Stormwater Management in Your Schoolyard Teacher In-Service Program

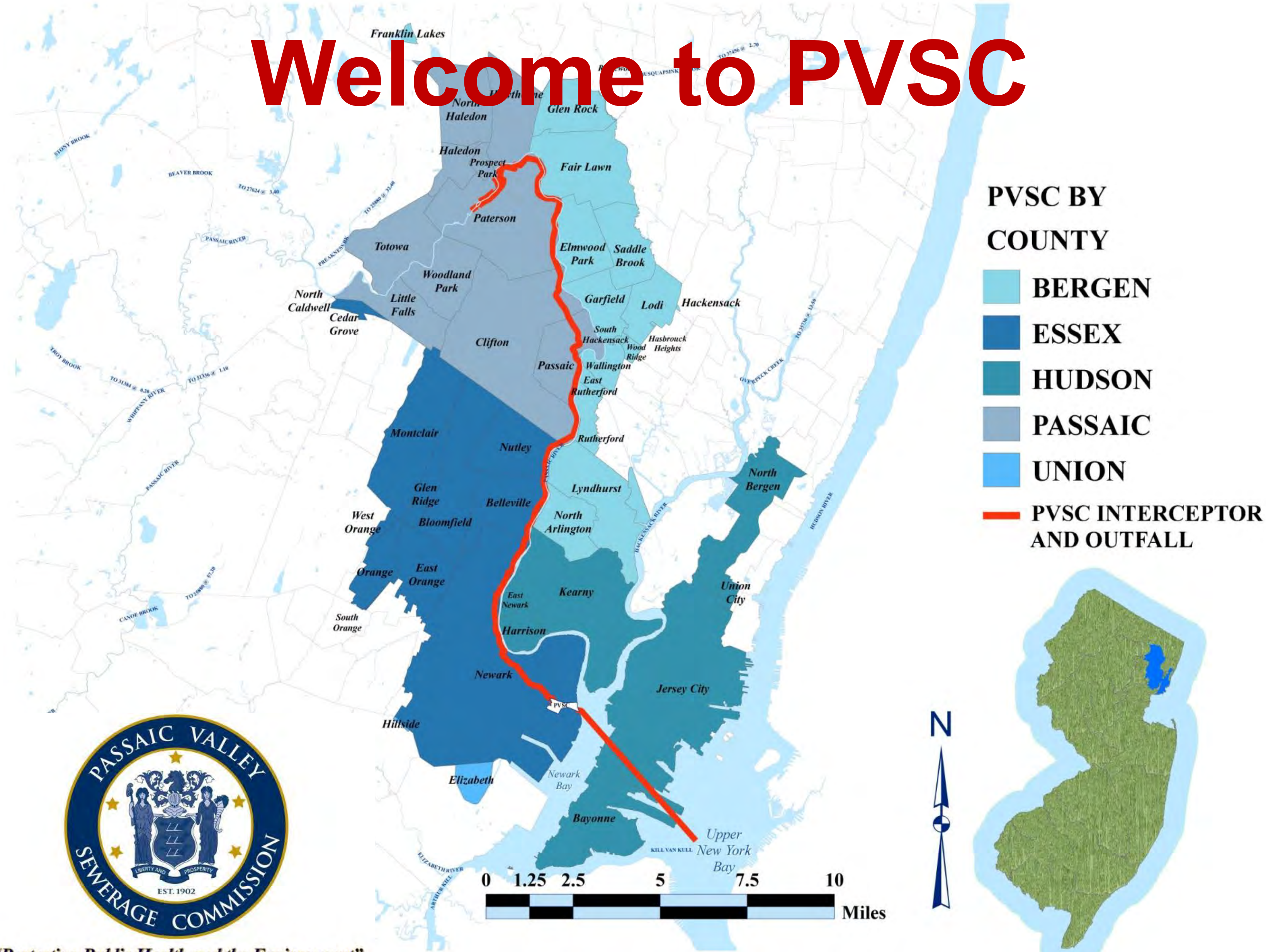
June 8, 2015

Passaic Valley Sewerage Commission, Newark, NJ 07105

Michael DeFrancisci

Christopher C. Obropta, Ph.D., P.E.

Welcome to PVSC



"Protecting Public Health and the Environment"

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PVSC's Plan for Promotion of Green Infrastructure

- The PVSC Sewerage District
  - 48 municipalities in 5 counties
  - Includes both Separate and Combined Sewer Systems
    - 9 with Combined Sewer Systems
- Combined Sewer Overflows (CSO)s and stormwater runoff can impact ambient water quality
  - Can be partially alleviated with use of Green Infrastructure

PVSC's Plan for Promotion of Green Infrastructure

- PVSC is dedicated to leading efforts throughout the PVSC Sewerage District to:
    1) intercept stormwater runoff
    2) reduce Combined Sewer Overflows (CSOs)
    3) manage existing water infrastructure
    4) minimize frequent flooding events

- PVSC has entered into a partnership with Rutgers Cooperative Extension (RCE) Water Resources Program to achieve these goals

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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.

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Water Resources Program

Our Mission is to identify and address community water resources issues using sustainable and practical science-based solutions.

The Water Resources Program serves all of New Jersey, working closely with the County Extension Offices.

Environmental County Agents

The Environmental County Agents teach people new skills and information so they can make better informed decisions and improvements to their businesses and personal lives.

- Michele Bakacs, Middlesex and Union
- Pat Rector, Morris and Somerset
- Amy Rowe, Essex and Passaic
- Mike Haberland, Camden and Burlington
- Sal Mangiafico, Salem and Cumberland
- Steve Yergeau, Ocean and Atlantic

www.njaes.rutgers.edu/county/

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This program is…

- Sponsored by Passaic Valley Sewerage Commission
- Funded by
  - New Jersey Department of Environmental Protection
  - New Jersey Agricultural Experiment Station
  - Rutgers, The State University of New Jersey
  - Newark DIG (Doing Infrastructure Green)

Today's Goal

To engage teachers in helping us address stormwater management issues in New Jersey

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Objectives

- Provide teachers knowledge about the science of stormwater management and green infrastructure
- Provide guidance in the linkages between stormwater management and the Next Generation Science Standards (NGSS)
- Provide teachers with hands-on activities and tools to work with students in water resources
- Increase teachers awareness of the resources available to enhance your science curriculum

Agenda

9:00 - 9:15	Introductions and Welcome
9:15 - 10:00	Introduction to Stormwater Management and Green Infrastructure
10:00 - 10:45	How Stormwater Management and Green Infrastructure fit's into the NGSS
10:45 - 11:00	**Break**
11:00 - 12:00	Keynote Speaker
12:00 - 12:30	Available Educational Partnerships and Programs
12:30 - 1:30	**Lunch**
1:30 - 1:45	Logistics for Afternoon Tours
1:45 - 2:30	Group A (PVSC) / Group B (Passaic River)
2:30 - 3:15	Group A (Passaic River) / Group B (PVSC)
3:15 - 3:30	Certification Pick Up

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PASSAIC VALLEY SEWERAGE COMMISSION
EST. 1902
"Protecting Public Health and the Environment"

Introduction to Stormwater Management and Green Infrastructure

Christopher C. Obropta, Ph.D., P.E.

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water.rutgers.edu

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

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.

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

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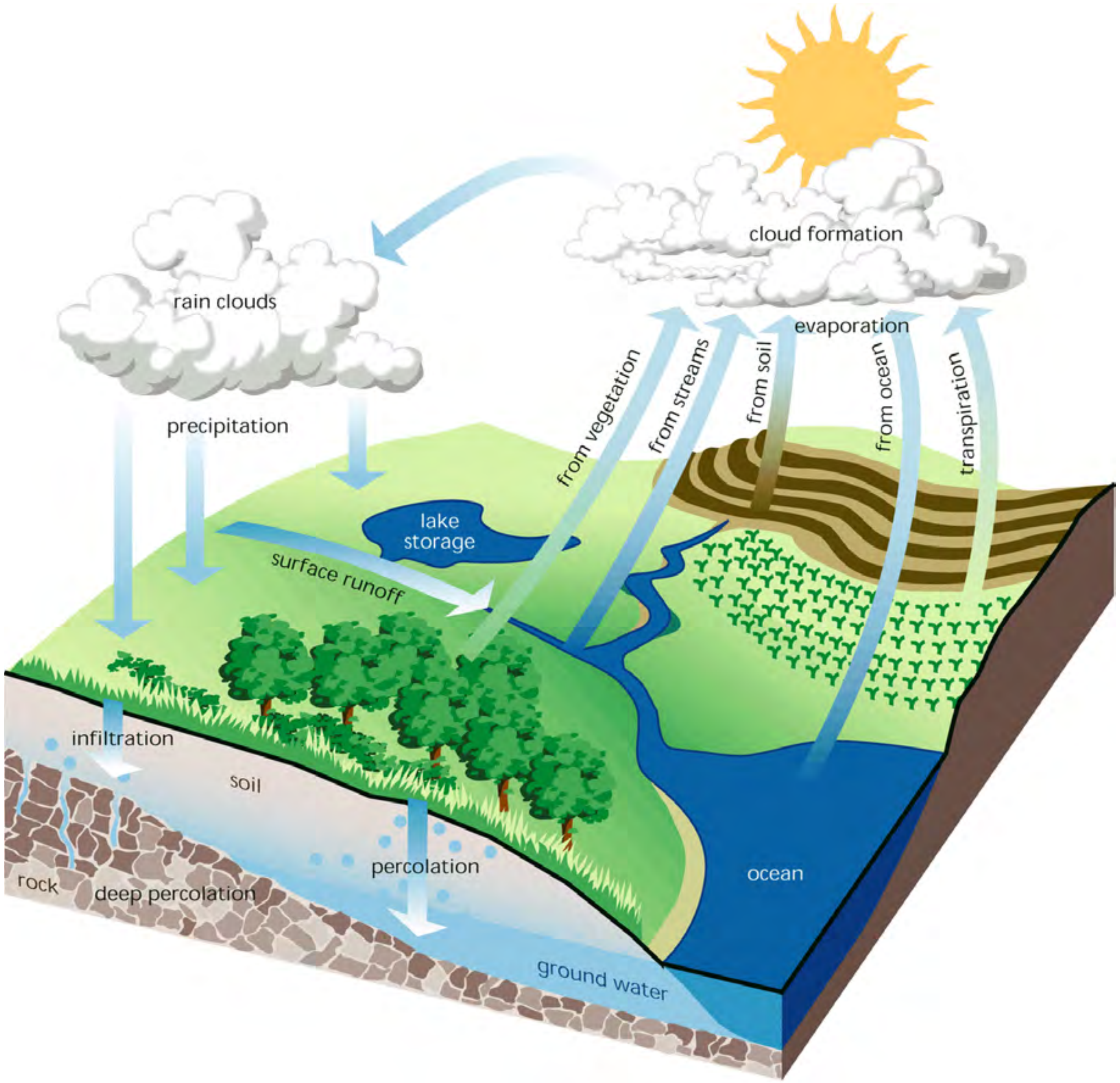
HYDROLOGIC CYCLE



