Hampton Park, Library of Congress (ca. 1910-1920)

R2 RESILIENCE GUIDANCE: LANDSCAPE

LANDSCAPE IMPROVEMENT GOALS

Capturing rain on site is a primary defense that can slow flooding by allowing it to be naturally absorbed into the ground. This is important because streets can become flooded, local storm drains overwhelmed, and water can spill onto a neighbor's property causing additional damage.

MAINTENANCE AND PERMITTING

A building permit may be required for any of these suggested work items. *(Refer to Resilience Guidance: Permit Review, page R1.5.)* Also, if the property is subject to review by the Board of Architectural Review or Design Review Board, additional reviews may be required. For any questions or concerns, contact the Permit Center. Additional resources and codes can be found on the last page of this topic section.

Landscape projects can significantly improve flood resilience. The most important goal is to capture stormwater on site, which can reduce water racing into streets and storm drains. Landscape improvements can be relatively low impact, inexpensive to implement, and completed as do-it-yourself projects by property owners or tenants over time. Many detailed ideas and resources can be found in the *Charleston Rainproof* program. *(Refer to charleston-sc.gov/rainproof.)*

In addition to absorbing stormwater, adding shade trees as landscape improvements reduces heat on a property. Mature, wind-resilient shade trees located on the south and west sides of a building can reduce the intensity of the sun on the roof and walls, and reduce indoor temperatures.

Other actions, like collecting compost and planting native species, are sustainable and resilient habits that can collectively improve the natural environment.

Some of the key projects to increase water storage on site include:

- Reducing hardscape or paved areas that do not absorb water
- Changing the grading pattern to control stormwater
- Installing stormwater collection systems
- Increasing shade trees and native plants
- Collecting compost and reducing chemical fertilizers
- Protecting natural shorelines from erosion

Identifying problem areas can help the design of solutions to guide water flow. The quantity of roadway stormwater runoff reaching the lawn is reduced by absorption through the gravel bed. The larger stones contain the gravel to minimize spread. Installing a smaller gravel bed may be a task that can be completed by property owner. Specialty equipment can be rented or a contractor hired for larger areas.

Water is pooling under this building. Prolonged exposure to standing water can compromise the mortar at the cast stone piers, making the building more vulnerable to damage from flooding and earthquakes. Ways to divert the water away from the foundation should be evaluated.

UNDERSTANDING PROPERTY DYNAMICS

For the most successful, resilient landscape, three components of a site should be understood when considering changes: water movement, soil type, and sun patterns.

WATER MOVEMENT

Floodwater can behave very differently than a heavy rainfall on a site. Knowing where puddles form, and how floodwater or stormwater flows across, off, or onto a property from neighbors or the right-of-way can indicate where change is needed to improve drainage. It is also valuable to understand the compound impact of water movement on a site when a significant rainfall event occurs at the same time as a coastal flood.

One of the flood resilience goals is to retain as much of the stormwater that falls onto a property as possible, rather than allowing it to flow into the street, stormwater system, or onto neighboring properties. If this is done collectively within a neighborhood, the volume of water that flows into the street and overwhelms the stormwater system would be reduced, lessening flood severity in the area.

Retaining stormwater on-site can be accomplished by allowing the stormwater to be captured and absorbed into the ground whenever possible, while also minimizing the risks to existing buildings. Several options for stormwater collection are presented in this section. This is easier to accomplish on larger parcels with a lot of land. When that is not possible, stormwater can be temporarily captured and retained in rain barrels or cisterns, and released when the ground is able to absorb more water, or used as a water source for a garden. *(Refer to Rain Barrels and Cisterns, page R2.7.)* For areas with a high water table, a specially-designed stormwater retention basin may be necessary to hold enough water in an area that is easily saturated.

Capturing stormwater on a property, but away from building foundations, prevents it from flowing onto a street. Ideally, standing water should drain within 48 hours.

The lower grade causes water to pool along the side of this house. Regular standing water prevents grass from growing in the area.

SOIL OBSERVATION AND TESTING

Simple tests can be performed without professional training to determine drainage, or percolation, rate. This is an important step before making any big decisions about stormwater improvements to a property.

Observations of Healthy Soil

- Water is not standing on the ground surface hours after a rainfall
- Digging a hole 2-3 feet into the ground is relatively easy
- Plants and earthworms are thriving

Soil Testing

- Test for drainage by digging a hole 12 inches deep and 12 inches wide and fill the hole with water. Take hourly observations of the water level below the ground surface. Sandy soils will drain at about 4 inches an hour, while 1 inch or less per hour indicates a problem with compaction or other issues.
- Home pH tests can be used. However, a county cooperative research center can conduct a soil sample for a nominal fee, providing information on the pH levels, nutrients and organic matter, and recommendations. *(Refer to Clemson University Agricultural Service Laboratory or the nearest extension office.)*

Based on the results, various actions on the following pages may be needed to improve drainage on the property.

(University of Maryland Extension, www.extension.umd.edu)

Soil can be spiked, or small plugs removed, using an aerator to improve air and water flow. Aerating also improves the health of the soil, making it easier to grow grass or groundcover. A hand-held aerator can be used for smaller areas, or a machine rented for large lawns.

Creeping thyme plants are burned out from the hot afternoon sun.

Pachysandra at the base of a tree protects the trunk while mowing and helps maintain soil moisture.

