Stormwater Basics

Paraprofessional Watershed Restoration Training

October 3, 2013
Duke Farms, Hillsborough, NJ

Christopher C. Obropta, Ph.D., P.E.
Email: obropta@envsci.rutgers.edu

Jessica Brown, EIT
jess@envsci.rutgers.edu

www.water.rutgers.edu

RUTGERS
New Jersey Agricultural Experiment Station

Water Resources Program

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.

RUTGERS
New Jersey Agricultural Experiment Station

Water Resources Program

OVERVIEW

1. What is a watershed?
2. Where does precipitation go?
3. Land Use/Land Cover Changes
4. Nonpoint Source Pollution
5. How can we better manage stormwater?

RUTGERS
New Jersey Agricultural Experiment Station
Water Resources Program

WHAT IS A WATERSHED?

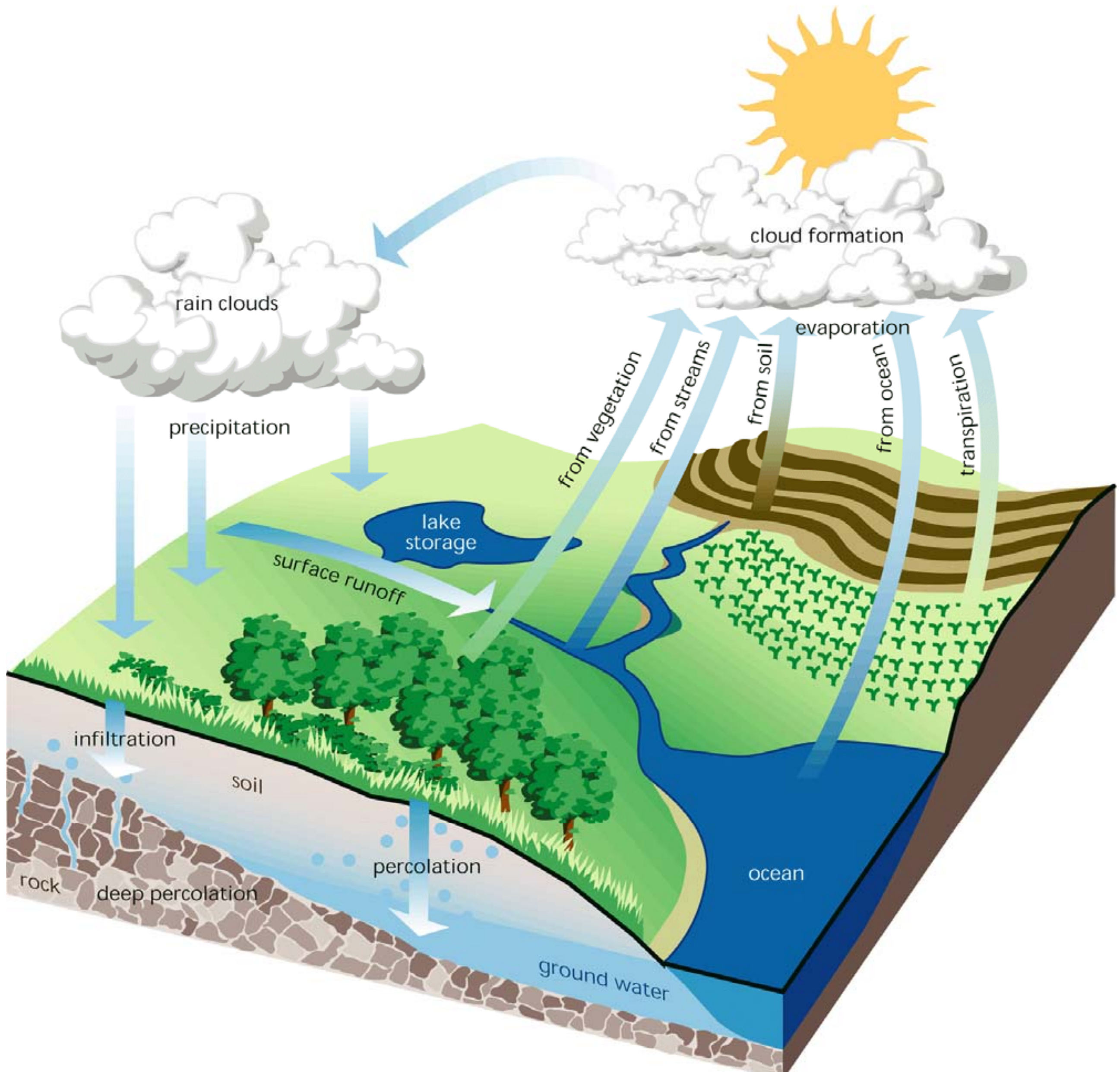
- An area of land that water flows across, through, or under on its way to a stream, river, lake, ocean or other body of water.

- A watershed is like one big bathtub...

[Do you know what a watershed is?]

Courtesy of Texas Watershed Stewards, Texas A&M AgriLife Extension

HYDROLOGIC CYCLE



Courtesy of www.fgmorph.com

WHERE DOES PRECIPITATION GO?

1. It can *run off*

Courtesy of Texas Watershed Stewards, Texas A&M AgriLife Extension

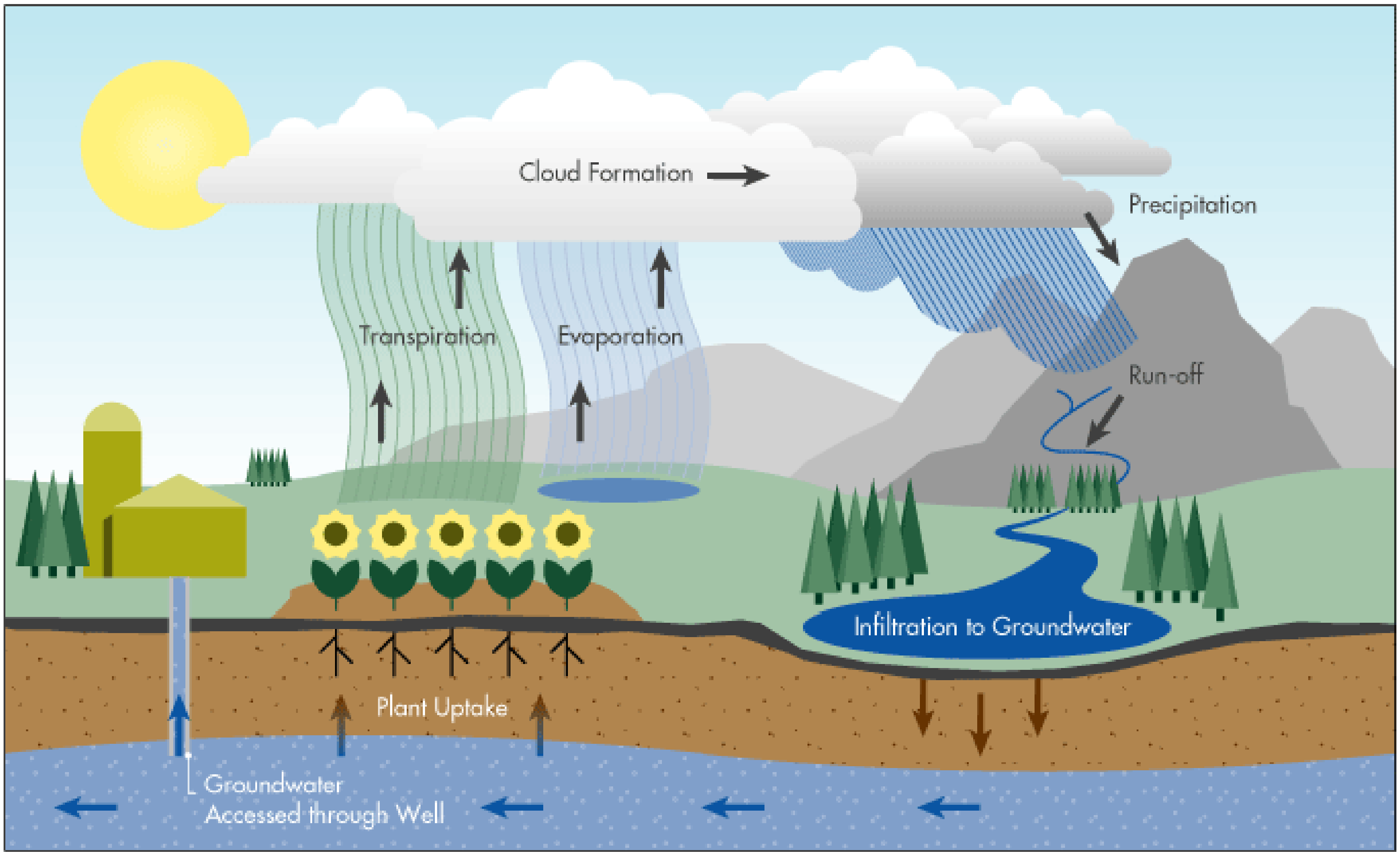
WHERE DOES PRECIPITATION GO?

2. It can be *absorbed* by plants and used for photosynthesis and other biological processes

Courtesy of Texas Watershed Stewards, Texas A&M AgriLife Extension

WHERE DOES PRECIPITATION GO?

3. It can *infiltrate* through the soil surface and percolate downward to groundwater *aquifers*



Courtesy of Texas Watershed Stewards, Texas A&M AgriLife Extension

Rutgers New Jersey Agricultural Experiment Station
Water Resources Program

WHERE DOES PRECIPITATION GO?

4. It can *evaporate*

Courtesy of Texas Watershed Stewards, Texas A&M AgriLife Extension

The Impact of Development on Stormwater Runoff

More development → *More impervious surfaces* → *More stormwater runoff*

LAND USE/LAND COVER CHANGES

LAND USE

HOW LAND IS USED BY HUMANS:

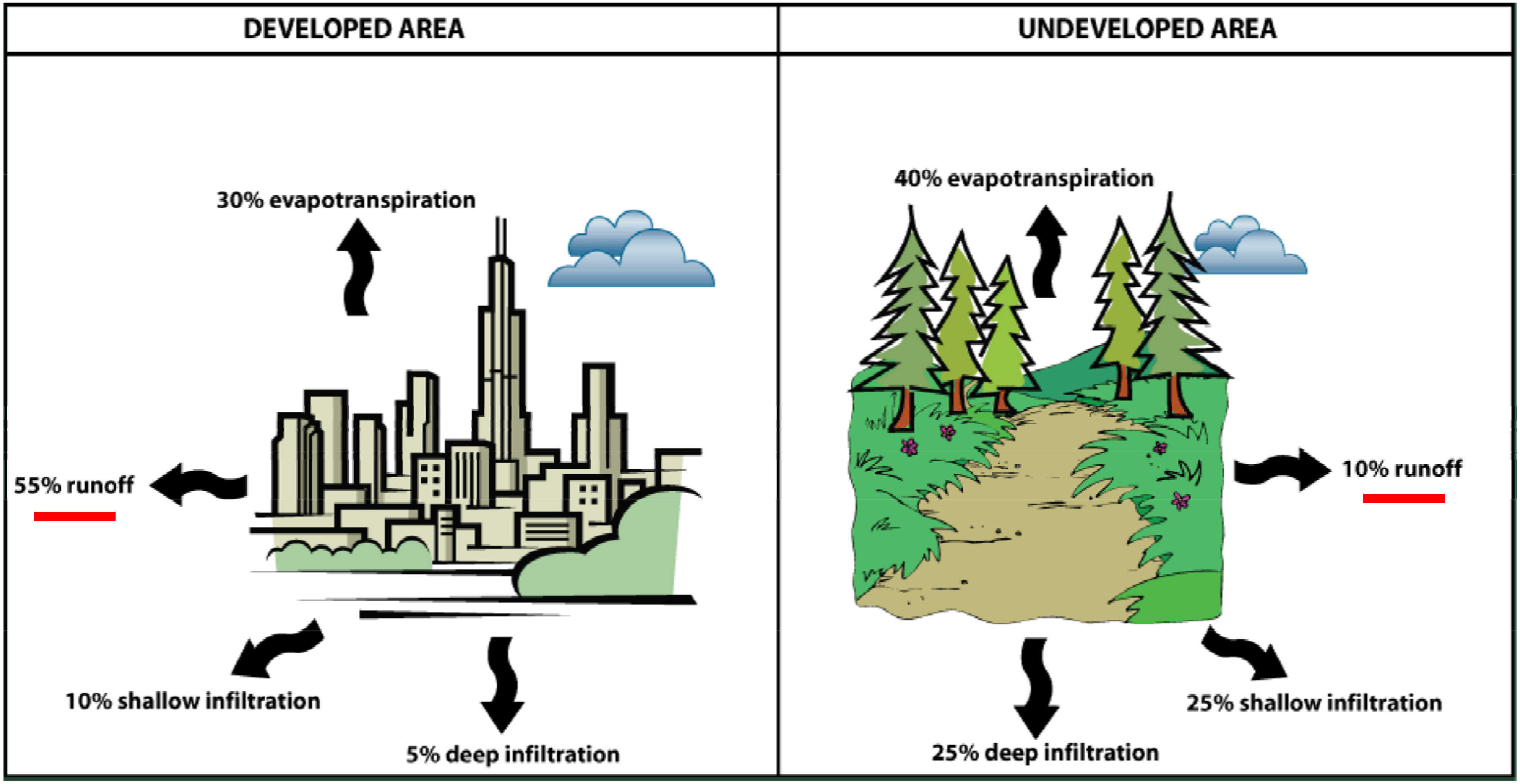
- AGRICULTURE
- INDUSTRY
- URBAN
- RESIDENTIAL
- RECREATION

LAND COVER

BIOLOGICAL AND PHYSICAL FEATURES OF THE LAND:

