Rutgers Cooperative Extension

Rutgers Cooperative Extension (RCE) helps the diverse population of New Jersey adapt to a rapidly changing society and improves their lives through an educational process that uses science-based knowledge.
Water Resources Program

Our mission is to identify and address community water resources issues using sustainable and practical science-based solutions.
The Natural Hydrologic Cycle
The Impact of Development on Stormwater Runoff

More development $\rightarrow$ More impervious surfaces $\rightarrow$ More stormwater runoff

10% 20% 30% 55%
The Urban Hydrologic Cycle
Original ICM developed based on 200+ reports and papers

Impervious Cover Model

Stream Quality
- Good
- Fair
- Poor

Watershed Impervious Cover
- 10%
- 25%
- 40%
- 60%
- 100%

- Urban Drainage
- Non-Supporting
- Impacted
- Sensitive

How are we dealing with these issues?

• Municipal Separate Storm Sewer System (MS4) Permit

• New Jersey Stormwater Management Regulations (N.J.A.C. 7:8)
  – Municipal Stormwater Management Plan
  – Municipal Stormwater Control Ordinance
  – Stormwater Mitigation Plan

• Clean Stormwater and Flood Reduction Act (Stormwater Utility Act)
MS4 Permit

- Municipal Separate Storm Sewer System (MS4)
- All NJ municipalities have MS4 permits
- General Permit for Tier A, Tier B, Public Complexes, and Highway Agencies
- EPA Requirement
MS4 Permit ...

requires municipalities to develop and implement a program to reduce discharges of pollutants entering our waters from stormwater systems to the maximum extent practical.
Stormwater Management Regulations N.J.A.C. 7:8

• Sets forth stormwater management goals for new development:
  • Reduce flood damage
  • Reduce soil erosion
  • Protect public safety through proper design and operation of stormwater management basins
  • Minimize increases in peak runoff
  • Maintain groundwater recharge
  • Protect water quality

• Sets forth the required components of regional and municipal stormwater management plans
Stormwater Management
Key Objectives

• Use nonstructural management strategies
• Protect communities from increases in stormwater volume and peak flows as a result of new development
• Maintain groundwater recharge
• Protect waterways from pollution carried in stormwater runoff

NJ.com, August 28, 2011
The approval of a developer’s stormwater management plans lies solely with the municipality.
What happens to the rain in our watersheds?

It runs off of rooftops and pavement...
What is stormwater?

Stormwater is the water from rain or melting snows that can become “runoff,” flowing over the ground surface and returning to lakes and streams.
Pollutants Found in Runoff

**Sediment**
- Soil particles transported from their source

**Toxics**
- Pesticides
  - Herbicides
  - Fungicides
  - Insecticides
- Metals (naturally occurring in soil, automotive emissions/tires)
  - Lead
  - Zinc
  - Mercury
- Petroleum Hydrocarbons (automotive exhaust and fuel/oil)

**Biochemical Oxygen Demand (BOD)**
- Oxygen depleting material
  - Leaves
  - Organic material

**Nutrients**
- Various types of materials that become dissolved and suspended in water (commonly found in fertilizer and plant material):
  - Nitrogen (N)
  - Phosphorus (P)

**Debris**
- Litter and illegal dumping

**Bacteria/ Pathogens**
- Originating from:
  - Pets
  - Waterfowl
  - Failing septic systems

**Thermal Stress**
- Heated runoff, removal of streamside vegetation
It is all about controlling runoff from impervious surfaces.
Impervious surfaces
Connected or Disconnected?
Example of Simple Disconnection

For 1.25 inch storm, 3,811 cubic feet of runoff = **28,500 gallons**

Total drainage area = 3 acres

1 acre directly connected impervious cover

2 acres pervious cover

Runoff Direction

Stormwater Inlet
For 1.25 inch storm, 581 cubic feet of runoff = 4,360 gallons

Total drainage area = 3 acres

1 acre directly connected impervious cover

2 acres pervious cover

Runoff Direction

Stormwater Inlet
<table>
<thead>
<tr>
<th>Design Storm</th>
<th>Connected (gallons)</th>
<th>Disconnected (gallons)</th>
<th>Percent Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25 inches (water quality storm)</td>
<td>28,500</td>
<td>4,360</td>
<td>85%</td>
</tr>
</tbody>
</table>
The Solution...