SOIL TYPE

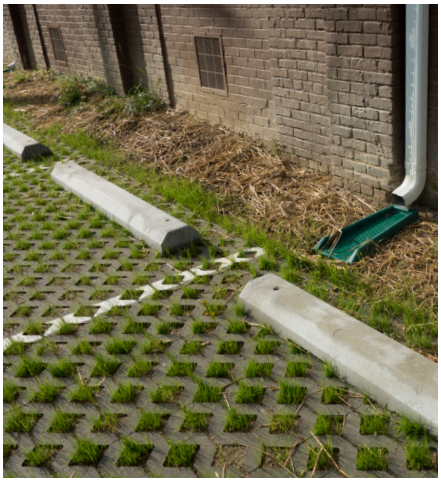
Soil type is important for water infiltration. Soil maps are readily available and can help with the design and performance of infiltration mechanisms and rates. Soil testing can also be performed to observe drainage rates and to determine the types of plants that will thrive. *(Refer to Soil Observation and Testing sidebar, at left.)*

SUN PATTERNS

Just like there are patterns in the way water behaves on a property, there are also patterns for the sun. These patterns vary during the course of each day and seasonally. Identifying areas that are shady or sunny can aid in selecting plants and trees that will thrive. It may also guide decisions on where to plant trees to improve shading for a garden or building, potentially reducing heat gain.

KEY TIPS:

- Photograph and document a property during or immediately after a coastal storm and/or heavy rainfall to understand how water flows and where puddles form
- Perform soil observations and tests to identify materials and determine drainage rate at different areas
- Understand seasonal and daily sun patterns, including sunny spots and where shade may be needed in the heat of the summer



Open concrete pavers allow grass to grow in this parking area, which helps absorb more stormwater.

Portions of this parking lot have been curbed to allow for planting areas that increase the capacity for stormwater.

Pavers are available with edge spacers that form open, pervious joints when laid, allowing water to flow through into the ground.

HARDSCAPE AND IMPERVIOUS SURFACES

Alternatives to solid, paved walkways, driveways, patios, and parking lots are beneficial to increase the water storage capacity on a site. Solid paved areas, in addition to covered areas of a property such as buildings and swimming pools, are referred to as impervious surfaces because they limit the ability for stormwater to be absorbed into the ground naturally. Impervious areas cause rainfall to behave as water runoff, overwhelming the local stormwater system and increasing the likelihood of neighborhood flooding.

The level of stormwater absorption into the ground can be enhanced by including more trees and plantings that absorb water naturally. *(Refer to Trees, page R2.9, and Ground Covers and Native Plantings, page R2.10.)* Additionally, if soils are heavily compacted, they can become effectively impermeable. *(Refer to Soil Observation and Testing, sidebar page R2.3.)* The process of reducing impervious surfaces and increasing stormwater capture on a property can be accomplished over time, and can be part of an overall landscape design strategy.

Driveways can be limited to tire paths or paved with pervious materials to increase the ability for stormwater to be captured on site.

KEY TIPS:

- Convert solid concrete or asphalt driveways and pads to pavers or loose material that allow water to drain (loose materials should have containment edging and can become airborne projectiles in heavy winds)
- Replace regular pavers with permeable pavers or install spaced pavers to allow groundcover to grow in joints
- Perform a drainage test in various locations of the yard to record how long it takes water to drain *(refer to Soil Observation and Testing, sidebar page R2.3)*
- Use an aerator tool to loosen compacted soils
- For severely compacted soils, till the soil (using a hand or power tool) and amend the soil with compost or other organic material, such as peat moss or vermiculite
- Avoid driving on yard surfaces, which can increase compaction and reduce water absorption and plant growth

***Hardscapes** are the non-living features – such as compacted gravel, stone pavers, retaining walls and fences – that prevent stormwater absorption.*

*Connected ditches (**bioswales**) collect stormwater from roadways and properties, allowing it to absorb into the ground. Water tolerant plantings can be added, similar to a rain garden.* *(Refer to Rain Gardens, page R2.6.)*

PERMIT REQUIREMENTS

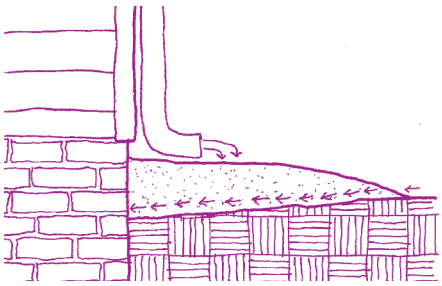
All development, including excavation and placement of fill, will require a permit under applicable federal, state, and local laws, ordinances, and regulations. Fill or erosion control structures such as a retaining wall may also have civil implications if floodwater, flow intensity, and/or direction is worsened for neighboring properties. Contact the Permit Center for additional information.

DEFINITIONS

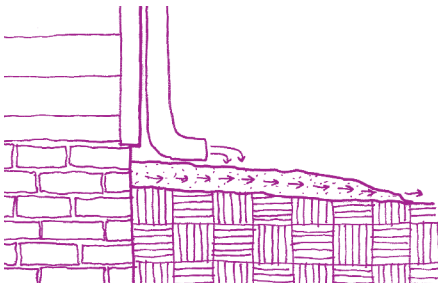
Berms: Berms are built up mounds in straight or curved shapes about five times as wide as they are tall. They can direct stormwater and provide an opportunity to add vertical interest to the landscape.

