

Green Infrastructure and Rain Gardens

Presented to the Environmental Stewards of Hunterdon County

Rutgers Snyder Research and Extension Farm, 140 Locust Grove Road, Pittstown, NJ 08867

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RUTGERS UNIVERSITY

Water Resources Program

New Jersey Agricultural Experiment Station



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A vibrant, colorful illustration celebrating Cinco de Mayo. The background is a deep purple, adorned with various Mexican-themed elements. At the top center is a yellow sombrero with a red and white striped band and a red and white striped egg-shaped decoration on top. To the left is a yellow guitar with a red headstock and a red pickguard. To the right are two yellow maracas with red and white striped bands. The scene is decorated with large red and yellow flowers, smaller pink and blue flowers, green cacti, and red chili peppers. A white skull is visible in the bottom right corner. The text "HAPPY CINCO DE MAYO" is centered in the middle of the image.

HAPPY
CINCO
DE MAYO

Welcome and Introduction

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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

www.water.rutgers.edu



Our mission is to identify and address water resources issues by engaging and empowering communities to employ practical science-based solutions to help create a more equitable and sustainable New Jersey.

New Jersey

- Most densely populated state
- 21 Counties, 565 municipalities
- 95% of our waterways are impaired
- Harmful Algal Blooms (HABS) in many of our lakes
- Hammered by Ida, Henri, Sandy, and a bunch of Nor'easters
- Climate change is real – more severe storms and sea level rise



Insight to current problem

- Stringent stormwater regulations on new development has not improved water quality
- We must retrofit existing older development with stormwater management to reduce impairments to our waterways
- Green infrastructure is a great tool to retrofit existing older development
- Local champions are needed to advocate for green infrastructure retrofits
- We need to create these champions where they don't already exist

Green Infrastructure Champion

Green Infrastructure Champions are key players in implementing green infrastructure as a stormwater management approach in their community.

Rutgers inputs to the Green Infrastructure Champion Program

- Training classes on various aspects of green infrastructure planning and implementation
- Professional staff to provide technical support to develop a design for a green infrastructure demonstration project
- Networking opportunities with other Green Infrastructure Champions for mutual support
- Assistance with grant writing and submission

<http://water.rutgers.edu/Projects/GreenInfrastructureChampions/GIC.html>

Stormwater Basics / Stormwater Management

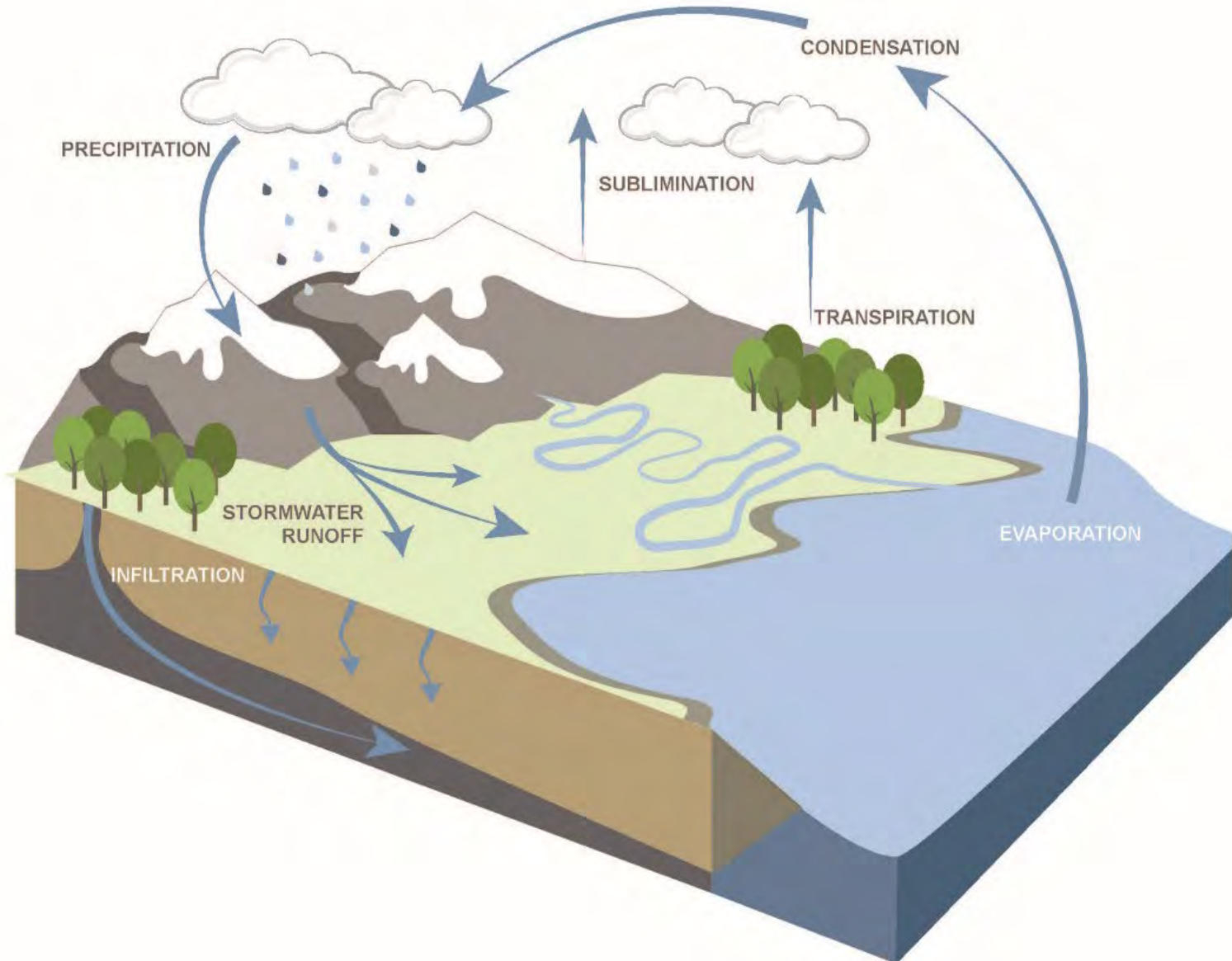


What is stormwater?

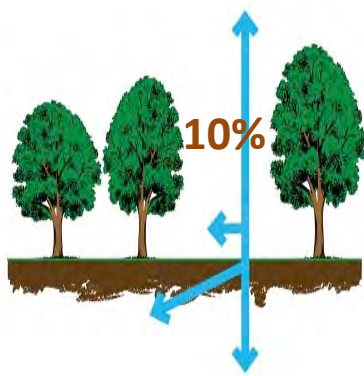


Stormwater is the water from rain or melting snows that can become “runoff,” flowing over the ground surface and returning to lakes and streams.

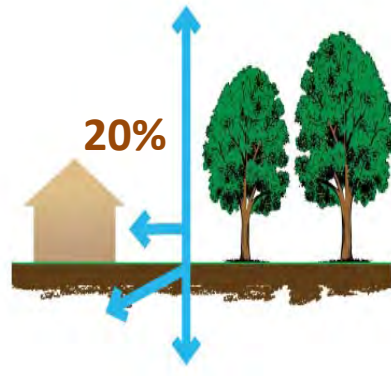
The Natural Hydrologic Cycle



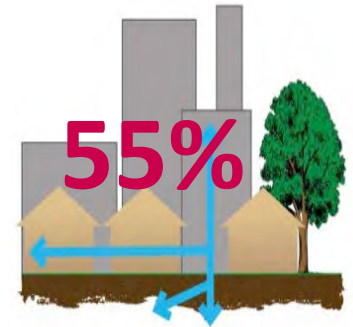
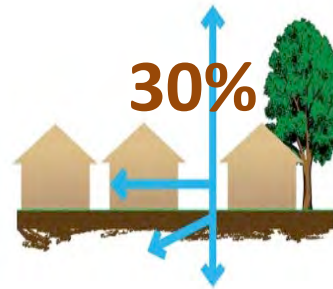
The Impact of Development on Stormwater Runoff



More development



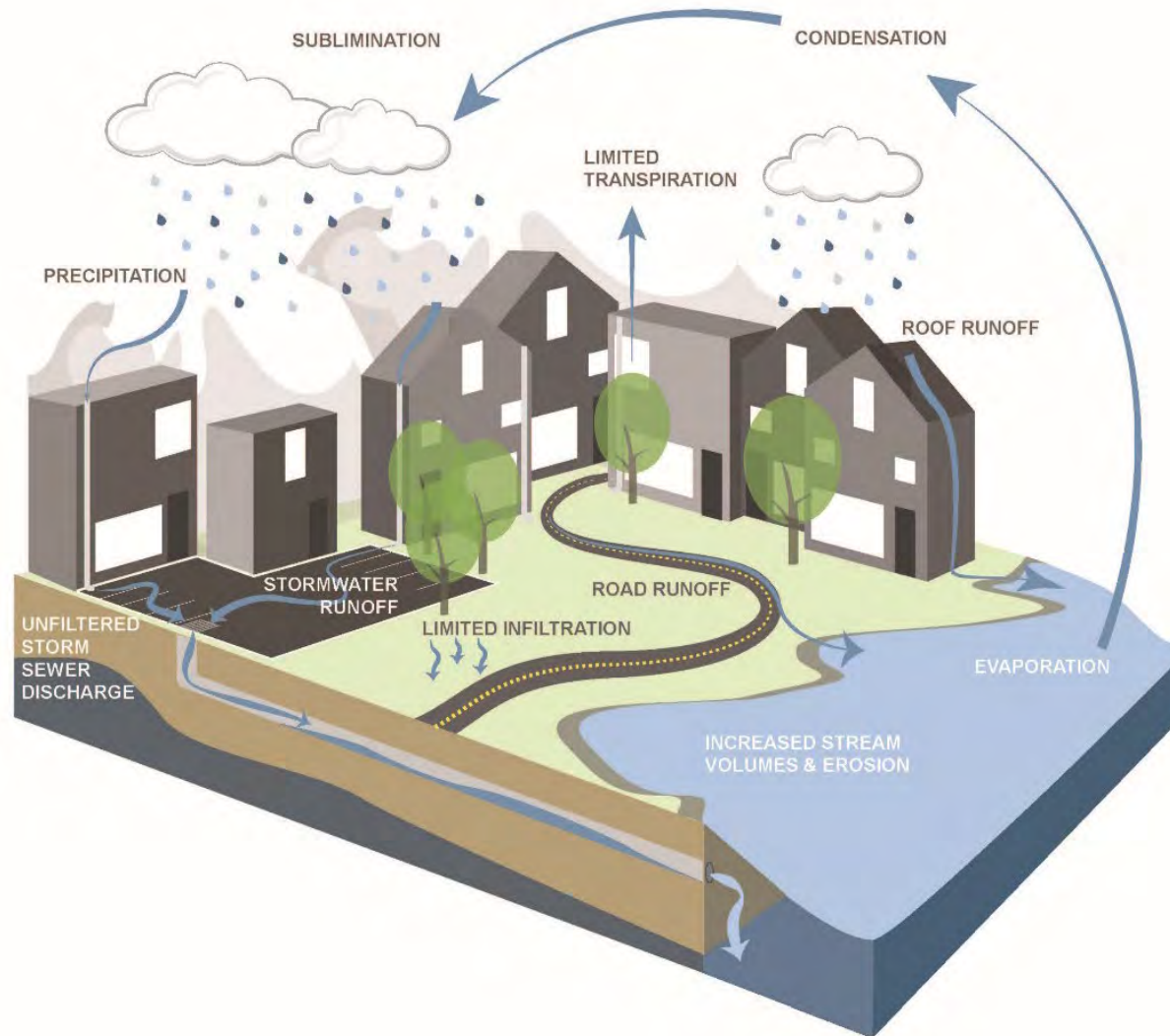
*More impervious
surfaces*



More stormwater runoff

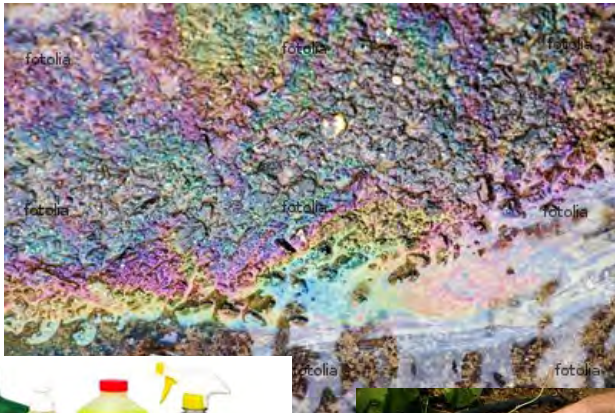


The Urban Hydrologic Cycle



Examples of Nonpoint Source Pollution

- Oil and grease from cars
- Fertilizers
- Animal waste
- Grass clippings
- Septic systems
- Sewage leaks
- Household cleaning products
- Litter
- Agriculture
- Sediment





History of Stormwater Management



1st Attempt at Stormwater Management

Capture all runoff, pipe it, and send it directly to the river . . . prior to mid 1970's



2nd Iteration of Stormwater Management

Capture runoff, detain it, release it slowly to the river...mid 1970's to 2004

- Detain peak flow during large storm events for 18 hours (residential) or 36 hours (commercial)
- Reduce downstream flooding during major storms
- Use concrete low flow channels to minimize erosion, reduce standing water, quickly discharge low flows
- Does not manage runoff from smaller storms allowing stormwater to pass through the system
- Directly discharges stormwater runoff to nearby stream, waterway, or municipal storm sewer system (at a controlled/managed rate)



3rd Generation of Stormwater Management

- Reduce stormwater runoff volume
- Reduce peak flows and flooding
- ...and....
- Maintain infiltration and groundwater recharge
- Reduce pollution discharged to local waterways

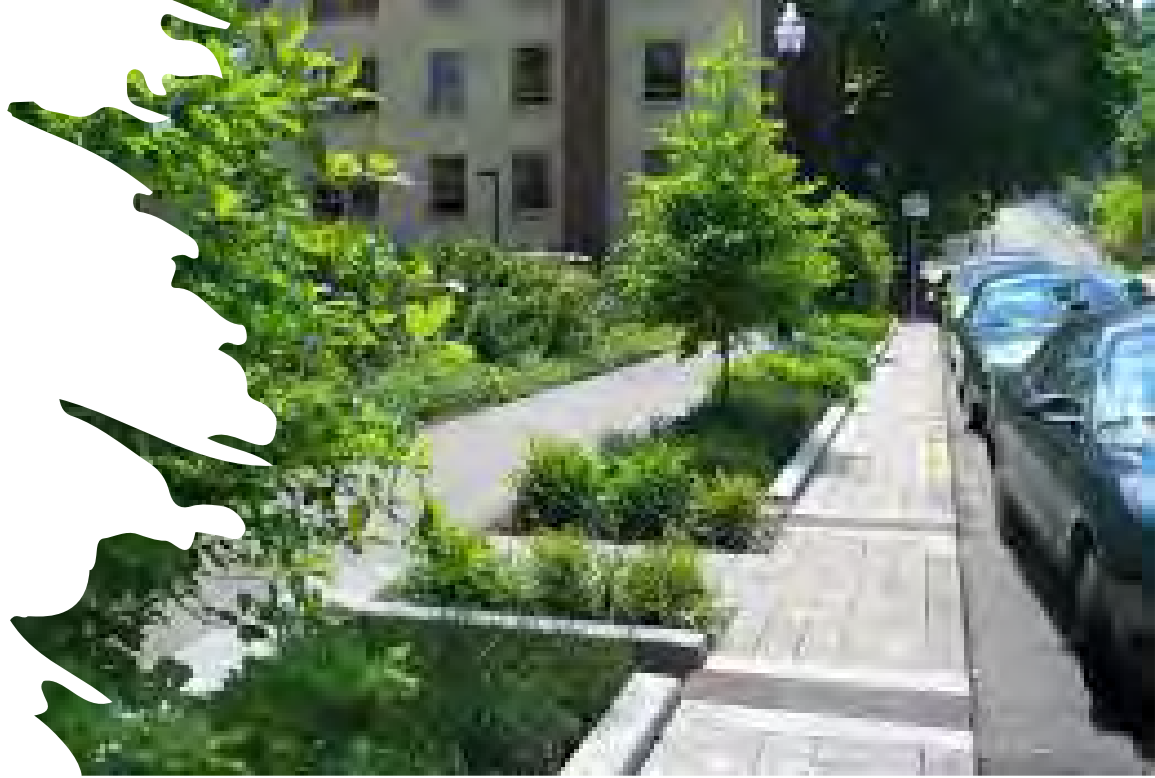


ABC Action News, August 27, 2012



4th Generation of Stormwater Management (Started March 2, 2021)

- All major development must use green infrastructure to comply with the New Jersey Stormwater Regulations



Green Infrastructure

...an approach to stormwater management that is cost-effective, sustainable, and environmentally friendly.

