun
<i>Wisteria sinensis</i> Chinese Wisteria	1,2,3	6b to 8	Lilac/Spring	Fast	Deciduous	Sun

GROUND COVERS <i>(*Indicates an extremely drought-tolerant plant.)</i>							
Botanical Name and Common Name	Water Use Zone	NC Hardiness Zone	Flower Color/Time of Bloom	Normal Height (in)	Growth Rate	Group	Exposure
<i>Ajuga reptans</i> Carpet Bugle	1,2	7a to 8	Purple/Spring	2-4	Medium to Fast	Evergreen	Shade/Semi-Shade
<i>Euonymus fortunei</i> 'Coloratus,' Wintercreeper Euonymus	1,2,3	6b to 7a	Not Showy	6-18	Fast	Evergreen	Sun/Semi-Shade
<i>Hedera canariensis</i> Algerian Ivy	1,2,3	8	None	6~	Medium	Evergreen	Shade/Semi-Shade
<i>Hedera helix</i> English Ivy	1,2,3	6b to 8	None	6-12	Slow to Medium	Evergreen	Shade
<i>Hypericum calycinum</i> Aaronsbeard, St. Johnswort	1,2,3	6b to 8	Yellow/Spring	8-12	Medium to Fast	Semi-Evergreen	Sun/Semi-Shade
<i>* Juniperus conferta</i> 'Blue Pacific,' Shore Juniper	2,3	6b to 8	None	12-18	Fast	Evergreen	Sun
<i>* Juniperus horizontalis</i> Creeping Juniper	2,3	6b to 8	None	12-24	Moderate	Evergreen	Sun
<i>Liriope muscarii</i> Liriope	1,2,3	6b to 8	Purple/Summer	8-15	Mdium	Evergreen	Sun/Shade
<i>Liriope spicata</i> Spreading Liriope	1,2,3	6b to 8	Purple/Summer	8-15	Medium	Evergreen	Sun/Shade
<i>Ophiopogon</i> Japonicus Dwarf Lilyturf or Mondograss	1,2	6b to 8	Not showy	5-6	Mdium	Evergreen	Shade
<i>Phlox subulata</i> Moss Phlox or Thrift	1,2	6b to 8	Pink, White, Purple/Spring	3-4	Medium	Evergreen	Sun
<i>Vinca minor</i> Common Periwinkle	1,2,3	6b to 7b	Purple/Spring	5-6	Fast	Evergreen	Shade

Water Use Zones: (1) high water use zone, (2) medium water use zone, (3) low water use zone.

HERBACEOUS PERENNIALS <i>(*Indicates an extremely drought-tolerant plant.)</i>						
Botanical Name & Common Name	Water Use Zone	Height	Color	Time of Bloom	Exposure	
* <i>Achillea millefolium</i> Yarrow	1,2,3	2-4 ft	W,P,Y,G	Summer	Sun	
<i>Aquilegia</i> Columbine	1,2	2-3 ft	W,P,B,Y	Spring	Partial Shade	
<i>Ajuga reptans</i> Carpet Bugle	1	2-3 in	B,W,P	Spring	Sun/Shade	
<i>Aster sp.</i> Aster	1,2,3	1-5 ft	All	Summer/Fall	Sun	
* <i>Asclepias tuberosa</i> Butterfly Weed	1,2,3	1-2 ft	O,Y	Summer	Sun	
<i>Astilbe japonica</i> Astilbe	1	1-3 ft	W,P,R	Spring	Partial Shade/Shade	
* <i>Baptisia australis</i> Baptisia	1,2,3	3ft	B	Spring	Sun/Partial Shade	
<i>Chrysanthemum x morifolium</i> Garden Chrysanthemum	1,2	1-3 ft	B	Summer/Fall	Sun	
<i>Chrysanthemum x suberbum</i> Shasta Daisy	1,2	1-3 ft	W	Summer	Sun/Partial Shade	
* <i>Coreopsis grandiflora</i> C. anceolata, C. verticillata Coreopsis	1,2	1-3 ft	Y,G	Summer	Sun	
* <i>Echinacea purpurea</i> Purple Coneflower	1,2	3-5 ft	L,P	Summer	Sun/Partial Shade	
<i>Gaillardia x grandiflora</i> Gaillardia	1,2,3	1-2.5 ft	Y,R,O	Summer/Fall	Sun	
<i>Gerbera jamesonii</i> Gerbera Daisy	1,2	1 ft	B	Spring/Fall	Sun/Partial Shade	
<i>Helleborus orientalis</i> Lenten Rose	1,2	12-15 in	W,P,L	Winter/Spring	Partial Shade/Shade	
* <i>Hemerocallis</i> Daylily	1,2,3	1-4 ft	13	Summer	Sun/Partial Shade	
<i>Heuchera americana</i> Coral Bells	1,2,3	6-12 in	W,P,R	Spring/Summer	Shade	
<i>Hosta sp</i> Hosta, Plaintain Lily	1,2	1-3 ft	Foliage	Spring/Summer	Partial Shade/Shade	
* <i>Iberis sempervirens</i> Evergreen Candytuft	1,2	12 in	W	Spring	Sun/Partial Shade	
<i>I. sibirica</i> Iris	1,2	2-4 ft	All	Spring/Summer	Sun/Partial Shade	
* <i>Kniphofia uvaria</i> Tritoma (Red Hot Pocker)	1,2,3	2-4 ft	R,O,Y	Summer	Sun	
* <i>Liatris scariosa</i> Gayfeather	1,2	2-6 ft	L,P	Summer/Fall	Sun/Partial Shade	
<i>Monarda didyma</i> Beebalm	1,2,3	2-3 ft	W,R,P	Spring/Summer	Sun	
<i>Paeonia lactiflora</i> Peony	1,2	3-4 ft	W,P,R	Spring	Sun/Partial Shade	
<i>Phlox paniculata,sublata P. divaricata</i> Phlox	1,2	1 in-3 ft	All	Spring/Summer	Sun/Shade	
<i>Rudbeckia hirta, R. hybrida</i> Rudbeckia	1,2	2-3 ft	Y,O,G	Summer/Fall	Sun	
* <i>Salvia farinacea</i> Blue Salvia	1,2,3	1/2-5 ft	W,B,R,L	Summer/Fall	Sun/Partial Shade	
* <i>Sedum spectabile</i> Sedum	1,2,3	1 in-2ft	W,P,R	Spring/Fall	Sun	
<i>Solidago hybrids</i> Goldenrod	1,2,3	1-3 ft	Y	Summer/Fall	Sun	
<i>Stokesia laevis</i> Stokes Aster	1,2	12-15 ft	B	Summer	Sun	
* <i>Verbena canadensis</i> Verbena	1,2,3	6 in	W,B,L	Spring/Fall	Sun	
<i>Veronica spicata</i> Speedwell	1,2	1 in-2 ft	B,W	Summer	Sun/Partial Shade	