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

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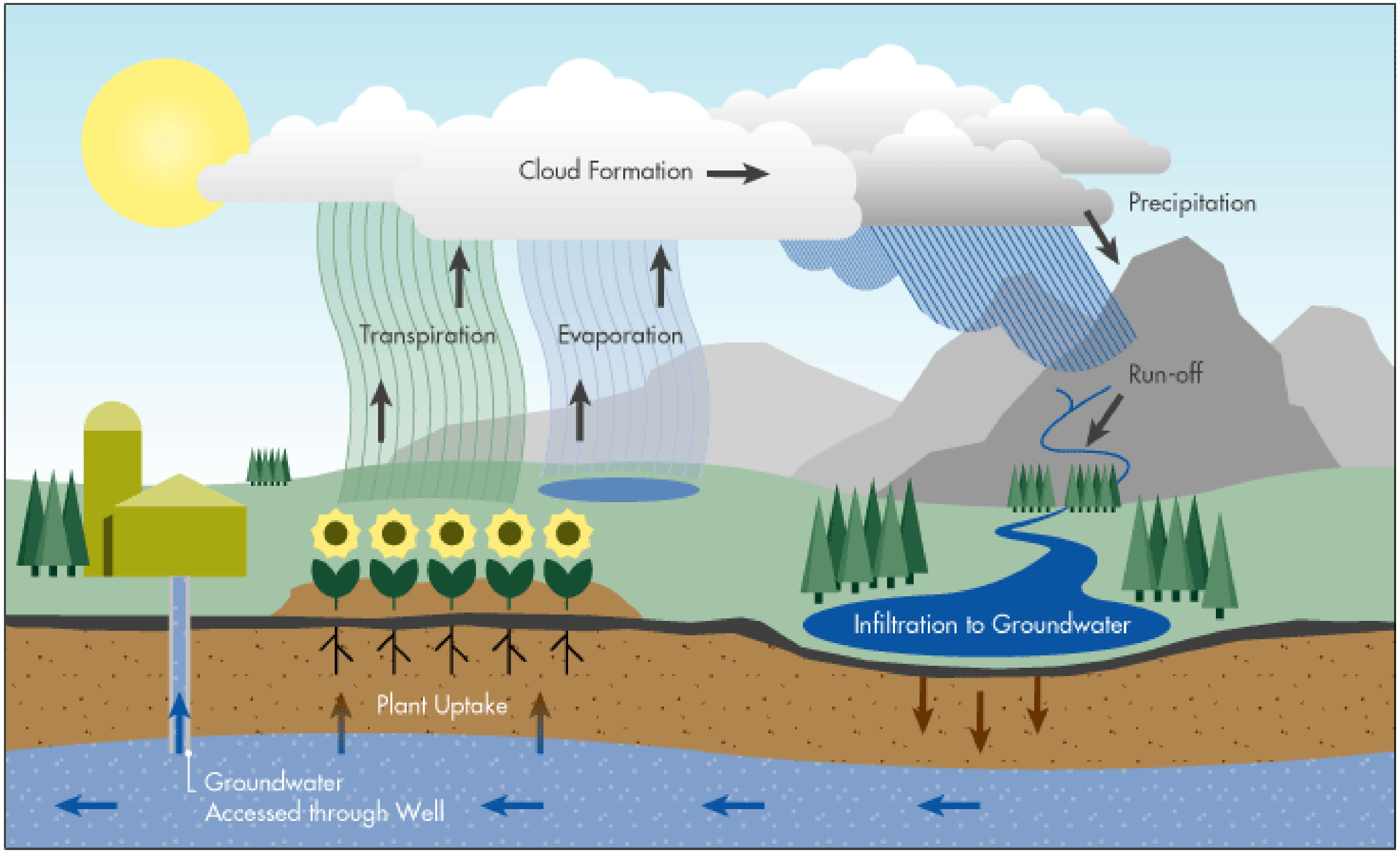
WHERE DOES PRECIPITATION GO?

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



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

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WHERE DOES PRECIPITATION GO?

4. It can ***evaporate***

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

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The Impact of Development on Stormwater Runoff

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

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LAND USE/LAND COVER CHANGES

LAND USE

HOW LAND IS USED BY HUMANS:

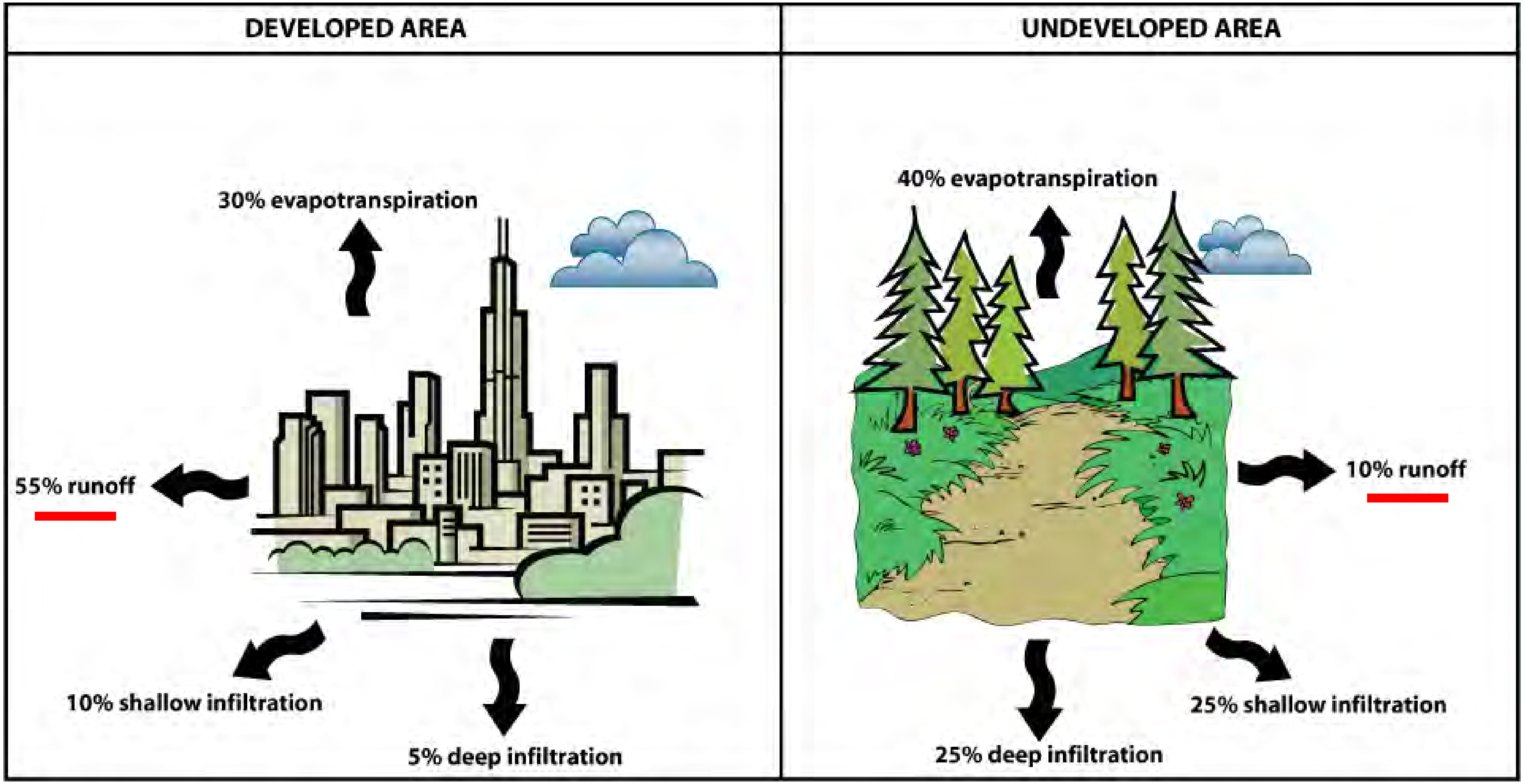
- AGRICULTURE
- INDUSTRY
- URBAN
- RESIDENTIAL
- RECREATION

LAND COVER

BIOLOGICAL AND PHYSICAL FEATURES OF THE LAND:

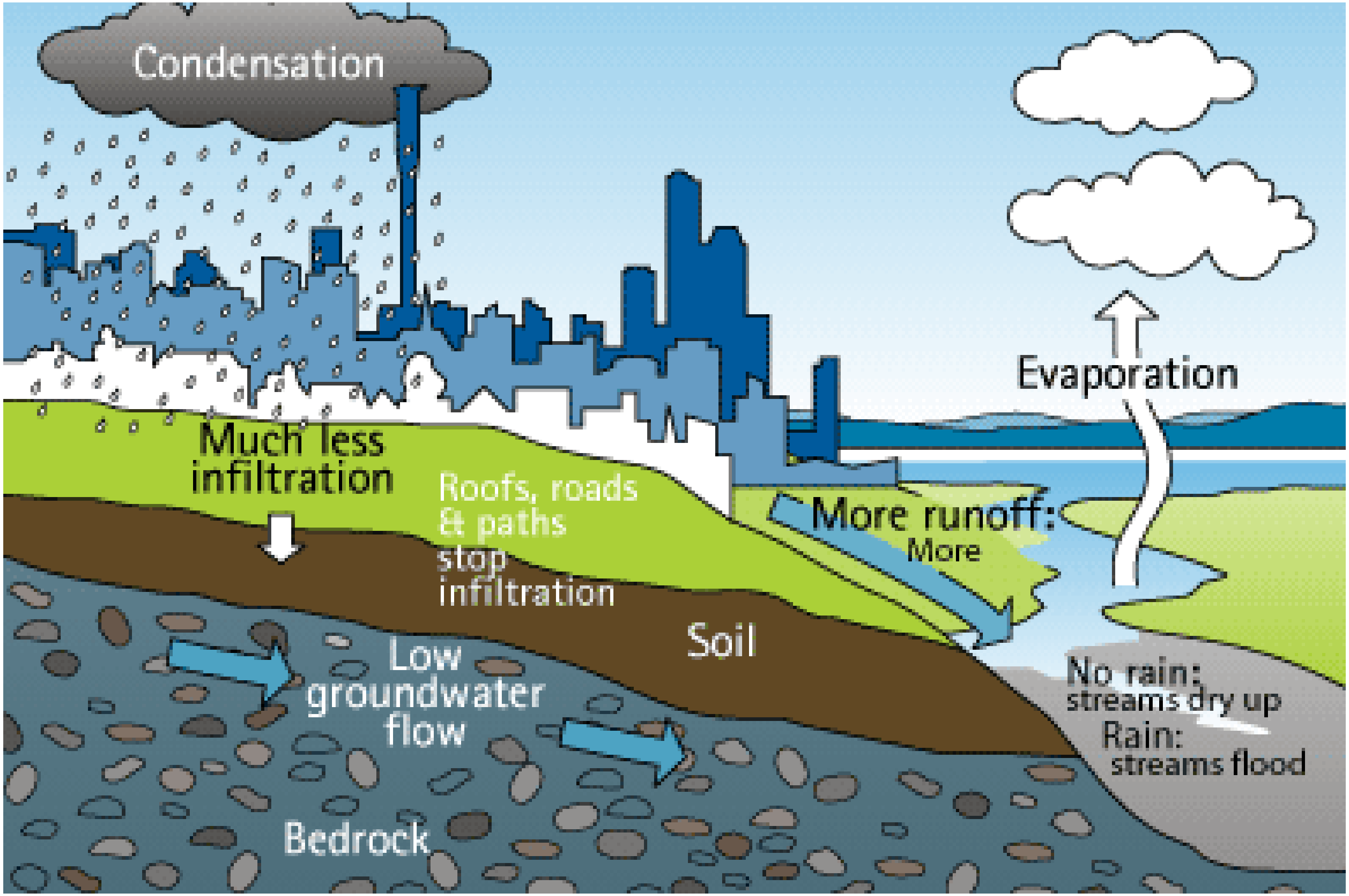
- FORESTS
- GRASSLANDS
- AGRICULTURAL FIELDS
- RIVERS, LAKES
- BUILDINGS, PARKING LOTS