Green Infrastructure projects:

- capture,
- filter,
- absorb, and
- reuse

stormwater to maintain or mimic natural systems and treat runoff as a resource.



Green Infrastructure

Stormwater management practices that protect, restore, and mimic the native hydrologic condition by providing the following functions:

- Infiltration
- Filtration
- Storage
- Evaporation
- Transpiration



Green Infrastructure Practices

Bioretention Systems

- Rain Gardens
- Bioswales
- Stormwater Planters
- Curb Extensions
- Tree Filter Boxes



Permeable Pavements

Rainwater Harvesting

- Rain Barrels
- Cisterns

Dry Wells

Rooftop Systems

- Green Roofs
- Blue Roofs



Parker Urban Greenscapes. 2009.

TYPES OF BIORETENTION



Rain Gardens

- Single-family lots
- Small commercial areas



Bioretention Swales/ Bioswales/Vegetated Swales

- Typically in right-of-way



Planters & Planter Boxes

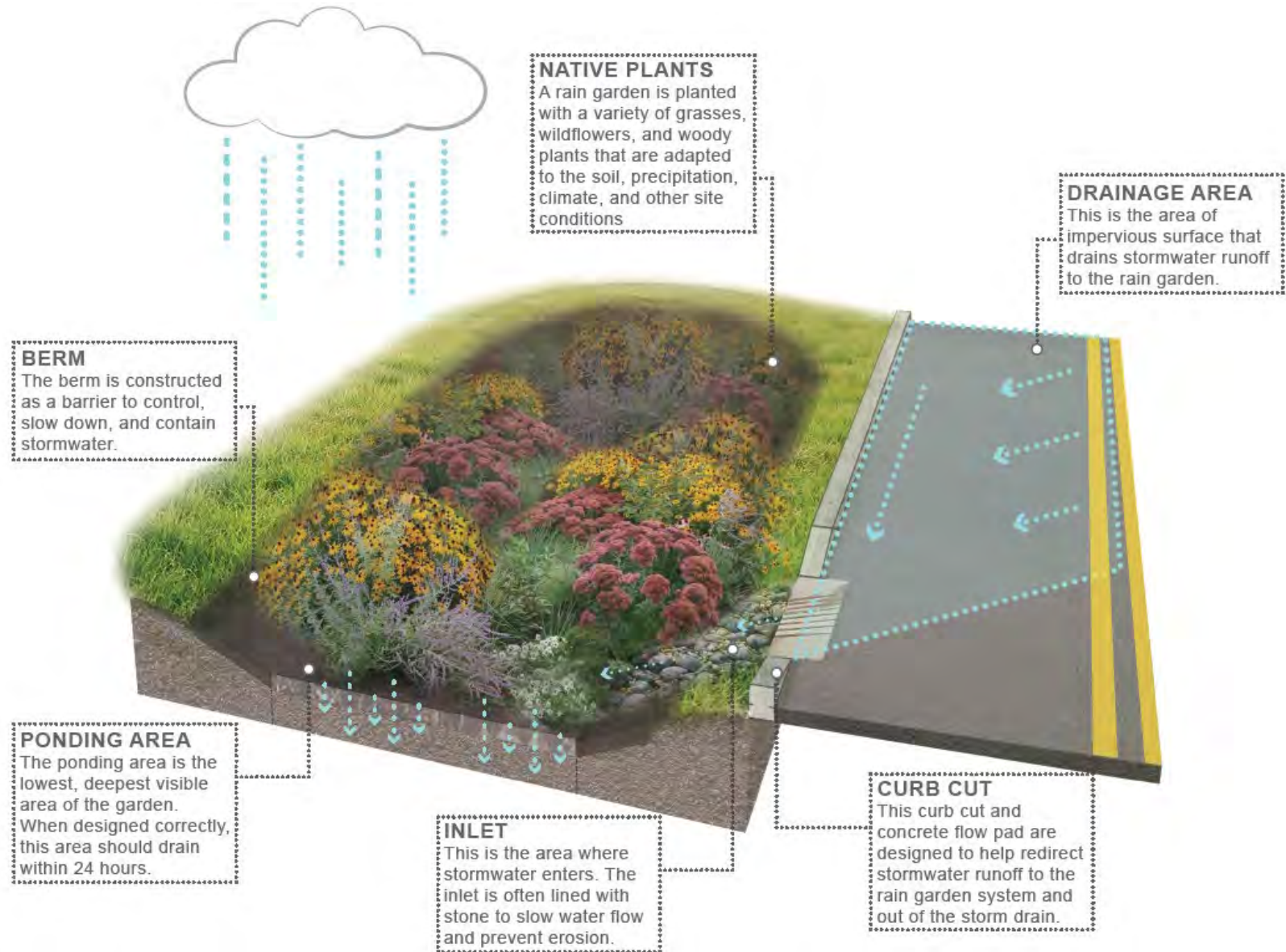
- Highly urban areas
- Right-of-way and adjacent to buildings



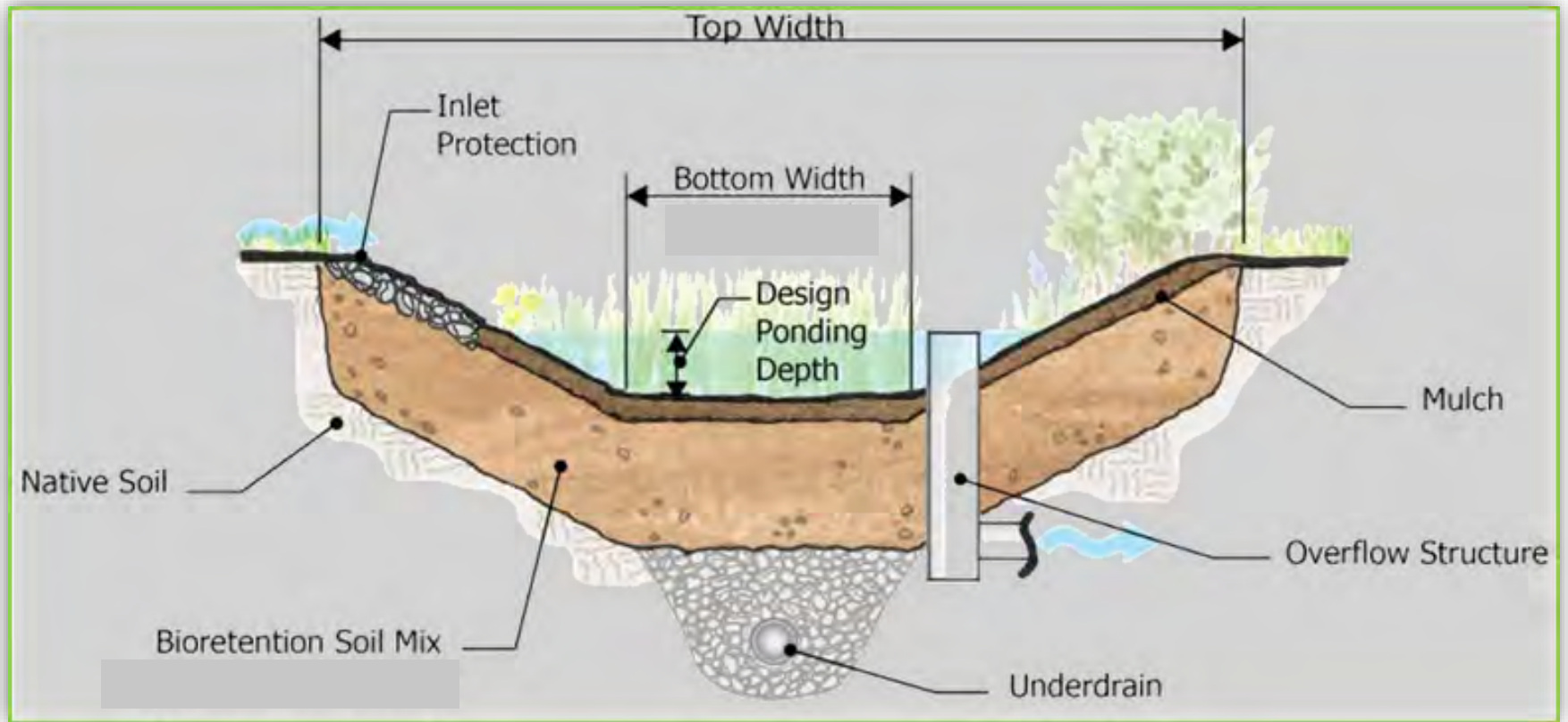
Vegetated Curb Extensions

- Bioretention incorporated into right-of-way in urban and suburban areas

Rain Gardens

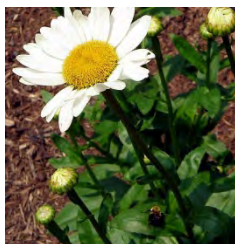
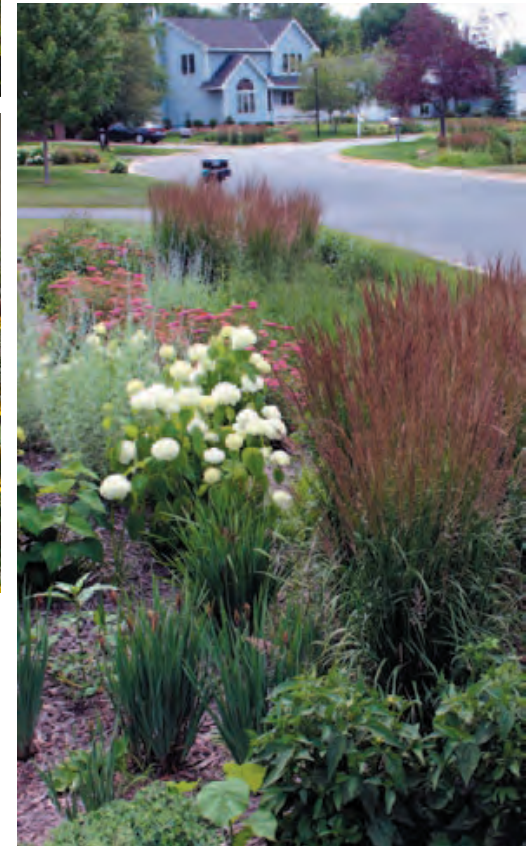


Rain Garden Cross-Section





Lots of Rain Gardens







Blue Garden
This garden is a beautiful example of a blue garden. It features a variety of blue flowers, including hydrangeas, delphiniums, and cornflowers. The garden is also filled with green foliage, including hostas and ferns. The overall effect is a cool and refreshing look that is perfect for a summer garden.







Bioswale

NATIVE PLANTS

A bioswale is planted with a variety of grasses, wildflowers, and woody plants that are adapted to the soil, precipitation, climate, and other site conditions. The vegetation helps filter stormwater runoff as it moves through the system.

CONVEYANCE

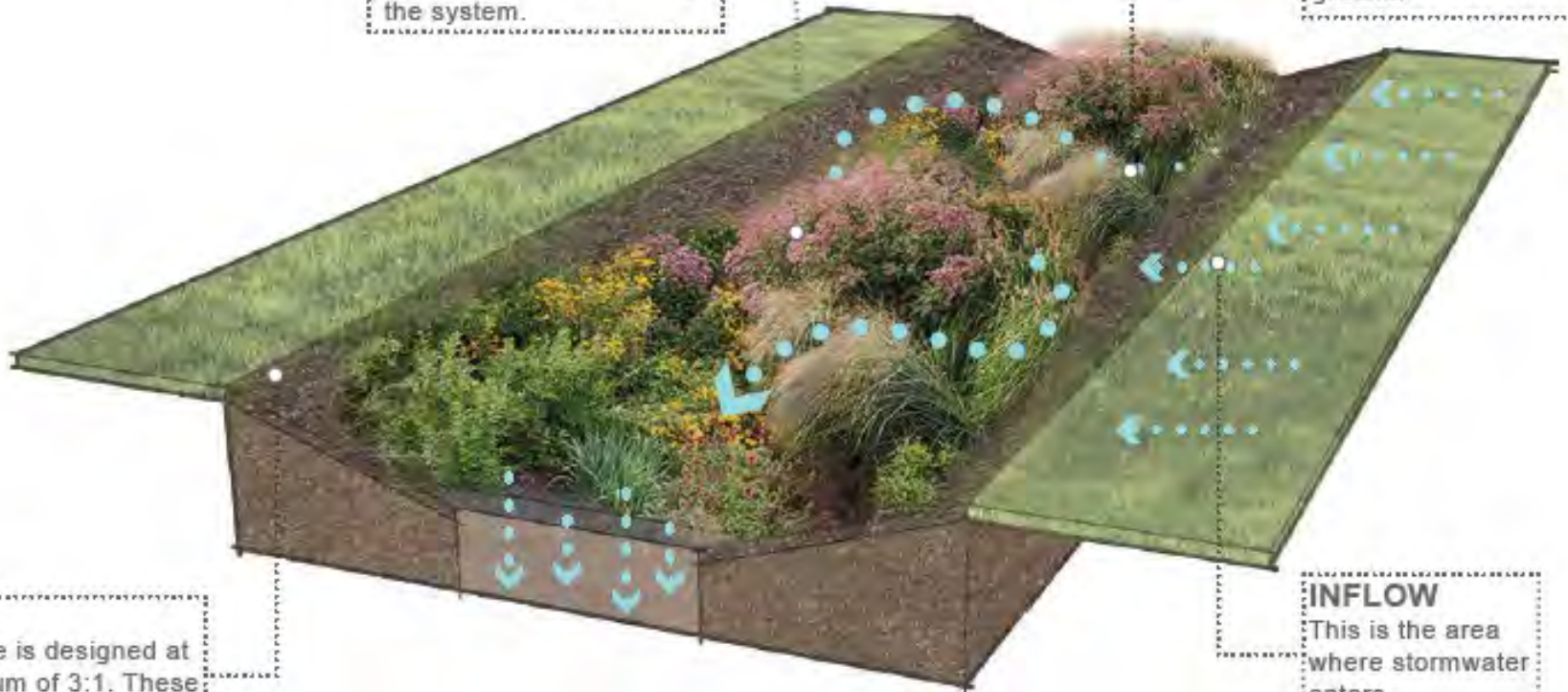
Unlike other systems, the bioswale is designed to move water through a vegetative channel as it slowly infiltrates into the ground.