Water Use Zones: (1) high water use zone, (2) medium water use zone, (3) low water use zone.

ANNUALS					
<i>(*Indicates an extremely drought-tolerant plant.)</i>					
Botanical Name & Common Name	Water Use Zone	Height (in)	Color	Suggested Planting Time	Exposure
<i>Ageratum houstonianum</i> Ageratum	1,2	24	Foliage	Spring/Summer	Partial Shade
<i>Anthirrhinum majus</i> Snapdragon	1,2	6-36	All but B	Spring/Fall	Sun/Partial Shade
<i>Begonia x semperflorens</i> Wax Begonia	1,2	6-12	WPR	Spring/Summer	Partial Shade/Shade
<i>Brassica oleracea</i> Ornamental Kale	1,2	6	Foliage	Early Fall/Late Winter	Sun
<i>Calendula officinalis</i> Calendula	1,2	12-24	YGO	Early Fall/Late Winter	Sun
<i>Capiscum annuum</i> Ornamental Pepper	1,2,3	6-12	Fruit	Spring/Summer	Sun
* <i>Catharanthus roseus</i> Madagascar Periwinkle	1,2,3	6-18	WPL	Spring/Summer	Sun/Partial Shade
<i>Celosia critata</i> Cockscomb	1,2,3	6-30	All but B	Spring/Summer	Sun
<i>Cleome hasslerana</i> Spider Plant	1,2,3	36-60	WPL	Spring/Summer	Sun
<i>Coleus x hybridus</i> Coleus	1,2	12-36	Foliage	Spring/Summer	Partial Shade/Shade
<i>Cosmos bipinnatus, C. x sulphureus</i> Gosmos	1,2	48	YGP	Spring/Summer	Sun
<i>Digitalis purpurea</i> Foxglove	1	12-60	All but B	Fall/Spring	Sun/Partial Shade
<i>Escholzia californica</i> California Poppy	1,2,3	12-24	All	Early Fall/Late Winter	Sun/Partial Shade
* <i>Gaillardia pulchella</i> Blanket Flower	1,2,3	12-30	YGR	Spring/Summer	Sun
* <i>Gomphrena globosa</i> Globe Amaranth	1,2	8-24	WPL	Spring/Summer	Sun
<i>Impatiens wallerana</i> Impatiens	1	6-36	All but B	Spring/Summer	Partial Shade/Shade
<i>Lobularia maritima</i> Sweet Alyssum	1,2	4,8	WPL	Early Fall/Late Winter	Sun/Partial Shade
* <i>Melampodium paludosum</i> Melampodium	1,2,3	24-36	Y	Spring/Summer	Sun/Partial Shade
<i>Nicotiana glauca</i> Flowering Tobacco	1,2	12-36	All but B	Spring/Summer	Sun/Partial Shade
<i>Pelargonium hortorum</i> Geranium	1,2	12-24	All but B,Y	Spring/Summer	Sun/Partial Shade
<i>Petunia x hybrida</i> Petunia	1,2,3	6-12	All	Spring/Summer	Sun
* <i>Portulaca grandiflora</i> Rose Moss	1,2,3	1-3	AL1 but B	Spring/Summer	Sun
<i>Salvia splendens, S. farinacea</i> Salvia	1,2,3	10-30	RWB	Spring/Summer	Sun/Partial Shade
* <i>Senecio cineraria</i> Dusty Miller	1,2,3	6-12	Foliage	Spring to Fall	Sun
* <i>Tagetes erecta, T. patula</i> Marigold	1,2	6-36	YGRO	Spring/Summer	Sun
<i>Verbena</i> Verbena	1,2,3	6-12	All	Spring/Summer	Sun/Partial Shade
<i>Viola x wittrockiana</i> Pansy	1,2	6	All	Fall/Winter	Sun/Partial Shade
<i>Zinnia elegans</i> Zinnia	1,2	6-36	All but B	Spring/Summer	Sun
* <i>Zinnia linearis</i> Creeeping Zinnia	1,2,3	8-10	y	Spring/Summer	Sun

Water Use Zones: (1) high water use zone, (2) medium water use zone, (3) low water use zone.