- FORESTS
- GRASSLANDS
- AGRICULTURAL FIELDS
- RIVERS, LAKES
- BUILDINGS, PARKING LOTS

LAND USE/LAND COVER CHANGES

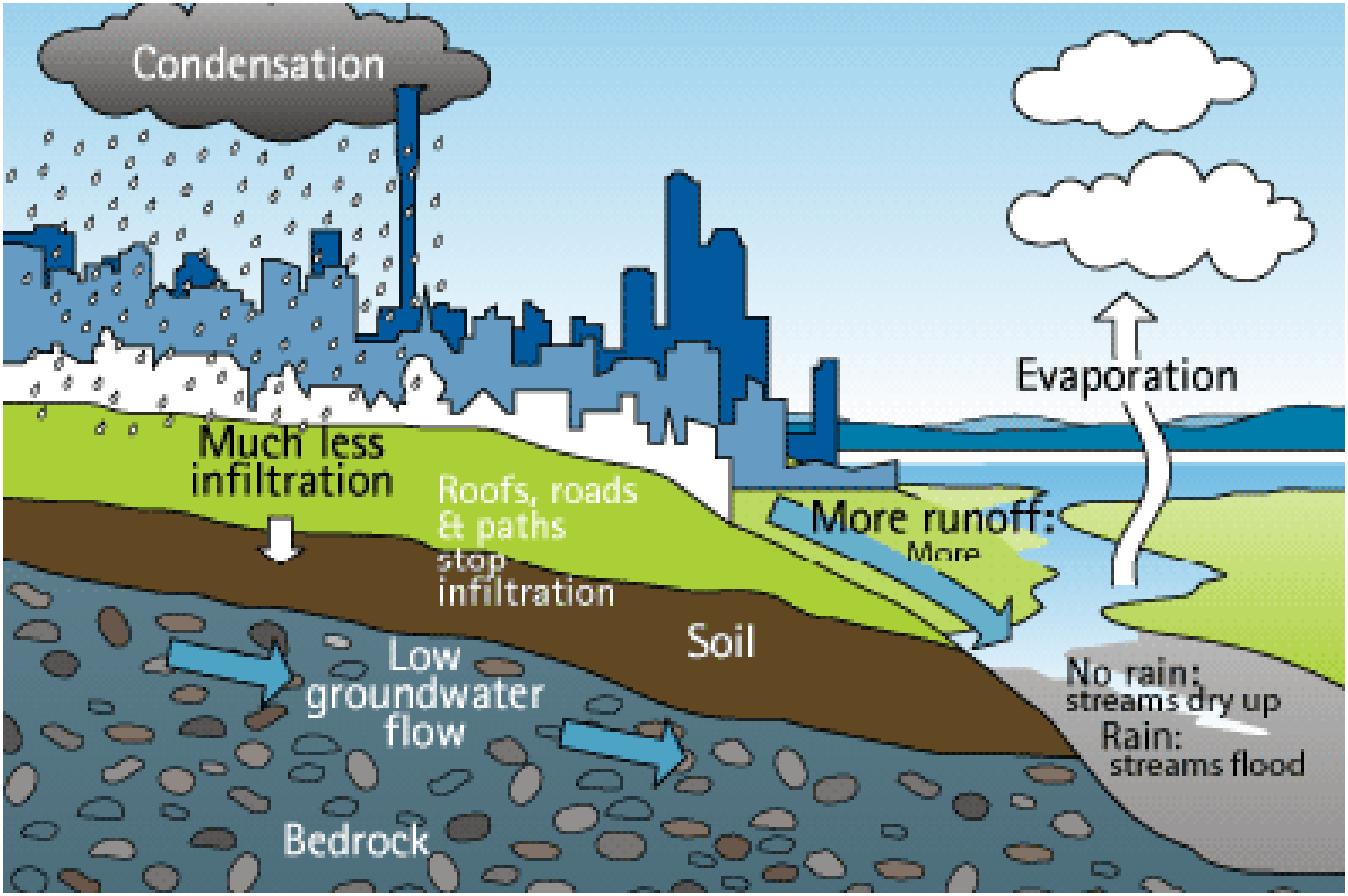


Courtesy of Texas Watershed Stewards, Texas A&M AgriLife Extension

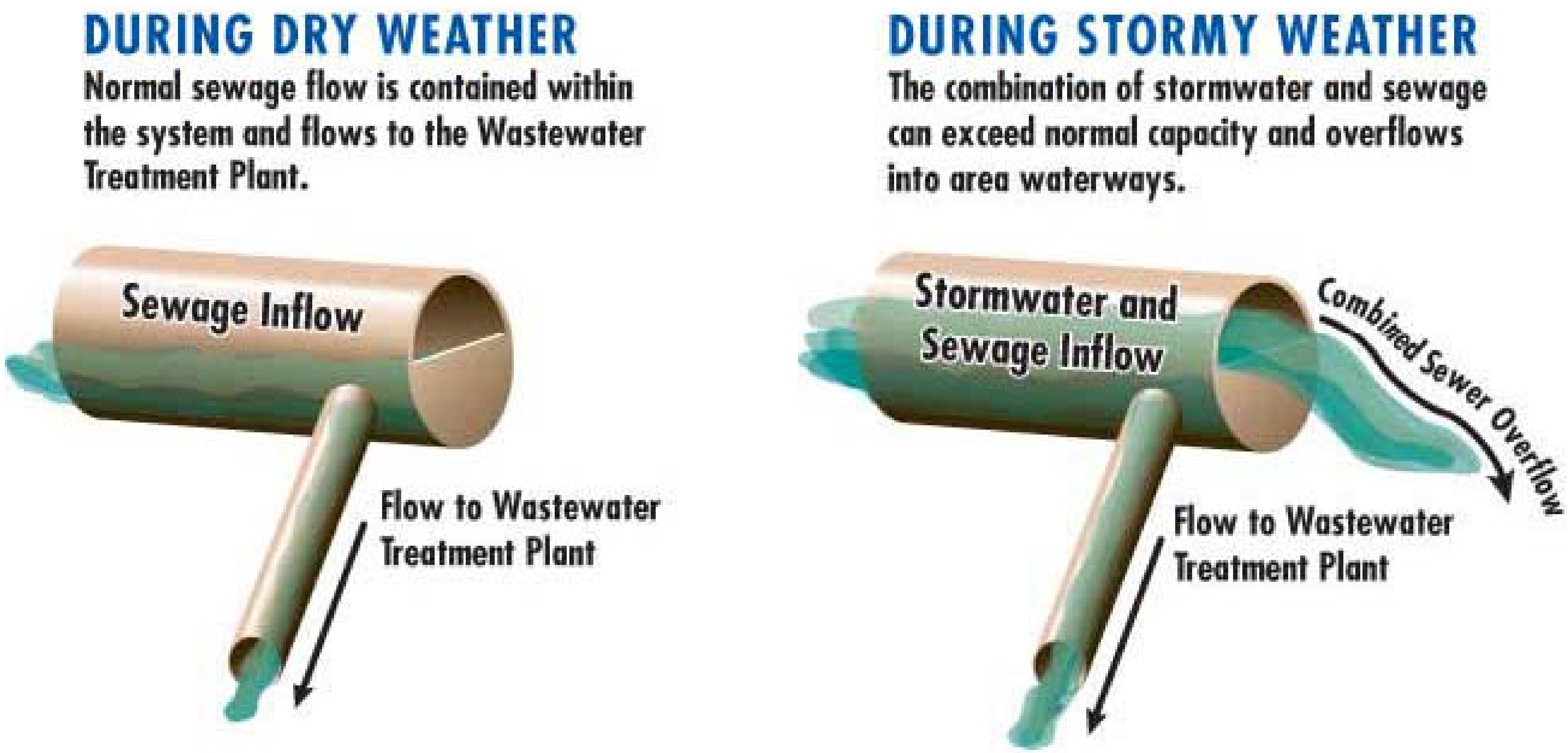
RUTGERS New Jersey Agricultural Experiment Station

Water Resources Program

The *Urban* Hydrologic Cycle

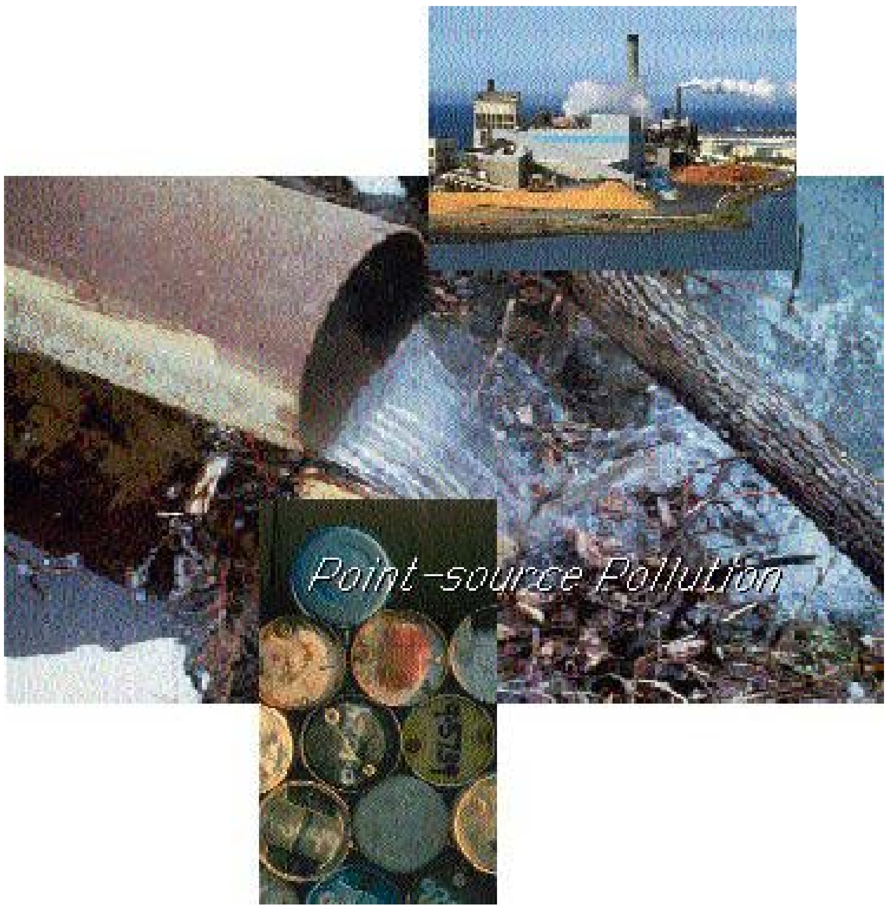


Combined Sewer Systems (CSOs)