SLOPE

The slope is designed at a maximum of 3:1. These slopes often require erosion control materials for stabilization.

INFLOW

This is the area where stormwater enters.







Stormwater Planters

NATIVE PLANTS

A stormwater planter is planted with a variety of grasses, wildflowers, and woody plants that are adapted to the soil, precipitation, climate, and other site conditions.

CURB CUT

This curb cut and concrete flow pad are designed to help redirect stormwater runoff to the rain garden system and out of the storm drain.

CONCRETE WALL

Concrete walls are installed to match the existing curb. These walls create the frame for the stormwater planter and continue to function as a curb.

INLET

This is the area where stormwater enters. The inlet is often lined with stone to slow water flow and prevent erosion.

SUBGRADE

Stormwater planter systems are unique because of their subgrade structure. This structure is layered with bioretention media, choker course, compact aggregate, and soil separation fabric.





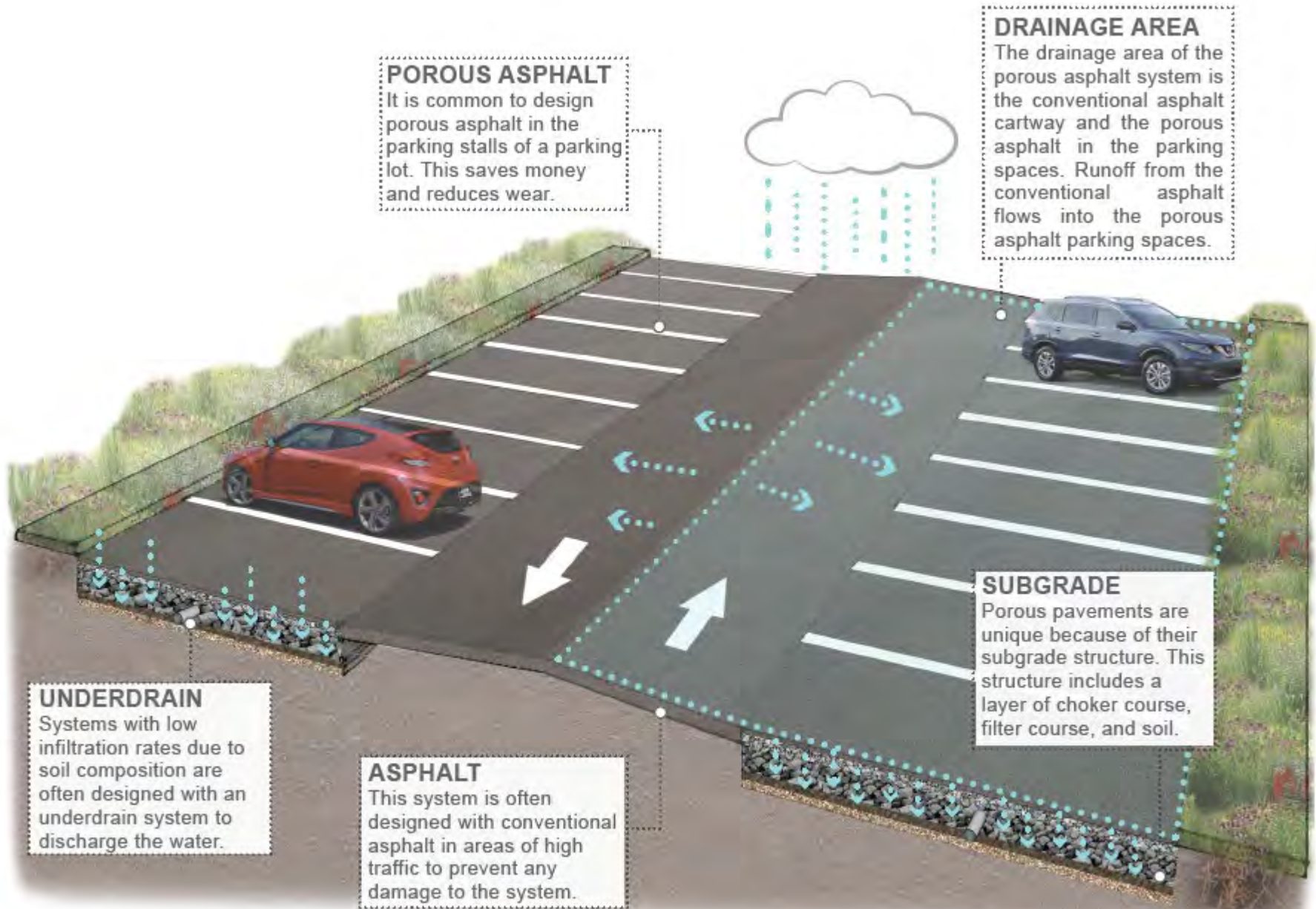


Curb Extensions





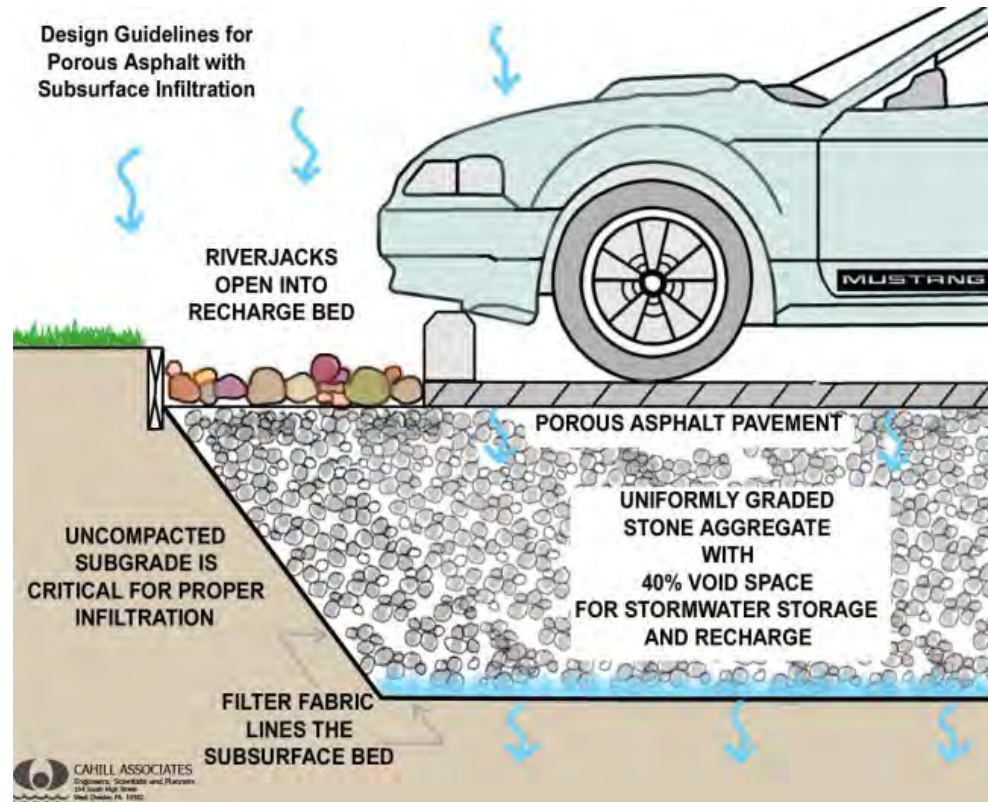
Permeable Pavement



ADVANTAGES

- Manage stormwater runoff
- Minimize site disturbance
- Promote groundwater recharge
- Low life cycle costs, alternative to costly traditional stormwater management methods
- Mitigation of urban heat island effect
- Contaminant removal as water moves through layers of system

COMPONENTS



Porous Asphalt





Pervious Concrete

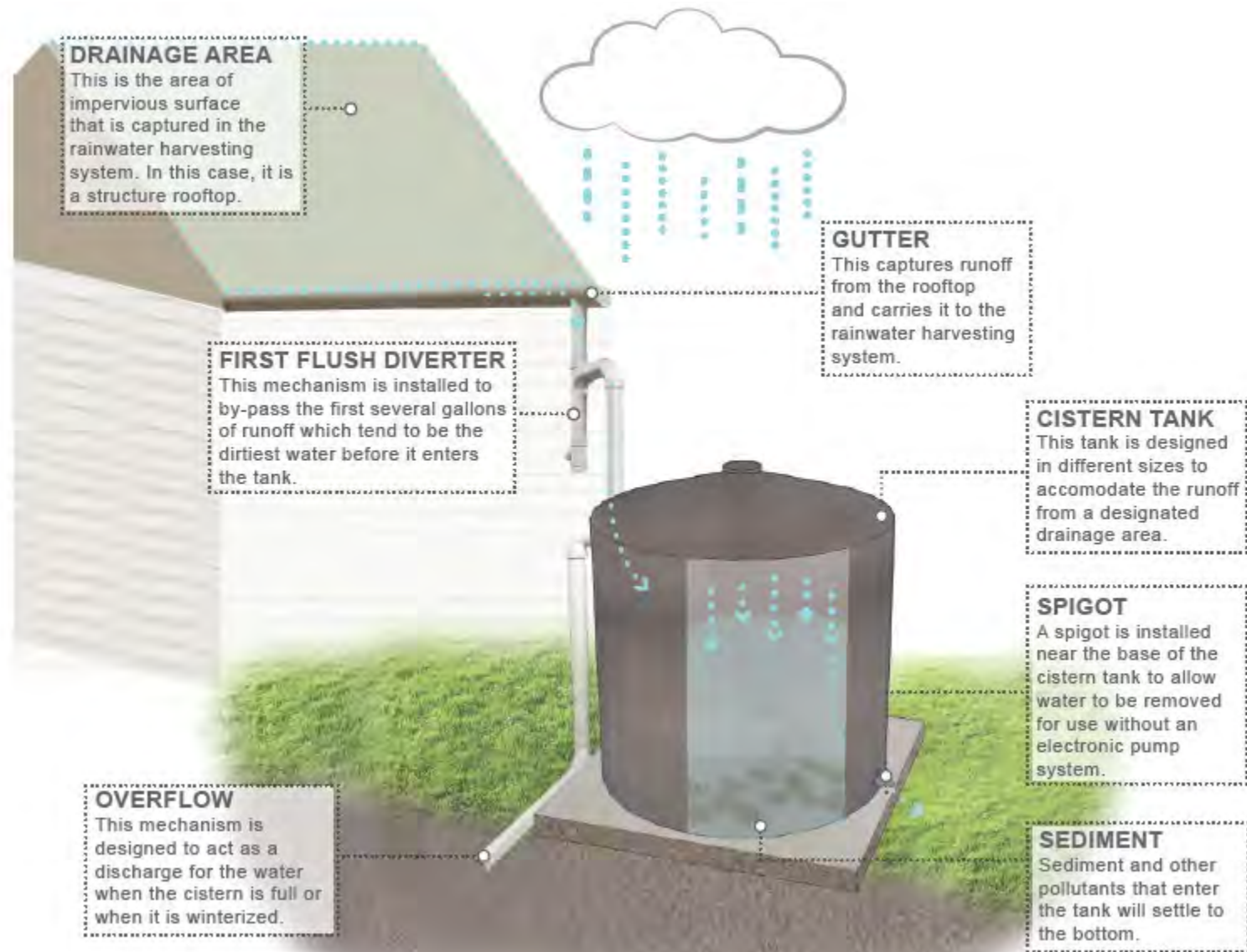


Permeable Pavers

A photograph showing a driveway paved with interlocking concrete pavers that have grass growing in the recessed areas. The pavers are arranged in a grid pattern. The driveway is covered with fallen autumn leaves in shades of brown, orange, and yellow. To the right of the paved area is a pile of dry, yellowed grass and more fallen leaves. In the upper left corner, the rear wheel and part of a dark-colored vehicle are visible. The background shows a chain-link fence and more foliage.