(Bio)Swales: Swales are shallow channels that are about four times as wide as they are deep. Swales can be built to direct stormwater away from building foundations, or toward areas that promote natural infiltration, like waterways, dry wells, and rain gardens. *(Refer to Rain Gardens, page R2.6.)*

***Grading** refers to leveling an area or changing the slope to control water flow. A retaining wall maintains soil height above the street level, which is lower along the sidewalk.*



Bad: Water flows through the ground cover layer to the soil surface that drains toward the foundation.



Good: Water flows through the ground cover to the soil surface that drains away from the foundation.

SITE GRADING

During and after rain events is the best time to visually survey water movement patterns and where water is collecting on a property. Look for puddles in the yard or driveway indicating depressions in the ground surface; dirt left on vertical surfaces from water splashing against a building foundation or landscape walls; and debris piles of pine needles, leaves, mulch, or other materials that the water picked up and deposited. Minor pooling sites can be filled or planted to elevate the low spots. However, if there are property-wide issues, more significant change may be needed requiring the assistance of a landscaper, and heavy equipment to build berms and swales to manage the movement and direction of stormwater.

KEY TIPS:

Please note that the site and building flood mitigation options listed below may not be feasible or successfully resolve flooding issues at a property. Intensifying storms and sea level rise may soon render mitigation options ineffective, diminishing their long-term cost effectiveness.

- Observe water flow paths and areas that are collecting water during heavy rains
- Use a combination of sand, soil, and plant material to fill in small depressions
- Prioritize grading around the building foundation to avoid water from flowing toward a building or crawlspace
- Consider building a berm and/or a swale if there is a significant amount of water collecting or flowing through the property

Rain gardens located along paved areas can collect roadway stormwater.

River stone-lined, dry creek beds are a type of garden that will only be wet immediately after a rain event.

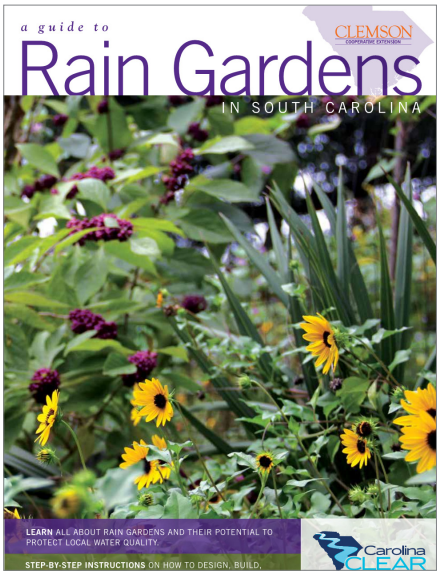
RAIN GARDENS

When stormwater is allowed to absorb naturally on-site, the water is filtered through the soil; which can reduce contaminants from going into natural waterways. ***Natural or man-made depressions in the ground are opportunities to create a rain garden, serving both a functional and decorative purpose.*** Rain gardens are designed to pool water in a defined location. In contrast, a bioswale is engineered to funnel water to a drainage system. *(Refer to Definitions, sidebar page R2.5.)* Either feature can be designed and built by a property owner, although special rental equipment may be beneficial for a large-scale project. Landscape architects, community cooperative extension offices (often at universities), and expert gardeners can help design a solution for the property's unique conditions. *(Refer to A Guide to Rain Gardens by Clemson Cooperative Extension.)*

Hybrid rain barrels can capture stormwater and support plantings or small gardens in paved area.

KEY TIPS:

- Perform a soil drainage test to determine whether the selected site has good drainage *(refer to Soil Observation and Testing, sidebar page R2.3)*
- Monitor areas that collect water and/or where water travels naturally in the yard *(refer to Site Grading, page R2.5)*
- Direct rain downspout extensions and/or cistern or rain barrel overflows to a rain garden or a swale *(refer to Definitions, sidebar page R2.5)*
- Use native plants and plants that are best suited to the unique conditions of the rain garden's location (sun, shade, saturation, salt tolerance) *(refer to Ground Covers and Native Plantings, page R2.10)*
- Limit any use of fertilizers and herbicides *(refer to Ground Covers and Native Planting, page R2.10)*
- Monitor weeds and erosion to ensure continued health
- Locate rain gardens at least 10 feet from building foundations
- Keep rain gardens at least 25 feet away from septic system drain fields
- Avoid areas where the water table is less than 18 inches deep
- Plan a rain garden that is 8 to 10 feet long in the direction of water flow
- Call #811 in S.C. before you dig to avoid buried cables and pipes



Clemson has a detailed rain garden publication. (clemson.edu/extension)

Rain barrels can be used as an irrigation source. (NC Cooperative Extension, www.ces.ncu.edu)

RAINWATER COLLECTION SYSTEMS

Harvesting rainwater can have several benefits. Become familiar with how the system works to help determine if and how it can work best on your property. Components of a rainwater collection system include:

- **Catchment area:** A location that collects or sheds water, like a downspout or an open corner at roof valley
- **Conveyance system:** The means to transport the water from a gutter, piping, or just a section of the roof that can pour rainwater into the storage tank
- **Filtration screen:** A screen added at the point where water enters the gutter and the tank to prevent most debris from collecting and clogging the system (periodic cleaning will be necessary)
- **Storage tank:** Acquire ready-made rain barrels or cisterns, converted 50-55 gallon food-grade containers, or a rectangular 275-gallon tote
- **Water distribution:** A spigot or pipe allows collected water to be distributed with a garden hose or by filling a watering can (pressure will be dependent on the volume)

(University of Florida Institute of Food and Agricultural Science, www.sfyl.ifas.ufl.edu)

RAIN BARRELS AND CISTERNS

Rainwater that falls onto a roof can be collected in rain barrels to water gardens or be slowly released when the ground is no longer saturated following a storm. *(Refer to Rain Gardens, page R2.6.)* Cisterns, larger stormwater collectors, can be installed above or below ground and even in large crawlspaces.