LAND USE/LAND COVER CHANGES



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

The *Urban* Hydrologic Cycle



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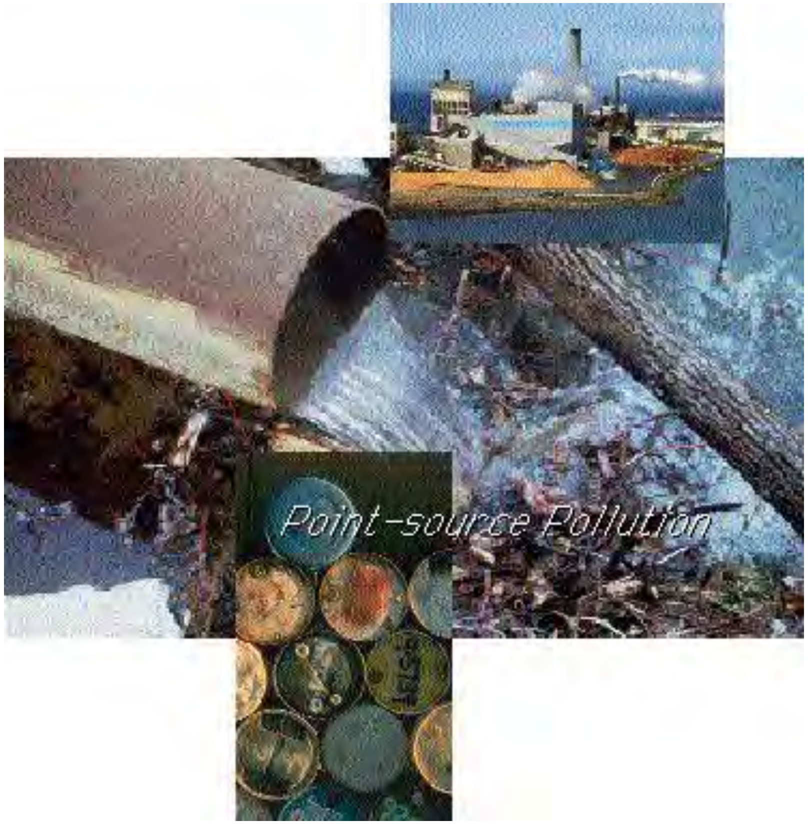
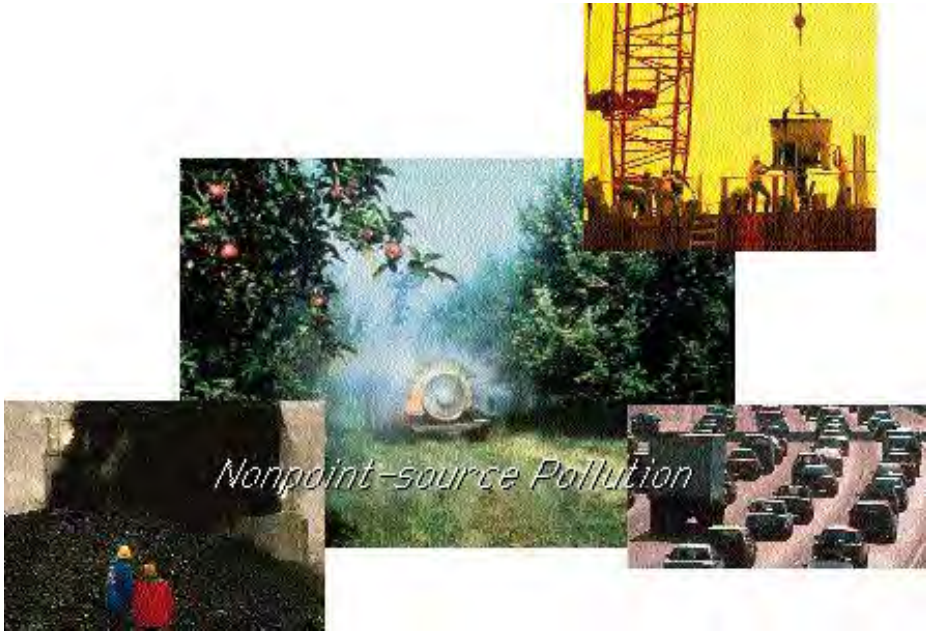
Combined Sewer Systems (CSOs)

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)

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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

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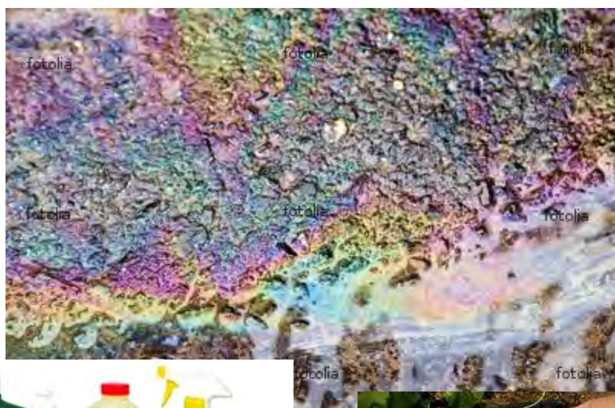
EXAMPLES OF NPS

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



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IMPACT OF NPS

- Fish and wildlife
- Recreational water activities
- Commercial fishing
- Tourism
- Drinking water quality

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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

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

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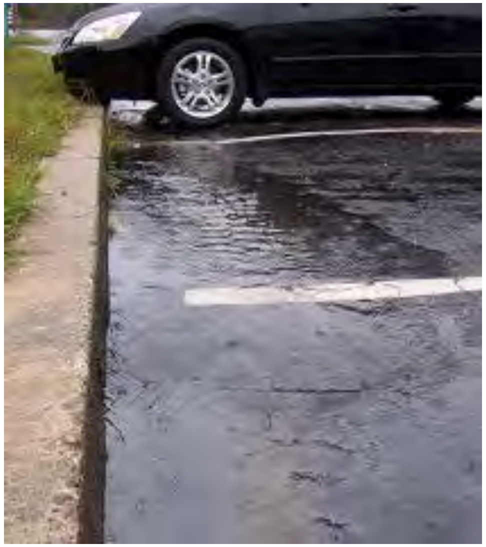
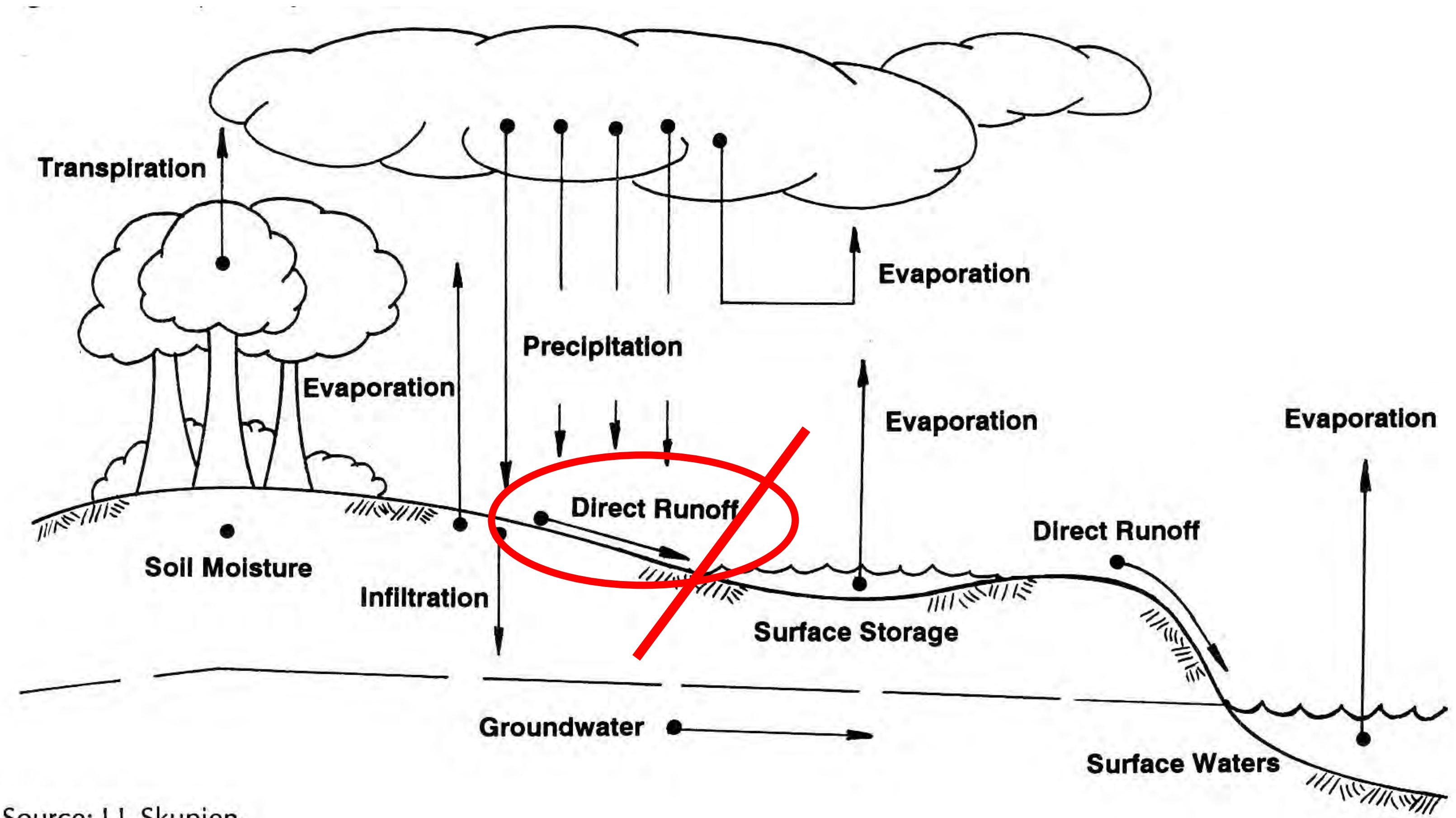
How NJ's regulations change the way we manage stormwater

How can we minimize the impact of stormwater runoff in our community?