Grass Pavers

Rainwater Harvesting Systems



Rain Barrels



Cisterns



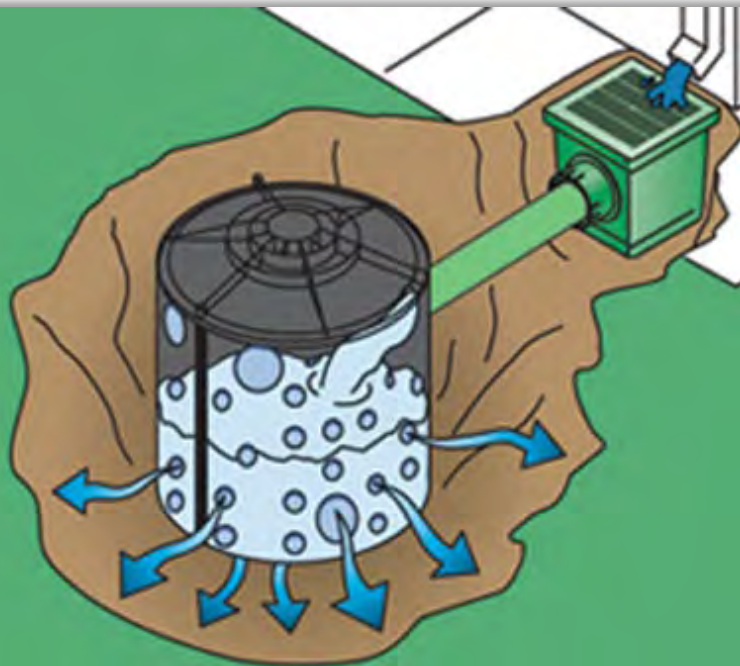
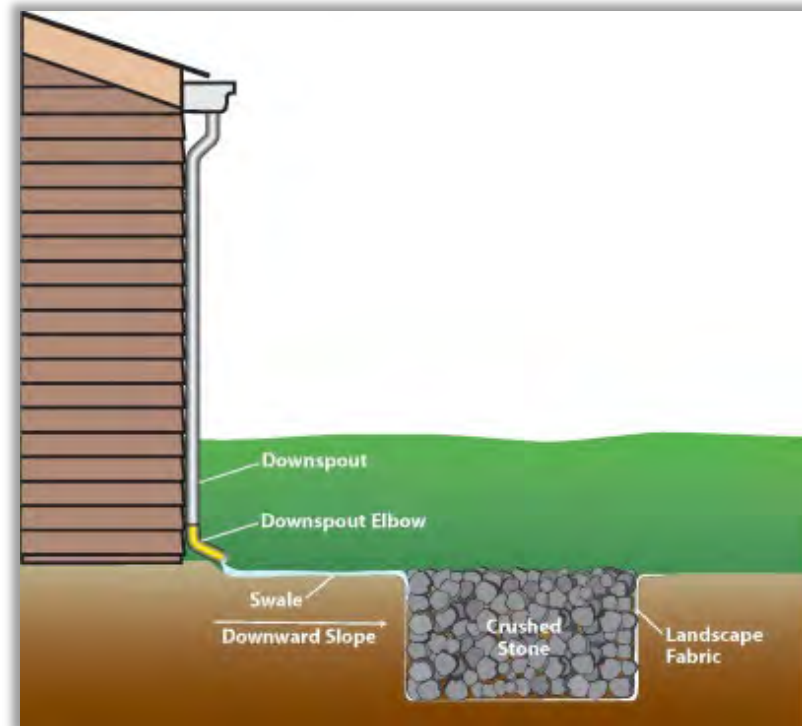




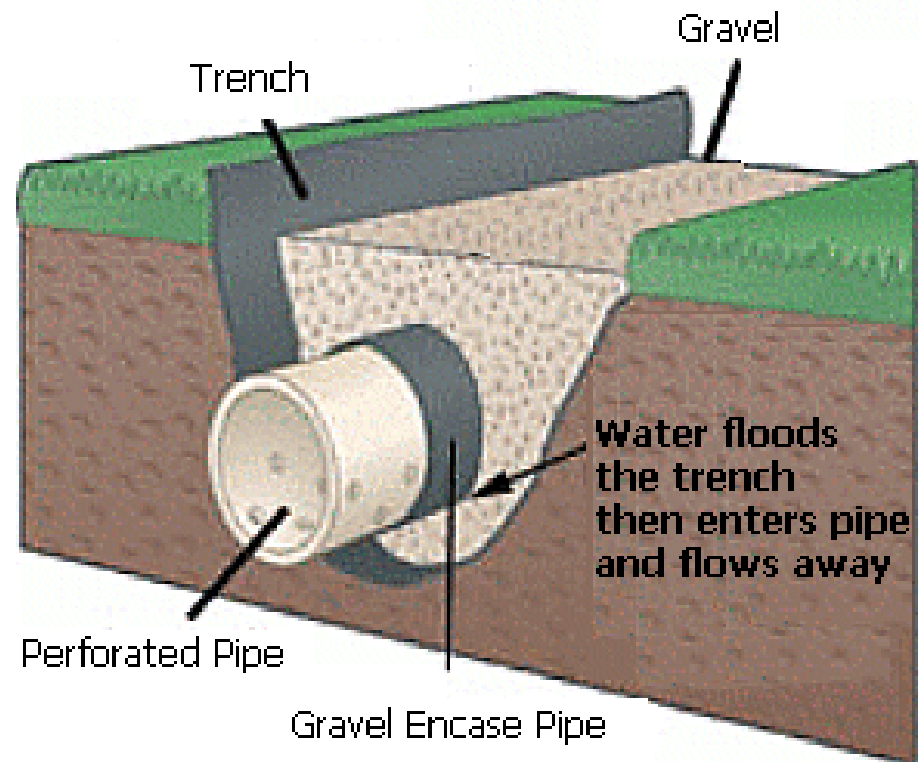




Dry Wells



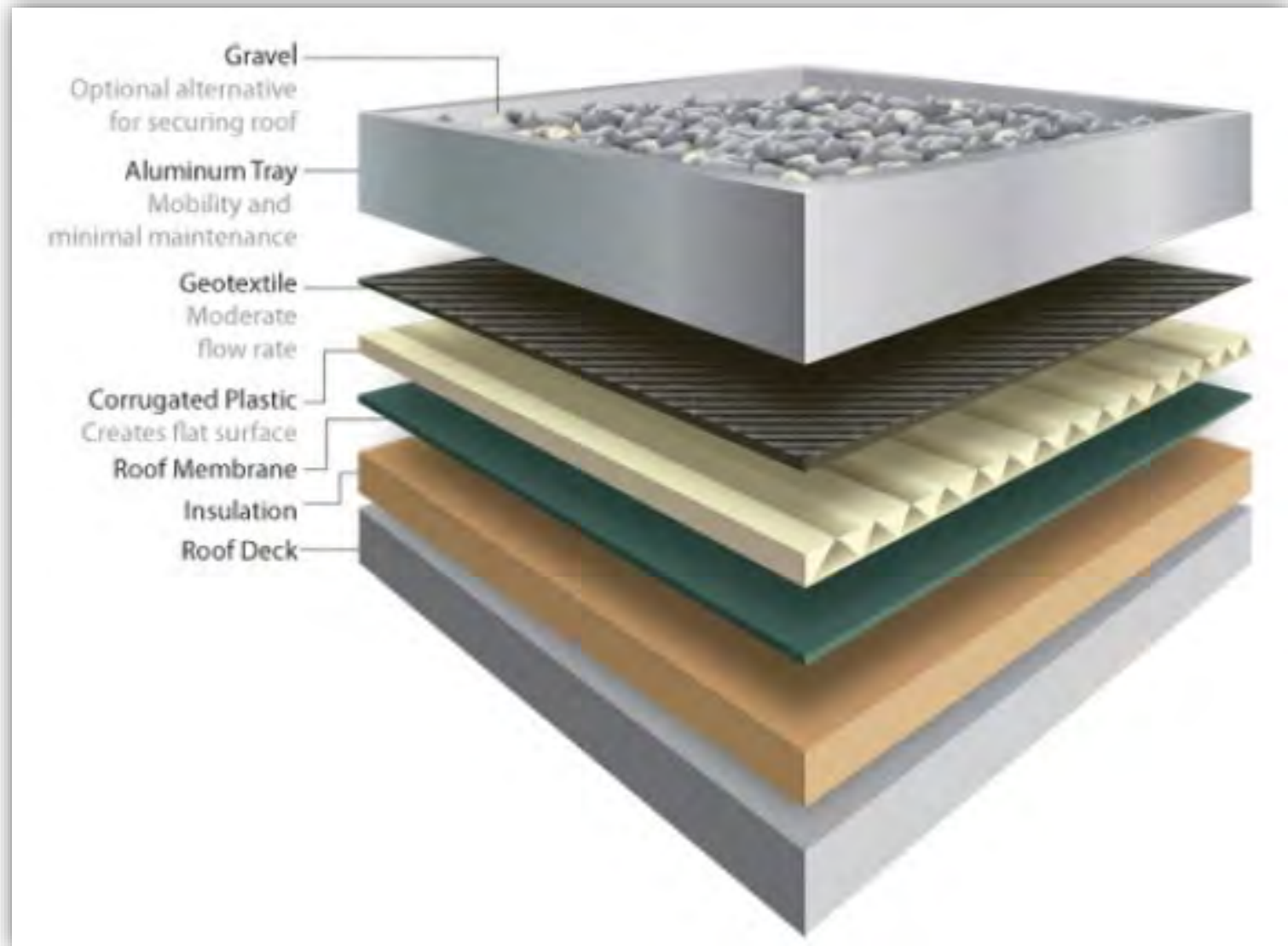
Infiltration Trench



Rooftop Practices – Green Roof



Rooftop Practices – Blue Roof





Stormwater Wetlands

A close-up, high-speed photograph of rain falling onto a dark, reflective surface. The image is filled with numerous concentric ripples of varying sizes, creating a complex, textured pattern. The lighting highlights the edges of the ripples, giving them a shimmering appearance. The overall color palette is monochromatic, consisting of various shades of gray and black, with the red text providing a sharp contrast.

Let's Talk About Rain

What's a 100-year storm?



How often do we get the 100-year storm?

Annual probability (%) = 100/recurrence interval (years)

100-year storm = $100/100$ = 1%

10-year storm = $100/10$ = 10%

2-year storm = $100/2$ = 50%



NEW JERSEY 24 HOUR RAINFALL FREQUENCY DATA

Rainfall Amounts in Inches

County	1 year	2 year	5 year	10 year	25 year	50 year	100 year
Atlantic	2.8	3.3	4.3	5.2	6.5	7.6	8.9
Bergen	2.8	3.3	4.3	5.1	6.3	7.3	8.4
Burlington	2.8	3.4	4.3	5.2	6.4	7.6	8.8
Camden	2.8	3.3	4.3	5.1	6.3	7.3	8.5
Cape May	2.8	3.3	4.2	5.1	6.4	7.5	8.8
Cumberland	2.8	3.3	4.2	5.1	6.4	7.5	8.8
Essex	2.8	3.4	4.4	5.2	6.4	7.5	8.7
Gloucester	2.8	3.3	4.2	5.0	6.2	7.3	8.5
Hudson	2.7	3.3	4.2	5.0	6.2	7.2	8.3
Hunterdon	2.9	3.4	4.3	5.0	6.1	7.0	8.0
Mercer	2.8	3.3	4.2	5.0	6.2	7.2	8.3
Middlesex	2.8	3.3	4.3	5.1	6.4	7.4	8.6
Monmouth	2.9	3.4	4.4	5.2	6.5	7.7	8.9
Morris	3.0	3.5	4.5	5.2	6.3	7.3	8.3
Ocean	3.0	3.4	4.5	5.4	6.7	7.9	9.2
Passaic	3.0	3.5	4.4	5.3	6.5	7.5	8.7
Salem	2.8	3.3	4.2	5.0	6.2	7.3	8.5
Somerset	2.8	3.3	4.3	5.0	6.2	7.2	8.2
Sussex	2.7	3.2	4.0	4.7	5.7	6.6	7.6
Union	2.8	3.4	4.4	5.2	6.4	7.5	8.7
Warren	2.8	3.3	4.2	4.9	5.9	6.8	7.8

**On July 17, 2023, NJDEP
passed new
Stormwater Management
Rules
Flood Hazard Area Control
Act Rules**

2020 Projection

Current Precipitation Adjustment Factors			
County	2-year	10-year	100-year
Atlantic	1.01	1.02	1.03
Bergen	1.01	1.03	1.06
Burlington	0.99	1.01	1.04
Camden	1.03	1.04	1.05
Cape May	1.03	1.03	1.04
Cumberland	1.03	1.03	1.01
Essex	1.01	1.03	1.06
Gloucester	1.05	1.06	1.06
Hudson	1.03	1.05	1.09
Hunterdon	1.02	1.05	1.13
Mercer	1.01	1.02	1.04

Current Precipitation Adjustment Factors			
County	2-year	10-year	100-year
Middlesex	1.00	1.01	1.03
Monmouth	1.00	1.01	1.02
Morris	1.01	1.03	1.06
Ocean	1.00	1.01	1.03
Passaic	1.00	1.02	1.05
Salem	1.02	1.03	1.03
Somerset	1.00	1.03	1.09
Sussex	1.03	1.04	1.07
Union	1.01	1.03	1.06
Warren	1.02	1.07	1.15

2100 Projection

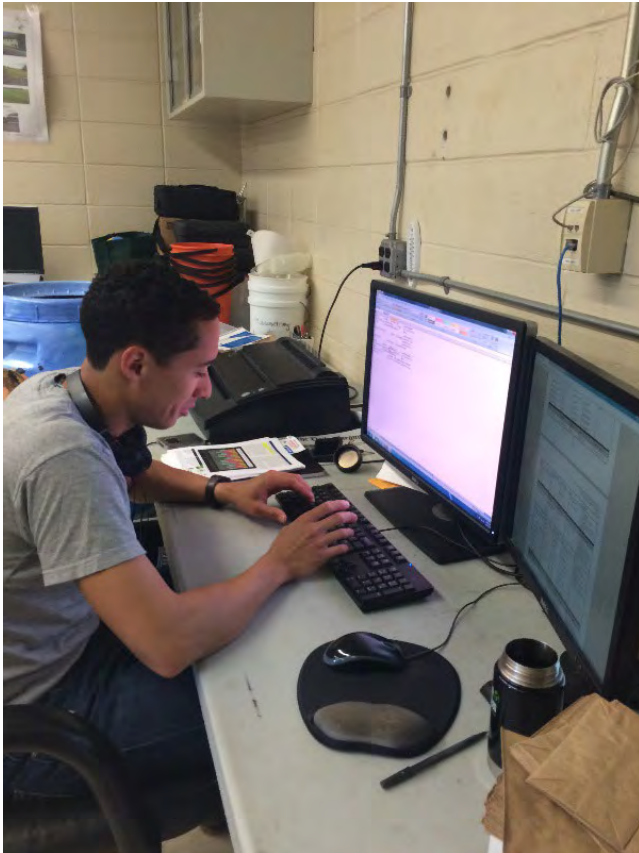
Future Precipitation Change Factors			
County	2-year Design Storm	10-year Design Storm	100-year Design Storm
Atlantic	1.22	1.24	1.39
Bergen	1.20	1.23	1.37
Burlington	1.17	1.18	1.32
Camden	1.18	1.22	1.39
Cape May	1.21	1.24	1.32
Cumberland	1.20	1.21	1.39
Essex	1.19	1.22	1.33
Gloucester	1.19	1.23	1.41
Hudson	1.19	1.19	1.23
Hunterdon	1.19	1.23	1.42
Mercer	1.16	1.17	1.36

Future Precipitation Change Factors			
County	2-year Design Storm	10-year Design Storm	100-year Design Storm
Middlesex	1.19	1.21	1.33
Monmouth	1.19	1.19	1.26
Morris	1.23	1.28	1.46
Ocean	1.18	1.19	1.24
Passaic	1.21	1.27	1.50
Salem	1.20	1.23	1.32
Somerset	1.19	1.24	1.48
Sussex	1.24	1.29	1.50
Union	1.20	1.23	1.35
Warren	1.20	1.25	1.37