TURFGRASSES (Listed in order from low to high maintenance) <i>(*Indicates an extremely drought-tolerant plant.)</i>							
Botanical Name & Common Name	Water Use Zone	NC Hardiness Zone	Shade Tolerance	Propagation	Green Foliage	When to Plant	Mowing Frequency
<i>* Eremochloa ophiuroides</i> Centipede (low maintenance)	1,2,3	7 to 8	Fair	Sprigs, Seeds, Plugs, Sod	Summer, Fall	May-July	Low
<i>* Axonopus affinis</i> Carpet Grass	1,2,3	7b to 8	Fair	Seed	Spring, Summer, Fall	May-July	Low
<i>Stenotaphrum secundatum</i> St. Augustine	1,2,3	8	Excellent	Springs, Plugs, Sod	Spring, Summer, Fall	May-July	Medium-high
<i>Zoysia</i> hybrids 'Emerald-', Meyer~, Matrella' Zoysia	1,2	6b to 8	Good	Sprigs, Plugs, Sod	Spring, Summer, Fall	May-July	Low-medium
<i>Cynodon dactylon</i> Common Bermuda	1,2,3	6b to 8	Poor	Sprigs or Seed	Spring, Summer, or Fall	May-July	Medium-high
<i>Cynodon dactylon</i> hybrids 'Tifway,' 'Tifgreen,' Bermuda (high maintenance)	1,2,3	6b to 8	Poor	Springs, Plugs, Sod	Summer, Fall		Very high

ORNAMENTAL GRASSES <i>(*Indicates an extremely drought-tolerant plant.)</i>						
Botanical Name & Common Name	Water Use Zone	NC Hardiness Zone	Texture	Height and Spread	Panicle Length	Exposure
<i>Arundo donax</i> var. <i>vericolor</i> Varigated Giant Reed	1,2,3	6b to 8	Coarse	9 ft/30 ft	24 in	Sun
<i>Calamagrostis x acutiflora</i> 'stricta,' Feather Reed Grass	1,2,3	6b to 8	Fine	5 ft/3 ft	12 in	Sun
<i>Carex morrowii</i> Japanese Sedge Grass	1,2,3	6b to 8	Fine	1 ft/ 1ft	3 in	Sun/Semi-Shade
<i>Chasmanthum latifolium</i> Northern Sea Oats	1,2,3	6b to 8	Fine	3 ft/2 ft	8 in	Sun/Semi-Shade
<i>* Cortaderia selloana</i> Pampas Grass	1,2,3	7b to 8	Fine to Medium	8 ft/6 ft	20 in	Sun
<i>Elymus glauous</i> Blue Wild Rye	1,2,3	6b to 8	Medium	5 ft/4 ft	10 in	Sun
<i>Erianthus ravennae</i> Ravenna Grass	1,2,3	6b to 8	Medium to Coarse	9 ft/4 ft	20 in	Sun
<i>Miscanthus sinensis</i> Chinese Silver Grass	1,2,3	6b to 8	Medium	6 ft/3 ft	10 in	Sun
<i>Miscanthus sinensis</i> 'Gracillimus,' Maiden Grass	1,2,3	6b to 8	Fine	6 ft/3 ft	11 in	Sun
<i>Miscanthus sinensis</i> 'Strictus,' Porcupine Grass	1,2,3	6b to 8	Medium	7 ft/4 ft	12 in	Sun
<i>Miscanthus sinensis</i> 'Variegatus,' Varigated Equalia	1,2,3	6b to 8	Fine	6 ft/3 ft	11 in	Sun
<i>Miscanthus sinensis</i> 'Zebrainus,' Zebra Grass	1,2	6b to 8	Fine	6 ft/3 ft	12 in	Sun
<i>Pennisetum alopecuroides</i> Australian Fountain Grass	1,2,3	6b to 8	Fine	3 ft/2 ft	3 in	Sun
<i>Pennisetum setaceum</i> Fountain Grass	1,2	Use Like an annual	Fine	4 ft/4 ft	12 in	Sun
<i>Pennisetum setaceum</i> 'Rubrum,' Crimson Fountain Grass	1,2	Use like an annual	Fine	4 ft/4 ft	12 in	Sun
<i>Pennisetum villosum</i> Feathertop Grass	1,2,3	6b to 8	Fine	3 ft/2 ft	3 in	Sun

Water Use Zones: (1) high water use zone, (2) medium water use zone, (3) low water use zone.