It is all about controlling runoff from impervious surfaces



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?

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Eliminate it!

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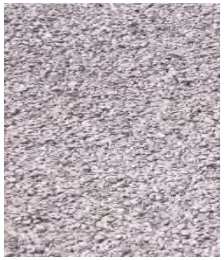
Reduce It!
Pervious Pavements

- 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 Pavement

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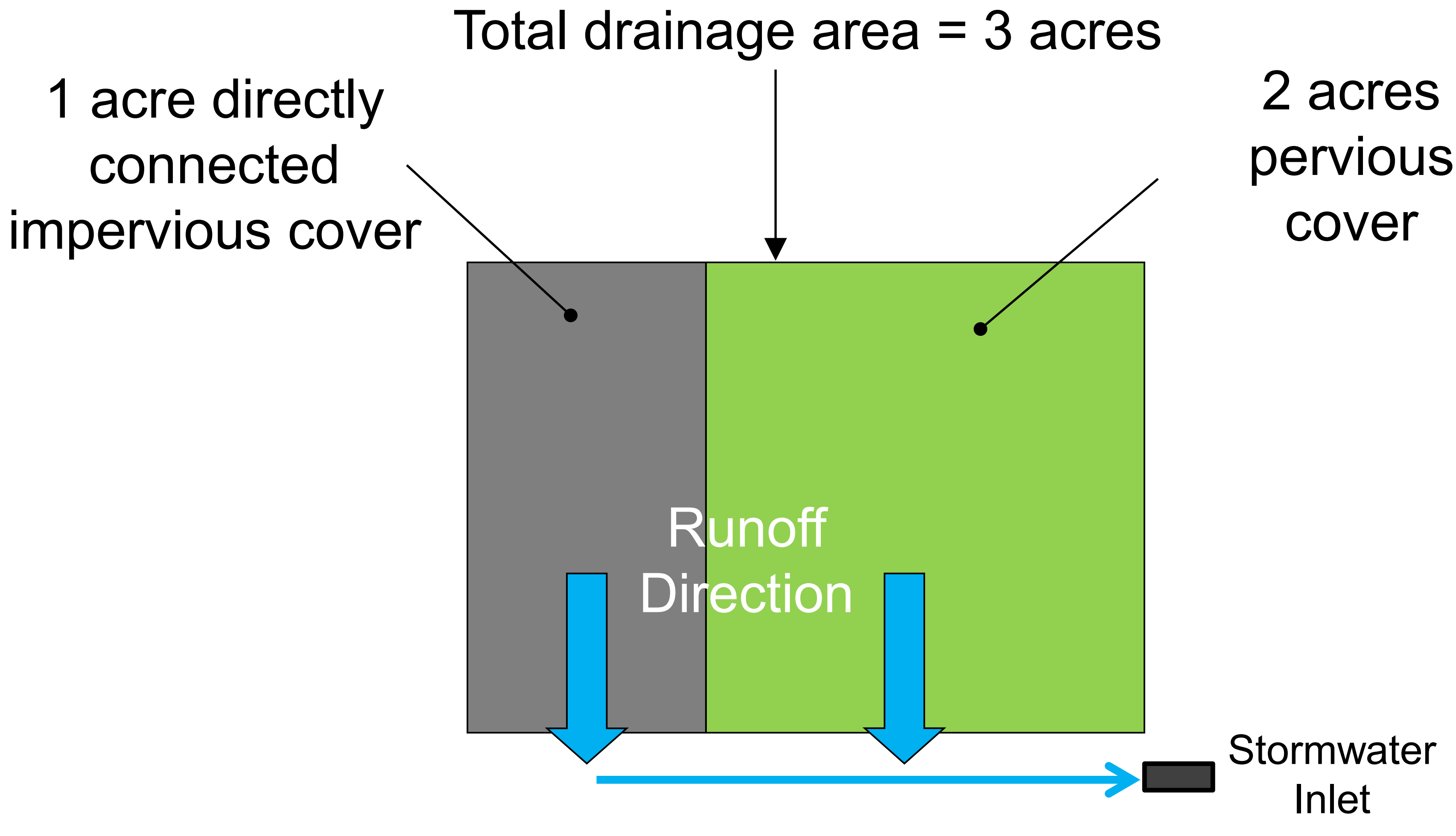
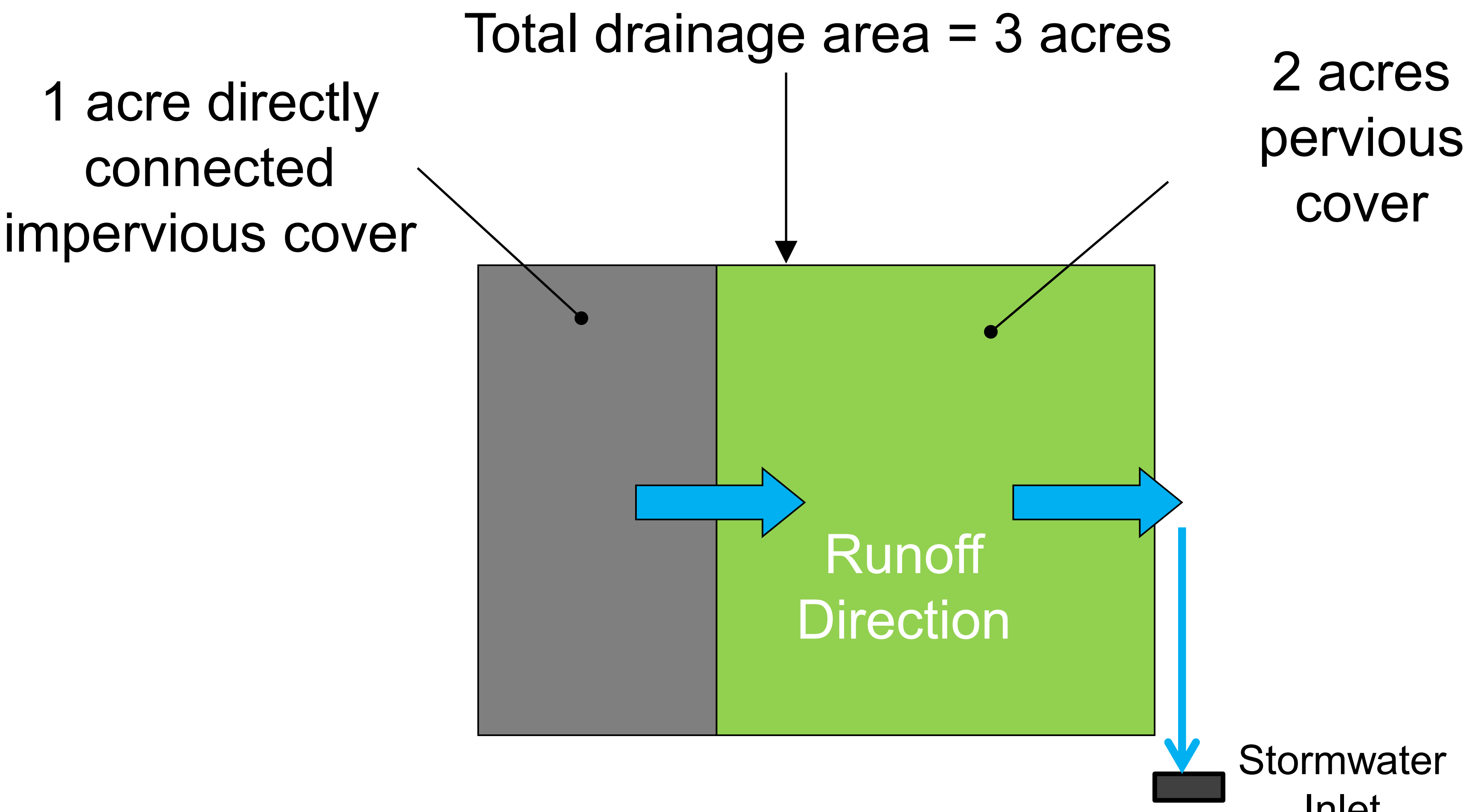
Disconnect It!

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

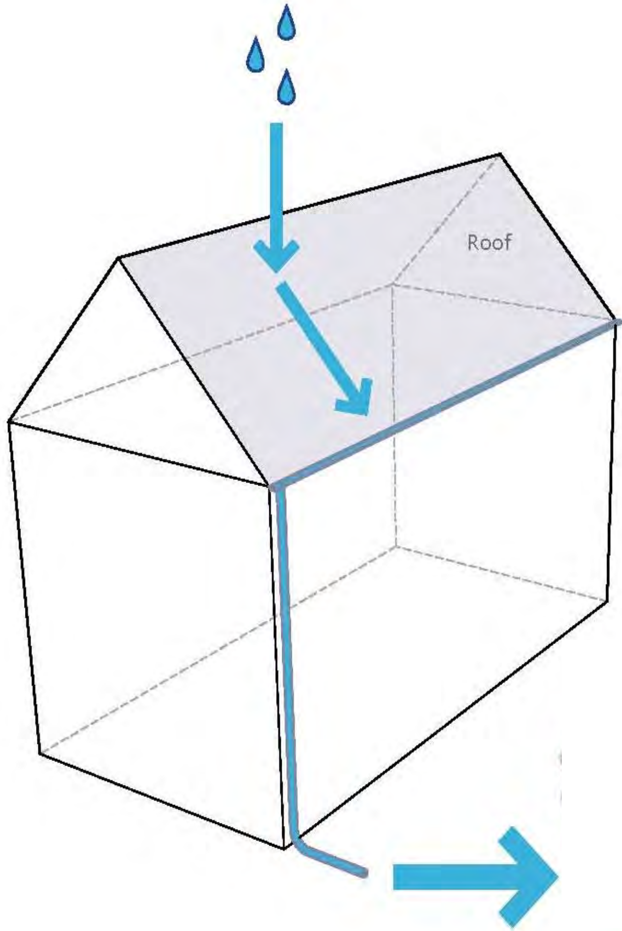


For 1.25 inch storm, 581 cubic feet of runoff = **4,360 gallons**

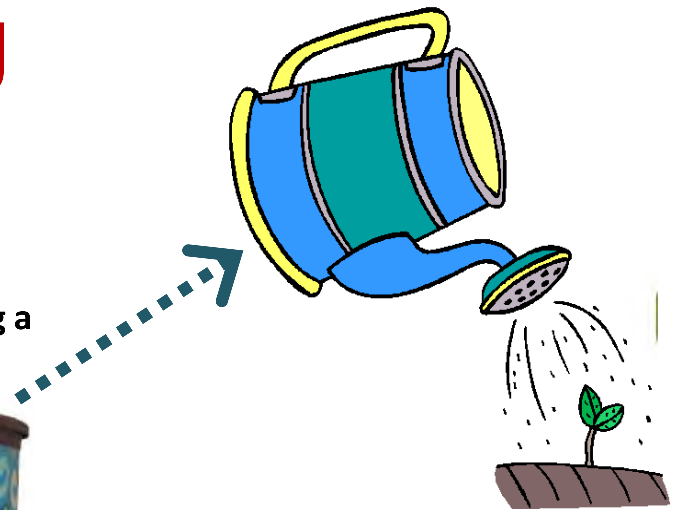


	Volume of Runoff		
Design Storm	**Connected (gallons)**	**Disconnected (gallons)**	**Percent Difference**
1.25 inches (water quality storm)	28,500	4,360	85%