Design Storms for Hunterdon County

	2-year Design Storm	10-year Design Storm	100-year Design Storm
2000 Rainfall	3.35	5.00	8.03
2020 Rainfall	3.45	5.25	9.07
2100 Rainfall	4.02	6.15	11.40

Green Infrastructure Implementation Part 1



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New Jersey Agricultural
Experiment Station





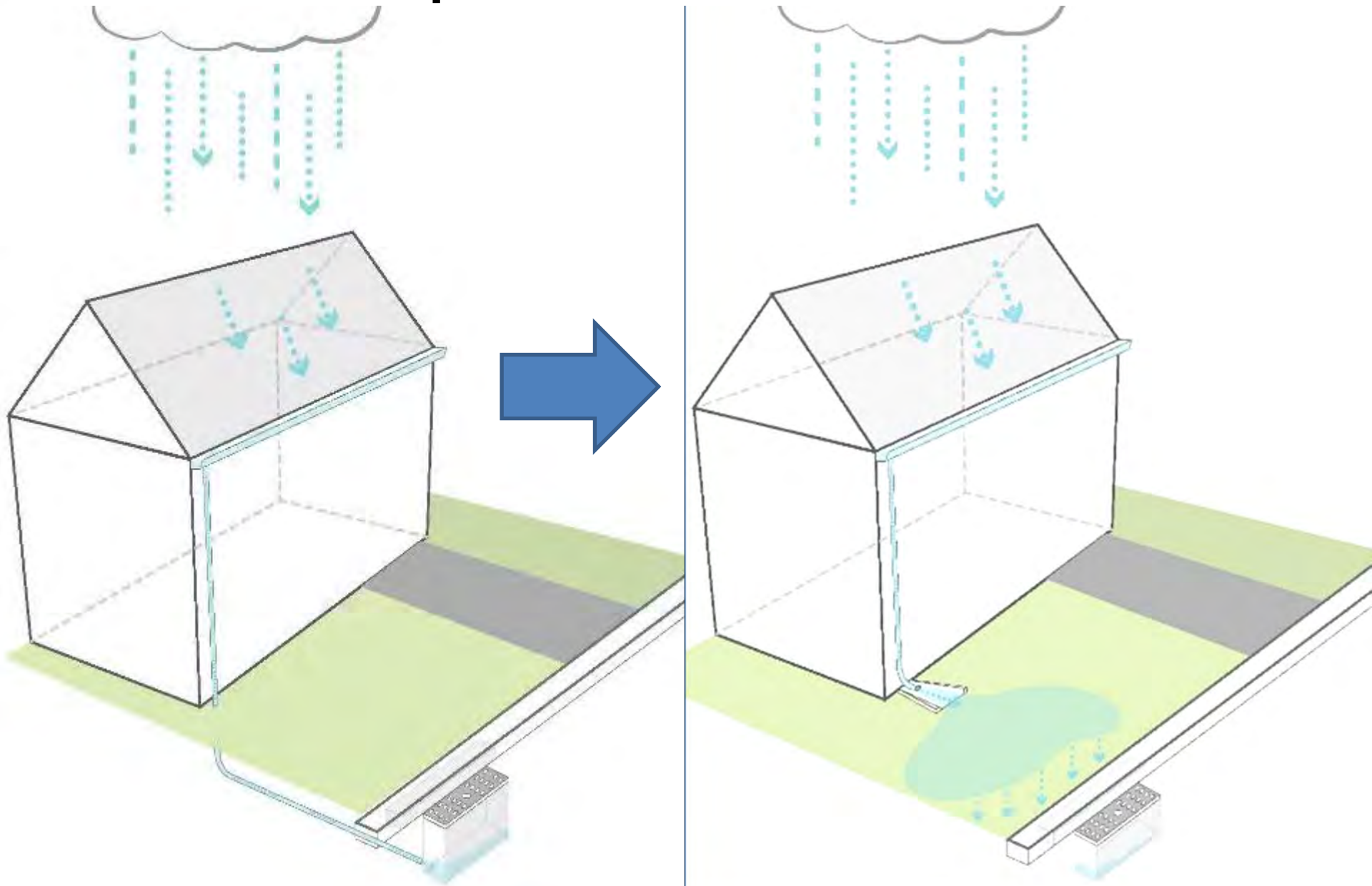
It is all about
controlling runoff
from impervious
surfaces



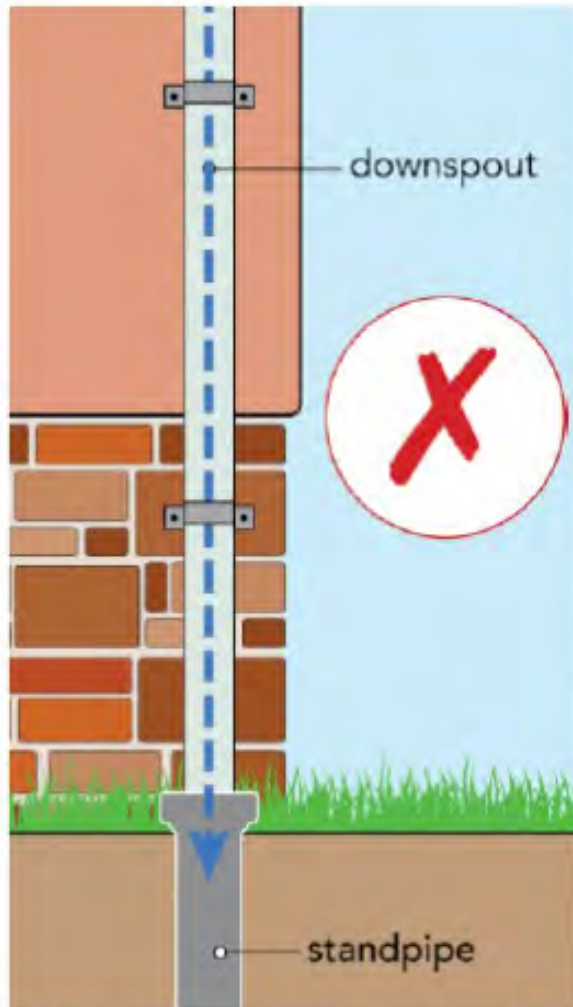
Connected or Disconnected?