KEY TIPS:

- Choose a rain barrel that is at least 42 gallons and has a screened collection area, outgoing spigot at the bottom, and overflow features
- Contact Charleston Rainproof for discount programs *(www.charleston-sc.gov)*
- Add pumps and connect multiple barrels to increase ease of use
- Install covers and screens to minimize clogging and mosquitos, and follow regular maintenance tips
- Elevate rain barrels to increase water pressure from the bottom hose spigot
- Install above-ground rain barrels and cisterns in a manner that is not obvious from the street or a neighboring property, using fencing or plant screening, such as a shrub or a trellis, to conceal it as necessary
- Use harvested water for plants, filling fountains and ponds, rinsing outdoor tools, keeping compost moist, and pet washing
- Do not use captured water for drinking or food preparation unless specific filtration systems are installed and the water is tested by the county

Plantings can conceal rain barrels.

Cisterns provide larger storage capacity.

The roof downspout discharges into a rain barrel.

Historic brick cisterns (Preservation Society of Charleston)

A French drain collects and moves water away from the foundation to reduce building water damage. (LSU Ag Center)

A solid downspout drain can divert water to a an absorption area or rain barrel.

Participation in the local Adopt-a-Drain program helps reduce flooding, protects waterways, and reduces litter.

DRAINS

Drains collect stormwater into pipes and direct it to a different area, such as a rain garden on-site, or into the municipal stormwater system. Drainage pipes are sloped in the desired direction of the water flow. However, during a flood event, rising water can back up through the piping, eventually coming up through the drains.

There are several types of drains. A French drain may be recommended to manage shallow groundwater by capturing water and redirecting it from a problem area, like along a building foundation, to a desired location such as a rain garden. A pipe with perforations at the top is laid in a sloped, gravel-filled trench, which uses gravity to move the water along the drain. These systems can be completely underground and covered with plantings, or a walkable, permeable surface. *(Refer to Hardscape and Impervious Surfaces, page R2.4.)*

Site drains are located in low-lying portions of a site or at paved surfaces such as parking lots. Conveyance drainage piping, which includes downspout extensions, direct stormwater to a desired location. Unlike French drains, site drains and conveyance drainage piping rely on solid piping that should be of sufficient size to prevent backups during severe storms and rain bombs.

KEY TIPS:

- Avoid routing the drain to paved surfaces, city stormwater utilities, or neighboring properties to encourage more water absorption on-site
- Record property elevations to determine any grade changes that may be necessary when digging the trench for a drain system
- Add valves to drain pipes to manage the direction of water flow in flood-prone areas
- Follow detailed installation guides; clean and maintain the system regularly to ensure peak performance
- Consider multipurpose solutions like gravel covered walkways or patios over French drains (loose materials should have containment edging)
- Install drainage pipes with sufficient capacity to manage severe stormwater
- Regularly clear site drains and street drains *(refer to Adopt-a-Drain Program, sidebar at right, and Plumbing, page R7.6)*

ADOPT-A-DRAIN

The City's Adopt-a-Drain program allows local residents and organizations to "adopt" storm drains to help protect nearby drains from unwanted debris, pollutants, or blockages.

This program helps to ensure neighborhood drainage systems work as efficiently as possible by keeping the surface drains clear of debris blockages, and simultaneously protects water quality.

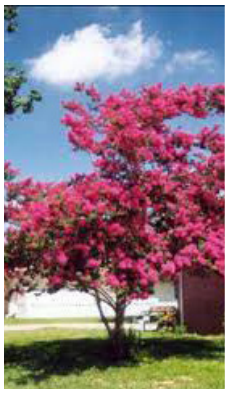
Participation in the program:

- Helps reduce or prevent flooding
- Helps protect waterways from pollution
- Helps keep a neighborhood clean and free of litter

(www.charleston-sc.gov/1984/Adopt-A-Drain)

PROTECTING STORM DRAINS

Per Section 27-40 through 27-43 of the City's Code of Ordinances, ***it is illegal to dump anything into any stream channel, pond, basin, or other part of the City's stormwater drainage system.*** Dumping of materials into Charleston's waters or drains pollutes the water, clogs storm drains, and leads to flooding. To report illegal dumping and illicit discharges, please contact the Citizen Services Desk at (843) 724-7311.


Crape Myrtle


Eastern Redbud


Eastern Red Cedar


East Palatka Holly


Magnolia (Little Gem)


Fringetree

There are several small-to-medium native trees that are recommended for Charleston's environmental conditions. When selecting a location and tree, consider the shape, height, and growth rate to determine potential conflicts with adjacent buildings, utility lines, existing trees, and paved areas. (South Carolina Master Gardener - Clemson Extension Program)


The Carolina Palmetto is the state tree.