SMALL SHRUBS (2 to 5 feet) <i>(*Indicates an extremely drought-tolerant plant.)</i>								
Botanical Name & Common Name	Water Use Zone	NC Hardiness Zone	Texture	Form	Normal Height	Growth Rate	Group	Exposure
<i>Aucuba japonica</i> Dwarf Aucuba	1,2,3	6b to 8	Coarse	Oval	3-4 ft	Slow	Evergreen	Shade/Semi- Shade
Azaleas, Hybrids	1, 2	6b to 8	Fine	Upright	3-5 ft	Slow to Medium	Evergreen	Semi- Shade
* <i>Berberis thunbergii</i> Japanese Barberry	1,2,3	6b to 8a	Medium	Oval	3-5 ft	Medium	Evergreen	Sun/Semi- Shade
<i>Buxus microphylla</i> var. japonica Japanese Boxwood	1,2,3	7a to 8	Fine	Rounded	3-4 ft	Slow	Evergreen	Sun/Semi- Shade
<i>Deutzia gracilis</i> Slender deutzia	1,2,3	6b to 8a	Fine	Mounded	2-4 ft	Medium	Semi- Evergreen	Sun/Semi- Shade
<i>Gardenia radicans</i> Creeping Gardenia	1,2	7a to 8	Fine	Spreading	2-4 ft	Slow	Evergreen	Semi- Shade
<i>Hydrangea arborescens</i> 'Annabelle' Smooth Hydrangea	1, 2	6b to 8	Coarse	Rounded	3-5 ft	Fast	Semi- Evergreen	Sun
* <i>Ilex cornuta</i> 'Carissa' Carissa Holly	1,2,3	6b to 8	Medium	Rounded	3-4 ft	Slow	Evergreen	Sun/Semi- Shade
* <i>Ilex cornuta</i> 'Rotunda' Dwarf Chinese Holly	1,2,3	6b to 8	Coarse	Rounded	3-4 ft	Slow	Evergreen	Sun/Semi- Shade
<i>Ilex crenata</i> 'Compacta' Compact Holly	1,2	6b to 7	Fine to Medium	Rounded	3-4 ft	Medium	Evergreen	Sun/Semi- Shade
<i>Ilex crenata</i> 'Green Lustre'	1,2,3	6b to 8a	Fine to Medium	Rounded	3-5 ft	Medium	Evergreen	Sun/Semi- Shade
<i>Ilex crenata</i> 'Helleri' (Heller) Japanese holly	1,2	6b to 7	Fine	Spreading	2-3 ft	Slow	Evergreen	Semi- Shade
<i>Ilex crenata</i> 'Hetzi' Hetz Holly	1,2	6b to 7	Fine to Medium	Rounded	4-5 ft	Medium	Evergreen	Sun/Semi- Shade
* <i>Ilex vomitoria</i> 'Nana' Dwarf Yaupon Holly	1,2,3	6b to 8	Fine	Rounded	3-4 ft	Slow	Evergreen	Sun/Semi- Shade
<i>Itea virginica</i> Virginia Sweetspire	1,2,3	6b to 8b	Medium Branching	Upright	3-5 ft	Medium	Deciduous	Sun/Shade
<i>Jasminum floridum</i> Showy Jasmine	1,2,3	8	Medium	Upright	3-5 ft	Medium	Evergreen	Sun/Semi- Shade
* <i>Jasminum nudiflorum</i> Winter Jasmine	1,2,3	6b to 8	Fine	Mounded Spreading	3-4 ft	Fast	Evergreen	Sun/Shade
* <i>Juniperus davurica</i> 'Expansa' Parsons Juniper	1,2,3	6b to 8	Fine	Spreading	2 ft	Medium to Fast	Conifer	Sun
* <i>Juniperus horizontalis</i> 'Plumosa,' Andorra Juniper	1,2,3	6b to 8	Fine	Spreading	2 ft	Slow	Conifer	Sun
<i>Kerria japonica</i> Japanese Kerria	1,2,3	6b to 8	Medium	Upright Arching	3-5 ft	Medium	Evergreen	Sun
<i>Lonicera pileata</i> Privet Honeysuckle	1,2,3	6b to 8a	Medium	Oval	2-3 ft	Medium	Evergreen	Sun/Semi- Shade
* <i>Nandina domestica</i> 'Harbour Dwarf' or 'Gulf Stream'	1,2,3	6b to 8	Fine	Upright layered	2-3 ft	Medium	Evergreen	Sun/Shade
* <i>Pittosporum tobira</i> 'Nana,' Dwarf Pittosporum	1,2	7b to 8	Medium	Spreading	3-4 ft	Medium	Evergreen	Sun/Semi- Shade
<i>Pyracantha koidzumii</i> 'Santa Cruz'	1,2,3	7b to 8	Medium	Prostrate Spreading	2-3 ft	Medium	Evergreen	Sun
* <i>Raphiolepis indica</i> Indian Hawthorne	1,2,3	7 to 8	Medium	Spreading	2-4 ft	Slow	Evergreen	Sun
<i>Spirea x bumalda</i> Bumald Spirea	1,2,3	6b to 8a	Fine	Mounded	2-3 ft	Fast	Deciduous	Sun/Semi- Shade

Water Use Zones: (1) high water use zone, (2) medium water use zone, (3) low water use zone.