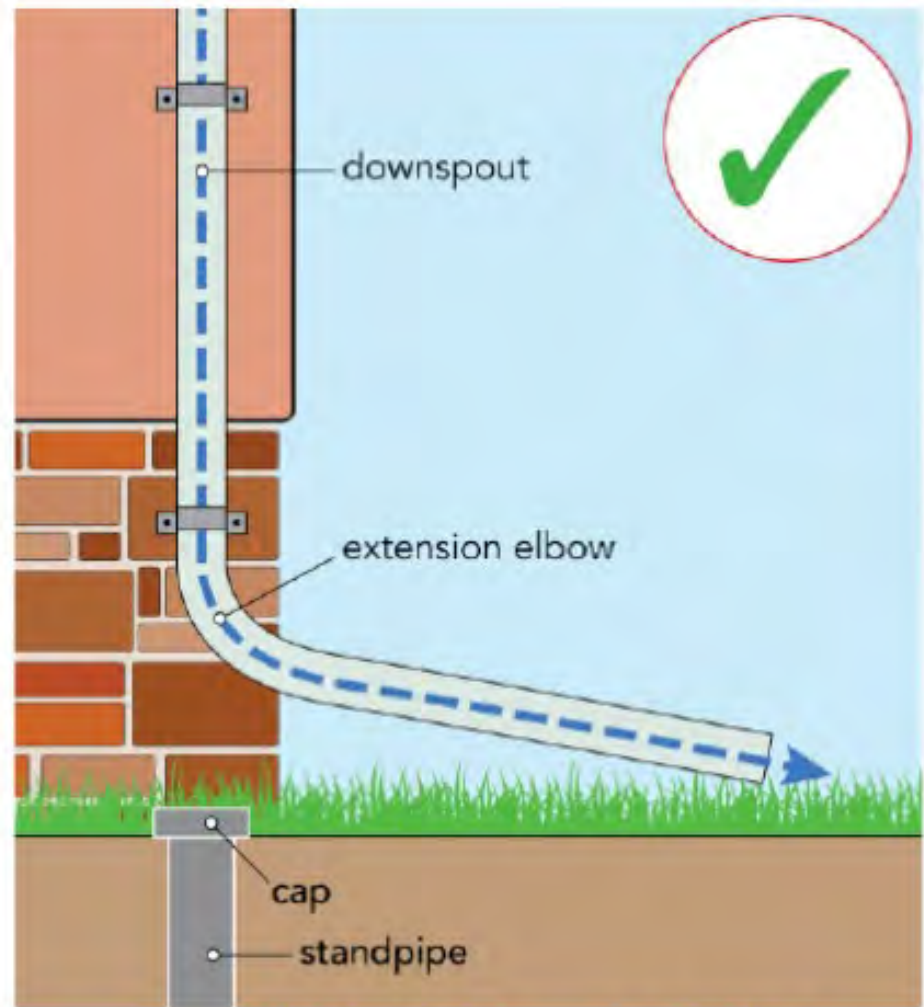
Simple Disconnection



Downspout Disconnection



**DOWNSPOUT CONNECTED
TO SEWER SYSTEM**



**DOWNSPOUT DISCONNECTED
FROM SEWER SYSTEM**

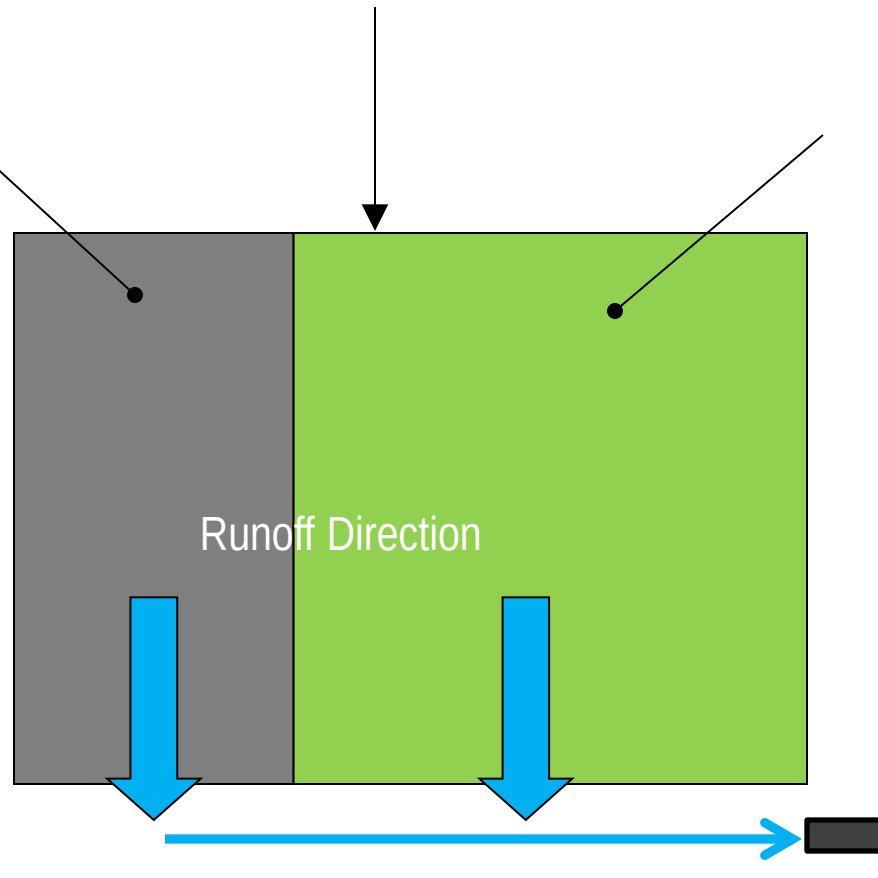
Another Example of Simple Disconnection

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

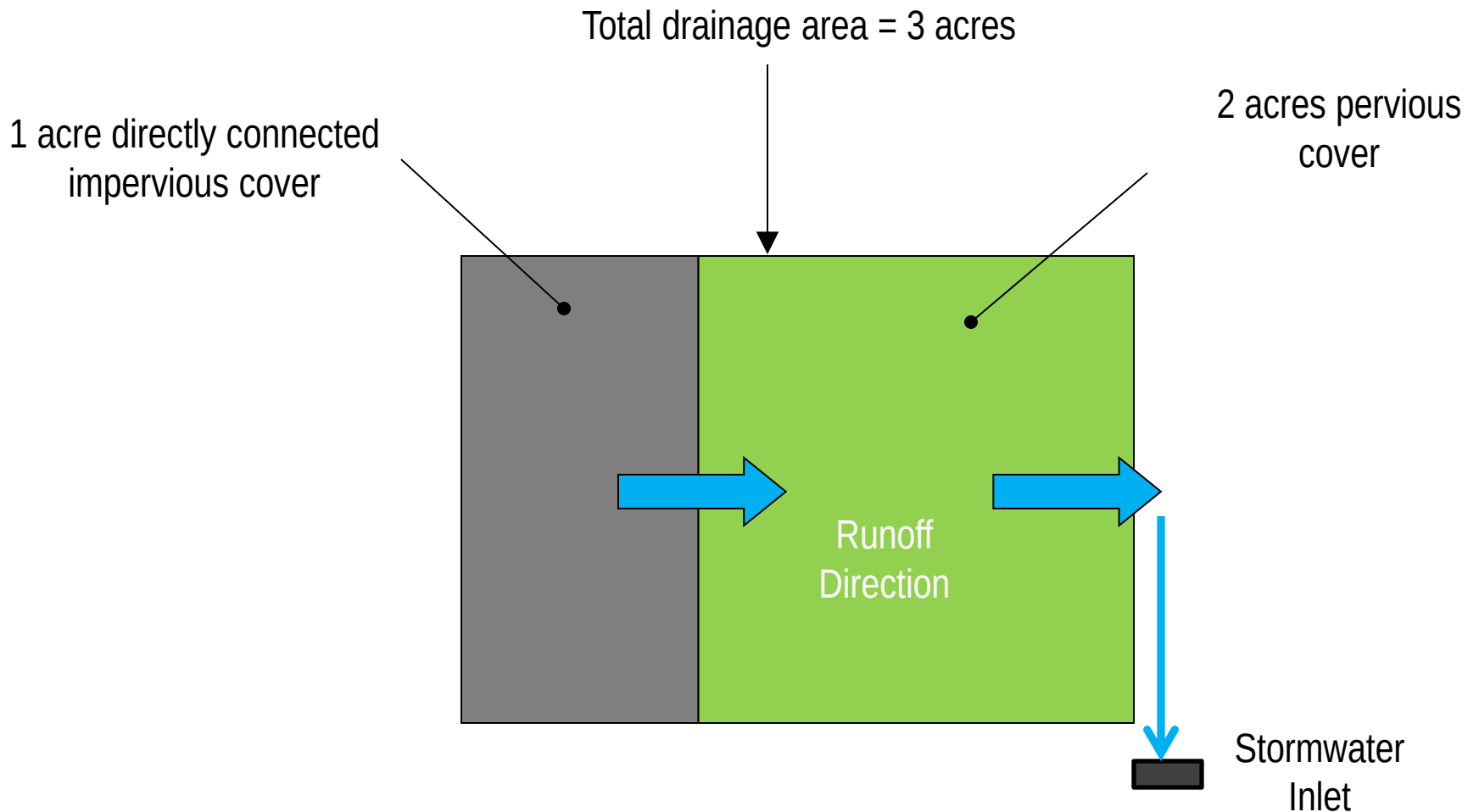
Total drainage area = 3 acres

1 acre directly connected
impervious cover

2 acres pervious
cover

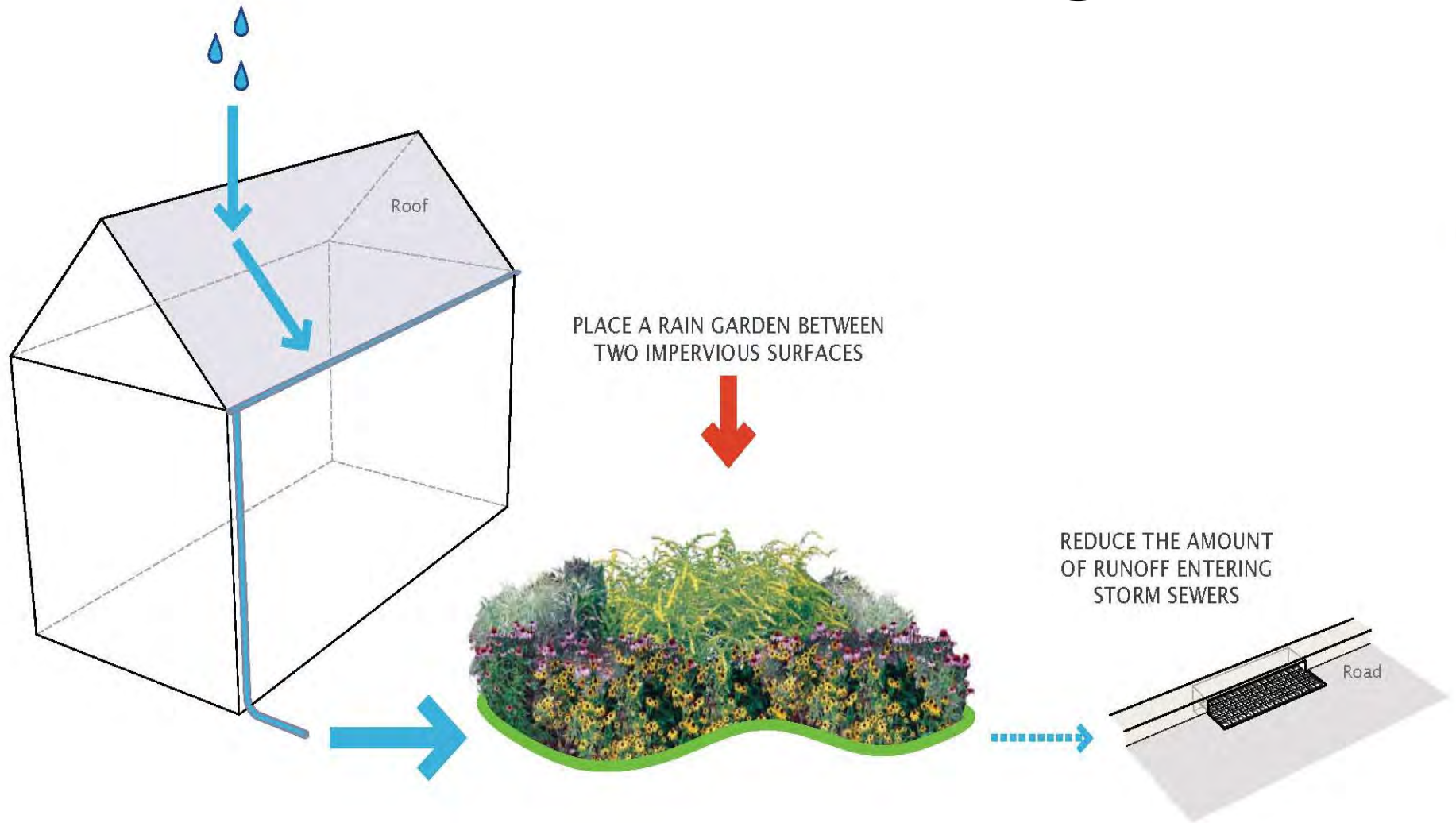


For 1.25 inch storm, 581 cubic feet of runoff = **4,360 gallons**



	Volume of Runoff		
Design Storm	Connected (gallons)	Disconnected (gallons)	Percent Difference
1.25 inches (water quality storm)	28,500	4,360	85%

Disconnect with a rain garden

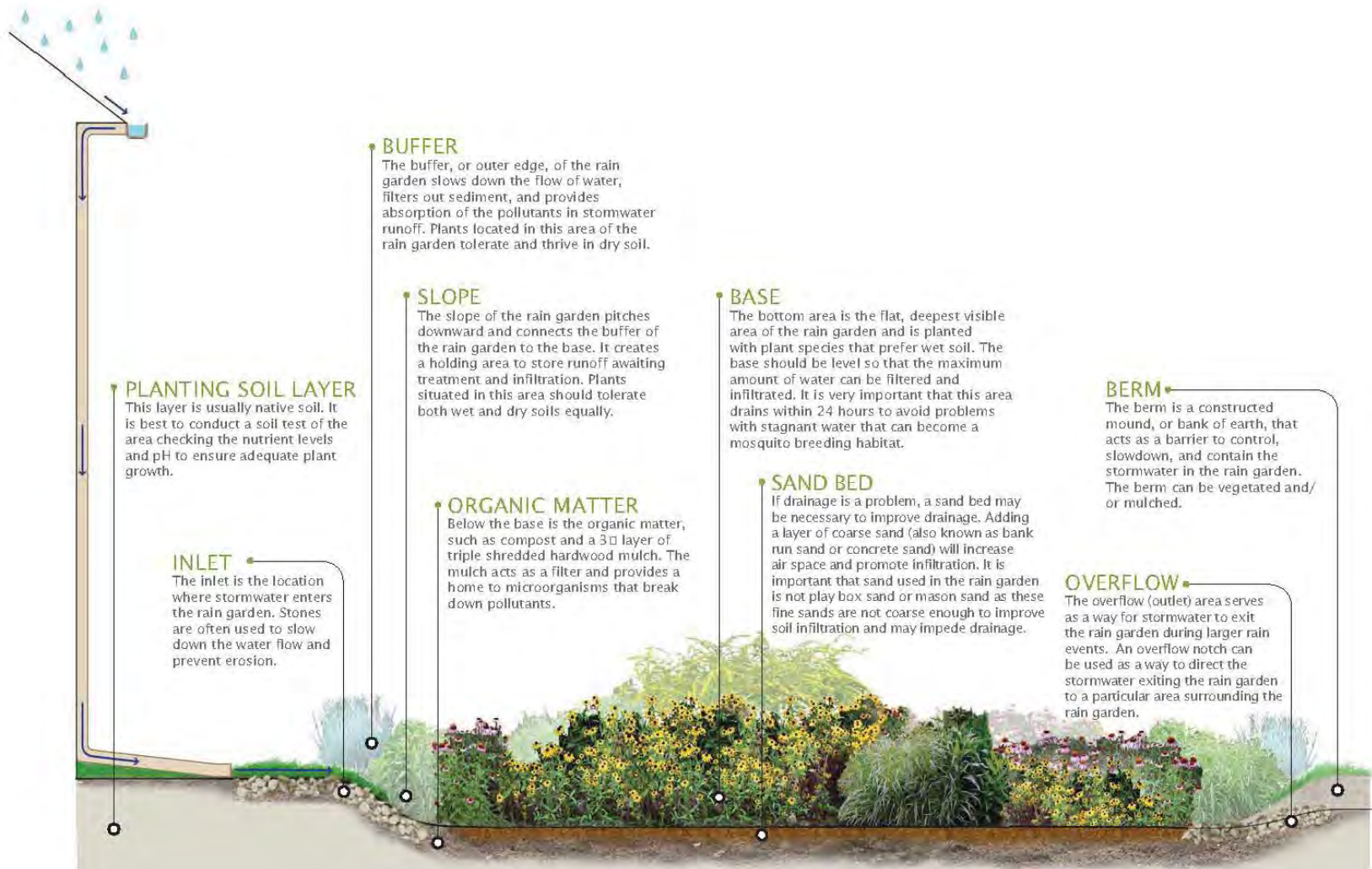


Rain Gardens

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.



PARTS OF A RAIN GARDEN





SITE SELECTION & DESIGN

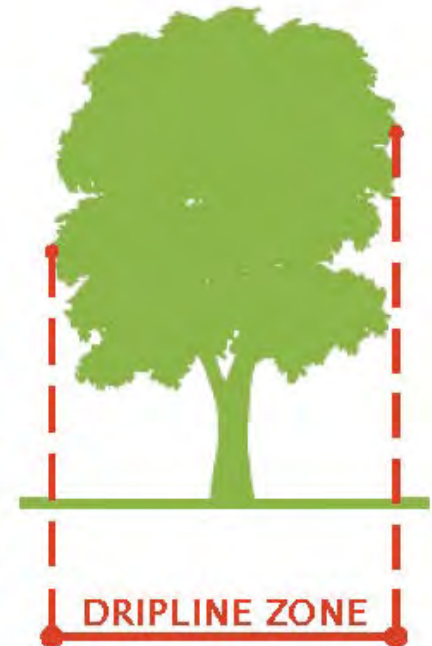
PLANNING YOUR RAIN GARDEN





SITE SELECTION

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







CALL BEFORE YOU DIG

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.

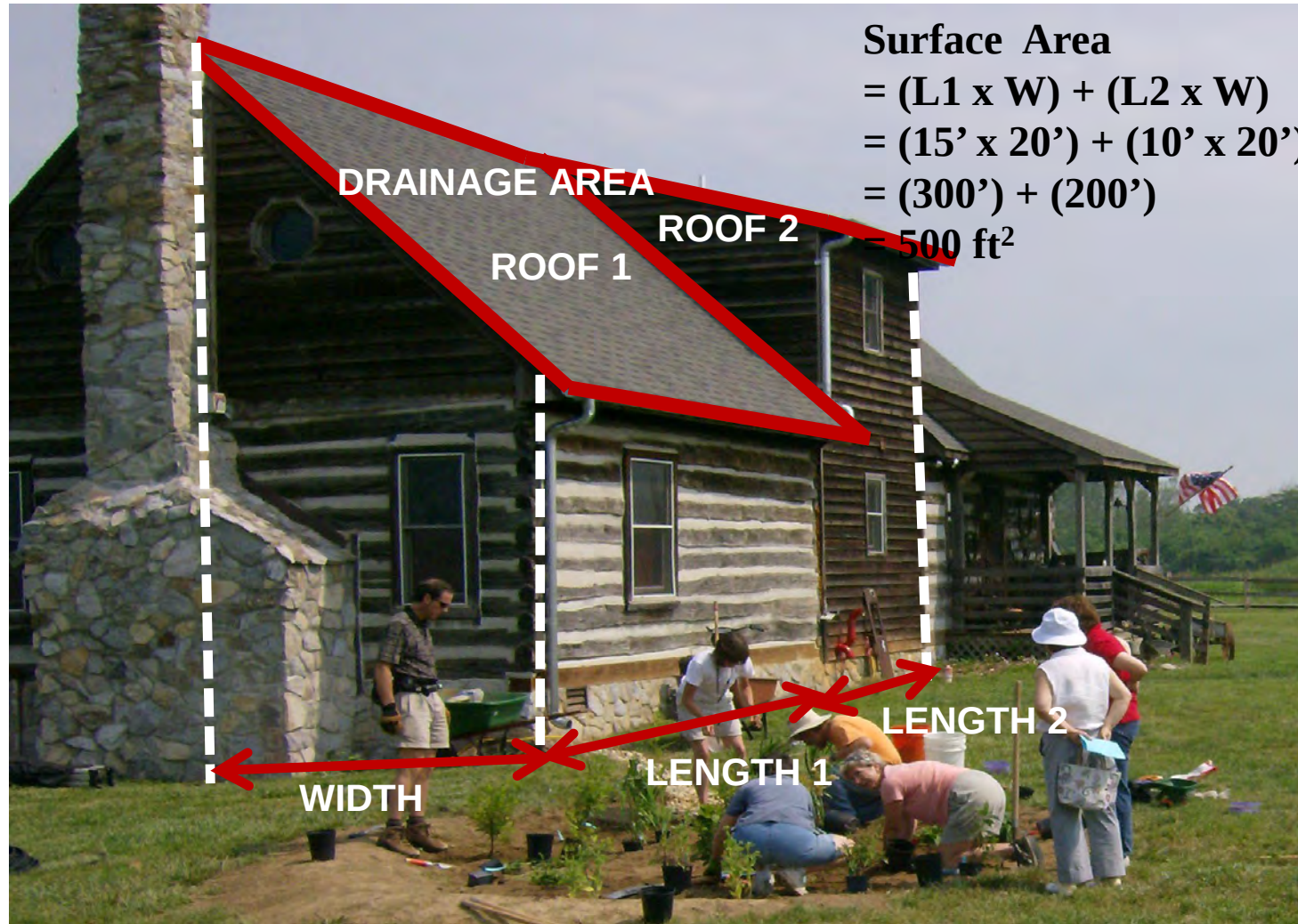
	ELECTRIC
	GAS, OIL, STEAM
	COMMUNICATIONS, CATV
	WATER
	SEWER

- **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

DRAINAGE AREA CALCULATION



p. 20



Surface Area

$$= (L1 \times W) + (L2 \times W)$$

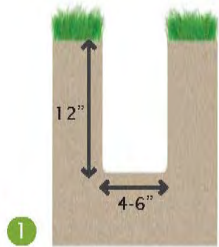
$$= (15' \times 20') + (10' \times 20')$$

$$= (300') + (200')$$

$$= 500 \text{ ft}^2$$



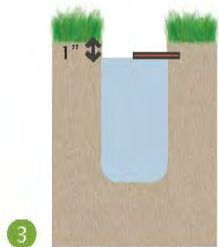
CHECK YOUR SOIL



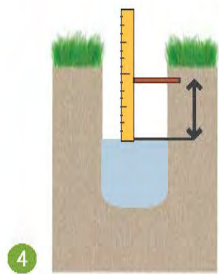
1



2



3



4

- 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



p. 25

6" DEEP RAIN GARDEN - NO SOIL AMENDMENTS



3" DEEP RAIN GARDEN - SOIL AMENDMENTS



- 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)