DID YOU KNOW?

- Trees are more than 50% water
- A mature oak tree can absorb 40,000 gallons of water each year
- A standard deciduous tree can intercept 500-760 gallons each year
- A standard evergreen tree can intercept 4,000 gallons each year

(Penn State Extension)

TREES

Trees can have a significantly positive environmental impact. Tree leaves and branches can slow down rainwater, while roots can reduce erosion and absorb and store a massive amount of rainwater. Shade trees can reduce the temperature in their surrounding area; and, if shading a building, they reduce the impact of the sun's rays, lowering interior temperatures.

In addition to shade, trees cool temperatures by transpiration. ***Transpiration is a process in which trees and vegetation absorb water through their roots and cool surroundings by releasing water vapor into the air through their leaves. Trees and vegetation also provide cooling through evaporation of rainfall collecting on leaves and soil.*** (U.S. EPA)

KEY TIPS:

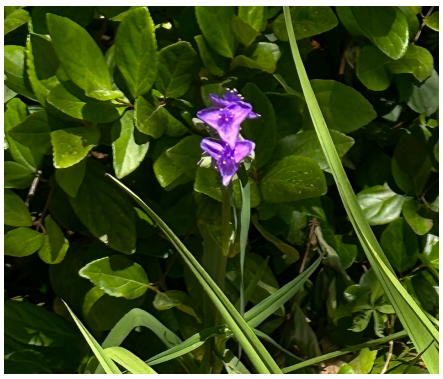
- Maintain existing trees by regularly observing their health and removing decaying limbs that may damage buildings or power lines during high winds
- Consider tree maintenance requirements such as pruning and raking
- Consider the wind resistance of trunks and branches
- Follow a professional's advice for selecting, siting, and planting a tree
- Select trees that are suited for Charleston's Zone 9A climate conditions
- Consider the shape, height, and growth rate to determine potential conflicts with adjacent buildings, utility lines, trees, and paved areas
- Allow for the roots to spread at least 2- to 3-times the mature width to promote a strong root system that can withstand strong winds
- To enhance shade, choose high, wide-crowned trees with deciduous leaves
- Provide 2-4 inches of mulch at the base of the tree to the extent of the dripline, leaving an inch clear around the trunk, to maintain soil moisture
- Wind resistant trees include hollies, crape myrtles, magnolias, bald cypress, Florida and Japanese maples, bottlebrushes, river birches, redbuds, fringe trees, and palms

GROUND COVERS AND NATIVE PLANTINGS

Native plantings are adapted to survive and evolve in place, making them suitable to existing soil, water, and sunlight conditions. Often, native plantings don't require additional irrigation, fertilizer, or pesticides to keep them alive because they are hardy where they naturally grow. *(Refer to Composting and Natural Fertilizers, page R2.11.)* In addition, native plants attract more wildlife, promoting a healthier biodiversity.

The Carolina Yards Plant Database can help you identify appropriate plants for different conditions (i.e., salt-tolerant species, low water requirement, etc.). Other resources include many of Charleston's public parks, such as Colonial Lake that has a native garden with labeled plants. ***Home gardeners can support wildlife and contribute to the restoration and support of local ecosystems by planting more native species, reducing chemicals used to treat garden problems, and implementing environmentally-friendly practices like leaving the leaves.*** *(Clemson Cooperative Extension, Home and Garden Information Center, Native Plants for Wildlife: Resources for Home Gardeners.)*

Charleston's parks can provide great inspirations for plant materials. Native plants provide soil stabilization, better storage for water, and stormwater infiltration. In contrast, conventional turf grass acts as an impervious surface since the grass's short roots are compacted over time.



Spiderwort adapts to many environments but performs well in sunny and moist gardens.

KEY TIPS:

- Replace portions of grass lawns with native ground covers to reduce mowing, fertilizing, and watering needs
- Understand the soil and conditions before purchasing new plants *(refer to Soil Observation and Testing, sidebar page R2.3)*
- Plant shade-tolerant ground covers near tree trunk bases to avoid root damage from mowing
- Selectively weed lawns to avoid pulling native plants like spiderwort, a type of native iris
- Reference Carolina Native Plant Society for information on native plant sales and other resources for native plants
- Avoid introducing invasive species and remove those that are present over time

INVASIVE SPECIES TO AVOID

Invasive plants can harm the environment and human health. (SC Forestry Commission)

- Bradford pear tree
- Kudzu
- Chinese tallow
- Japanese honeysuckle
- Chinaberry
- Golden bamboo
- Mimosa tree
- Chinese, European, and Japanese privets

RECOMMENDED GROUND COVERS AND NATIVE PLANTS

The Clemson Home and Garden Center recommends the ground covers appropriate for Charleston's environment. Consult their website for information regarding plant size and preferred sun and soil conditions. *(hgic.clemson.edu)* (N - native, ST - salt tolerant. *While plants may indicate salt tolerance, regular inundation or extended inundation with salt water may damage some plants. Consult with a professional to determine the right balance for the property's characteristics.*)