MEDIUM SHRUBS (5 to 8 feet) <i>(*Indicates an extremely drought-tolerant plant.)</i>								
Botanical Name & Common Name	Water Use Zone	NC Hardiness Zone	Texture	Form	Normal Height	Growth Rate	Group	Exposure
* <i>Abelia x grandiflora</i> Abelia	1,2,3	6b to 8	Fine	Irregular	3-4 ft	Slow to Medium	Evergreen	Sun/Semi-Shade
<i>Aucuba japonica</i> Japanese Aucuba	1,2	6b to 8	Coarse	Upright	6-8 ft	Medium	Evergreen	Semi-Shade/Shade
<i>Berberis julianae</i> Wintergreen Barberry	1,2,3	6b to 8	Medium	Oval	5-6 ft	Slow to Medium	Evergreen	Sun
<i>Buxus sempervirens</i> Common Boxwood	1,2,3	6b to 7a	Fine to Medium	Rounded	5-8 ft	Slow to Medium	Evergreen	Semi-Shade
<i>Cytissus scoparius</i> Scotch Broom	1,2,3	6b to 8a	Fine	Upright Open	5-6 ft	Medium	Evergreen	Sun
<i>Forsythia intermedia</i> , hybrids Border Forsythia	1,2	6b to 8	Medium	Irregular	5-7 ft	Fast	Deciduous	Sun
<i>Hydrangea macrophylla</i> Bigleaf Hydrangea	1,2	6b to 8	Course	Rounded	5-8 ft	Fast	Evergreen	Semi-Sun
<i>Hydrangea quercifolia</i> Oakleaf Hydrangea	1,2,3	6b to 8	Coarse	Upright	6-8 ft	Medium	Deciduous	Sun
* <i>Ilex cornuta</i> , 'Burfordii Nana' Dwarf Buford Holly	1,2,3	6b to 8	Medium to Coarse	Rounded	5-6 ft	Slow	Evergreen	Sun/Semi-Shade
<i>Ilex glabra</i> Inkerry Holly	1,2,3	6b to 8	Medium	Rounded	6-8 ft	Medium	Evergreen	Sun
* <i>Lespedeza thunbergii</i> Thunberg Lespedeza	1,2,3	6b to 8a	Medium	Upright Arching	5-6 ft	Fast	Deciduous	Sun
* <i>Mahonia bealei</i> Leatherleaf Mahonia	1,2,3	6b to 7b	Coarse	Upright	6-7 ft	Medium	Evergreen	Semi-Shade/Shade
* <i>Nandina domestica</i> Nandina or Heavenly Bamboo	1,2,3	6b to 8	Medium	Upright	5-6 ft	Medium	Evergreen	Sun/Semi-Shade
Southern Indian Azalea	1,2	7a to 8	Medium	Rounded	5-8 ft	Medium	Evergreen	Semi-Shade
<i>Spiraea prunifolia</i> , 'Plena' Bridalwreath Spirea	1,2,3	6b to 8	Fine to Medium	Rounded	5-7 ft	Medium to Fast	Deciduous	Sun
<i>Spiraea vanhouttei</i> Vanhoutte Spirea	1,2,3	6b to 7b	Medium	Rounded	5-7 ft	Medium to Fast	Deciduous	Sun
* <i>Yucca filamentosa</i> Adam's Needle Yucca	1,2,3	6b to 8	Coarse	Upright	5-6 ft	Medium	Evergreen	Sun

LARGE SHRUBS (8 feet and up) <i>(*Indicates an extremely drought-tolerant plant.)</i>								
Botanical Name & Common Name	Water Use Zone	NC Hardiness Zone	Texture	Form	Normal Height	Growth Rate	Group	Exposure
* <i>Buddleia davidii</i> Butterfly Bush	1,2,3	6b to 8	Medium	Upright, Oval	10-15 ft	Fast	Deciduous	Sun
<i>Calycanthus floridus</i> Sweetshrub	1,2,3	6b to 8	Medium	Broad, Rounded	8-12 ft	Medium	Deciduous	Sun/Shade
<i>Camellia japonica</i> Camellia	1,2	6b to 8	Medium to Coarse	Rounded to Oval	8-10 ft	Slow to Medium	Evergreen	Sun/Semi-Shade
<i>Camellia sasanqua</i> Sasanqua Camellia	1,2	7 to 8	Medium	Irregular to Upright	8-10 ft	Slow to Medium	Evergreen	Sun/Semi-Shade
<i>Chaenomeles speciosa</i> Flowering Quince	1,2,3	6b to 8	Medium	Rounded	8-10 ft	Medium	Deciduous	Sun/Semi-Shade
* <i>Elaeagnus x ebbingii</i> Elaeagnus	1,2,3	6b to 8	Medium	Irregular	8-10 ft	Fast	Evergreen	Sun/Semi-Shade
<i>Euonymus alatus</i> Winged Euonymus	1,2,3	6b to 8	Medium	Mounded	15-20 ft	Slow	Deciduous	Sun/Shade
<i>Hamamllis vernalis</i> Vernal Witchhazel	1,2,3	6b to 8a	Medium	Dense, Rounded	8-12 ft	Medium	Deciduous	Sun/Semi-Shade
* <i>Hibiscus syriacus</i> Shrub Althea (Rose of Sharon)	1,2,3	6b to 8	Medium	Rounded	8-12 ft	Medium	Deciduous	Sun

Water Use Zones: (1) high water use zone, (2) medium water use zone, (3) low water use zone.