Drainage Area	Size of 3" Deep Rain Garden CLAY SOIL*	Size of 6" Deep Rain Garden SILTY SOIL	Size of 8" Deep Rain Garden SANDY SOIL
500 ft ²	200 ft ²	100 ft ²	75 ft ²
750 ft ²	350 ft ²	150 ft ²	112 ft ²
1,000 ft ²	400 ft ²	200 ft ²	149 ft ²
1,500 ft ²	600 ft ²	300 ft ²	224 ft ²
2,000 ft ²	800 ft ²	400 ft ²	299 ft ²

*SOIL TEXTURE AMENDMENTS NEEDED

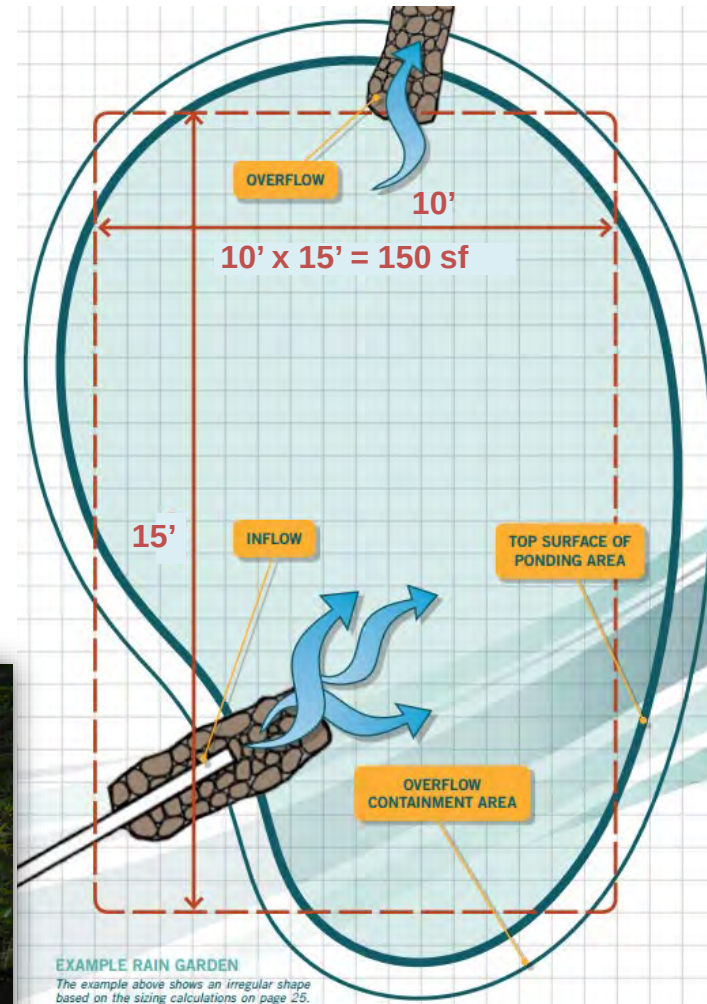
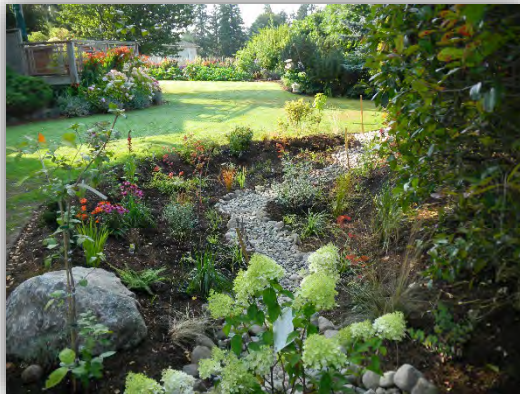
RAIN GARDENS

Typical Size

Modified from Rain Garden Handbook for Western WA

What is a typical rain garden size?

- Typically 100-200 square feet.
- A 100 square foot rain garden will often receive water from an area 5 to 10 times larger than the rain garden..





SOIL AMENDMENTS

- Soil amendments improve the rain garden's infiltration rate and help the plants grow





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 (River Stone)



DETERMINING MULCH QUANTITY



p. 27



- 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)



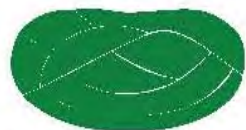
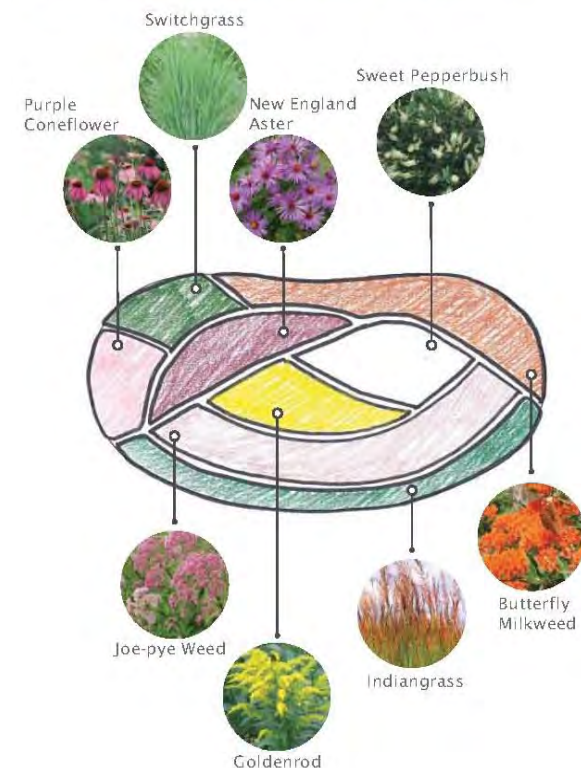


RAIN GARDEN DESIGN

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

Butterfly Habitat Rain Garden: Planting Plan



May



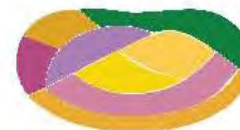
June



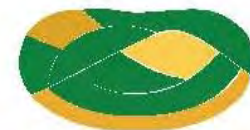
July



August



September



October



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

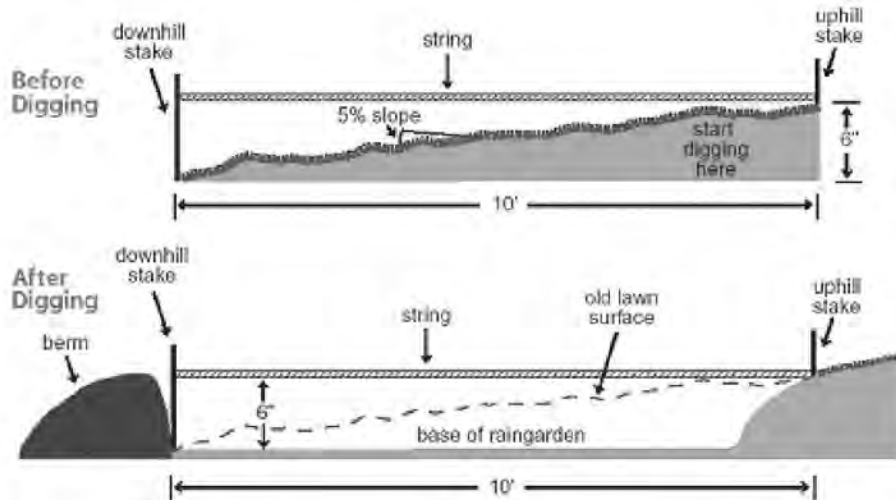
- Add soil amendments, if necessary



- Combine amendments with existing soil using shovels or rototiller
- Loosen and prepare soil for grading and planting

STEP FOUR

- Prepare the berm, if necessary



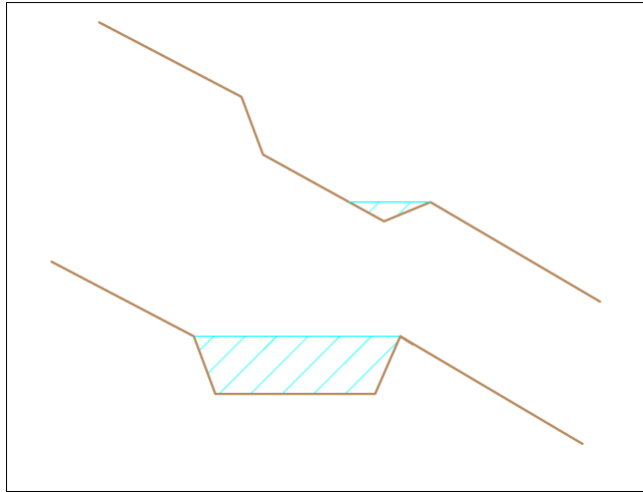
STEP FIVE

- Prepare the overflow



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



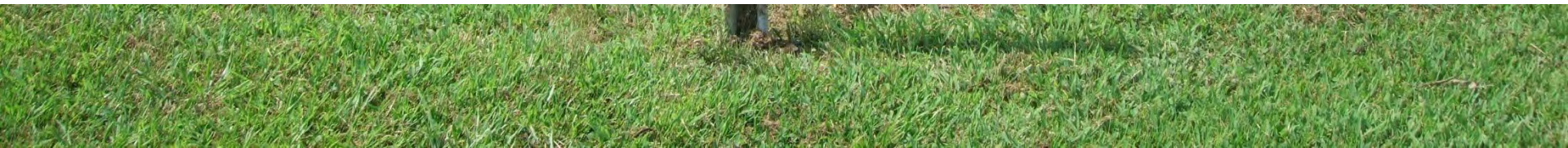
STEP TEN

- Appreciate a job well done



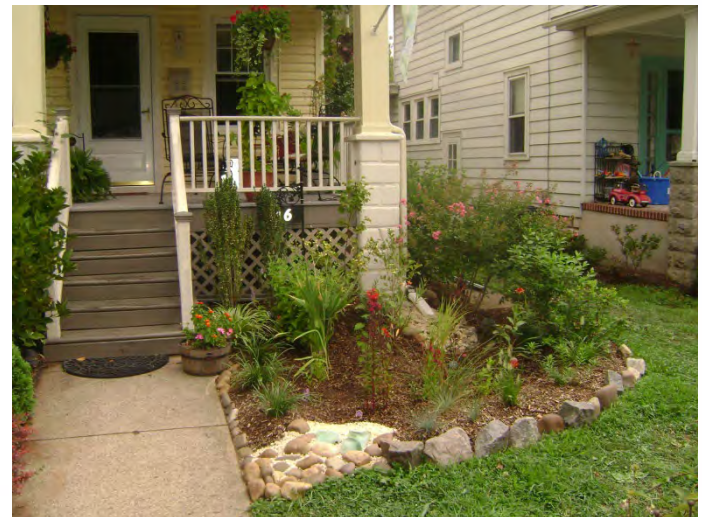


RAIN GARDEN PLANTING DESIGN



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



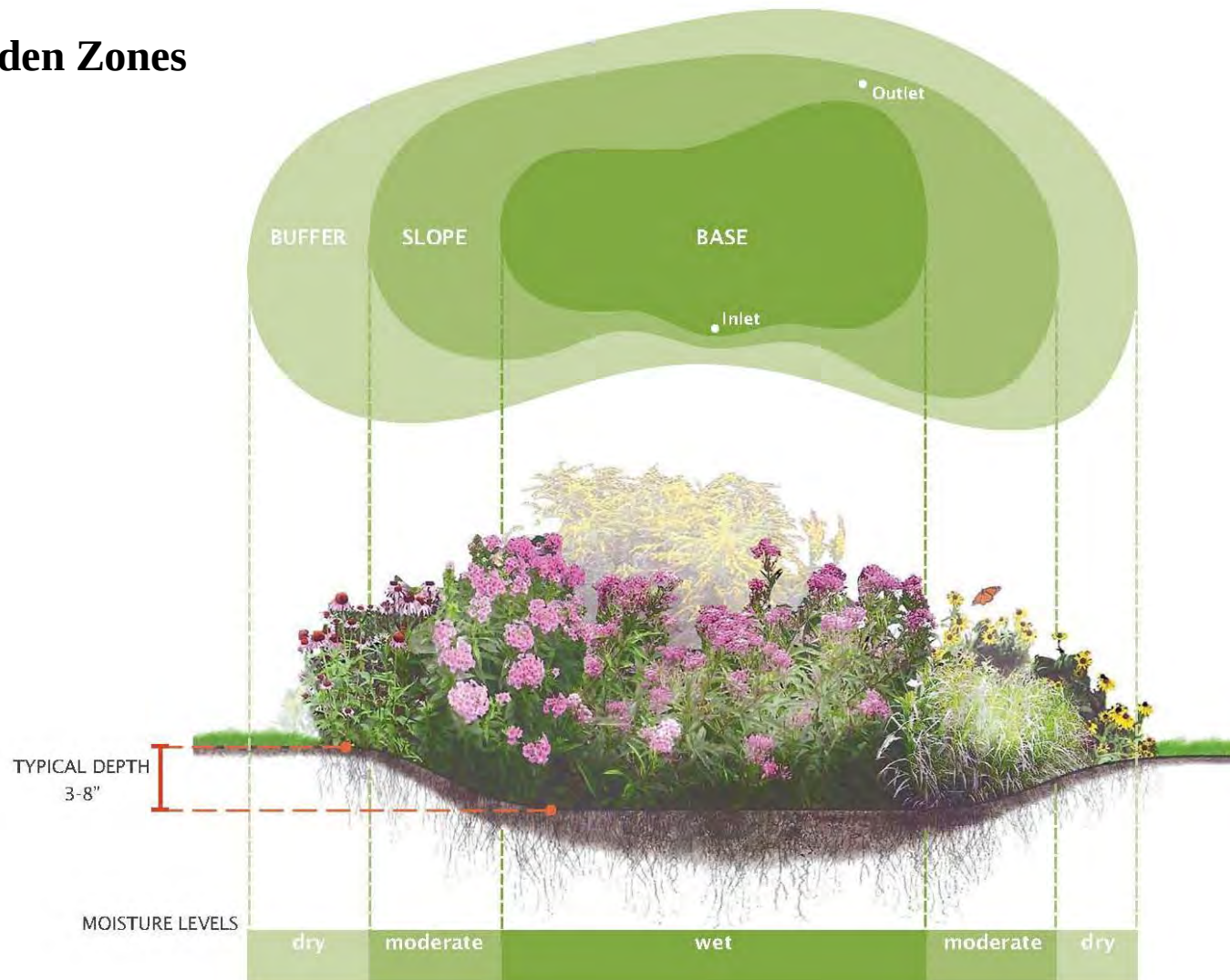
PLANTS IN THE RIGHT PLACE...