WATER POLLUTION SOURCES

POINT SOURCE POLLUTION



NONPOINT SOURCE POLLUTION

Environmental Health Perspective, National Institute of Health

POINT SOURCE POLLUTION

- Comes from a specific source, like a pipe
- Factories, industry, municipal treatment plants
- Can be monitored and controlled by a permit system (NPDES)

RUTGERS
New Jersey Agricultural Experiment Station

Water Resources Program

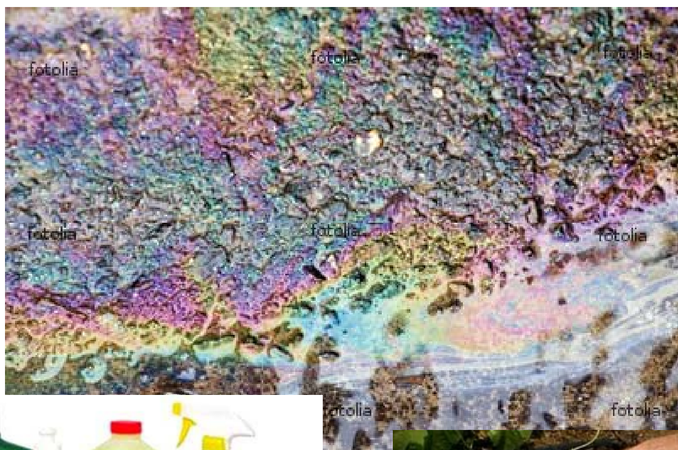
Nonpoint Source Pollution (NPS)

- Associated with stormwater runoff
- Runoff collects pollutants on its way to a sewer system or water body
- **It cannot be traced** to a direct discharge point such as a wastewater treatment facility

RUTGERS
New Jersey Agricultural Experiment Station
Water Resources Program

EXAMPLES OF NPS

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





Impacts from Changing the Landscape

Hydrologic Effects:

- Disruption of natural water balance
- Increased flood peaks
- Increased stormwater runoff
- More frequent flooding
- Increased bankfull flows
- Lower dry weather flows

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

RUTGERS
New Jersey Agricultural Experiment Station

Water Resources Program

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

How NJ's regulations change the way we manage stormwater

ASLA VIDEO

Video by the American Society of Landscape Architects

Play

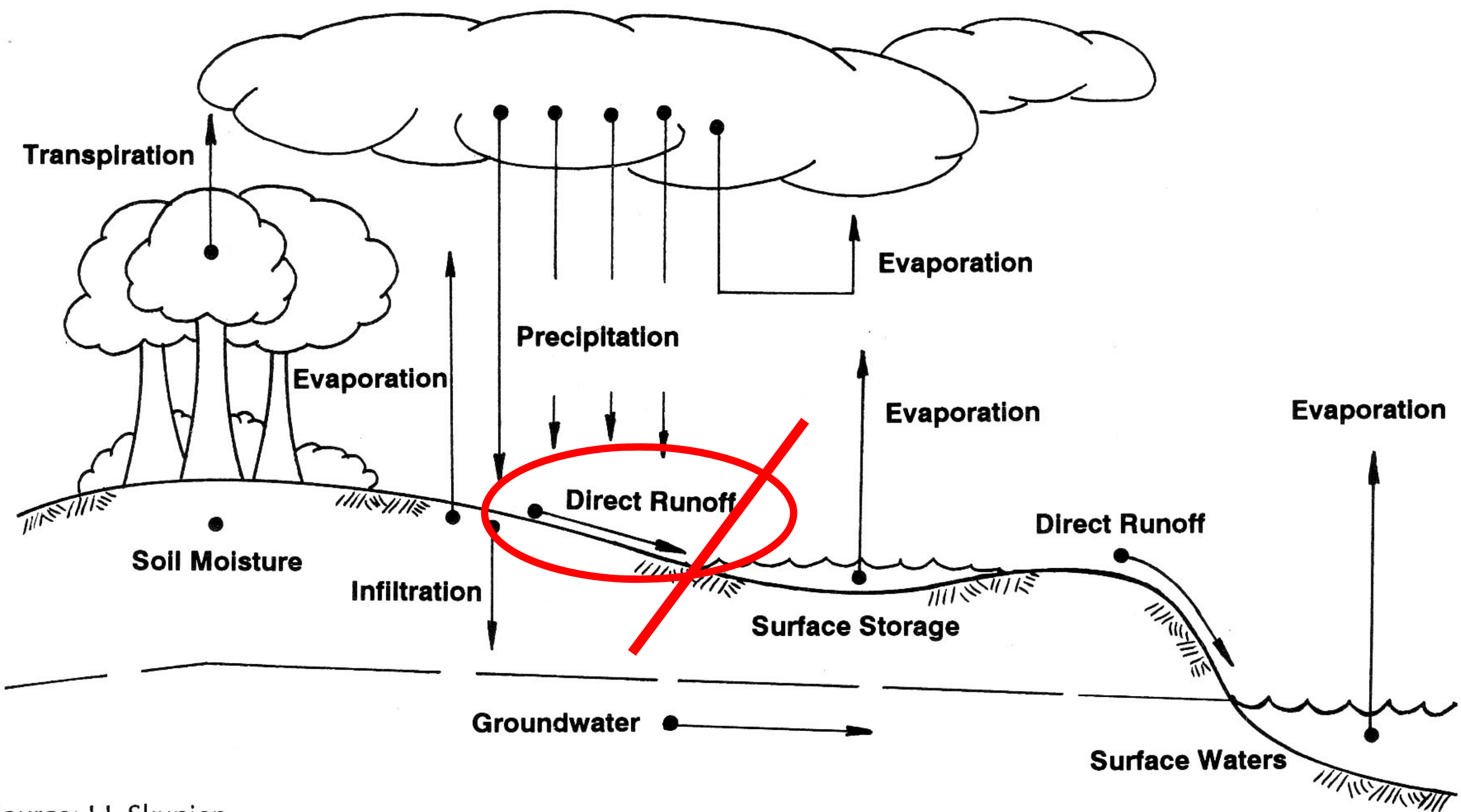
Stormwater Management

It is all about controlling runoff from impervious surfaces

Rutgers New Jersey Agricultural Experiment Station

Water Resources Program

The Hydrologic Cycle



Source: J.J. Skupien.

We must deal with impacts from impervious cover

Are there impervious surfaces that you can eliminate?

If we can't eliminate it, can we reduce it?

If we can't eliminate or reduce it, can we disconnect it?

Are there impervious surfaces that you can harvest rainwater for reuse?

Are there conveyance systems that can be converted to bioswales?

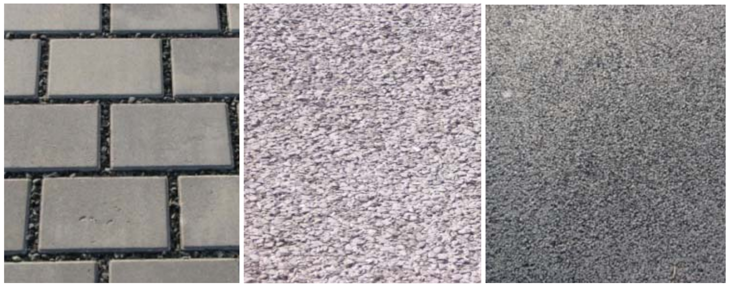
Eliminate it!

RUTGERS
New Jersey Agricultural Experiment Station

Water Resources Program

Reduce It!
Pervious Pavements

- Underlying stone reservoir
- Porous asphalt and pervious concrete are manufactured without "fine" materials to allow infiltration
- Grass pavers are concrete interlocking blocks with open areas to allow grass to grow
- Ideal application for porous pavement is to treat a low traffic or overflow parking area