LARGE SHRUBS (continued)	Water Use Zone	NC Hardiness Zone	Texture	Form	Normal Height	Growth Rate	Group	Exposure
<i>Ilex x attenuata</i> 'Fosteri,' Foster Holly	1,2	6b to 8	Medium	Upright	8-10 ft	Slow	Evergreen to Medium	Sun/Semi- Shade
* <i>Ilex cornuta</i> 'Burfordii,' Buford Holly	1,2,3	6b to 7b	Coarse	Oval to Rounded	8-12 ft	Medium to Fast	Evergreen	Sun/Semi- Shade
* <i>Ilex vomitoria</i> Yaupon Holly	1,2,3	6b to 8	Fine	Upright	8-12 ft	Medium to Fast	Evergreen	Sun/Semi- Shade
* <i>Juniperus Chinesis</i> 'Hetzi,' Hetz Juniper	2,3	6b to 8	Fine	Upright	15 ft	Fast	Conifer	Sun
* <i>Juniperus chinensis</i> 'Pfitzeriana,' Pfitzer Juniper	2,3	6b to 8	Fine	Broad, Upright	8-10 ft	Fast	Conifer	Sun
<i>Leucothoe populufolia</i> Fetterbrush	1,2	7a to 8	Medium	Upright, Arching	8-12 ft	Medium	Evergreen	Semi- Shade/Shade
<i>Ligustrum japonicum</i> Japanese Privet	1,2,3	7b to 8	Coarse	Dense/Rounded	8-12 ft	Medium	Evergreen	Sun/Shade
<i>Ligustrum lucidum</i> Waxleaf Privet	1,2,3	7b to 8	Medium to Coarse	Rounded	10-20 ft	Medium to Fast	Evergreen	Sun/Semi- Shade
<i>Ligustrum x vicaryi</i> Vicary Golden Privet	1,2,3	6b to 8	Medium	Rounded	10-12 ft	Medium	Evergreen	Sun/Semi- Shade
<i>Magnolia stellata</i> Star Magnolia	1,2,3	6b to 8a	Coarse	Rounded	10-15 ft	Medium	Deciduous	Sun/Semi- Shade
* <i>Myrica cerifera</i> Southern Waxmyrtle	1,2,3	7b to 8b	Medium	Upright, Rounded	8-10 ft	Medium	Evergreen	Sun/Semi- Shade
<i>Osmanthus fortunei</i> Fortunes Osmanthus	1,2,3	6b to 8	Medium	Rounded	8-10 ft	Slow to Medium	Evergreen	Semi-Shade
* <i>Pittosporum tobira</i> Japanese Pittosporum	1,2	7b to 8b	Medium	Rounded	8-10 ft	Fast	Evergreen	Sun/Semi- Shade
<i>Podocarpus macrophyllus</i> var <i>maki</i> Southern Yew	1,2	7a to 8b	Medium	Upright	8-12 ft	Medium	Evergreen	Sun/Semi- Shade
<i>Pyranantha species</i> Firethorn	1,2	6b to 8	Medium	Irregular	10-12 ft	Fast	Evergreen	Sun
<i>Rhus typhina</i> Staghorn Sumac	1,2,3	6b to 8	Fine	Open, Spreading	15-25 ft	Fast	Deciduous	Sun/Semi- Shade
<i>Ternstroemia gymnathera</i> Cleyera	1,2	6b to 8	Medium	Upright	8-10 ft	Slow to Medium	Evergreen	Sun/Semi- Shade
<i>Viburnum lantana</i> Wayfaringtree, Viburnum	1,2,3	6b to 8a	Coarse	Round, Spreading	10-15 ft	Medium	Deciduous	Sun/Semi- Shade
<i>Viburnum plicatum var.</i> <i>tomentosum</i> Doublefile Viburnum	1,2,3	6b to 8a	Coarse	Round, Spreading	8-10 ft	Medium	Deciduous	Sun/Semi- Shade
<i>Viburnum x pragense</i> Prague Viburnum	1,2,3	6b to 8a	Medium	Oval	10-12 ft	Medium	Deciduous	Sun/Semi- Shade

Water Use Zones: (1) high water use zone, (2) medium water use zone, (3) low water use zone.