PLACE A RAIN GARDEN BETWEEN TWO IMPERVIOUS SURFACES

REDUCE THE AMOUNT OF RUNOFF ENTERING STORM SEWERS
Rain Gardens

A rain garden is a landscaped, shallow depression that is designed to intercept, treat, and infiltrate stormwater at the source before it becomes runoff. The plants used in the rain garden are native to the region and help retain pollutants that could otherwise harm nearby waterways.
Rain Gardens

Capture: A rain garden catches runoff and holds standing water for no more than 24 to 48 hours.

Soak: Deep-rooted plants loosen the soil, creating a sponge zone. Water soaks in and groundwater aquifers are recharged.

LESS water down the storm sewer! Cleaner lakes & streams!

Filter: In the soil, microbes break down pollutants and nutrients washed in by the rain.

Courtesy of City of Maplewood, MN
PARTS OF A RAIN GARDEN

**BUFFER**
The buffer, or outer edge, of the rain garden slows down the flow of water, filters out sediment, and provides absorption of the pollutants in stormwater runoff. Plants located in this area of the rain garden tolerate and thrive in dry soil.

**SLOPE**
The slope of the rain garden pitches downward and connects the buffer of the rain garden to the base. It creates a holding area to store runoff awaiting treatment and infiltration. Plants situated in this area should tolerate both wet and dry soils equally.

**BASE**
The bottom area is the flat, deepest visible area of the rain garden and is planted with plant species that prefer wet soil. The base should be level so that the maximum amount of water can be filtered and infiltrated. It is very important that this area drains within 24 hours to avoid problems with stagnant water that can become a mosquito breeding habitat.

**PLANTING SOIL-LAYER**
This layer is usually native soil. It is best to conduct a soil test of the area checking the nutrient levels and pH to ensure adequate plant growth.

**INLET**
The inlet is the location where stormwater enters the rain garden. Stones are often used to slow down the water flow and prevent erosion.

**ORGANIC MATTER**
Below the base is the organic matter, such as compost and a 3-5 layer of triple shredded hardwood mulch. The mulch acts as a filter and provides a home to microorganisms that break down pollutants.

**BERM**
The berm is a constructed mound, or bank of earth, that acts as a barrier to control, slow down, and contain the stormwater in the rain garden. The berm can be vegetated and/or mulched.

**OVERFLOW**
The overflow (outlet) area serves as a way for stormwater to exit the rain garden during larger rain events. An overflow notch can be used as a way to direct the stormwater exiting the rain garden to a particular area surrounding the rain garden.
SITE SELECTION & DESIGN

PLANNING YOUR RAIN GARDEN
1. Next to a building with a basement, rain garden should be located min. 10’ from building; no basement: 2’ from building
2. Do not place rain garden within 25’ of a septic system
3. Do not situate rain garden in soggy places where water already ponds
4. Avoid seasonably-high water tables within 2’ of rain garden depth
5. Consider flat areas first – easier digging
6. Avoid placing rain garden within dripline of trees
7. Provide adequate space for rain garden
Rain Garden
Water Quality and Habitat Enhancement Project

This garden is designed to intercept, treat, and infiltrate stormwater at the source, before it becomes runoff. The plants are native to the region and help retain pollutants that could otherwise harm nearby waterways.

Rain gardens are beautiful, low-maintenance, and inexpensive gardens that you can install at home.

www.water.rutgers.edu
CALL BEFORE YOU DIG

- **NJ One Call: 1-800-272-1000**
- Free markout of underground gas, water, sewer, cable, telephone, and electric utility lines
- Call at least 3 full working days, but not more than 10 days, prior to planned installation date
- Do not place rain garden within 5’ horizontally and 1’ vertically from any utilities

**LOCATE YOUR UTILITY LINES!

Call BEFORE You Dig!

NJ One Call
1-800-272-1000

The different colors of the markout flags represent specific utilities.