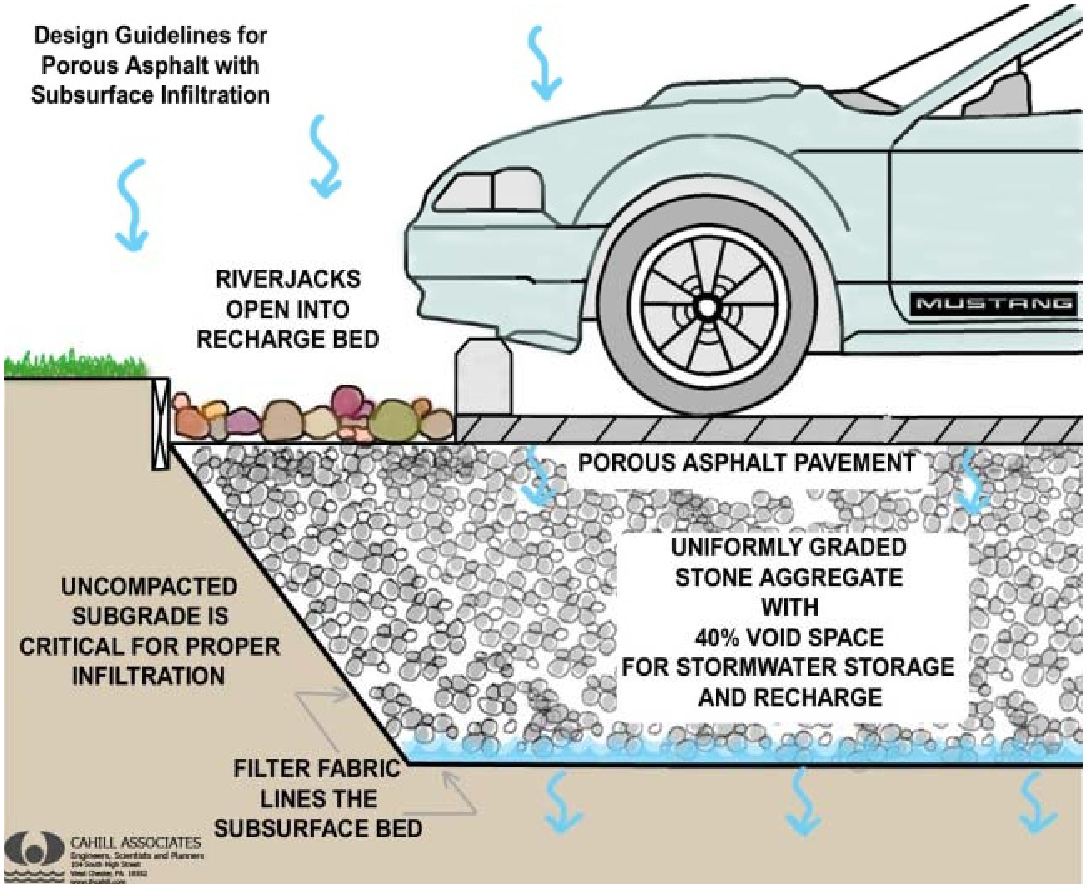


Pervious Pavements

FUNCTIONS

- 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



RUTGERS New Jersey Agricultural Experiment Station
Water Resources Program

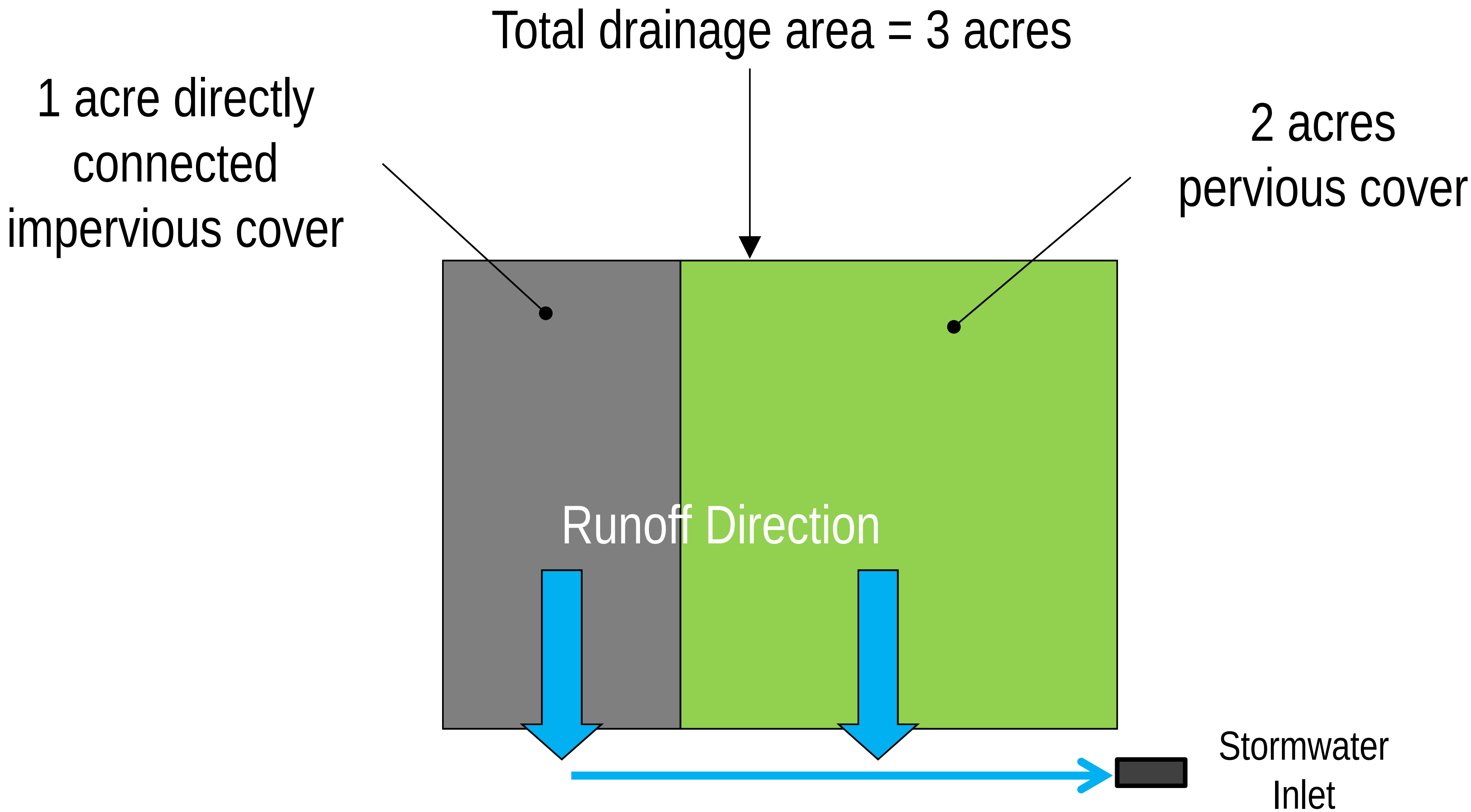
Pervious Pavement

Pervious Pavements

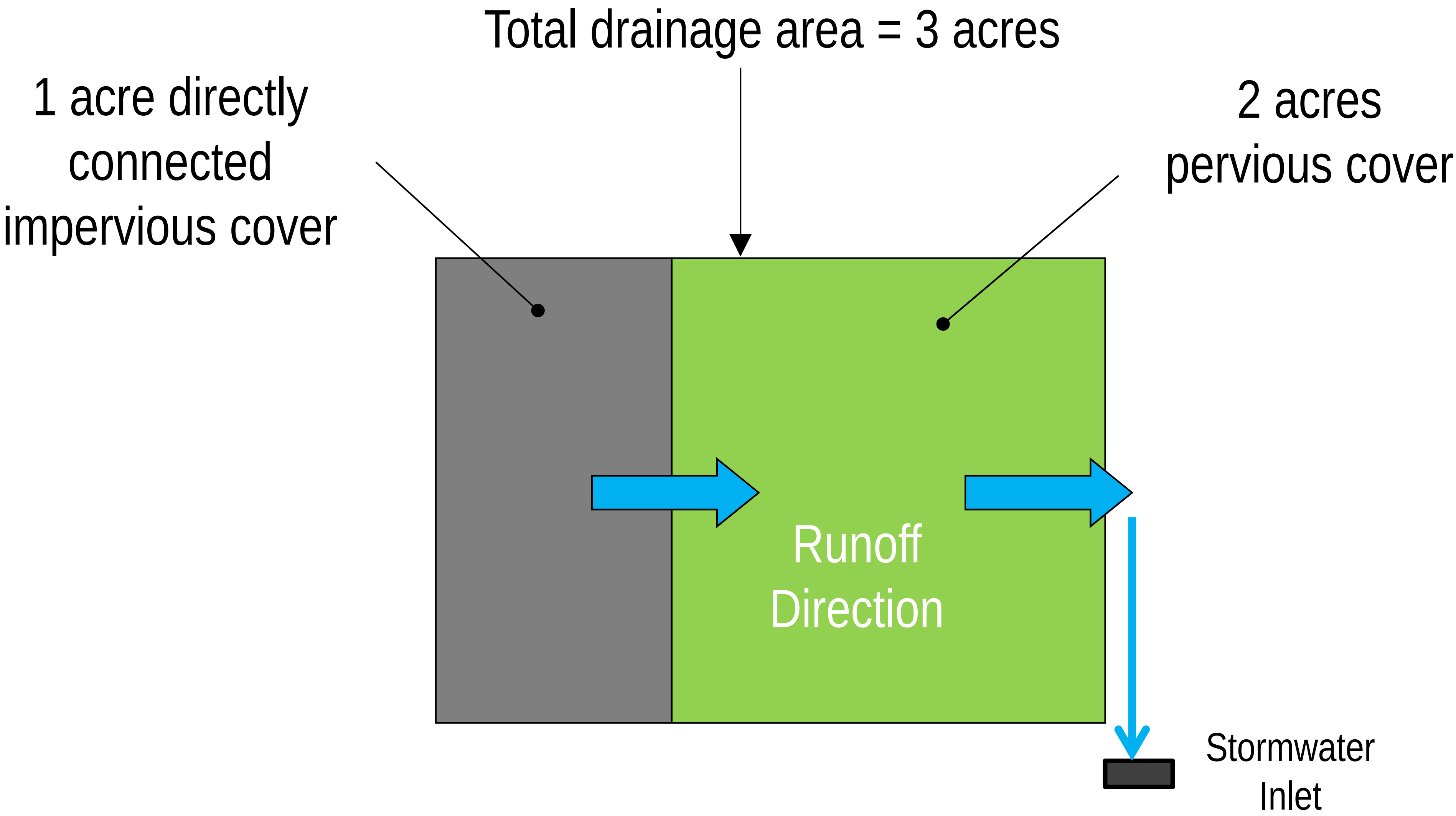
Disconnect It!