SMALL TREES (10 feet to 30 feet tall) <i>(*Indicates a drought-tolerant tree.)</i>								
Botanical Name & Common Name	Water Use Zone	NC Hardiness Zone	Texture	Form	Height/Spread (ft)	Growth Rate	Group	Exposure
<i>*Acer buergeranum</i> Trident Maple	1,2,3	7b to 8	Medium	Oval	20-25/10-15	Slow	Deciduous	Sun
<i>Carpinus caroliniana</i> American Hornbeam (Ironwood)	1,2,3	6b to 5	Medium	Loose,Rounded	20-30/15-25	Slow	Deciduous	Sun/Shade
<i>Cercis canadensis</i> Redbud or Judas Tree	1,2	6b to 8	Medium	Oval	25-30/20-28	Medium	Deciduous	Sun/Shade
<i>Chionanthus virginicus</i> Fringe Tree or Grancy Gray-beard	1,2	6b to 8	Coarse	Irregular	10-20/15-20	Slow to Medium	Deciduous	Sun/Semi- Shade
<i>Continus coggygria</i> Common Smoketree	1,2,3	6b to 8a	Medium	Upright, Spreading	10-15/10-15	Medium	Deciduous	Sun/Semi- Shade
<i>Eriobotrya japonica</i> Loquat	1,2	7b to 8	Coarse	Rounded	10-20/8-12	Medium to Fast	Evergreen	Sun
<i>Halesia carolina</i> Silverbell	1,2,3	6b to 8	Medium	Spreading	20-30/15-20	Medium	Deciduous	Sun/Semi- Shade
<i>Ilex x attenuata</i> 'Savannah,' Savannah Holly	1,2,3	6b to 8	Coarse	Pyramidal	25-30/10-15	Medium	Evergreen	Sun/Shade
<i>Ilex decidua</i> Possumhaw	1,2,3	6b to 8	Medium	Loose, Rounded	20-30/15-20	Medium	Deciduous	Sun/Semi- Shade
<i>Ilex latifolia</i> Lusterleaf Holly	1,2,3	6b to 8	Coarse	Pyramidal	20-25/15-20	Medium	Evergreen	Sun/Shade
<i>Ilex x 'Nellie R. Stevens'</i> Nellie R. Stevens, Holly	1,2,3	6b to 8	Coarse	Pyramidal	15-25/10-15	Medium	Evergreen	Sun/Shade
<i>Ilex opaca</i> American Holly	1,2	6b to 8	Medium to Coarse	Pyramidal	20-30/15-20	Medium	Evergreen	Sun/Shade
<i>Koelreuteria paniculata</i> Goldenraintree	1,2,3	6b to 8	Fine	Rounded	20-30/10-15	Medium	Deciduous	Sun
<i>*Lagerstroemia indica</i> Crape Myrtle	1,2,3	6b to 8	Fine	Upright	20-30/10-15	Fast	Deciduous	Sun
<i>*Maclura promifera</i> Osage-orange	1,2,3	6b to 8	Medium	Rounded, Irregular	20-60/20-30	Fast	Deciduous	Sun
<i>Magnolia x soulangiana</i> Saucer Magnolia	1,2,3	6b to 8	Coarse	Rounded	20-30	Medium	Deciduous	Sun/Semi- Shade
<i>Malus species</i> Flowering Crab	1,2	6b to 8	Medium	Rounded to Upright	15-30/15-30	Medium	Deciduous	Sun
<i>Oxydendrum arboreum</i> Sourwood	1,2,3	6b, 7a	Medium to Coarse	Upright	30-40/15-20	Medium	Deciduous	Sun/Semi- Shade
<i>Pinus virginiana</i> Virginia Pine	1,2,3	6b to 8a	Fine	Conical	15-30/10-30	Slow	Evergreen	Sun
<i>Prunus caroliniana</i> Carolina Laurel, Cherry	1,2,3	7 to 8	Medium	Oval	20-30/15-20	Fast	Evergreen	Sun/Shade
<i>Prunus serrulata</i> (many cultivars) Japanese Flowering Cherry	1,2	6b to 8a	Medium	Oval, Spreading, Weeping	20-30/20-30	Medium	Deciduous	Sun
<i>Prunus x yedoensis</i> Yoshino Cherry	1,2	6b to 8a	Medium	Oval, Spreading	10-15/20-25	Medium	Deciduous	Sun
<i>*Vitex agnus-castus</i> Chastetree	1,2,3	6b to 8	Medium	Oval	15-20/10-15	Medium	Deciduous	Sun

Water Use Zones: (1) high water use zone, (2) medium water use zone, (3) low water use zone.

LARGE TREES (30 feet and taller) <i>(*Indicates a drought-tolerant tree.)</i>								
Botanical Name & Common Name	Water Use Zone	NC Hardiness Zone	Texture	Form	Height/Spread (ft)	Growth Rate	Group	Exposure
<i>*Acer Campestre</i> Hedge Maple	1,2,3	5 to 8	Medium	Round	25-35/25-35	Slow	Deciduous	Sun
<i>Acer floridanum</i> Florida Maple or Southern Sugar Maple	1,2,3	6b to 8	Medium	Oval	40-50/20-25	Medium to Fast	Deciduous	Sun/Semi-Shade
<i>Acer rubrum</i> Red Maple	1,2	6b to 8	Medium	Rounded	40-50/25-35	Medium	Deciduous	Sun/Semi-Shade
<i>Betula nigra</i> River Birch	1,2	6b to 8	Medium	Oval	40-70/40-60	Fast	Deciduous	Sun
<i>Carya illinoensis</i> Pecan	1,2	7a to 8	Medium	Rounded	50-60/30-40	Medium	Deciduous	Sun
<i>Cunninghamia lanceolata</i> Common Chinafir	1,2	7b to 8	Fine	Conical	30-75/10-30	Slow	Evergreen	Sun/Semi-Shade
<i>Franxius pennsylvanica</i> Green Ash	1,2,3	6b to 8	Medium	Upright, Spreading	50-60/20-30	Medium	Deciduous	Sun
<i>*Ginkgo biloba</i> Ginkgo or Maiden Tree	1,2	6b to 8	Medium	Irregular	50-70/30-40	Very Slow	Deciduous	Sun
<i>Liriodendron tulipifera</i> Tuliptree (Yellow Poplar)	1,2,3	6b to 8	Coarse	Broad, Rounded	70-90/35-50	Fast	Deciduous	Sun
<i>*Liquidambar styraciflua</i> American Sweetgum	1,2,3	6b to 8	Coarse	Broad, Rounded	60-75/30-40	Fast	Deciduous	Sun
<i>Magnolia grandiflora</i> Southern Magnolia	1,2	6b to 8	Course	Upright, Pyramidal	60-80/40-50	Slow to Medium	Evergreen	Sun
<i>Metasequoia glyptostroboides</i> Dawn Redwood	1,2	6b to 8	Fine	Conical	40-50/20-25	Fast	Deciduous	Sun
<i>*Pinus palustris</i> Longleaf Pine	1,2,3	7b to 8	Medium	Horizontal Branching	80-100/15-20	Fast	Evergreen	Sun
<i>Pinus taeda</i> Loblolly Pine	1,2,3	6b to 7	Medium	Horizontal Branching	80-100/20-30	Fast	Evergreen	Sun
<i>*Quercus acutissima</i> Sawtooth Oak	1,2,3	6b to 8	Medium	Broad, Oval	35-45/35-45	Medium	Deciduous	Sun
<i>Quercus falcata</i> Southern Red Oak	1,2	6b to 8	Coarse	Rounded	70-80/30-40	Medium	Deciduous	Sun
<i>Quercus nigra</i> Water Oak	1,2,3	6b to 8	Medium	Rounded	80-90/40-50	Medium to Fast	Deciduous	Sun
<i>*Quercus palustris</i> Pin Oak	1,2	6b to 8a	Medium	Pyramidal	70-80/40-50	Medium	Deciduous	Sun
<i>*Quercus phellos</i> Willow Oak	1,2	6b to 8	Fine	Rounded	80-100/40-50	Medium	Deciduous	Sun
<i>Quercus shumardii</i> Shumard Oak	1,2,3	6b to 8	Medium	Pyramidal	40-60/40-60	Medium	Deciduous	Sun
<i>*Quercus virginiana</i> Live Oak	1,2,3	7b to 8	Medium	Rounded	60-80/50-60	Medium	Evergreen	Sun
<i>Sophora japonica</i> Japanese pagoda	1,2,3	6b to 7	Medium	Upright, Spreading	50-75/50-60	Fast	Deciduous	Sun
<i>*Taxodium distichum</i> Common Baldcypress	1,2,3	6b to 8	Fine	Conical	50-70/20-30	Medium	Deciduous	Sun
<i>*Ulmus parvifolia</i> True Chinese Elm (Lacebark Elm)	1,2,3	6b to 8	Medium	Rounded	40-50/30-40	Fast	Deciduous	Sun
<i>Zelkova serrata</i> Japanese Zelkova	1,2,3	6b to 8a	Medium	Broad, Oval	50-80/50-60	Fast	Deciduous	Sun