Disconnection with Rain Water Harvesting



Disconnect your downspout by installing a rain barrel



REDUCE THE AMOUNT OF RUNOFF ENTERING STORM SEWERS

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

So Many Barrels to Choose From…

Or Larger Rainwater Harvesting Systems…

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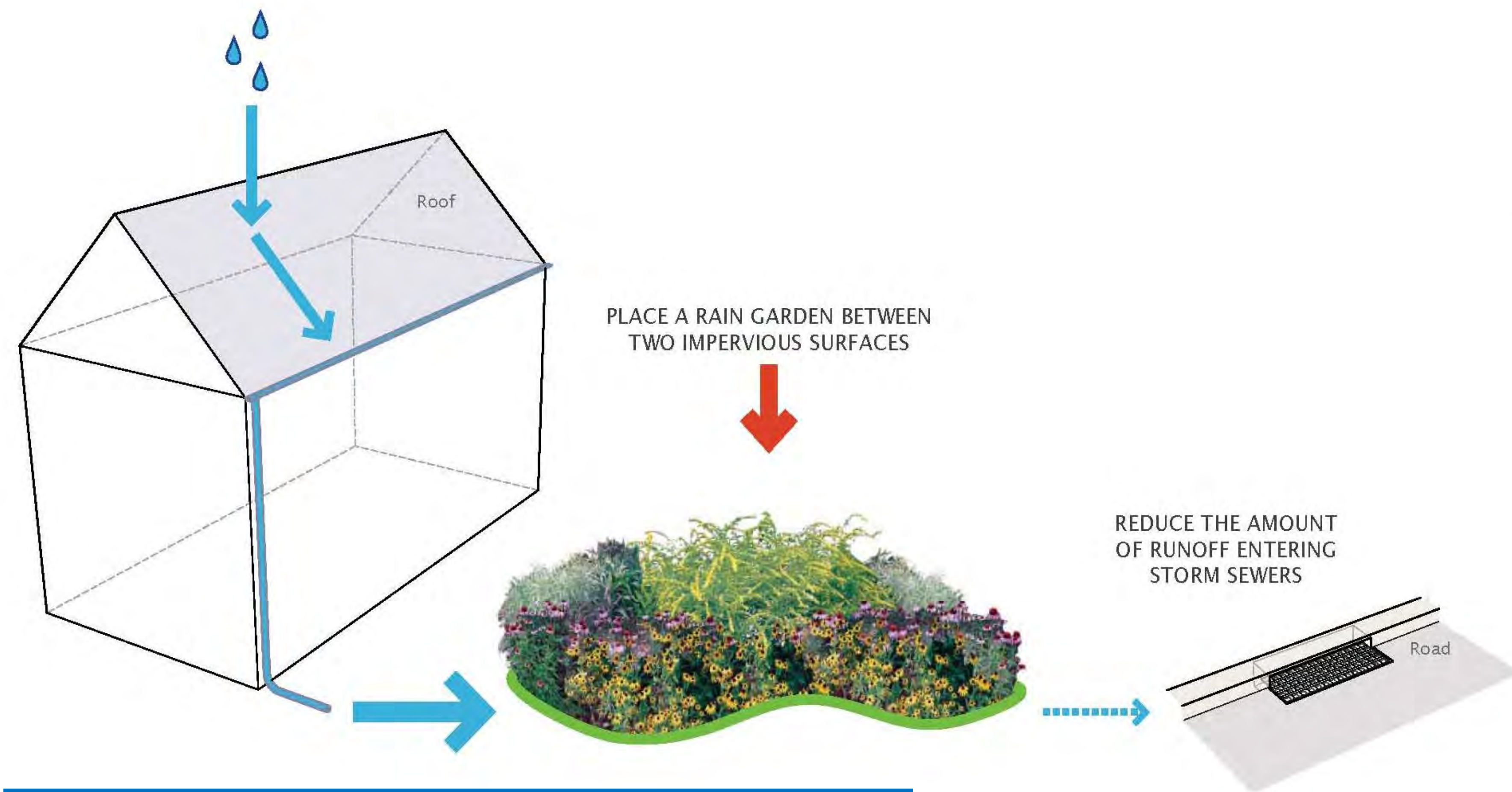
Disconnection with Rain Gardens



Rooftop runoff is now ***<u>"disconnected"</u>*** from flowing directly into the storm sewer system

Lots of Rain Gardens

Soils in Watershed Management

- Soils play an important role in drainage of our land

- All soils start as bedrock. Wind and rain break rocks into small soil particles over time. This is called the "parent material." Organic material (breakdown of plants and animals) combine with parent material to form soil.

Soil Properties

- Sandy soils (have large particles)
- Clay soils (have the smallest particles)
- Silt soils (have medium particles)
- Loamy soils (have particles of clay, silt and sand)

Clay → Silt → Loam → Sand

Slow Draining → Fast Draining

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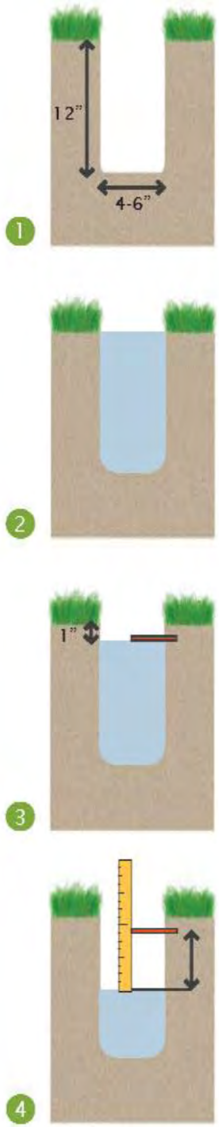
p. 22

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

What is Green Infrastructure?

Green infrastructure is an approach to wet weather management that is cost-effective, sustainable, and environmentally friendly. Green Infrastructure management approaches and technologies infiltrate, evapotranspire, capture and reuse stormwater to maintain or restore natural hydrologies.

Rain Garden in Holmdel, NJ

Native NJ Purple Coneflower

Pervious Pavers

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Green Infrastructure

Green Infrastructure projects:

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

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

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Green Infrastructure includes:

- Green Roofs
- Rainwater Harvesting Systems
- Planter Boxes
- Rain Gardens
- Permeable Pavements
- Vegetated Swales

Natural Retention Basins

Rain Gardens

Green Roofs

Permeable Pavements

Rainwater Harvesting

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Rainwater Harvesting Systems

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.

Rainwater Harvesting Systems

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Rainwater Harvesting Systems

Samuel Mickle School Rainwater Harvesting System

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Green Roofs

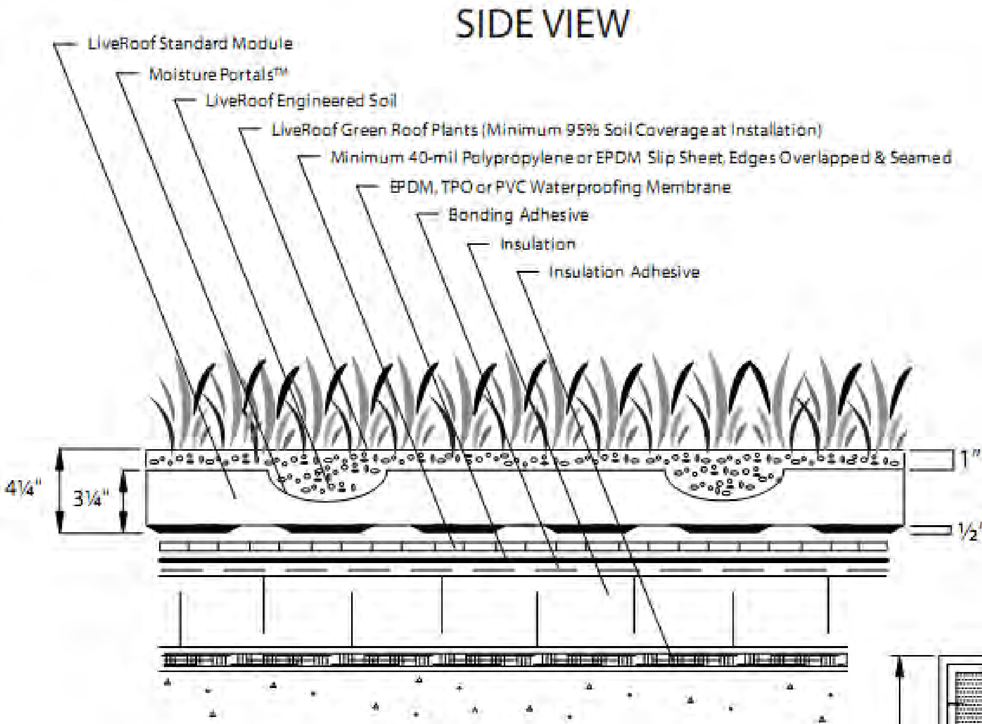
FUNCTIONS

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

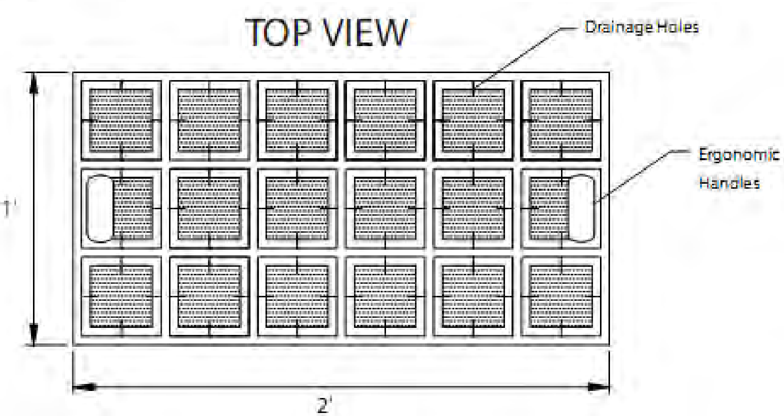
COMPONENTS

Green Roof Design

Modular System Specifications:




Parker Urban Greenscapes.