- Beach Wormwood (ST)
- Willowleaf Cotoneaster
- Carolina Jessamine (N, ST)
- Confederate Jasmine (ST)
- Carpet Bugle, Ajuga
- Plumbago (ST)
- Cheddar Pink (ST)
- Juniper (some N ST)
- Phlox (some N)
- Barrenwort
- Green and Gold (N)
- Fern (some N)
- Lamb's Ears
- Lantana (ST)
- Lily-of-the-Valley (ST)
- Creeping Rosemary (ST)
- Mondo Grass
- Lavender Cotton (ST)
- Sweet Box
- Purple Heart (ST)
- St. John's-Wort (N)
- Inland Sea Oats (N, ST)
- Sweetgrass (ST)
- Pachysandra

TEMPORARY FLOOD BARRIERS

Temporary barrier systems include sand bags, water-filled rubber tubes, or structural wall systems installed immediately before a flood event. Empty rubber tubes are laid on the ground and filled with water, providing up to two feet of protection depending on the contour of the land and whether joints between sections are properly sealed. Temporary structural wall systems typically require installation into pre-mounted ground anchors and can provide protection to higher elevations. ***Both of these options rely on available, trained personnel to establish a continuous perimeter barrier and do not necessarily include a secondary drainage system to evacuate water seepage and rainwater collected within the barrier.*** The National Flood Barrier Testing and Certification Program tests and certifies flood barrier products used for floodproofing. *(www.floodsciencecenter.org.)* These options are labor intensive efforts and are not a long-term solution to all types of flooding, since increasing water tables can keep pushing water from the ground to the surface.

Temporary barriers can reduce flood risk for a short duration if installed prior to an event. (Courtesy of Glenn Keyes)

Low retaining walls can be used to manage a change in slope, control water flow, and collect stormwater to allow it to percolate.

WALLS AND FENCES

Another way to control or impede water flow across a property is a landscape wall or a fence. Retaining walls can be used to stabilize inclines, enclose a water retention basin, or reinforce a landscape berm. In some cases, wood or metal fences can accumulate soil and debris, which can create unintended trenches or berms. To prevent future problems, regular observation and maintenance of these features is important for a property-wide stormwater and resilience plan.

KEY TIPS:

- Check for deterioration; repair, and/or replace components as needed
- Remove rust from metal fences and prime and repaint every 5-8 years
- Anticipate repainting or staining wood fences every 5-8 years
- Secure all vertical, horizontal, and gate connections to prevent fence elements from becoming airborne or waterborne projectiles

COMPOSTING AND NATURAL FERTILIZERS

Compost collection allows organic materials to decompose, creating an excellent natural fertilizer that can improve soil nutrients and stormwater capacity. The compost materials can be cultivated and used on site, or households can participate in Charleston's residential composting program, which has multiple free drop-off locations.

KEY TIPS:

- Fertilize only as needed to maintain the health of lawns and landscape plants, using fertilizers that have a minimum of 50% slow-release nitrogen
- Establish a 10- to 30-foot "no fertilizer, no pesticide" zone along the shoreline
- Compost in a bin or level spot in a yard, about three- to five-feet square, and collect yard trimmings, fruit and vegetable scraps, crushed eggshells, coffee grounds and filters, and tea bags (staples removed)
- Stir compost with a pitchfork or stick every few weeks to circulate air, speed up the "cooking" process, and distribute moisture evenly

DID YOU KNOW?

- Approximately one quarter of all collected garbage in the Charleston region are food scraps
- Composting reduces garbage truck trips and landfill space
- Compost reduces the need for chemical fertilizer and is healthier for plants and wildlife

(City of Charleston, Charleston Composts Program)

SHORELINE PERMITTING

Activities that disturb beachfront and wetlands should not be undertaken without first obtaining permits from the South Carolina Department of Health and Environmental Control (SCDHEC) Office of Ocean and Coastal Resource Management. Any disturbance of freshwater wetlands requires a permit from the U.S. Army Corps of Engineers and certification from SCDHEC's Office of Ocean and Coastal Resource Management.

Seawalls require many levels of environmental and social consideration.

Stone and rock rip-rap can help stabilize the shoreline.

Cordgrasses help stabilize shorelines and reduce wave erosion further inland.

SHORELINE PROTECTION

Most of Charleston's shorelines are publicly owned, but some private properties abut marshy shorelines that ebb and flow with the tide. During flood events, water levels will typically rise and are sometimes compounded by wave action, storm surge, or high-velocity water flow threatening adjacent properties. A range of shoreline protection measures can provide protection for individual properties. A combination of techniques may be used, generally falling into two categories based on their construction method: either "hard," or "armored" adaptations; and/or whether they are "soft," "natural," or "landscape" adaptations that emulate natural processes.

STRUCTURAL SHORELINES

Structural protective measures can be constructed parallel to a shoreline or property line to fortify it against potential flood-related damage. However, their ability to halt all types of shoreline erosion is not guaranteed and their construction could create erosion issues in adjacent unprotected areas.

- **Seawalls** are vertical walls constructed along a shoreline to provide protection from waves on one side and retain earth on the other, possibly extending above existing grade. They are constructed to reflect incoming wave energy back out towards the water.
- **Bulkheads**, like seawalls, are vertical walls that extend along a shoreline. However, their primary function is to retain soil, not to withstand forceful wave action.
- **Revetments and rip-rap** are fortified slopes or banks constructed of boulders or chunks of concrete that disperse wave energy from currents or light waves. They can prevent erosion and improve the structural stability of soil slopes.

