

Green Infrastructure Elements



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① Rain Gardens

A rain garden is a planted, indented landscape feature to temporarily store stormwater and reduce runoff rates and pollutant loads by infiltrating, evaporating and transpiring runoff from impervious areas such as parking lots, roofs, driveways, and walkways. The filtered runoff can be collected in a perforated underdrain and returned to the storm drain system. Rain gardens can be located anywhere, from parking lots to small pockets of residential and nonresidential land. The location, size and depth of the rain garden must all be considered to maximize their ecosystem services. To ease the burden of maintenance while making use of the multiple functions of this landscape feature, native plants should be used.



② Native Vegetation for Landscaping

The use of native vegetation, plants that are indigenous to an area, is recommended for a site that is being developed or redeveloped to preserve or restore natural resources and habitat, prevent flooding and erosion, and enhance the quality and quantity of water resources. Native vegetation can be used when installing roof or rain gardens, as well. Native vegetation is well suited for its environment and typically requires less maintenance than conventional landscaping.



③ Green Roofs

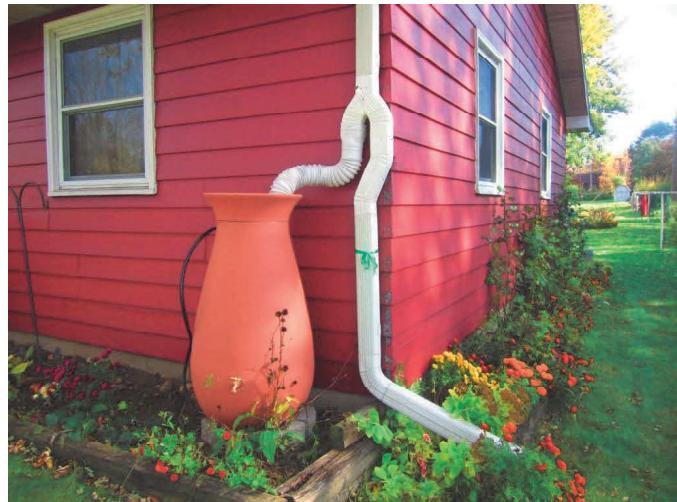
A great tool to spruce up any building. In addition to providing aesthetic improvement, roof gardens help with handling rainwater quantity and quality, and increasing the building's energy efficiency. Roof gardens are an especially beneficial and cost effective way to address impervious surface stormwater runoff and reducing heat island effects in dense urban environments. Roof gardens can be installed during initial construction and as a retrofit for industrial, commercial and residential buildings.

Not all structures are suitable for green roofs and more studies are needed to measure impact of hurricane force winds on green roofs. Green roofs can contribute to both energy efficiency of the structure, and managing stormwater on site. Depending on the location of the structure, the green roof design must consider local wind loads.



④ Debris –Free Streets

Leaves, yard clippings, and other debris items can contribute to street flooding by blocking and clogging culverts and drains. To avoid this source of flooding, property owners should clear the street of leaves prior to rain and generally not dispose of yard waste into the drains, gutters, and culverts. Those neighborhoods near canals or open drainage ditches should also monitor debris accumulation and report to local public works department when clearing is necessary.



⑤ Rainwater Harvesting System

Installing a rainwater harvesting system will keep initial stormwater out of the drainage system. The harvesting system should be designed to meet local standards for capacity where applicable. The water collected can be used for irrigation or other non-potable use on site. Rainwater harvesting systems are also beneficial in areas where drought is a hazard. The rainwater harvesting system channels water into a container to store stormwater. Its components can consist of gutters and downspouts, rain barrels, cisterns or any other type of water conveyance and storage. The water can be used for lawns during dry periods, as a source of "grey" water for flushing toilets and washing cars, pressure washing and other activities for which non-potable water can be used.

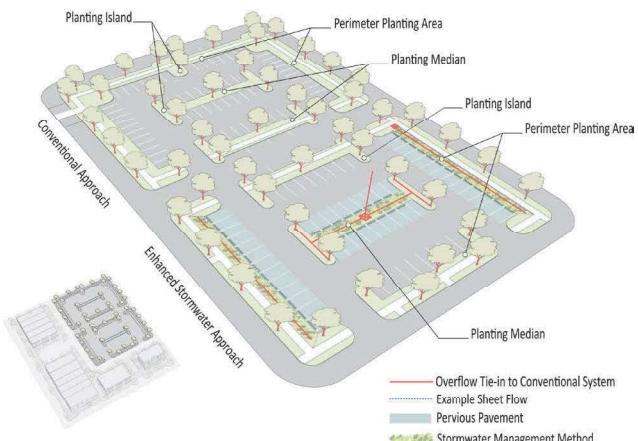
A rainwater harvesting system consists of a combination of the following:

Gutters - to channel runoff from the roof of buildings.

Disconnected downspout- to redirect rainwater from sewer connection to pervious areas for infiltration or water storage containers (barrels, cisterns).