RUTGERS New Jersey Agricultural Experiment Station
Water Resources Program

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

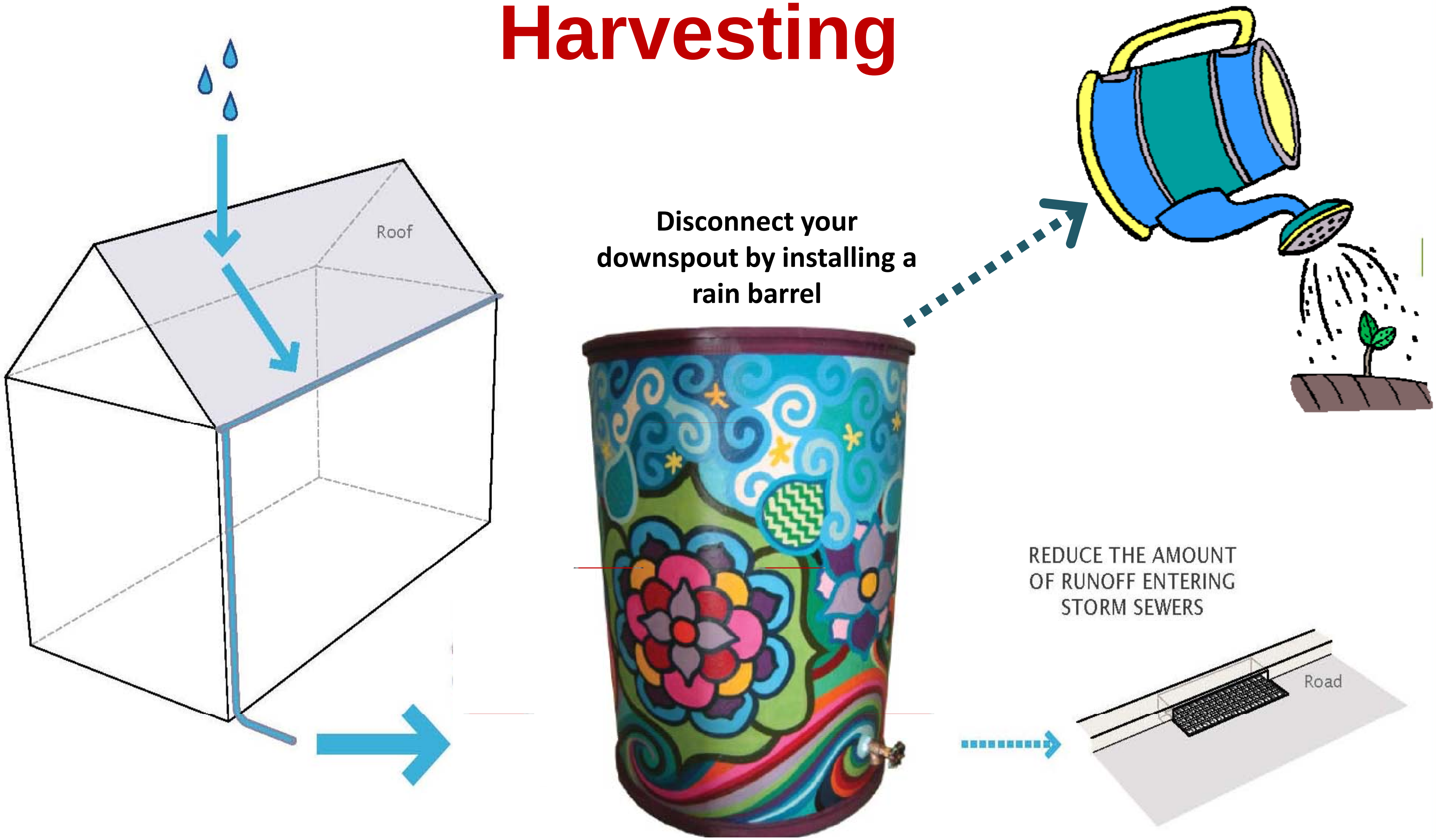


For 1.25 inch storm, 581 cubic feet of runoff = **4,360 gallons**



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

Disconnection with Rain Water Harvesting

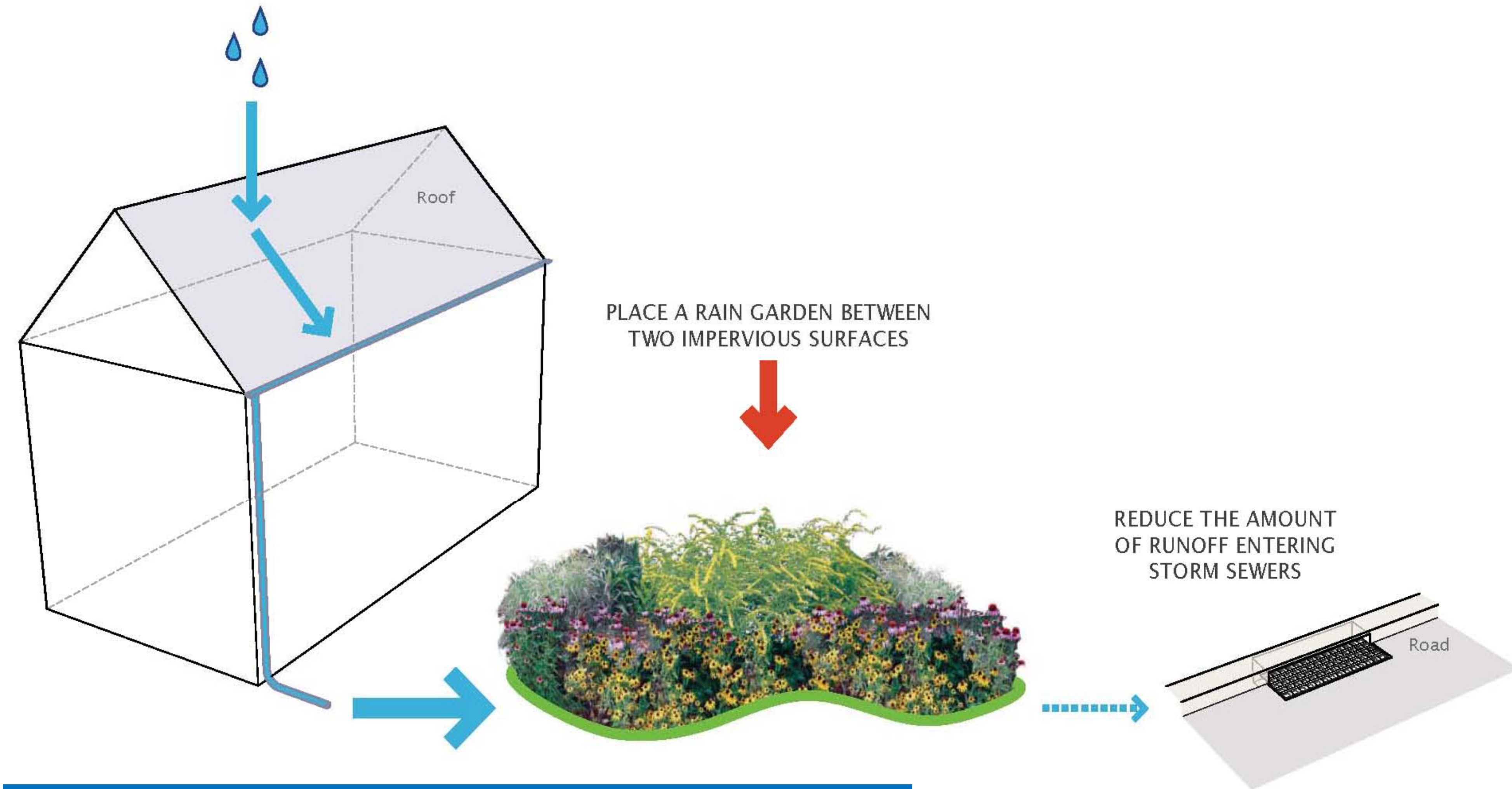


Impervious area is now ***"disconnected"*** from flowing directly into the storm sewer system

So Many Barrels to Choose From…

Or Larger Rainwater Harvesting Systems…

Disconnection with Rain Gardens



Rooftop runoff is now ***"disconnected"*** from flowing directly into the storm sewer system

Lots of Rain Gardens

Green Infrastructure is …

…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.

RUTGERS New Jersey Agricultural Experiment Station
Water Resources Program

Green Infrastructure includes:

Green Roofs

Rainwater Harvesting

Planter Boxes

Rain Gardens

Permeable Pavements

Vegetated Swales

Natural Retention Basins

Trees & Urban Forestry

Brownfield Redevelopment


Natural Retention Basins


Rain Gardens


Green Roofs


Permeable Pavements


Rainwater Harvesting

RUTGERS
New Jersey Agricultural Experiment Station

Water Resources Program

Rainwater Harvesting

FUNCTIONS

- Collecting, filtering and storing water from roof tops, paved and unpaved areas for multiple uses.
- Harvested water can be used for nonpotable or potable purposes after testing and treatment.
- Surplus water after usage can be used for recharging ground water.
- Systems can range in size from a simple PVC tank or cistern to a contractor designed and built tank/sump with water treatment facilities.


overflow pipe
roof washer system

Rainwater Harvesting

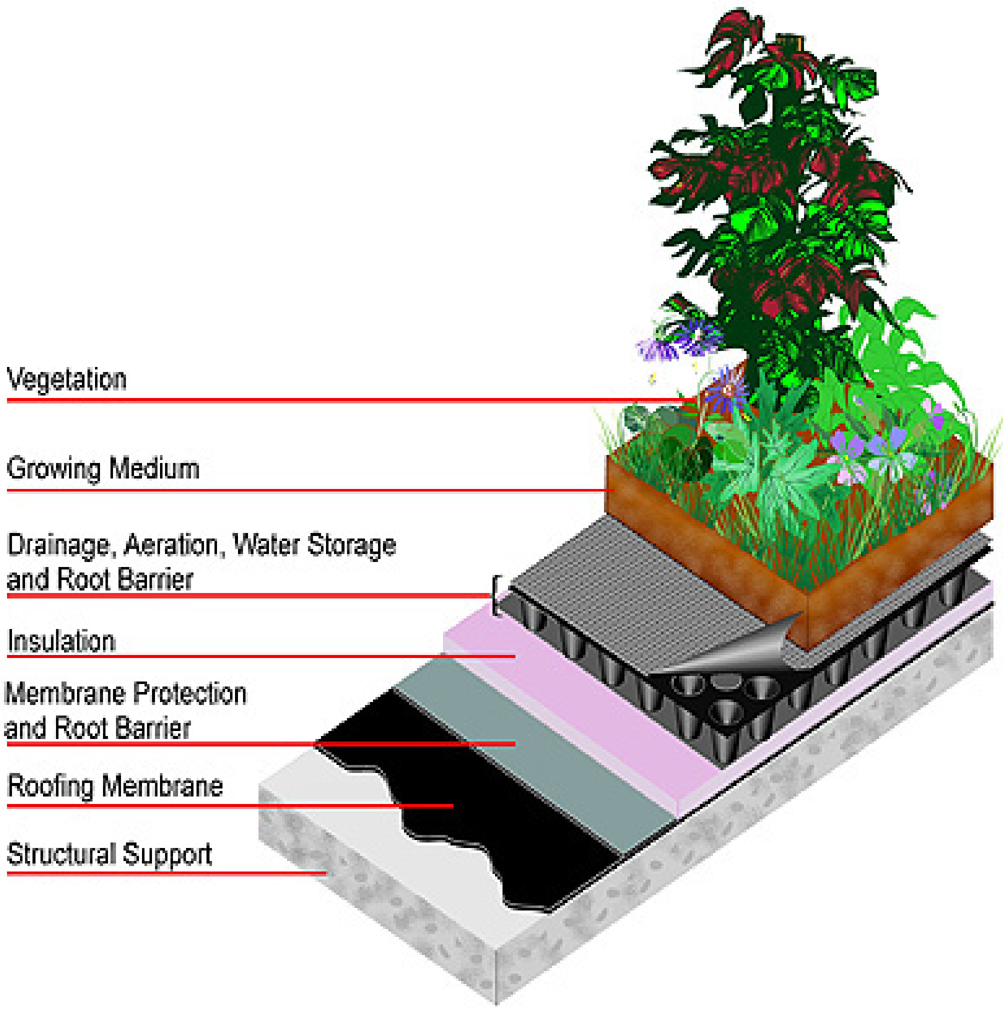
Samuel Mickle School Rainwater Harvesting System

Green Roofs

FUNCTIONS

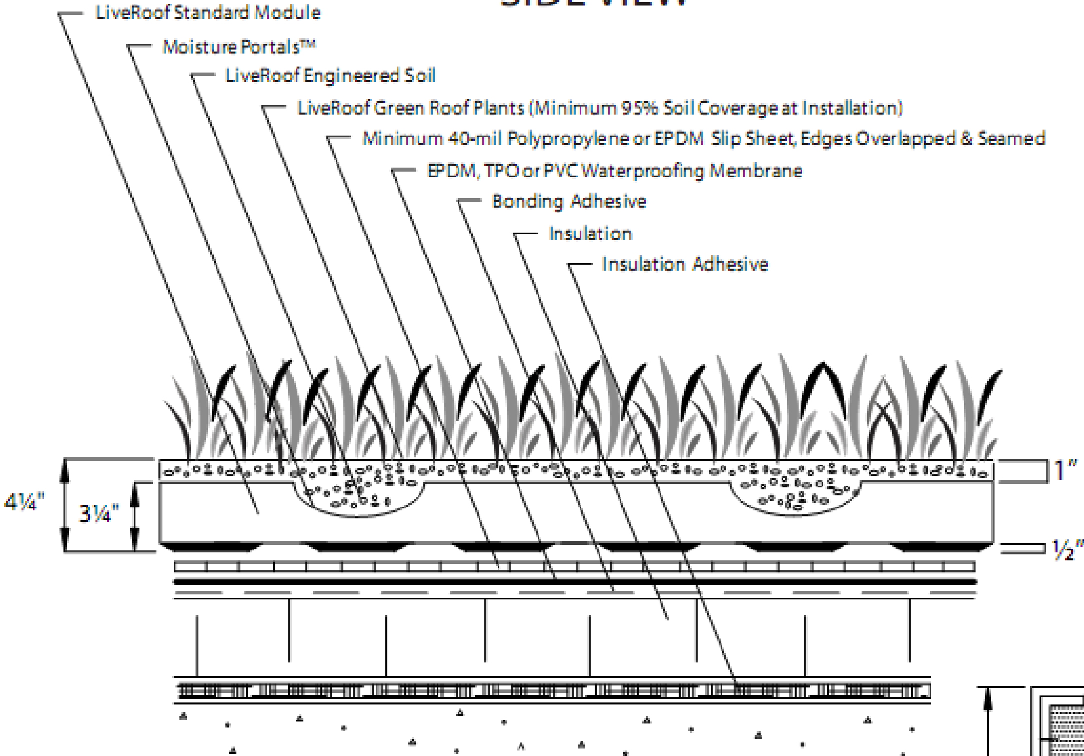
- Improves stormwater management
- Improves air quality
- Temperature regulation (moderation of Urban Heat Island Effect)
- Carbon dioxide/oxygen exchange
- Increased urban wildlife habitat

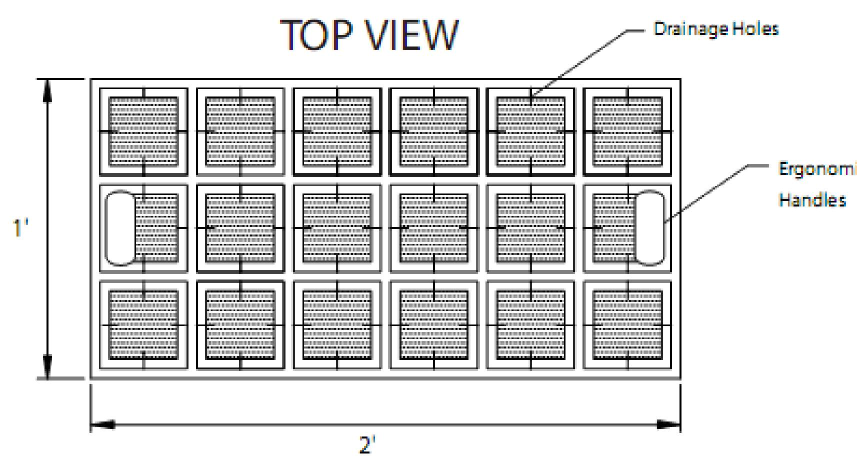
COMPONENTS



Green Roof Design

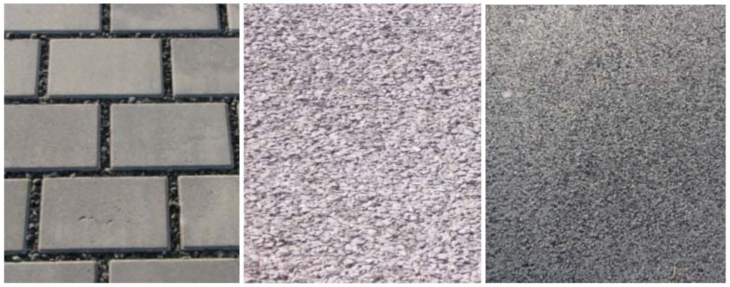
Modular System Specifications:





Pervious Pavements

- Underlying stone reservoir that temporarily stores surface runoff before infiltrating into the subsoil
- Porous asphalt and pervious concrete are manufactured without "fine" materials, and incorporate void spaces to allow infiltration
- Grass pavers are concrete interlocking blocks or synthetic fibrous grid systems with open areas designed to allow grass to grow within the void areas
- Ideal application for porous pavement is to treat a low traffic or overflow parking area

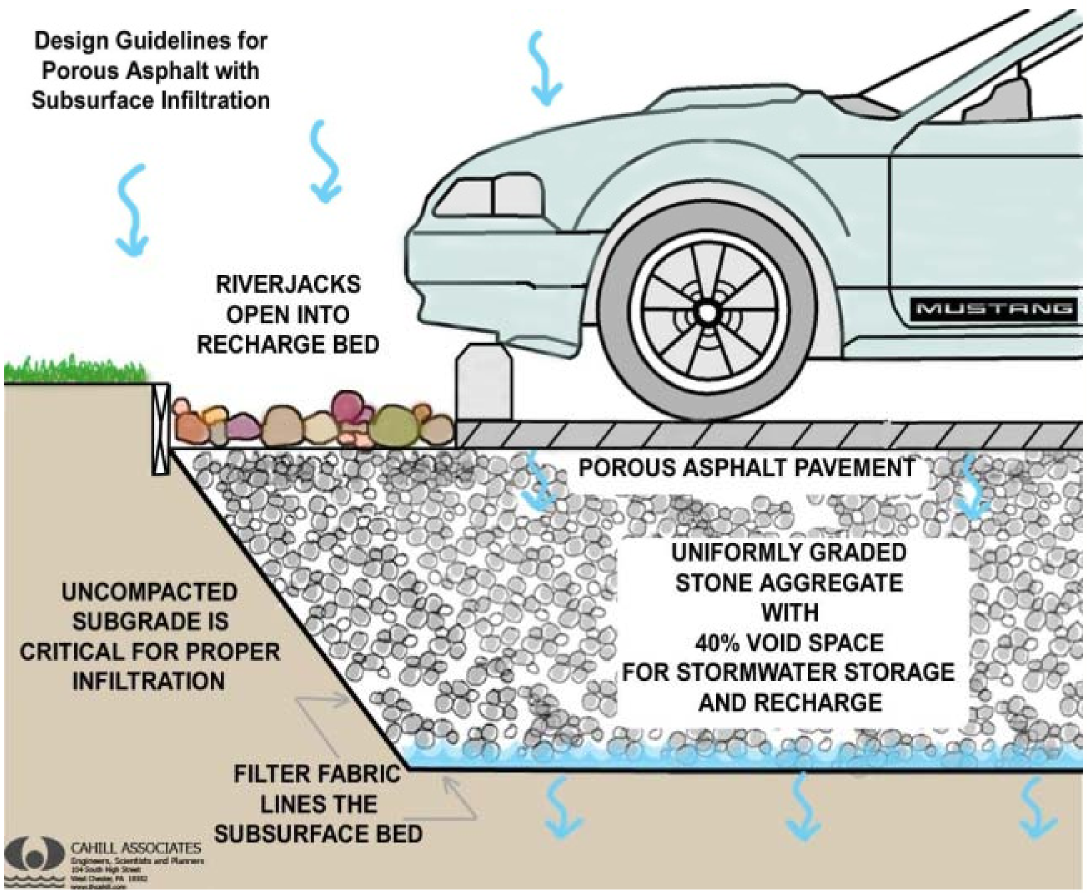


Pervious Pavements

FUNCTIONS

- Manage stormwater runoff
- Minimize site disturbance
- Possibility of 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



RUTGERS New Jersey Agricultural Experiment Station

Water Resources Program

Pervious Pavement

Pervious Pavements

Bioretention Systems & Rain Gardens

Traditional Approach

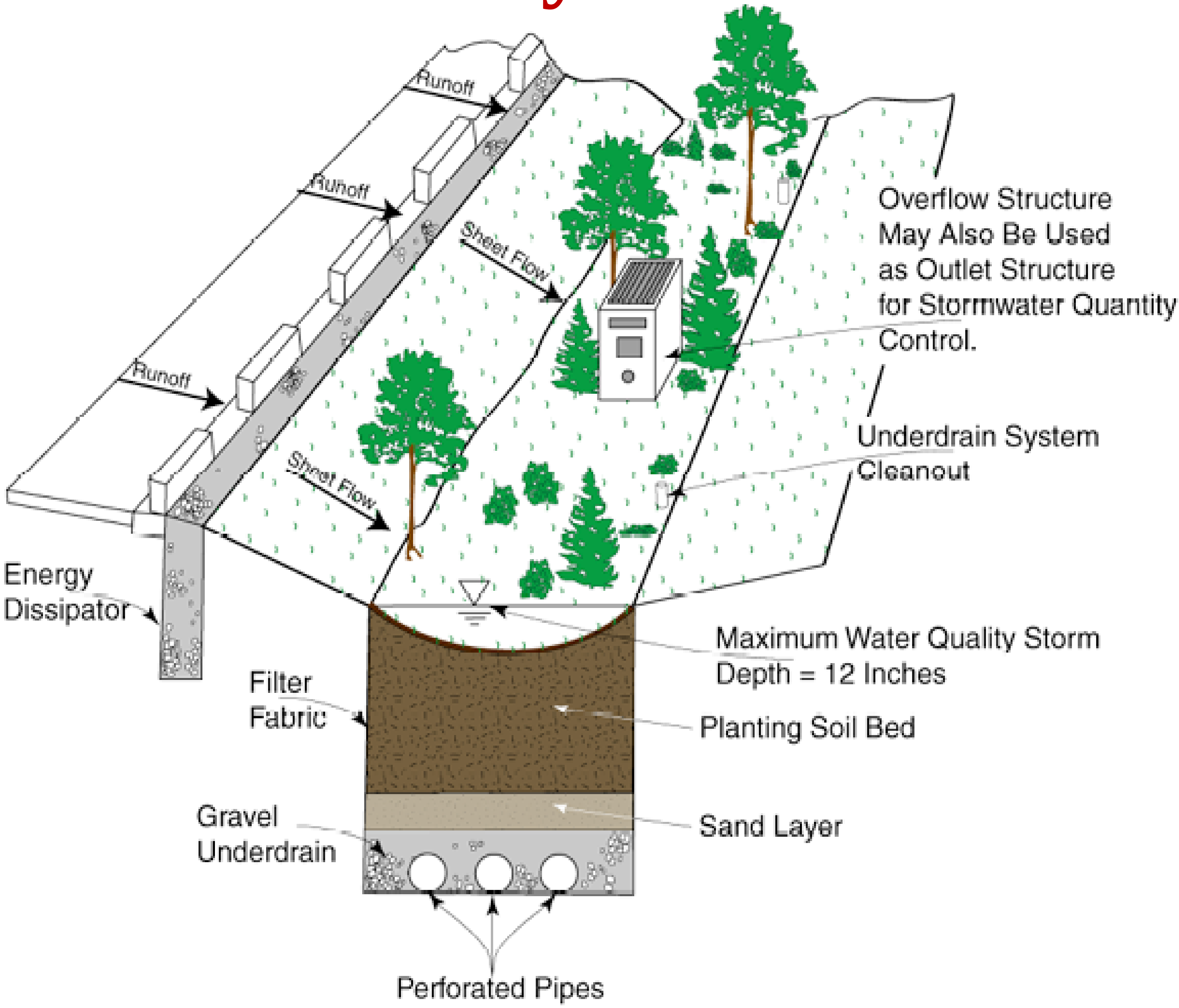
Design Dry Detention Basin:

- Treat Water Quality Storm (1.25” rain over 24 hours)
- Detain for 18 hours (residential) or 36 hours (commercial)
- Minimum outflow orifice = three inches
- Use Concrete Low Flow Channels to Minimize Erosion

New Approach

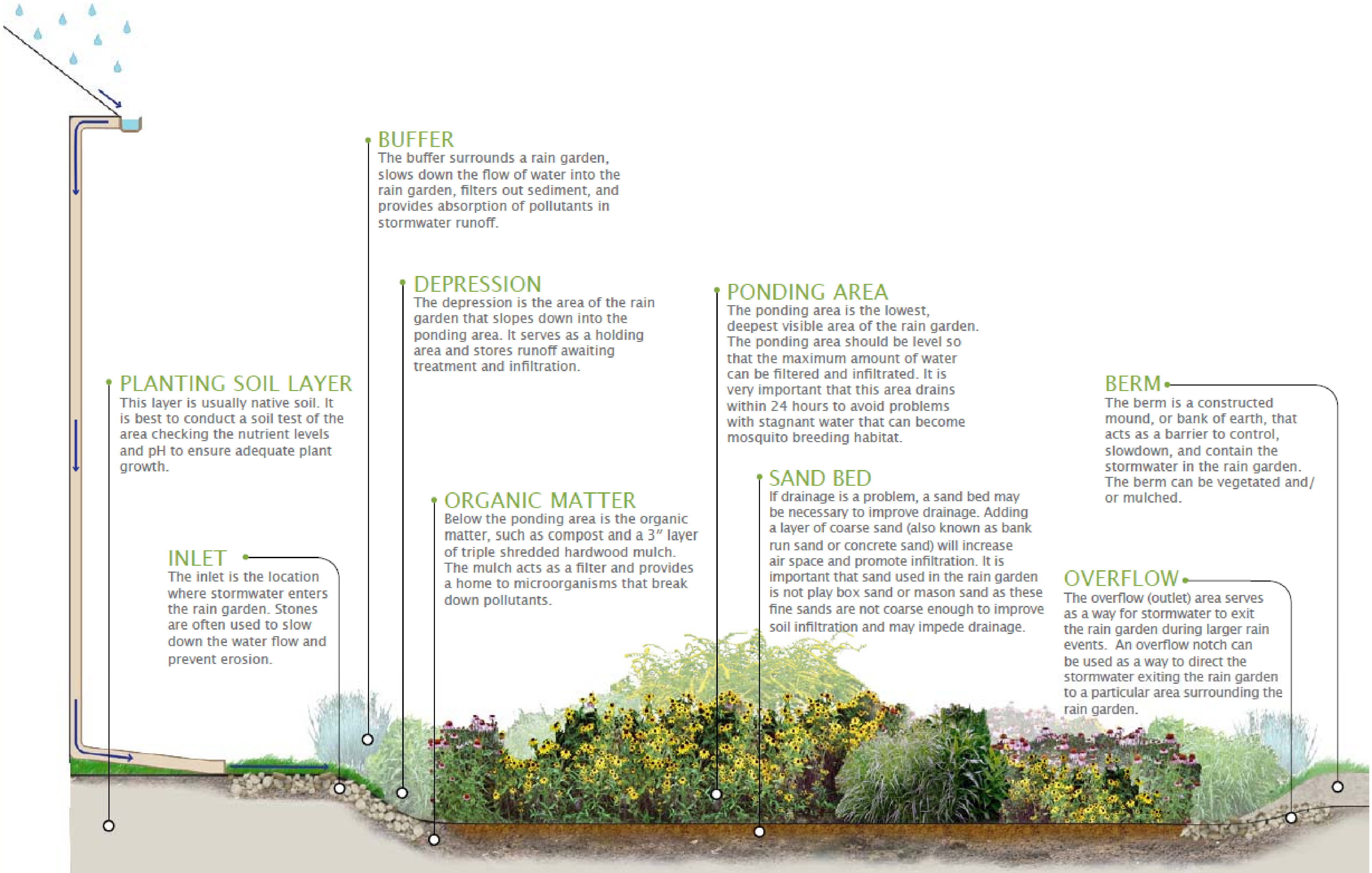
- Combines settling of detention basin with physical filtering and absorption processes
- Provides very high pollutant removal efficiencies
- More aesthetically pleasing than conventional detention basins
- Can be incorporated into the landscapes of individual homes

Bioretention Systems & Rain Gardens



NJDEP. 2004. NJ Stormwater BMP Manual.