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

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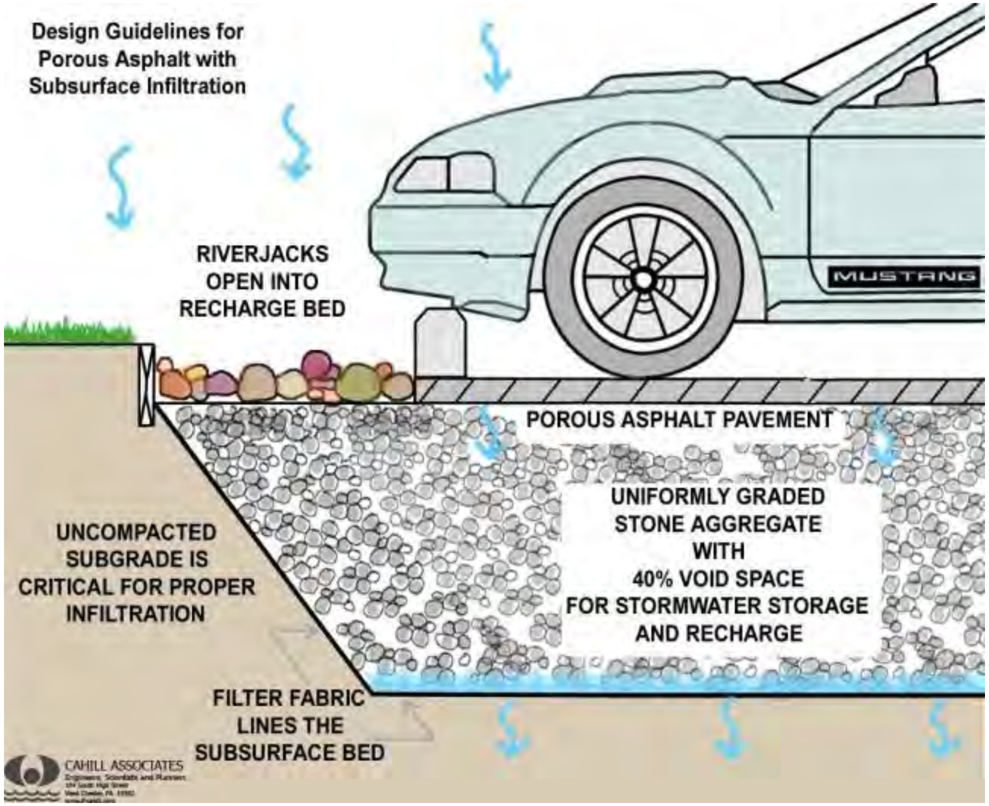
Pervious Pavements

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



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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

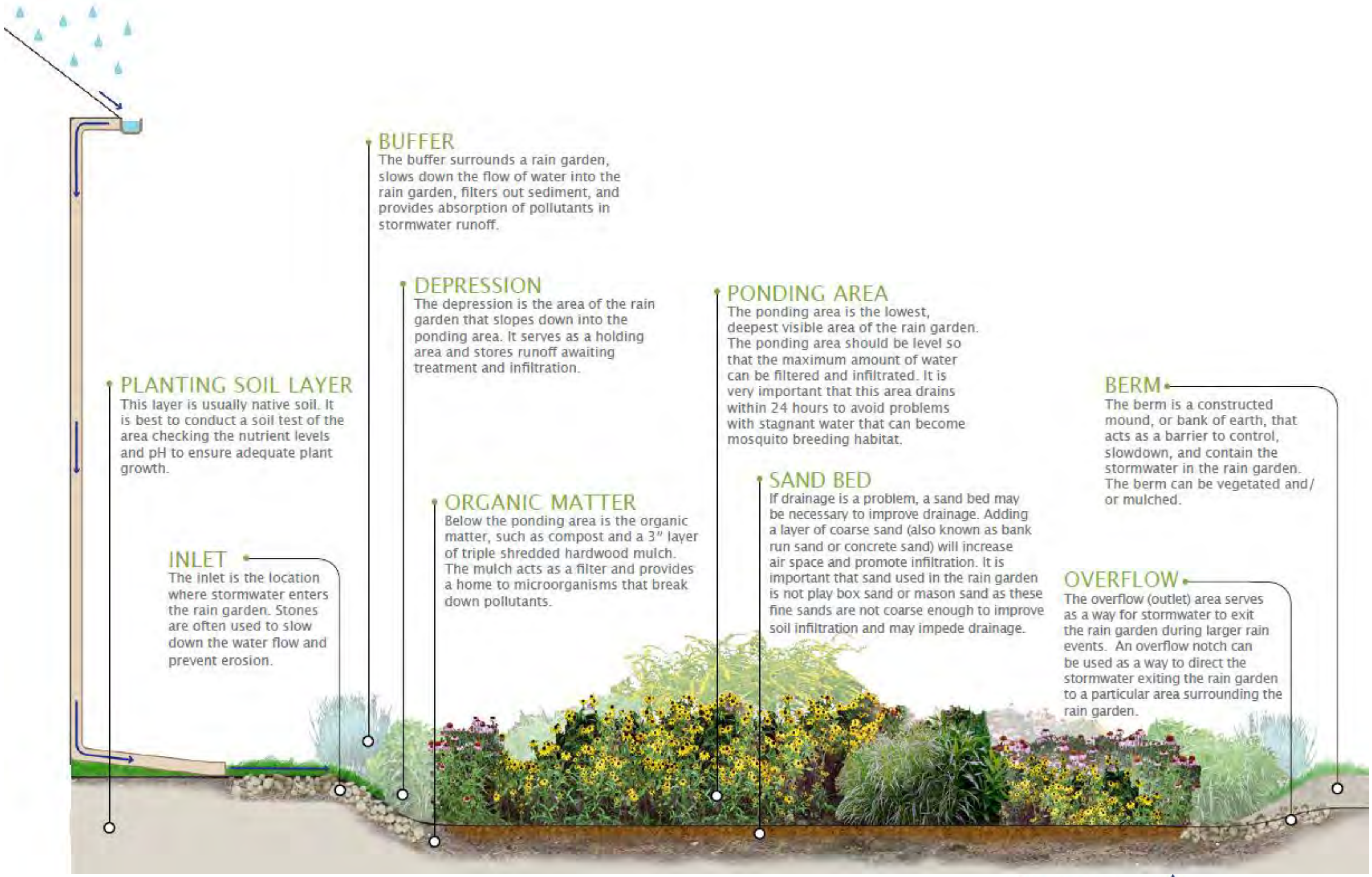
New Approach

- 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



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Bioretention Systems & Rain Gardens

Curb Extensions/Green Streets

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QUESTIONS?

Rutgers Cooperative Extension Water Resources Program

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How Stormwater Management and Green Infrastructure align with the Next Generation Science Standards

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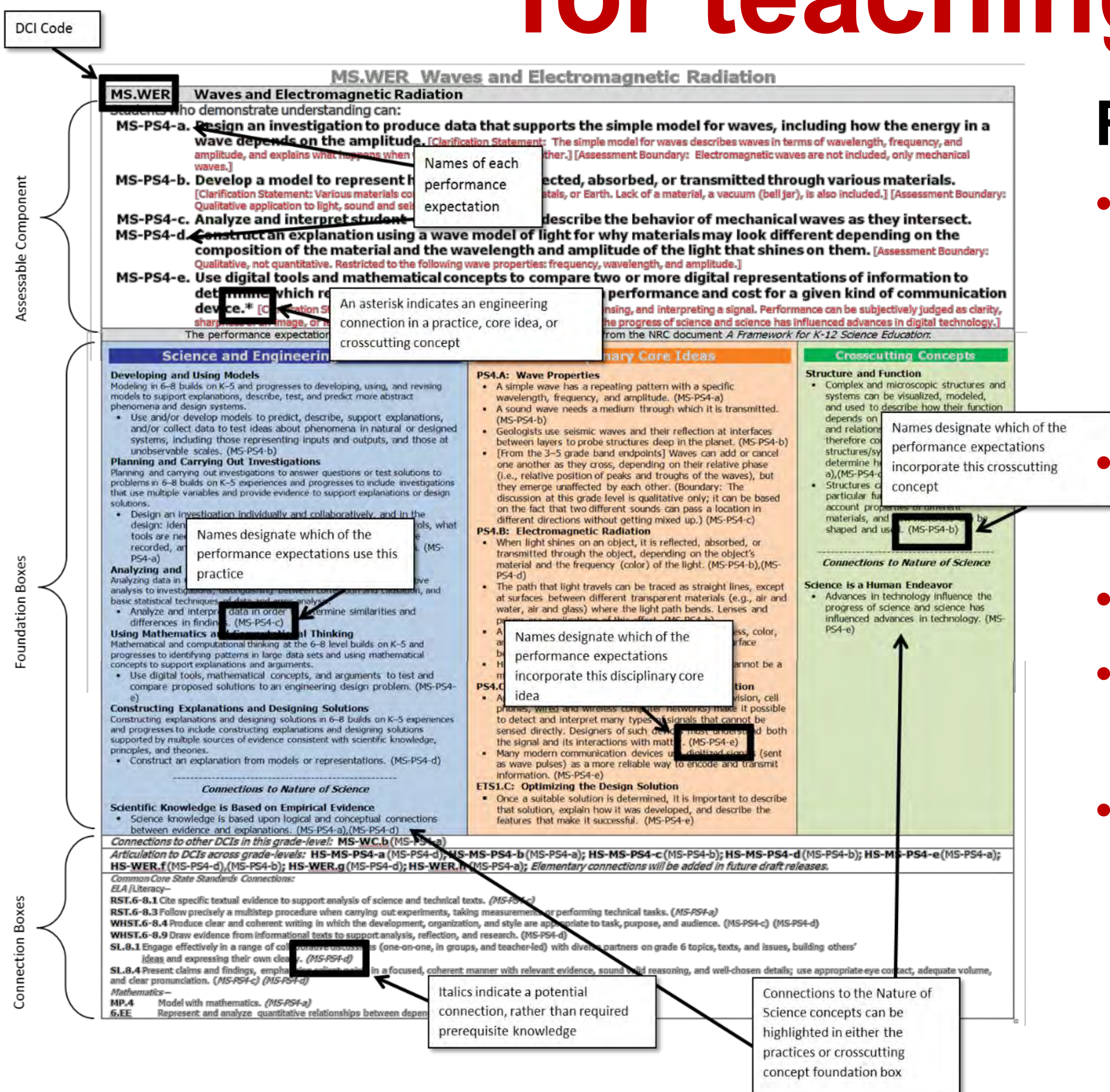
A QUICK REVIEW OF THE NGSS

Where should I start when tackling the NGSS?

What resources are available to help me understand the NGSS?

What does the NGSS look like for teaching?