- **RED** ELECTRIC
- **YELLOW** GAS, OIL, STEAM
- **ORANGE** COMMUNICATIONS, CATV
- **BLUE** WATER
- **GREEN** SEWER
DRAINAGE AREA CALCULATION

Surface Area

\[ \text{Surface Area} = (L_1 \times W) + (L_2 \times W) \]

\[ = (15' \times 20') + (10' \times 20') \]

\[ = (300') + (200') \]

\[ = 500 \text{ ft}^2 \]
DRAINAGE AREA:
THE ROOFTOP SCENARIO

DRAINAGE AREA

BEFORE

AFTER
CHECK YOUR SOIL

• Infiltration/Percolation Test

1. Dig a hole in the proposed rain garden site (12” deep, 4-6” wide)

2. Fill with water to saturate soil and then let stand until all the water has drained into the soil

3. Once water has drained, refill the empty hole again with water so that the water level is about 1” from the top of the hole

4. Check depth of water with a ruler every hour for at least 4 hours

5. Calculate how many inches of water drained per hour
DETERMINING THE DEPTH OF THE RAIN GARDEN

TYPICAL DEPTH 3-8"

MOISTURE LEVELS
- dry
- moderate
- wet
- moderate
- dry
DETERMINING THE DEPTH OF THE RAIN GARDEN

- Depth of rain garden is dependent upon the soil texture found at the site of the rain garden
- Depth is usually 3-8 inches
DETERMINING THE SIZE OF THE RAIN GARDEN

- The size of the rain garden is dependent upon the amount of runoff entering the rain garden

**Rain Garden Sizing Table**

Based on New Jersey’s Water Quality Design Storm (1.25” of rain over 2 hours)

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Size of 3” Deep Rain Garden CLAY SOIL*</th>
<th>Size of 6” Deep Rain Garden SILTY SOIL</th>
<th>Size of 8” Deep Rain Garden SANDY SOIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 ft²</td>
<td>200 ft²</td>
<td>100 ft²</td>
<td>75 ft²</td>
</tr>
<tr>
<td>750 ft²</td>
<td>350 ft²</td>
<td>150 ft²</td>
<td>112 ft²</td>
</tr>
<tr>
<td>1,000 ft²</td>
<td>400 ft²</td>
<td>200 ft²</td>
<td>149 ft²</td>
</tr>
<tr>
<td>1,500 ft²</td>
<td>600 ft²</td>
<td>300 ft²</td>
<td>224 ft²</td>
</tr>
<tr>
<td>2,000 ft²</td>
<td>800 ft²</td>
<td>400 ft²</td>
<td>299 ft²</td>
</tr>
</tbody>
</table>

*SOIL TEXTURE AMENDMENTS NEEDED
SOIL TEXTURE AMENDMENTS

- Soil texture amendments improve the rain garden’s infiltration rate.
SOIL QUALITY AMENDMENTS

- Soil quality amendments improve the rain garden’s growing conditions for plants
- Improve soil’s nutrient capacity

REMEMBER:
Your rain garden should NOT be permanently filled with water – it should drain within 24 hours.
DETERMINING THE INLET AND OVERFLOW

• Stormwater runoff enters the rain garden from an **inlet**

• Stormwater exits through the **overflow**
PREVENTING EROSION

• Slope no greater than 3:1
• Slow down velocity of water flowing through rain garden
  – Add rocks to inlet area
DETERMINING MULCH QUANTITY

- Allow for a 3” depth mulch (triple-shredded hardwood with no dye) to be spread throughout the entire rain garden
- Every 100 square feet of rain garden needs 1 cubic yards (3” depth)
SHAPING YOUR RAIN GARDEN

- Use a garden hose or rope to outline the desired shape of your rain garden on the ground.
- Many rain gardens are in the shape of a circle or kidney bean, but your rain garden can take on whatever shape you prefer.
SELECTING PLANTS FOR YOUR RAIN GARDEN

• The success of your rain garden depends on selecting the right plants for the right place
• Plant your rain garden with plants adapted for your specific site
• **Native plants** can thrive without a lot of care, extra water, fertilizer, or pesticides
• **Native plants** are tolerant to dry and wet conditions
Select species based upon the following qualities:

- Plant size
- Moisture tolerances
- Sun preferences
- Plant aggressiveness
- Salt tolerance
- Habitat creation
PLANTING DESIGN TIPS

- Plants that prefer wet conditions should be planted in the deepest part (the base) of the rain garden
- Create depth in the rain garden by placing large and tall plants in the back, smaller plants in the front
- Plant masses of the same species together in odd numbers
- Incorporate plants that have visual interest in the fall and winter
- Native plants provide habitat to animals and require less watering
QUESTIONS?
THE FUN PART!