NATURAL SHORELINE PROTECTION

Natural shoreline protection methods are also known as non-structural or "soft" measures, and are based on emulating the natural ecosystem of an area for a flood-resilient design. For helpful resources, contact the South Carolina Department of Natural Resources (SCDNR) or local natural estuarine resource staff, university partners, or water conservation district staff.

- **Wetland restoration** reestablishes wetlands that have been removed or reduced over time with vegetation that has the ability to filter and store water, and promote ground absorption.
- **Living shoreline** efforts include creating oyster reefs and sustaining cordgrass plantings to reduce wave action and filter pollutants.
- **Floodplain restoration** involves increasing surface areas to distribute water and to increase storage adjacent to a water body or channel that is subject to flooding during a heavy rain or flood event.

Most projects are undertaken by a government entity and implemented at a community scale. However, projects on individual properties can supplement these efforts. To be eligible for a living shoreline, a parcel or lot must be defined as waterfront property in SC Code of Regulations 30-1.D(54) and will require an individual critical area permit from SCDNR.

BAR

Refer to the BAR Jurisdiction Chart and Map or speak with City staff to determine if a property has additional permit or review requirements.

BAR Policy Statements:

- *Hardscaping*
- *Elevation Design Guidelines*

HISTORIC PRESERVATION CONSIDERATIONS

Properties located in a historic district or design review district may require additional City review whether a permit is required or not. This may include hardscaping, cisterns, walls, fences, or other built/permanent type features. Contact the Permit Center, or the BAR or DRB staff, to speak with someone directly. Information is provided below for best practices toward maintaining the historic character of a property when changes are made to outdoor spaces and landscapes.

IMPERVIOUS SURFACES

- Minimize impervious surfaces in prominently visible areas
- Consider use of historically appropriate paving options that allow stormwater filtration such brick pavers, structured landscape parking pavers, and crushed shells or stones

LANDSCAPE OPTIONS

- Utilize landscape elements such as swales and berms in a natural slope and incorporate native and salt resistant plantings
- If retaining walls are necessary, use concrete blocks finished with paint or stucco or traditional bricks that are fitting within the historic character
- Plant shade trees in areas that do not compromise historic features
- Install rain barrels in an inconspicuous manner at the base of downspouts, and screen with shrubs or fencing to minimize visibility
- Construct and maintain fences with traditional designs and materials
- Remove plant and algae growth from historic materials

SHORELINE PROTECTION

- Consider the potential visual impact of bulkheads and the property's relationship with the water when selecting materials

LANDSCAPE IMPROVEMENT CHECKLIST

The Landscape Improvement Checklist on the following pages identifies maintenance tips, plant and paving material recommendations, and related potential resilience improvements. Information on the relative costs, expertise, and vulnerabilities addressed are keyed with icons described at right.

Level of Risk and Professional Help: The Checklist identifies work that can be completed by property owners or tenants who are able to safely and comfortably use hand tools or power equipment, as needed. Any lifting, bending, or exertion beyond a person's abilities should be undertaken by professionals.

Vulnerabilities: The icons below are used throughout this guide. Completion of the proposed improvements can increase a building's resilience from the following vulnerabilities:

- Flood
- Wind
- Earthquake
- Heat
- Good maintenance

Cost: The relative cost of the proposed improvement is denoted by symbols below. The cost will vary based on the conditions and extent of the impacted area.

- ¢ Minimal supplies under $100
- $ $100-$1,000
- $$ $1,000-$5,000
- $$$ $5,000 and above

"Off-the-Shelf" Solution Available: An item that is relatively available for purchase and easy to install by a property owner or contractor.

LANDSCAPE IMPROVEMENT CHECKLIST

ACTION / PROJECT ***PERMITS:*** *A building permit may be required for any of these suggested work items. Additionally, if the property is subject to review by the Board of Architectural Review or Design Review Board, additional reviews may be required. For any questions or concerns, contact the Permit Center.*	RESILIENCE BENEFIT	COST	DO-IT-YOURSELF	CONTRACTOR MAY BE REQUIRED	ARCHITECT OR ENGINEER MAY BE REQUIRED	"OFF-THE SHELF" SOLUTION AVAILABLE
UNDERSTANDING PROPERTY DYNAMICS						*Page R2.2*
❑ Perform soil observations and tests		¢	●	●		●
HARDSCAPES AND IMPERVIOUS SURFACES						*Page R2.4*
❑ Reduce or replace solid paved surfaces with pavers or loose material to allow drainage		$$-$$$	●	●		
❑ Replace solid pavers with permeable pavers or re-install pavers in a spaced pattern allowing for drainage and/or groundcover		¢-$$$	●	●		
❑ Use an aerator to loosen compacted soils, till severely compacted soil and add compost or organic material like peat moss or vermiculite		¢-$	●	●		
SITE GRADING						*Page R2.5*
❑ Fill in small depressions in yard		¢	●			●
❑ Build a berm and/or a swale		¢-$$	●	●	●	
RAIN GARDENS						*Page R2.6*
❑ Direct stormwater to a rain garden from downspouts, rain barrels, and cistern overflows		¢	●			●
❑ Add native plants best-suited to the unique conditions of the rain garden or swale		¢-$	●			
❑ Limit use of fertilizers and herbicides		¢	●			●
RAIN BARRELS AND CISTERNS						*Page R2.7*
❑ Install rain barrels or cisterns to maximum benefit		¢-$	●			●
❑ Use fencing or plant screening to conceal visible barrels or cisterns		¢-$	●			●
❑ Periodically test water for watering plants, filling fountains and ponds, rinsing outdoor tools, keeping compost moist, and pet washing		¢	●			
DRAINS						*Page R2.8*
❑ Install drain(s) directed toward an on-site absorption area		¢-$$	●	●		●
❑ Add valves to manage the direction of water flow in flood-prone areas		¢-$	●	●		
❑ Clean drains regularly, especially before a storm, and participate in the Adopt-a-Drain program		¢	●			