Bioretention Systems & Rain Gardens



RUTGERS
New Jersey Agricultural Experiment Station
Water Resources Program

Curb Extensions/Green Streets

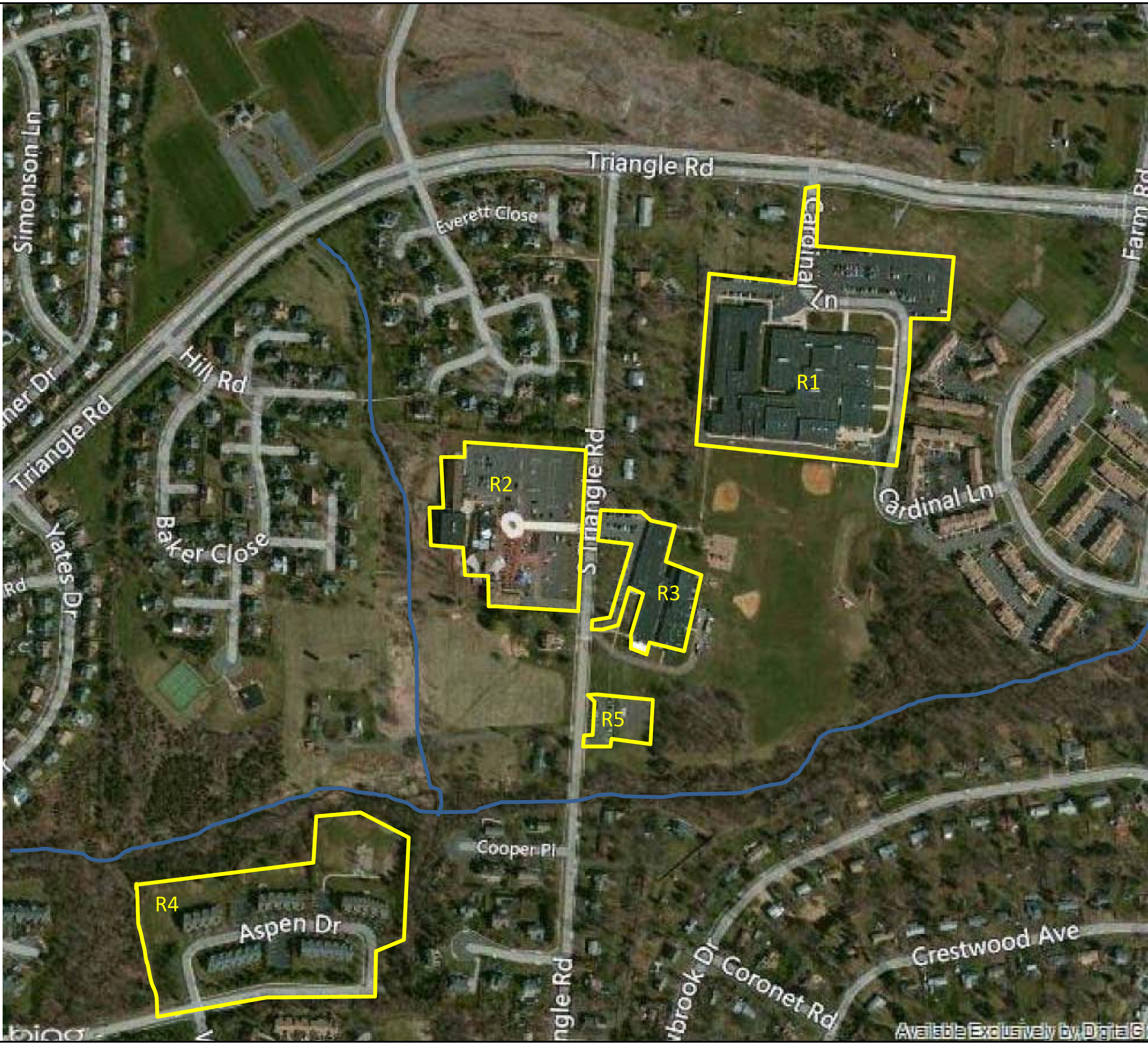
Curb extension with a planted swale that captures stormwater from the gutter: Portland, OR (Credit: Abby Hall)

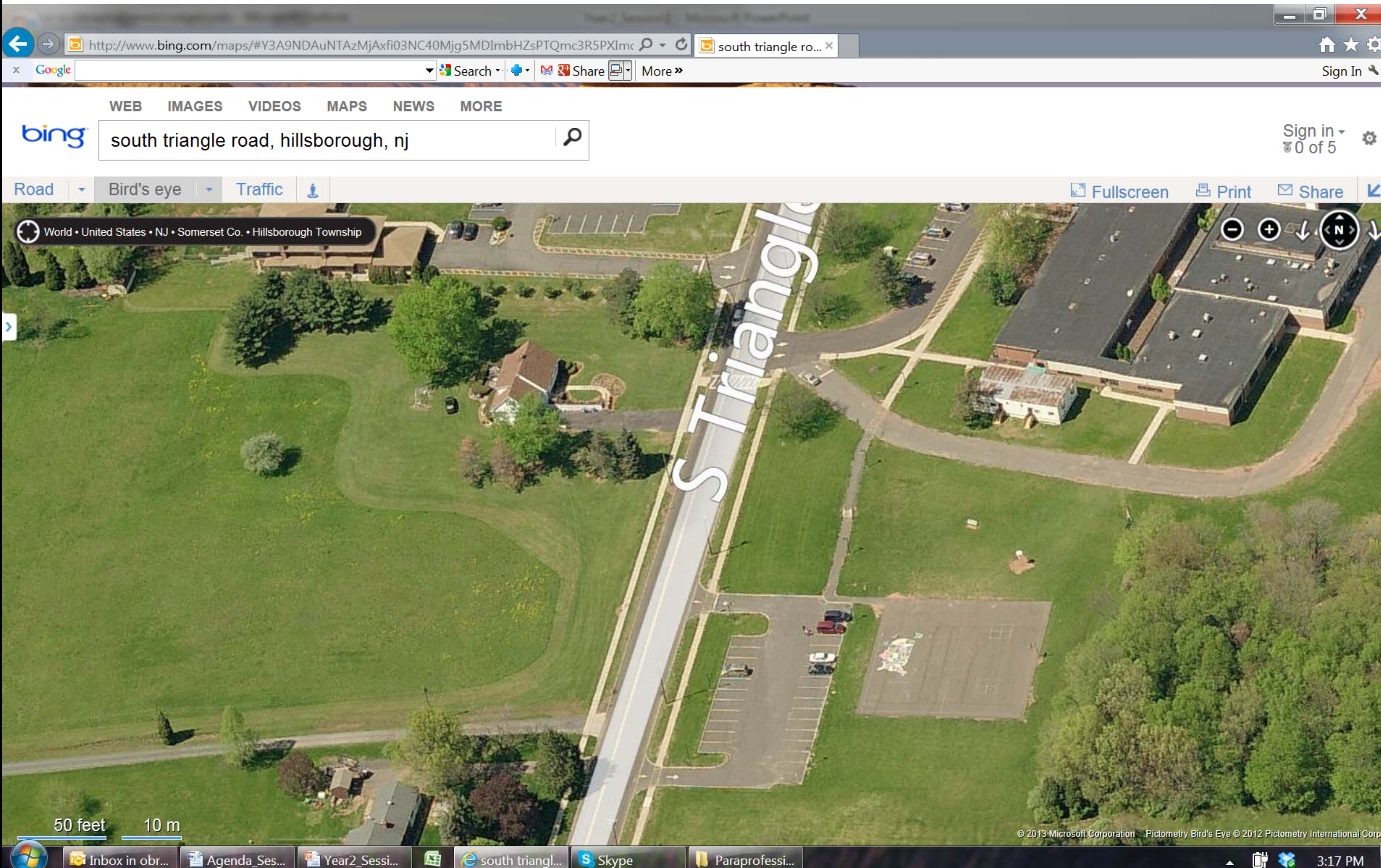

25

Paraprofessionals

Here is what you're gonna do!

Desktop Analysis


Triangle Rd
Simonson Ln
Everett Close
Hill Rd
Triangle Rd
Cardinal Ln
Farm Rd
R1
R2
S Triangle Rd
R3
Cardinal Ln
Baker Close
Yates Dr
R5
Cooper Pl
R4
Aspen Dr
Coronet Rd
Crestwood Ave
Available Exclusively by DigitalGlobe


http://www.bing.com/maps/#Y3A9NDAuNTAzMjAxfi03NC40Mjg5MDImbHZsPTQmc3R5PXImc
south triangle ro...
Google
Search
Share
More »
Sign In
WEB
IMAGES
VIDEOS
MAPS
NEWS
MORE
bing
south triangle road, hillsborough, nj
Sign in
0 of 5
Road
Bird's eye
Traffic
Fullscreen
Print
Share
World • United States • NJ • Somerset Co. • Hillsborough Township
S Triangle
50 feet
10 m
© 2013 Microsoft Corporation Pictometry Bird's Eye © 2012 Pictometry International Corp
Inbox in obr...
Agenda_Ses...
Year2_Sessi...
south triangl...
Skype
Paraprofessi...
3:17 PM

Site Visits

Site Photos:

Stormwater Best Management Practice Opportunities

Royce Brook Watershed - Hillsborough Township

Project Identifier	**Geographic Coordinates**	
R5 - Parking Lot Next to Triangle School	N40° 58' 46.26"	W074° 2' 38.76"

Site Description and BMP Implementation Opportunities: This site is the overflow parking lot and paved playground lot for Triangle Elementary School on South Triangle Road. The site is adjacent to Royce Brook. The parking lot flows to a single catch basin at the south end of the parking lot, which dumps directly into the Royce Brook. The parking lot is in fair condition. The paved playground lot does not have any catch basins but rather flows onto the grassed area adjacent to the lot and ultimately into the stream. The paved playground lot is in fair condition. The flow from the parking lot can be diverted to a bioretention system bypassing the existing catch basin. There is ample area for the bioretention system. The design and construction of this bioretention basin or rain garden can be incorporated into the fourth grade science curriculum at the elementary school. The paved playground lot could be converted to pervious asphalt and serve as an outstanding demonstration project for the watershed.

Document Recommendations

<table>
<tr><td colspan="2">Project ID: R5 - Parking Lot Next to Triangle School</td></tr>
<tr><td rowspan="2">Location:
South Triangle Road at Triangle Elementary School</td><td>Municipality: Hillsborough</td></tr>
<tr><td>Subwatershed: Royce Brook</td></tr>
<tr><td>BMP Description:
Bioretention System/Rain Garden and Educational Program</td><td>Targeted Pollutants:
Total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) in surface runoff</td></tr>
<tr><td colspan="2">Existing Conditions and Issues:
This site is the overflow parking lot for Triangle Elementary School on South Triangle Road. The site is adjacent to Royce Brook. The parking lot flows to a single catch basin at the south end of the parking lot, which dumps directly into the Royce Brook. The parking lot surface is in fair condition. The pollutants that accumulate in the parking lot are directly discharged to Royce Brook during storm events with no level of treatment. Additionally, the stormwater runoff is quickly discharged to the stream, contributing to the stream's flashy hydrology, which cause bank erosion, downcutting, and localized flooding.</td></tr>
<tr><td colspan="2">Proposed Solution(s):
The flow from the parking lot (12,000 square feet in size) can be diverted to a bioretention system or rain garden bypassing the existing catch basin. There is ample area for the rain garden, which would be approximately 2,400 square feet in size with a depth of six to eight inches. The design and construction of this bioretention basin or rain garden can be incorporated into the fourth grade science curriculum at the elementary school. The RCE Water Resources Program has a Stormwater Management in Your School Yard program that could be incorporated into the 4th grade curriculum. The students could gain knowledge and increase their awareness of issues associated with stormwater runoff while building a BMP on the school grounds that actually helps address some of the problems.</td></tr>
</table>

Anticipated Benefits:

The rain garden would be designed to capture, treat and infiltrate the water quality design storm (1.25 inches of rain over two hours). Since 90% of the annual rainfall in New Jersey comes in storms events less than water quality design storm, the rain garden would remove 90% of the TN, TP, and TSS on an annual basis. Pathogens and Bacteria such as E. coli and Fecal Coliform will be reduced by up to 90% as well. A rain garden would also provide ancillary benefits, such as enhanced wildlife habitat and aesthetic appeal to surrounding property owners. The Triangle Elementary School is located at the proposed site. Rutgers Cooperative Extension Water Resources Program could present the *Stormwater Management in Your School Yard* curriculum to students and then include them in the rain garden design and planting efforts as an augmentation to the in-class lessons. It can also be used as a demo project to launch educational programming for Hillsborough Department of Public Works staff.