INSTALLING YOUR RAIN GARDEN
STEP ONE

• Delineate rain garden area

• Remove existing grass with a shovel or machinery
STEP TWO

• Excavate to design depth based on necessary storage and soil amendment requirements
STEP THREE

• Add soil amendments, if necessary

• Combine amendments with existing soil using shovels or rototiller

• Loosen and prepare soil for grading and planting
STEP FOUR

- Prepare the berm, if necessary
STEP FIVE

• Prepare the overflow

- BUFFER
  The buffer, or outer edge, of the rain garden slows down the flow of water, filters out sediment, and provides absorption of the pollutants in stormwater runoff. Plants located in this area of the rain garden tolerate and thrive in dry soil.

- SLOPE
  The slope of the rain garden pitches downward and connects the buffer of the rain garden to the base. It creates a holding area to store runoff awaiting treatment and infiltration. Plants situated in this area should tolerate both wet and dry soils equally.

- BASE
  The bottom area is the flat, deepest visible area of the rain garden and is planted with plant species that prefer wet soil. The base should be level so that the maximum amount of water can be filtered and infiltrated. It is very important that this area drains within 24 hours to avoid problems with stagnant water that can become a mosquito breeding habitat.

- PLANTING SOIL LAYER
  This layer is usually native soil. It is best to conduct a soil test of the area checking the nutrient levels and pH to ensure adequate plant growth.

- INLET
  The inlet is the location where stormwater enters the rain garden. Stones are often used to slow down the water flow and prevent erosion.

- ORGANIC MATTER
  Below the base is the organic matter, such as compost and a 3D layer of triple-shredded hardwood mulch. The mulch acts as a filter and provides a home to microorganisms that break down pollutants.

- SAND BED
  If drainage is a problem, a sand bed may be necessary to improve drainage. Adding a layer of coarse sand (also known as bank run sand or concrete sand) will increase air space and promote infiltration. It is important that sand used in the rain garden is not play box sand or mason sand as these fine sands are not coarse enough to improve soil infiltration and may impede drainage.

- BERMA
  The berm is a constructed mound, or bank of earth, that acts as a barrier to control, slow down, and contain the stormwater in the rain garden. The berm can be vegetated and/or mulched.

- OVERFLOW
  The overflow (outlet) area serves as a way for stormwater to exit the rain garden during larger rain events. An overflow notch can be used as a way to direct the stormwater exiting the rain garden to a particular area surrounding the rain garden.
STEP SIX

• Level the rain garden base
STEP SEVEN

• Plant native species
STEP EIGHT

• Apply mulch

• Allow for a 3” depth mulch (triple-shredded hardwood with no dye) to be spread throughout the entire rain garden

• For every 100 square feet of rain garden, you will need about 1 cubic yard of mulch (3” depth)
STEP NINE

• Water Plants
STEP TEN

- Appreciate a job well done
MAINTAINING YOUR RAIN GARDEN

INSPECTION AND MAINTENANCE
MAINTENANCE MEASURES

**WEEKLY TASKS:**

1. Watering
2. Weeding
3. Inspecting

**ANNUAL TASKS:**

1. Mulching
2. Pruning
3. Re-planting
4. Removing sediment
5. Soil Testing
6. Harvesting Plants
7. Cleaning of Gutters
8. Replacing materials (stone, landscape fabric)
DETAILED MAINTENANCE PRACTICES

• For detailed maintenance practices go to the Rain Garden Rebate Program website to view a Maintenance PowerPoint Presentation
RAIN GARDEN PLANTING DESIGN
DESIGN AESTHETICS

• Formal or traditional design
  – Shrub bed
  – Perennial garden
  – Hedges

• Naturalized planting & design
  – Butterfly garden
  – Meadow (warm season grasses & wildflowers)
  – Buffer plantings
SITE CONSTRAINTS