Review of the NGSS

- Concepts under the standard
  - Clarification Statement
- Disciplinary Core Ideas (DCI)
- Crosscutting Concepts
- Science and Engineering Practices
- NGSS Framework further explains the goals of learning under the standard

NGSS Resources

- Download the NGSS Standards: http://www.nap.edu/catalog/18802/guide-to-implementing-the-next-generation-science-standards
- Download the Framework: http://www.nap.edu/catalog/13165/a-framework-for-k-12-science-education-practices-crosscutting-concepts
- Download Assessment Guide: http://www.nap.edu/catalog/18409/developing-assessments-for-the-next-generation-science-standards
- Additional Resources:
  - http://www.nextgenscience.org/resources
  - http://www.nextgenscience.org/next-generation-science-standards

TACKLING STORMWATER MANAGEMENT AND THE NGSS

Where to begin when designing and integrating stormwater management into the curriculum

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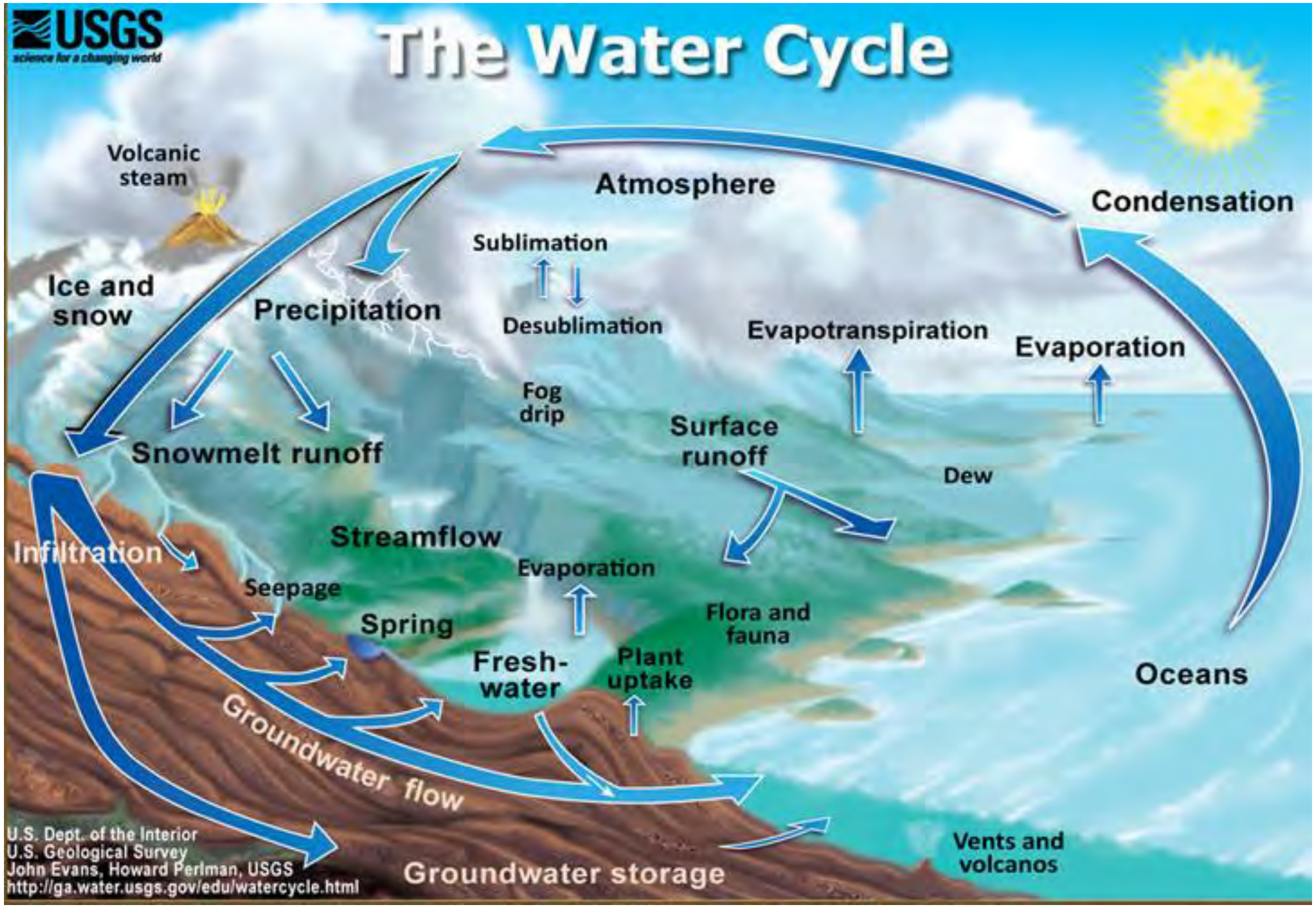
Where does Stormwater Management fit into the NGSS?



- Common Core Standard 5.4 Earth Science
- Strand F Climate and Weather: Earth's weather and climate systems are the result of complex interactions between land, ocean, ice, and atmosphere.

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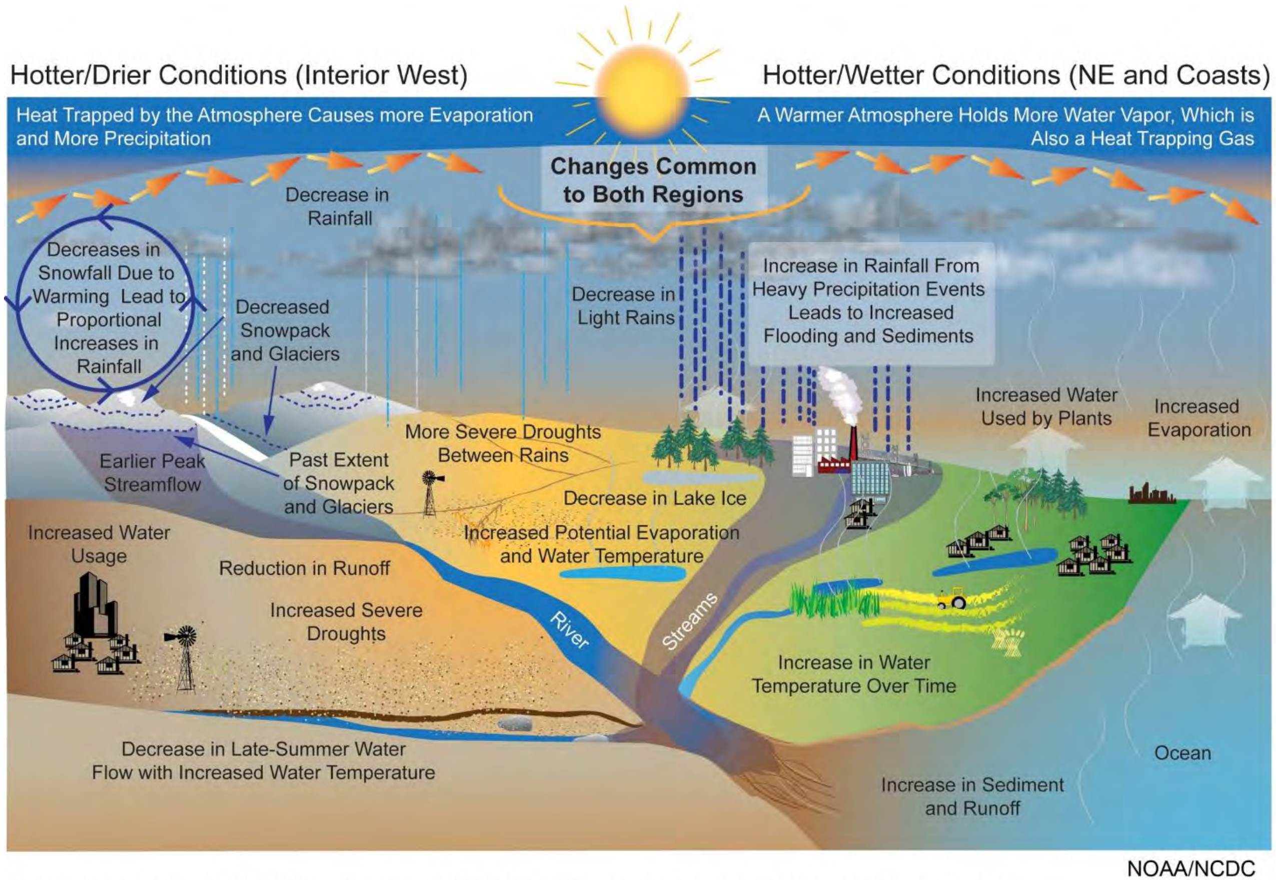
Where does Stormwater Management fit into the NGSS?



The water cycle exhibits many changes as the earth warms. Wet and dry areas respond differently.

- The water cycle is still embedded in the Earth's Systems
- The change? Opportunity to explore the Urban Water Cycle and enable students to model.

Where does Stormwater Management Fit into the NGSS?

MS-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]

MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. [Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).] [Assessment Boundary: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.]

- **By the end of grade 5**: Water is found almost everywhere on Earth: as vapor; as fog or clouds in the atmosphere; as rain or snow falling from clouds; as ice, snow, and running water on land and in the ocean; and as groundwater beneath the surface. **The downhill movement of water as it flows to the ocean shapes the appearance of the land**. Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.

Where does Stormwater Management fit into the NGSS?

MS-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]

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- **By the end of grade 8.** Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and **precipitation as well as downhill flows on land**. The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. Global movements of water and its changes in form are propelled by sunlight and gravity. Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. **Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.**

Where does Stormwater Management fit into the NGSS?

Disciplinary Core Idea

ESS2.C: The Roles of Water in Earth's Surface Processes

- Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4)
- The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5)

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5)

Science & Engineering Practices

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena. (MS-ESS2-1),(MS-ESS2-6)
- Develop a model to describe unobservable mechanisms. (MS-ESS2-4)

Planning and Carrying Out Investigations

Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.

- Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-ESS2-5)

Where does Stormwater Management fit into the NGSS?

- **ELA/Literacy**
  - **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-2, MS-ESS2-3, MS-ESS2-5)
  - **RST.6-8.9** Compare and contract the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ESS2-3, MS-ESS2-5)
- **Mathematics**
  - **MP.2** Reason abstractly and quantitatively (MS-ESS2-2, MS-ESS2-3, MS-ESS2-5)

How do I apply NGSS and Stormwater Management?

- Opportunities for students to understand their watershed through modeling the urban water cycle
  - How does water flow in the schoolyard?
  - Where does rain water go from the street? Roof? Sidewalk? Etc.
  - Where does water go when I flush the toilet?

Stormwater Management in Your Schoolyard Program

www.water.rutgers.edu

Rain Garden Installation and Maintenance

This module is designed to provide students with an overview of how rain gardens are installed. Students also work in small groups to plant their school's rain garden.

Curriculum:

- Rain Garden Installation
  - Rain Garden Installation PowerPoint Presentation
  - Homework - Video Questions

Rain Garden Maintenance and Community Presentations

This module is designed to provide students with an opportunity to determine how to take care of their school's rain garden and to teach their local community about stormwater management and rain gardens. Video technology and/or poster presentations can be used to deliver their message.

Curriculum:

- Rain Garden Maintenance and Community Presentations
  - Taking Care of our Rain Garden Checklist

- Topics include:
  - Watersheds
  - Land Use/Cover
  - Stormwater Runoff and Nonpoint Source Pollution
  - Soil/Plant Considerations
  - Rain Garden Design
  - Rain Garden Installation and Maintenance

Stormwater Management Modeling with Evidence

- Provide scientific data to students to evaluate between what is good vs. bad evidence
  - Bring out misconceptions and come to a class agreement of what the standards should be
- Students to use the evidence given to design or describe models of how the system (i.e., rain gardens) promote water quality and impact the environment
- This enables students to become scientists through analyzing data and applying it to their schoolyard scenario

Stormwater Management Modeling with Evidence

- Student Evidence Example:
  - Scientist Potter and team compared experimental parameters of rain gardens and whether the system recharges ground water. Through model simulations and field evaluations, the table below displays their findings.

Table 5. Experimental data vs. model parameters (values in parenthesis are the result of model simulations).