Possible Funding Sources:

319(h) grants from the New Jersey Department of Environmental Protection
Soil Conservation District of Somerset-Union Counties
Hillsborough Township
Sustainable Jersey
Triangle School Home and School Association

Partners/Stakeholders:

Rutgers Cooperative Extension
Stony Brook-Millstone Watershed Association

Estimated Cost:

Task	Task Description			Estimated Cost
1	Complete topographic survey and soils test			$500
2	Prepare final design			$1,000
3	Activities for BMP installation	Unit Cost	Quantity	
	Plant materials	$0.50/sq.ft.	2,400	$1,200
	Soil amendments (course sand)	$35/cu.yd.	10	$350
	Mulch	$25/cu.yd.	20	$500
	Installation (assume volunteer-based effort)	$25.22/hr*	30 people 4 hr/person	$3,027 (no charge)
	Supervision of volunteers	$1,000	1	$1,000
	Educational Programs (Schools and DPW)	$2,000		$2,000
	Contingency (10%)	-	-	$655
			Total Estimated Project Cost	**$7,205**

*Based on New Jersey State Value for Volunteer Time as reported by the Corporation for National and Community Service

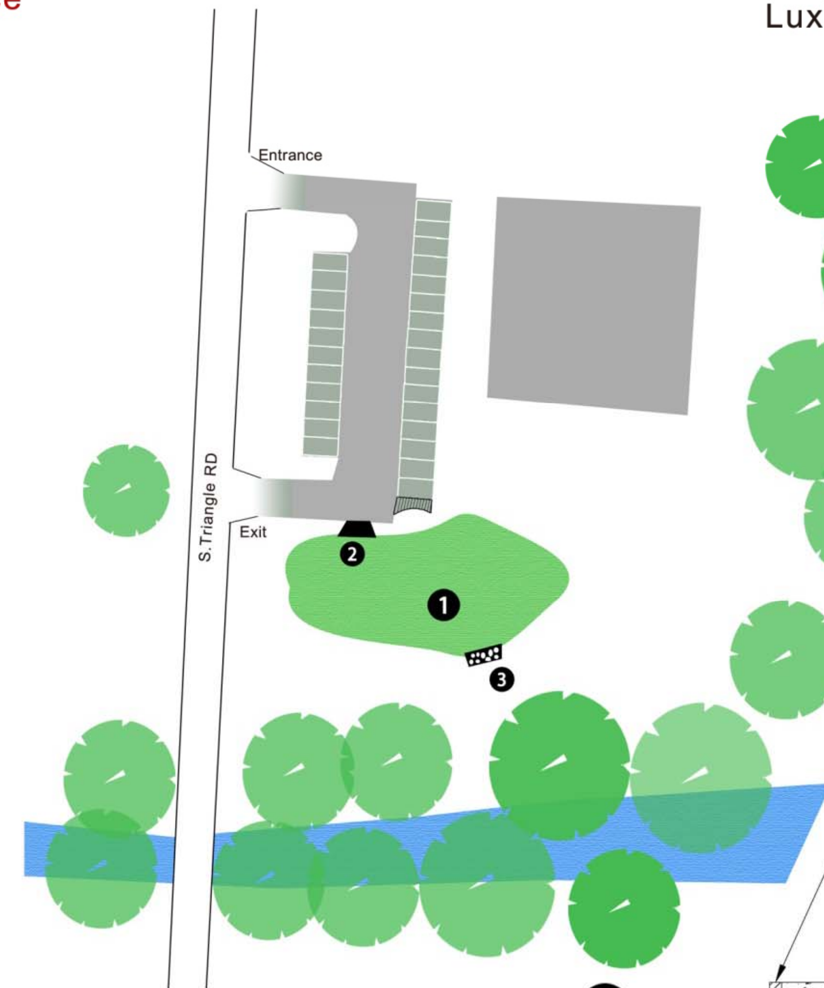
Picture is worth 1,000 words

Triangle Elementary School Parking lot Stormwater Management Practice

Bioenvironmental Engineering Design

Luxin Li

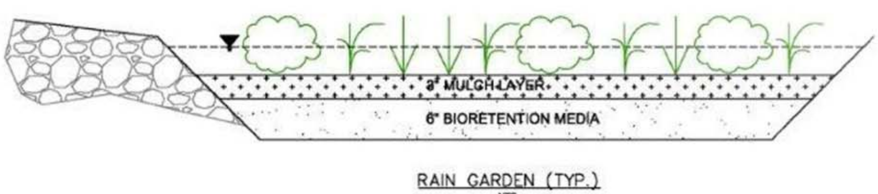
Project location



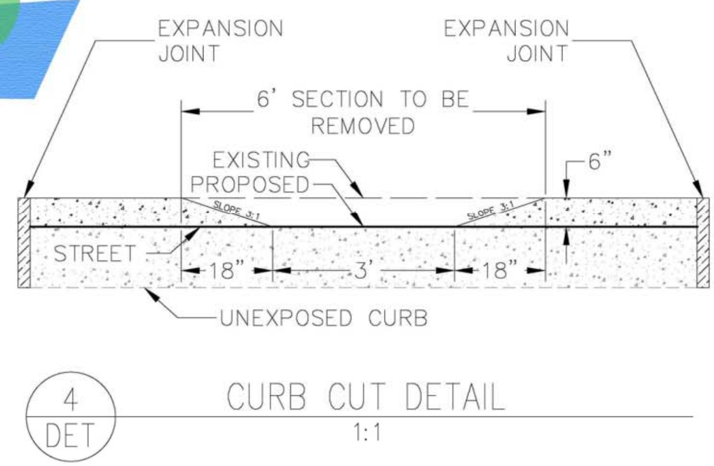
SITE PHOTO

A rain garden can be built on the green space, and we can cut the curb near the drainage inlet to lead rain water to the rain garden. One overflow stone weir can be built near the river side Therefore, overflows from rain garden can flows to river.

❶



❷



Resources Available to You

- Jessica Brown (jess@envsci.rutgers.edu)
- Lisa Galloway Evrard (Evrard@rci.rutgers.edu)
- Steve Yergeau (syergeau@envsci.rutgers.edu)
- Kyle Gourley (kgourley@envsci.rutgers.edu)

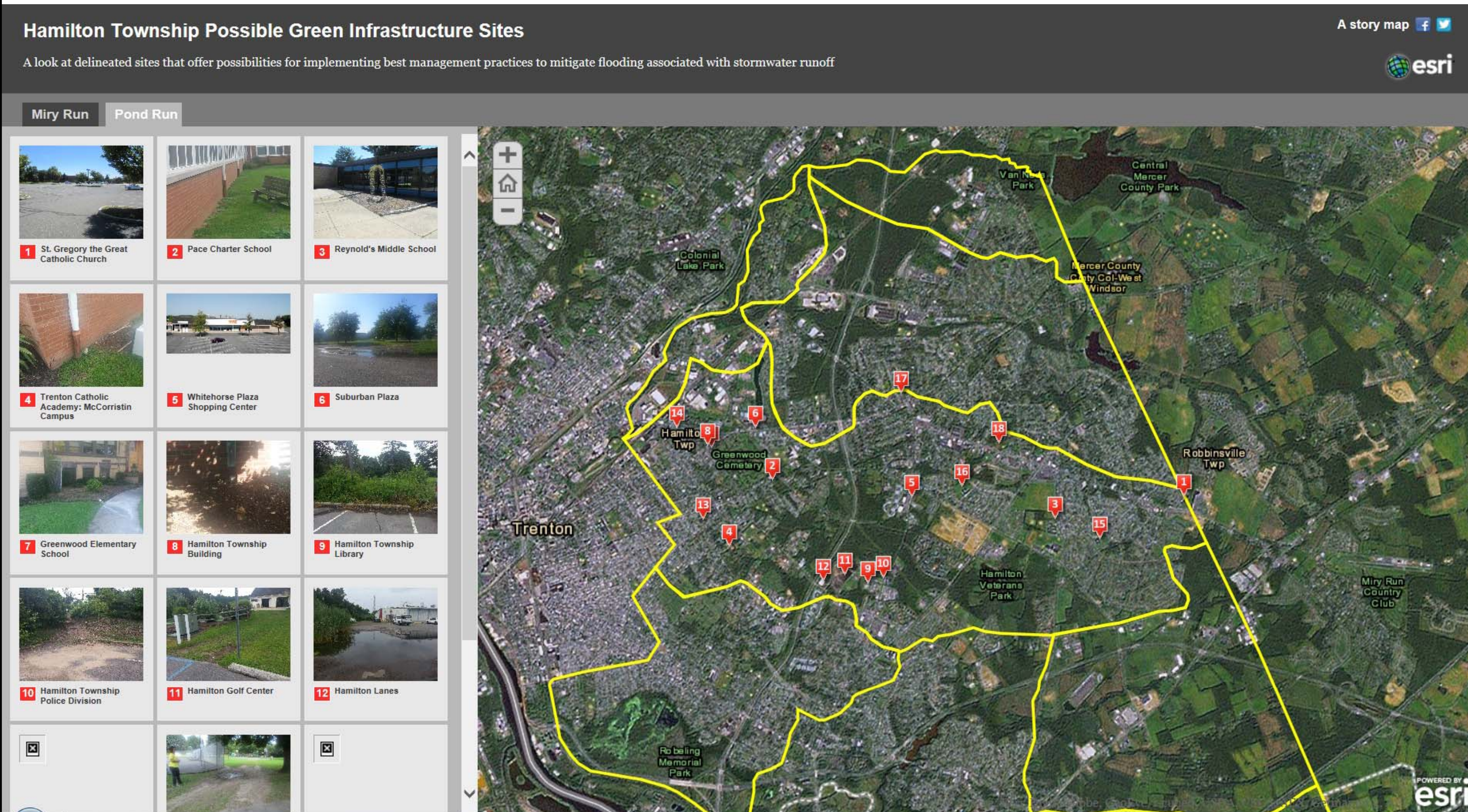
How this can be used to develop plans?

- Develop an Impervious Cover Reduction Action Plan
- Develop a Watershed Restoration Plan

How the plans can be used to implement projects?

- Implementing community projects
- Developing local ordinances
- Identification of mitigation for new development and redevelopment

Stormwater Mitigation Plan Online Tool



Hamilton Tow

A look at delineated si

Miry Run | Pond

6 Suburban Plaza

14 Bromley Park

Greenwood Elementary School

2069 Greenwood Avenue

Area (sq. ft.): 83,374 ; Block: 1884; Lot: 1

Impervious Cover (sq. ft.): 75, 121 ; Percent Impervious: 90%; Total Runoff from Impervious Surfaces for the 1.25" Quality Storm (gal): 58,536

Total Phosphorus Loads (lbs/yr): 4; Total Nitrogen Loads (lbs/yr): 42; Total Suspended Solids Loads (lbs/yr): 383

Recharge Potential:____; Total Suspended Solids Removal Potential:_____; Stormwater Peak Reduction Potential: _______

Suitable for: Bioretention (with underdrain system), Bioretention (infiltration), Dry Pond, Grass Swale, Infiltration Trench, Porous Pavement, Vegetated Filter Strips


QUESTIONS?