• Sun vs. shade
• Exposure/wind
• Soil characteristics
• Hydrologic conditions
• Road salts
• Vehicle/pedestrian traffic
PLANTS IN THE RIGHT PLACE…

Courtesy of Pinelands Nursery & Supply
PLANTING DESIGN: Wet + Dry Conditions

Rain Garden Zones

BUFFER
SLOPE
BASE
Outlet
Inlet

TYPICAL DEPTH
3-8"

MOISTURE LEVELS
dry moderate wet moderate dry
SELECTING PLANT SPECIES

• Mature plant size
  – Proximity to buildings and utility lines
  – Pruning and shaping

• Seasonal interest
  – Flowers
  – Fall color
  – Winter character

• Beneficial wildlife
  – Flowers for butterflies
  – Fruits for song birds
# GRASSES & GROUND COVERS

<table>
<thead>
<tr>
<th>BUFFER</th>
<th>BASE</th>
<th>SLOPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broomseedge</td>
<td>Big bluestem</td>
<td>Bluejoint grass</td>
</tr>
<tr>
<td>Bearberry</td>
<td>Virginia wild-rye</td>
<td>Sedges</td>
</tr>
<tr>
<td>Panic grass</td>
<td>Switchgrass</td>
<td>Fowl mannagrass</td>
</tr>
<tr>
<td>Switchgrass</td>
<td>Wool grass</td>
<td>Softrush</td>
</tr>
<tr>
<td>Little bluestem</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indiangrass</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
GRASSES & GROUND COVERS

Switchgrass (Panicum virgatum) - FAC

Tussock Sedge (Carex Stricta) - OBL

Woolgrass (Scirpus cyperinus) - FACW+

Little Bluestem (Schizachyrium scoparium) - FACU
## WILDFLOWERS & FERNS

### BUFFER
- Butterfly milkweed
- Wild indigo
- Purple coneflower
- Beebalm
- Black-eyed susan

### BASE
- New England aster
- New York aster
- Columbine
- Coreopsis
- Joe-pye weed
- Blazing star
- Sensitive fern
- Cinnamon fern
- Ironweed

### SLOPE
- Swamp milkweed
- Marsh marigold
- Turtlehead
- Boneset
- Rose-mallow/hibiscus
- Blueflag iris
- Cardinal flower
- Blue lobelia
- Monkey flower
- Royal fern
WILDFLOWERS & FERNS

Blueflag (Iris versicolor) - OBL

Joe-Pye Weed (Eupatorium perfoliatum) - FAC

Black-eyed Susan (Rudbeckia hirta) - FACU-

New England Aster (Aster novae-angliae) - FACW
TREES & SHRUBS

BUFFER

- Hackberry
- Red Bud
- Pepperbush
- American Holly
- Bayberry
- Witchhazel
- White Oak
- Red Oak
- Arrowwood
- Viburnum

BASE

- Red Maple
- Service Berry
- River Birch
- Silky Dogwood
- Red-twig Dogwood
- Inkberry Holly
- Winterberry
- Sweetbay Magnolia

SLOPE

- River Birch
- Buttonbush
- Silky Dogwood
- Green Ash
- Swamp White Oak
- Pin Oak
- Cranberrybush
- Viburnum
PLANTING DESIGN

• Native Species
• Tolerance of both wet + dry conditions
• Mature size of plants
• Aesthetics (layering, clustering, unity)
• Value for wildlife
PLANTING DESIGN: Native Plants

NATIVE PLANTS:
• Provide habitat areas
• Adapted to local conditions (soil, temperature, weather)
• Attract other natives (migratory birds, beneficial insects and butterflies)
• Reduce the need for irrigation
• Reduce the need for maintenance
• Reduce the use of fertilizer
• Reduce the use of pesticides
• Absorb water more efficiently than turf-style grasses
PLANTING DESIGN: Mature Size of Plants

At time of installation
Springfield Township Municipal Annex Building
Springfield, NJ

First growing season

Second growing season

Third growing season

Fourth growing season
Questions?

Christopher C. Obropta, Ph.D., P.E.
Extension Specialist in Water Resources
Rutgers Cooperative Extension
908-229-0210
obropta@envsci.rutgers.edu
www.water.rutgers.edu