Rain Barrels- can hold up to 50 gallons and are ideal for residential stormwater management. The captured water can be easily used to irrigate residential landscaping.

Cistern - hold typically between 300-1000 gallons and are most often used with larger buildings designed for commercial and industrial use.



parking lot example from Coastal Toolkit

⑥ Green Parking

Green parking refers to the use of permeable surfaces and stormwater capturing features such as rain gardens and permeable pavers during parking lot development. Green parking can reduce manage stormwater runoff on site and reduce urban heat island effect. This tool is applicable to any sites and is especially suitable for large parking lot areas.

Urban heat island: Increased urban temperature compared to rural surrounding caused by decrease in vegetation and thus evapotranspiration rates, and increase in surfaces that absorb more solar radiation, such as asphalt and concrete.

⑦ Permeable Pavements

Applicable to industrial, commercial and residential sites, permeable or pervious pavement enables stormwater to infiltrate, be treated and stored where it falls. Permeable pavement also reduces runoff, effectively traps suspended solids and filters pollutants from water on site. For most residential areas, the material can be permeable interlocking pavers, crushed stone, gravel or shell, or wood planks.

⑧ Stormwater Curb Extensions

Stormwater curb extensions are vegetated treatment area incorporated into road, street, or walkway designs. They are frequently used as a retrofit option to manage stormwater and runoff prior to entering the drainage system. Planting can be diverse, but should consider maintenance, climate, seasons, and appeal.

⑨ Infiltration Trenches

An infiltration trench (also called infiltration gallery) is a rock-filled trench with no outlet that receives stormwater runoff. Stormwater runoff passes through some combination of pretreatment measures, such as a swale and detention basin, and into the trench. Runoff is stored in the void space between the stones and infiltrates through the bottom and into the soil matrix. The soil matrix filters the runoff and removes pollutants from the runoff.





⑩ Infiltration Planters

These structures or containers have open bottoms containing a layer of gravel, soil, and vegetation. They come in many sizes and shapes and are made of stone, concrete, brick, plastic, lumber, or wood. They allow stormwater to temporarily pool on top of the soil then slowly infiltrate through the planter into the ground.



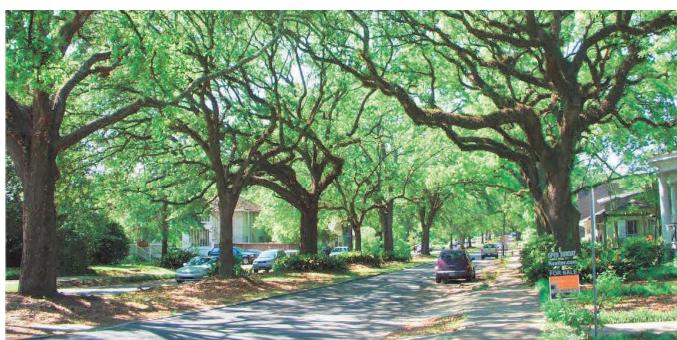
⑪ Bioswales

Swales can be grassed channels, dry swales, wet swales, biofilters, or bioswales and are generally vegetated, open-channels designed to treat stormwater runoff for a specified water quality and volume. As stormwater runoff flows along these channels, vegetation slows the water to allow sedimentation and removal of silt and pollutants from surface runoff water. Grassed Swales filter stormwater runoff through the soil and infiltrate water into the underlying soils.



⑫ Filter Strips

Vegetated filter strips (also called grassed filter strips, filter strips, and grassed filters) are vegetated surfaces that are designed to treat runoff from adjacent surfaces. Filter strips function by slowing runoff velocities and filtering out sediment and other pollutants, and by providing some infiltration into underlying soils. Using native vegetation will reduce maintenance of the filter strip.



⑬ Urban Forestry

Urban forestry is the presence of trees and forests located in and around neighborhoods. Since trees absorb water, patches of forest and the trees that line streets can help provide some of the stormwater management required in an urban setting. Urban forests help break up a landscape of impervious cover, provide small but essential green spaces to reduce the heat island effect, and pull pollutants from the air.



14 Common Open Space

Common Open Space is space is undeveloped land and available for the public's enjoyment. It can have a variety of functions, such as providing a recreational area. Common open space is usually permeable and vegetated and thus can manage stormwater and runoff in the same way as filter strips. If this feature is located along streets, it can also provide a natural buffer between vehicular and non-motorized traffic



15 Multi-functional Spaces

In many areas nationwide, playgrounds, baseball fields, soccer fields and other types of recreational spaces are intentionally created as multi-functional spaces to retain water during rain events. Retaining water on site provides many ecosystem services, including infiltration, pollutant and silt removal, and slowing runoff velocity which reduces soil erosion.

Intelligent Transportation Systems (ITS)

ITS is an operational systems in which information and technology is applied to transportation and mobility management. It aims to improve how various users make "smarter" use of transport networks by providing innovative services related to different modes of transportation.