Courtesy of Pinelands Nursery & Supply

PLANTING DESIGN: Wet + Dry Conditions

Rain Garden Zones



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



BUFFER

- Broomsedge
- Bearberry
- Panic grass
- Switchgrass
- Little bluestem
- Indiangrass

BASE

- Big bluestem
- Virginia wild-rye
- Switchgrass
- Wool grass

SLOPE

- Bluejoint grass
- Sedges
- Fowl mannagrass
- Softrush

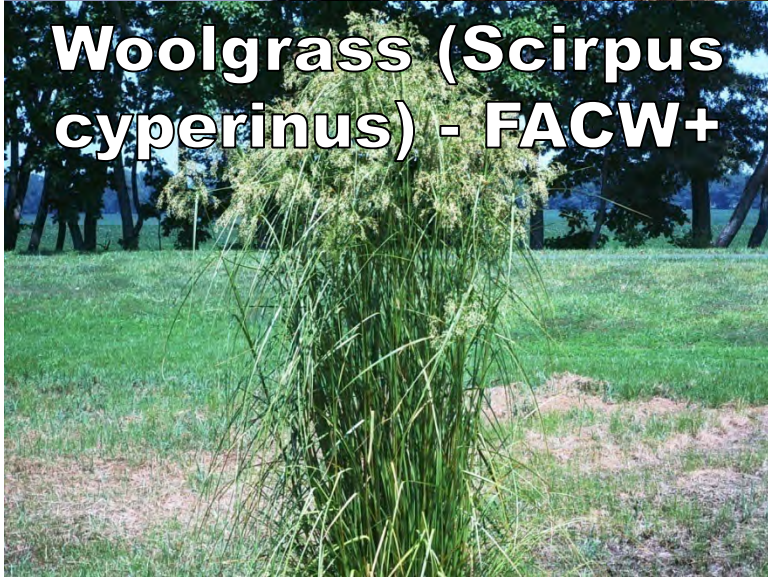


GRASSES & GROUND COVERS

Switchgrass
(*Panicum virgatum*) - FAC



Woolgrass (*Scirpus cyperinus*) - FACW+



Tussock Sedge
(*Carex stricta*) - OBL



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



WILDFLOWERS



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



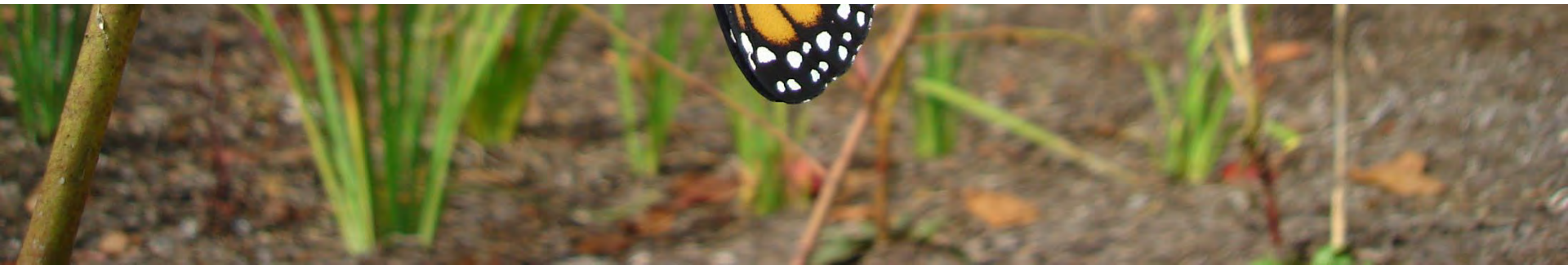
TREES & SHRUBS





INSPECTION AND MAINTENANCE

MAINTAINING YOUR RAIN GARDEN



MAINTENANCE MEASURES

WEEKLY TASKS:

1. Watering
2. Weeding
3. Inspecting

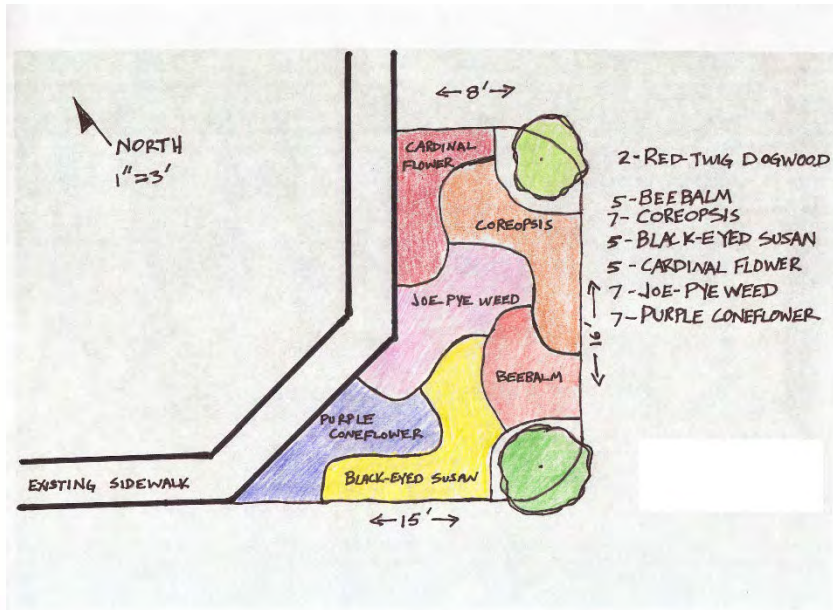
ANNUAL TASKS:

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)

Installed Rain Gardens from the Rain Garden Rebate Program

Design Example for Roof Runoff

Design



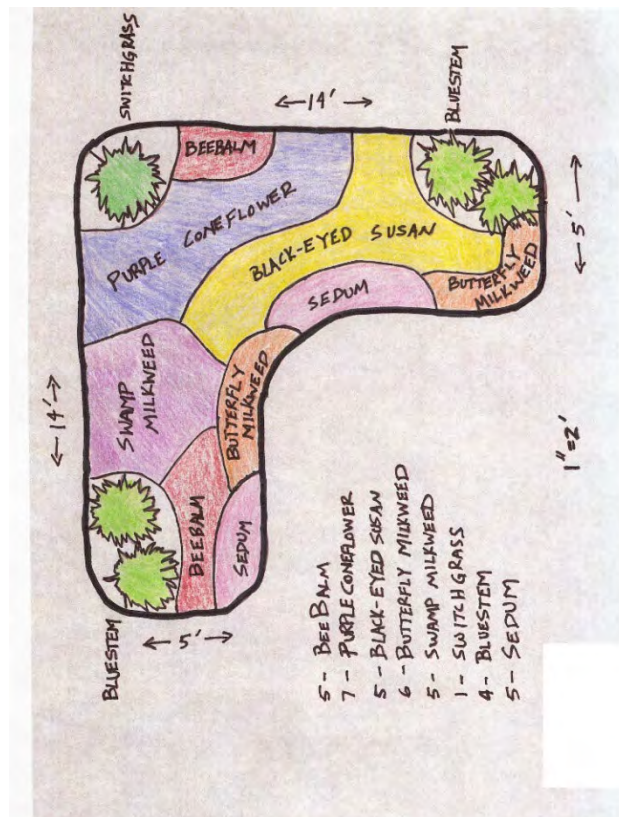
Installed Rain Garden





Design Example for Parking Lot Runoff

Design

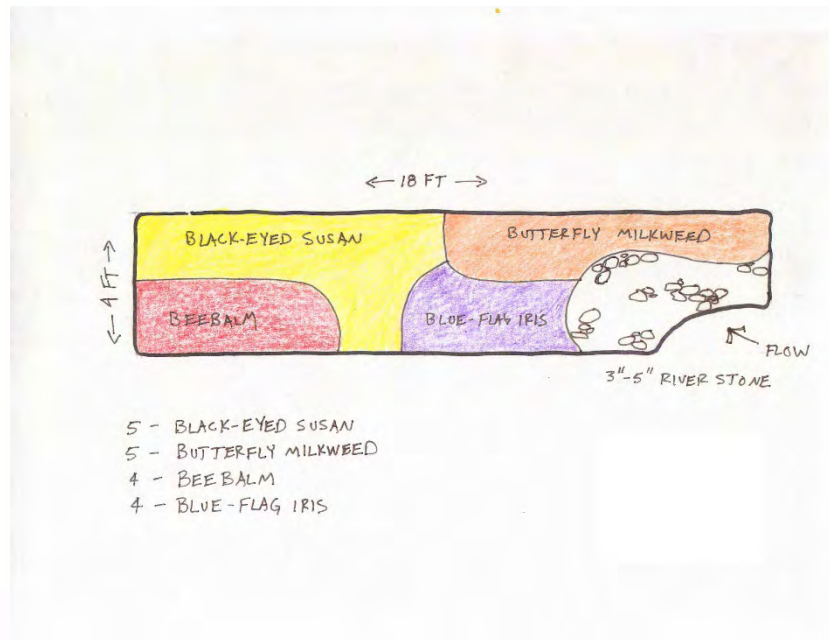


Installed Rain Garden



Roof, Sump Pump and Driveway Runoff – WOW!

Design



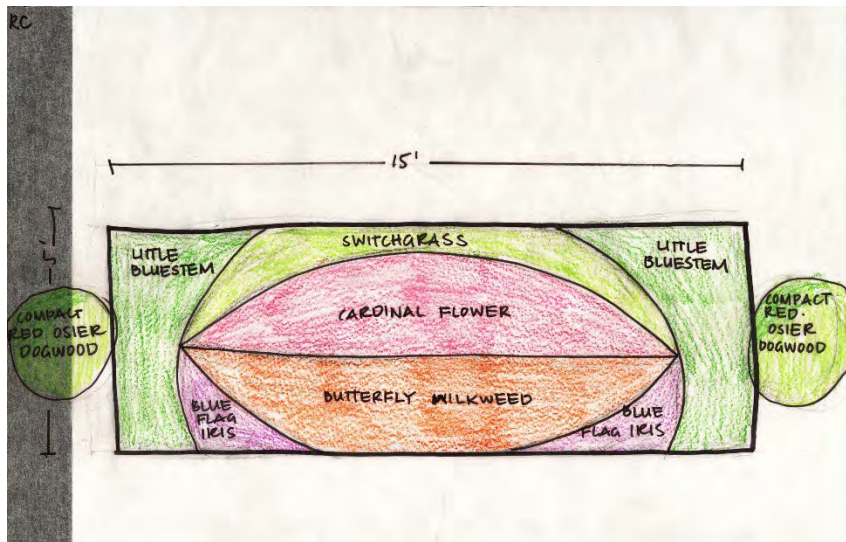
Installed Rain Garden





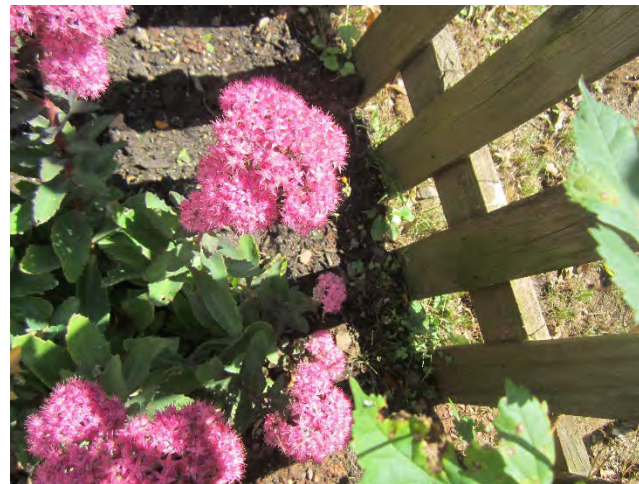
Roof Runoff from Rain Barrel Overflow

Design



Installed Rain Garden







10/12/2018



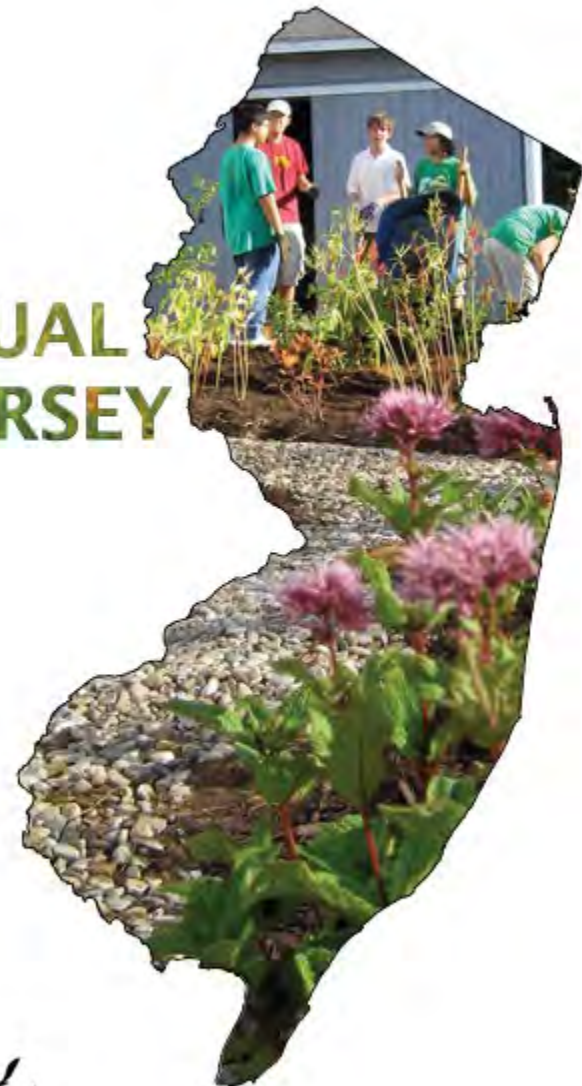
10/12/2015

Season 2



10/12/2018

RAIN GARDEN MANUAL OF NEW JERSEY





Rain Garden 4+

University of Connecticut
Designed for iPhone

★★★★★ 2.6 • 11 Ratings

Free

iPhone Screenshots



Artistic Rendering Help Sell A Project



"Protecting Public Health and the Environment"

RUTGERS

New Jersey Agricultural
Experiment Station



Artistic Rendering Help Sell A Project



"Protecting Public Health and the Environment"

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CURRENT CONDITION



CONCEPT DESIGN



RUTGERS

New Jersey Agricultural
Experiment Station



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