ACTION / PROJECT ***PERMITS:*** *A building permit may be required for any of these suggested work items. Additionally, if the property is subject to review by the Board of Architectural Review or Design Review Board, additional reviews may be required. For any questions or concerns, contact the Permit Center.*	RESILIENCE BENEFIT	COST	DO-IT-YOURSELF	CONTRACTOR MAY BE REQUIRED	ARCHITECT OR ENGINEER MAY BE REQUIRED	"OFF-THE SHELF" SOLUTION AVAILABLE
TREES						*Page R2.9*
❑ Remove decaying tree limbs		¢-$	●	●		
❑ Plant wind-resistant, wide-crowned trees with deciduous leaves to maximize shade, allowing wide root system spread		$	●	●		
❑ Maintain 2-4 inches of mulch at the base of the tree to the extent of the dripline		¢-$	●			
GROUND COVERS AND NATIVE PLANTINGS						*Page R2.10*
❑ Replace portions of grass lawn areas with native ground covers		$-$$	●			
❑ Plant shade-tolerant ground cover around tree bases		¢-$	●			
❑ Maintain and plant native garden species		¢	●			
WALLS AND FENCES						*Page R2.11*
❑ Remove accumulated debris or soil that interrupts stormwater flow		¢	●			
❑ Maintain routine re-coatings on wood and metal finishes		¢-$	●	●		
❑ Secure all fence connections to prevent elements from becoming airborne/waterborne projectiles		¢-$	●	●		
❑ Purchase or prepare temporary stormwater barriers		$-$$	●			●
COMPOSTING AND NATURAL FERTILIZERS						*Page R2.11*
❑ Fertilize only as needed using a minimum of 50% slow-release nitrogen fertilizers		¢-$	●			●
❑ Establish a 10- to 30-foot "no fertilizer, no pesticide" zone along the shoreline		¢-$	●			
❑ Collect yard trimmings and food scraps for composting		¢	●			●
❑ Participate in Charleston's compost drop-off or compost in a bin or on a level spot in the yard		¢-$	●			
SHORELINE PROTECTION						*Page R2.12*
❑ Plan and design hard armoring projects that do not negatively harm other properties		$-$$$		●	●	
❑ Maintain natural grasses and encourage living shoreline growth		$-$$	●	●	●	

LANDSCAPE RESOURCES

American Society of Landscape Architecture
Resilience Beyond Rhetoric in Urban Landscape Planning and Design, Nina-Marie Lister, Hon. ASLA, in Nature and Cities, Lincoln Institute of Land Policy, 2016
Sustainable Residential Design: Improving Water Management and Applying Ecological Design
asla.org/flooding

Charleston Soil and Water Conservation District
www.charlestonsoilwaterconservationdistrict.com

City of Charleston
Adopt-a-Drain, Charleston Rainproof, *www.charleston-sc.gov*

Clemson Home and Garden Information Center (HGIC)
A Guide to Rain Gardens
Creating an Environmentally Friendly Landscape
Carolina Yards: Plant Database
Native Plants for Wildlife: Resources for Home Gardeners
hgic.clemson.edu

Louisiana State University Agricultural Center
Installing and Maintaining a French Drain, *lsuagcenter.com*

Lowcountry Master Gardener Association
Preferred Trees for the Low Country, *lowcountrymga.org*

National Flood Barrier Testing and Certification Program
www.floodsciencecenter.org

North Carolina Cooperative Extension
Rain Barrels, *ces.ncu.edu*

South Carolina Department of Health and Environmental Control (SCDHEC)
Runoff Diversion Measures, *scdhec.gov*

South Carolina Department of Natural Resources (SCDNR)
Summary of Living Shoreline Research and ACE Basin National Estuarine Research Reserve, *dnr.scgov*

South Carolina Forestry Commission
Urban Tree Species Guide for South Carolina and Invasive Species, *scfc.gov*

The Nature Conservancy
Building Coastal Resilience, *nature.org*

University of Florida Food and Agricultural Science
Rainwater Collection Systems, *sfyl.ifas.ufl.edu*

U.S. Environmental Protection Agency
Coastal Adaptation Toolkit and EPA Green Streets Design Manual
Composting at Home
Using Trees and Vegetation to Reduce Heat Islands
epa.gov

REGULATIONS TO REVIEW

- City of Charleston Buffer Ordinance
- City of Charleston BAR policies as applicable
- City of Charleston Tree Protection Ordinance
- City of Charleston Stormwater Management Utility and Land Use ordinances
- City of Charleston Flood Hazard Prevention and Control Ordinance
- SC Department of Natural Resources and Department of Health and Environmental Control

This is not a comprehensive list and is intended only to provide additional resources to consider when planning a project. Contact the Permit Center for detailed information.

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PRESERVATION SOCIETY ESTD 1920 of CHARLESTON

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