GLOSSARY

Algal bloom - Algae that occurs in waterways and can be hazardous to humans & aquatic life.

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

Best Management Practice (BMP) - a landscape addition or technique that protects water quality by reducing pollution and sediment carried in storm water runoff.

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 - Small barrier built across the direction of water flow to retain excess water during heavy rains. Used with grassy swales.

Deciduous tree - A tree that sheds or loses its foliage (leaves) at the end of each growing season.

Groundwater - Water below the earth's surface, often between saturated soil and rock, that supplies 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 and should be free of harmful contaminants and pollution.

Locally-adapted plant - A plant that is adapted to the weather, temperature, and soil conditions of this region. Locally-adapted plants usually require less (if any) fertilizers, pesticides or irrigation.

Impervious surface - Any surface that cannot be penetrated by water. Examples include parking lots, streets, sidewalks and roofs.

Nonpoint source pollution (NPS) - Pollution from many different sources that is carried by runoff into local waterways. Typical NPS pollutants are pet waste, lawn fertilizer/pesticides, car washing soap, litter and sediment. Everyone contributes to nonpoint source pollution.

NPDES - National Pollutant Discharge Elimination System, a provision of the Clean Water Act that prohibits discharge of pollutants into waters of the United States unless a special permit is issued by EPA, a state, or other delegated agency.

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 surface - Pervious surfaces allow water to soak through them by virtue of their porous nature or by large spaces in the material.

Point source pollution - Water pollution coming from a single point (i.e. industrial outflow pipe.)

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

Runoff - Water from rain, melted snow or landscaping irrigation that flows over land and into local creeks, streams and waterways. Runoff often carries pollutants in it.

Sediment - Soil that washes into a body of water and contributes additional nutrients to the water. Sediment includes decaying algae/weeds, soil, and organic matter (grass clippings & leaves).

Sanitary sewer system - The system that collects and transports commercial and domestic wastewater (i.e. from sinks, toilets, waterfountains, etc) to a wastewater treatment plant where it is treated.

Storm drainage system - The system built to collect and transport runoff to prevent street and property flooding. This system consists of storm drains, catch basins, drainage ditches, pipes and culverts. Anything that flows into the storm drainage system flows directly into local creeks, streams, and waterways. (Storm water runoff is not treated.) The storm drainage systems is completely separate from the sanitary sewer system.

Watershed - The land area that drains runoff into a particular stream, river, lake or waterway. For instance, if you live in the Burnt Mill Creek Watershed, runoff from your property will flow into Burnt Mill Creek and eventually into the Cape Fear River.



This guide developed by: Jennifer DiLullo, Outreach & Education Coordinator-City of Wilmington Storm Water Services and Tammy Caudill, UNCW Intern . We would like to thank the following people and organizations for their contributions to this guide: Nina Cain, Wanda Thorpe & City Parks crews-City of Wilmington Parks, Recreation and Downtown Services, Charlotte Glen-New Hanover Cooperative Extension Service, Bill Hunt-NCSU, Mary Ann Metcalf-New Hanover Cooperative Extension Service, Marilyn Stowell & Shelly Miller-New Hanover Soil & Water Conservation District, Jennifer Coyner-Cape Fear River Watch, Inc. and the sources/websites/pictures cited in this guide.