Parameters	Experiment 1	Experiment 2	Experiment 3
Start time of application	16:00	15:00	12:17
End time of application	17:10	16:52	13:57
Water application time (h)	1.17	1.87	1.67
Total water applied (gal)	477.36	740.52	701.40
Start time of ponding	16:53 (16:59)	16:08 (16:11)	13:20 (13:12)
End time of ponding	19:02 (18:59)	20:08 (19:54)	16:42 (16:58)
Total ponding time (h)	2.15 (2.0)	4.00 (3.7)	3.37 (3.7)
Ponded infiltration (cm/h)	5-6 (5.0)	5-7 (5.0)	5-7 (5.0)
Overspill runoff	no (no)	no (6% input)	no (4% input)
Max. ponding depth (cm)	15 (9.0)	15 (15.0)	15 (15.0)

Potter, K. (2002), *Field Evaluation of Rain Gardens as a Method for Enhancing Groundwater Recharge.* University of Wisconsin-Madison.

Stormwater Management Modeling with Evidence

- Student Task: Analyzing the data – what is it telling me?
  - The evidence shows that in experiment 2 and 3, the model predicted 4-6% stormwater input would spill, while no spill occurred in the experimental rain garden in each of the experiments.
  - The analysis provides evidence that the rain garden is infiltrating stormwater and it is entering into the ground.

- Student Task: Assessing all data to design a model of how stormwater can be managed through green infrastructure practices like rain gardens

GREEN INFRASTRUCTURE DESIGN SCENARIOS

NGSS that can apply to Stormwater Management and Green Infrastructure in the classroom

Rutgers
New Jersey Agricultural Experiment Station

Standards that can apply to Green Infrastructure

- MS Life Science – Ecosystems: Interactions, Energy, and Dynamics
- MS ESS – Earth and Human Activity
- MS Engineering Design

MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

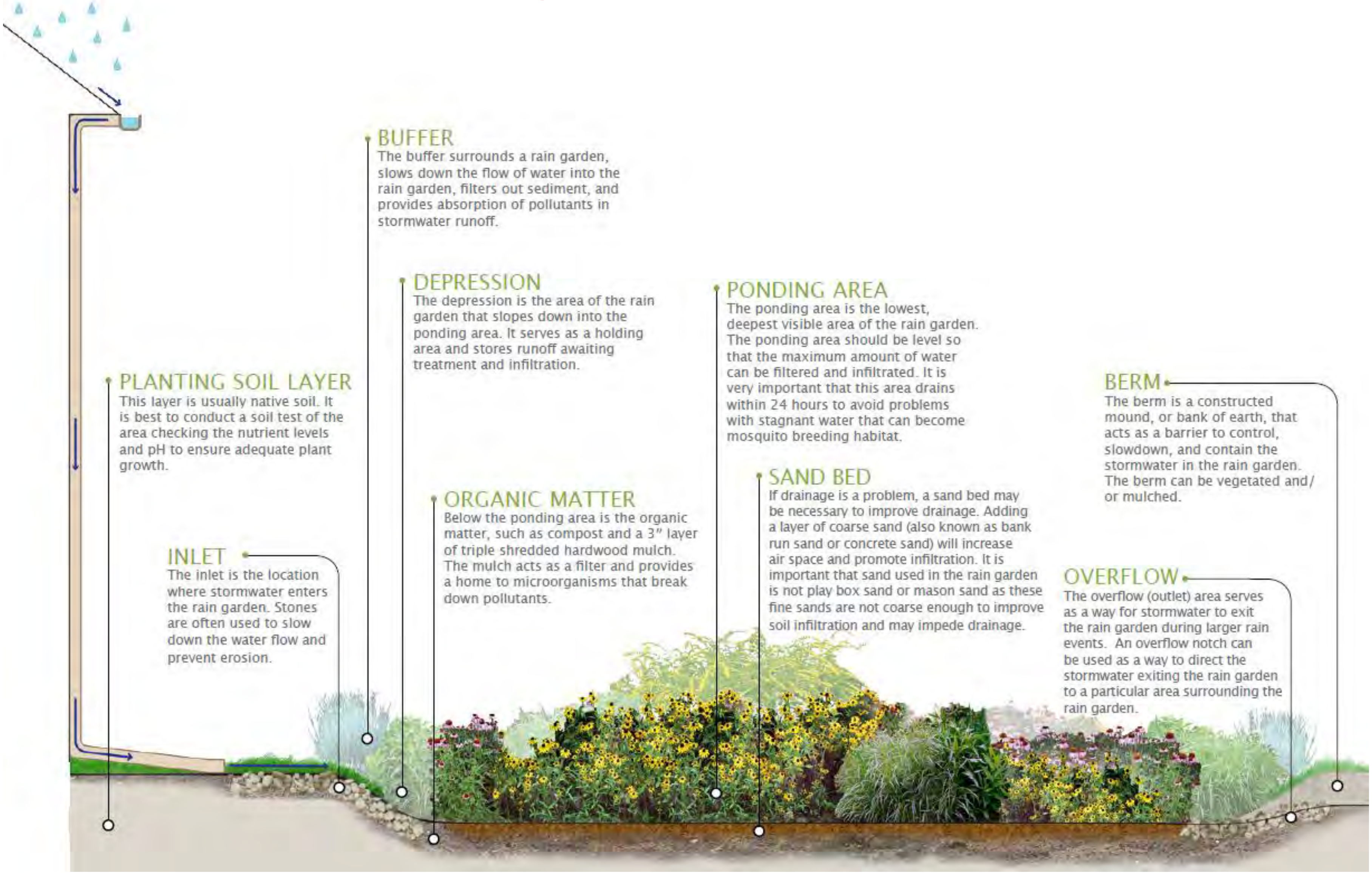
MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Bioretention Systems & Rain Gardens

- Documenting how water behaves on impervious surfaces
- Using green infrastructure, in this case rain gardens, as a solution to capture stormwater
- Understanding the benefits of green infrastructure

Bioretention Systems & Rain Gardens



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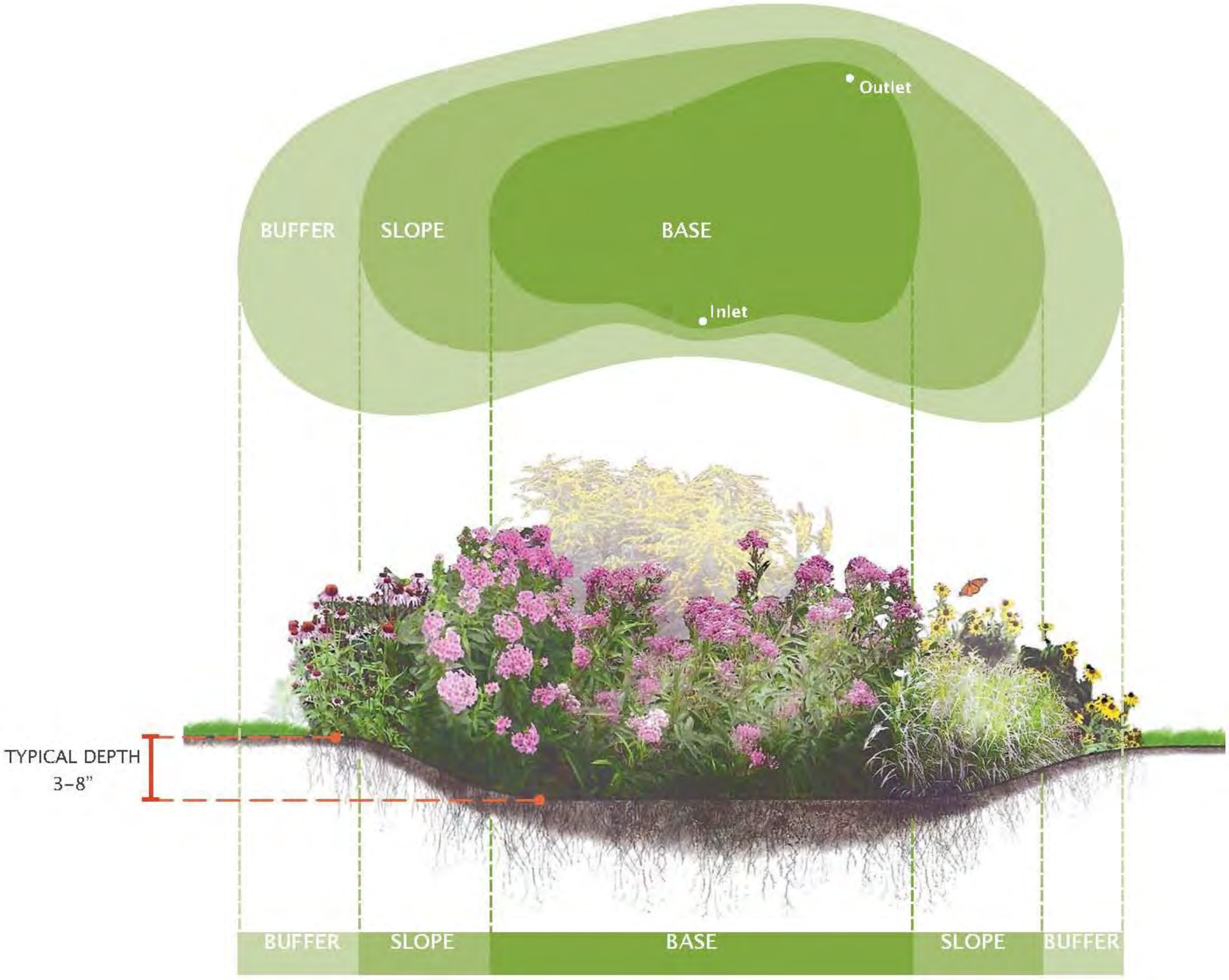
New Jersey Agricultural Experiment Station

Bioretention Systems & Rain Gardens



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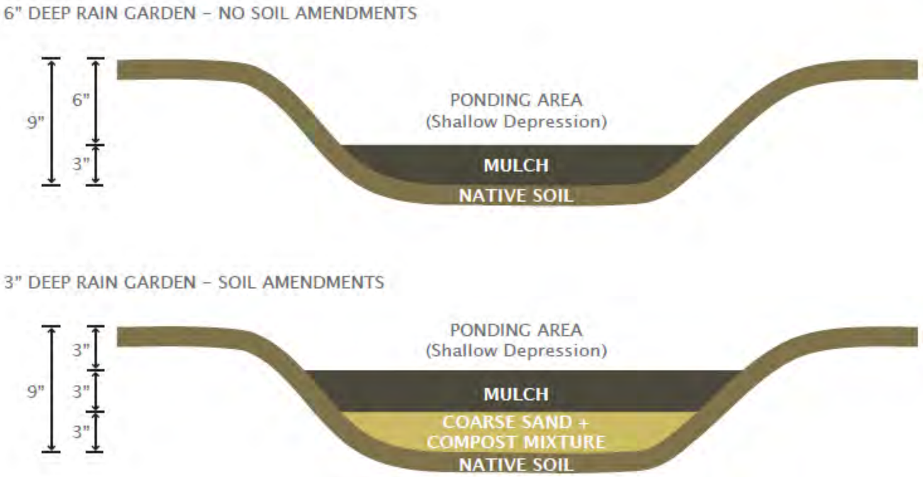
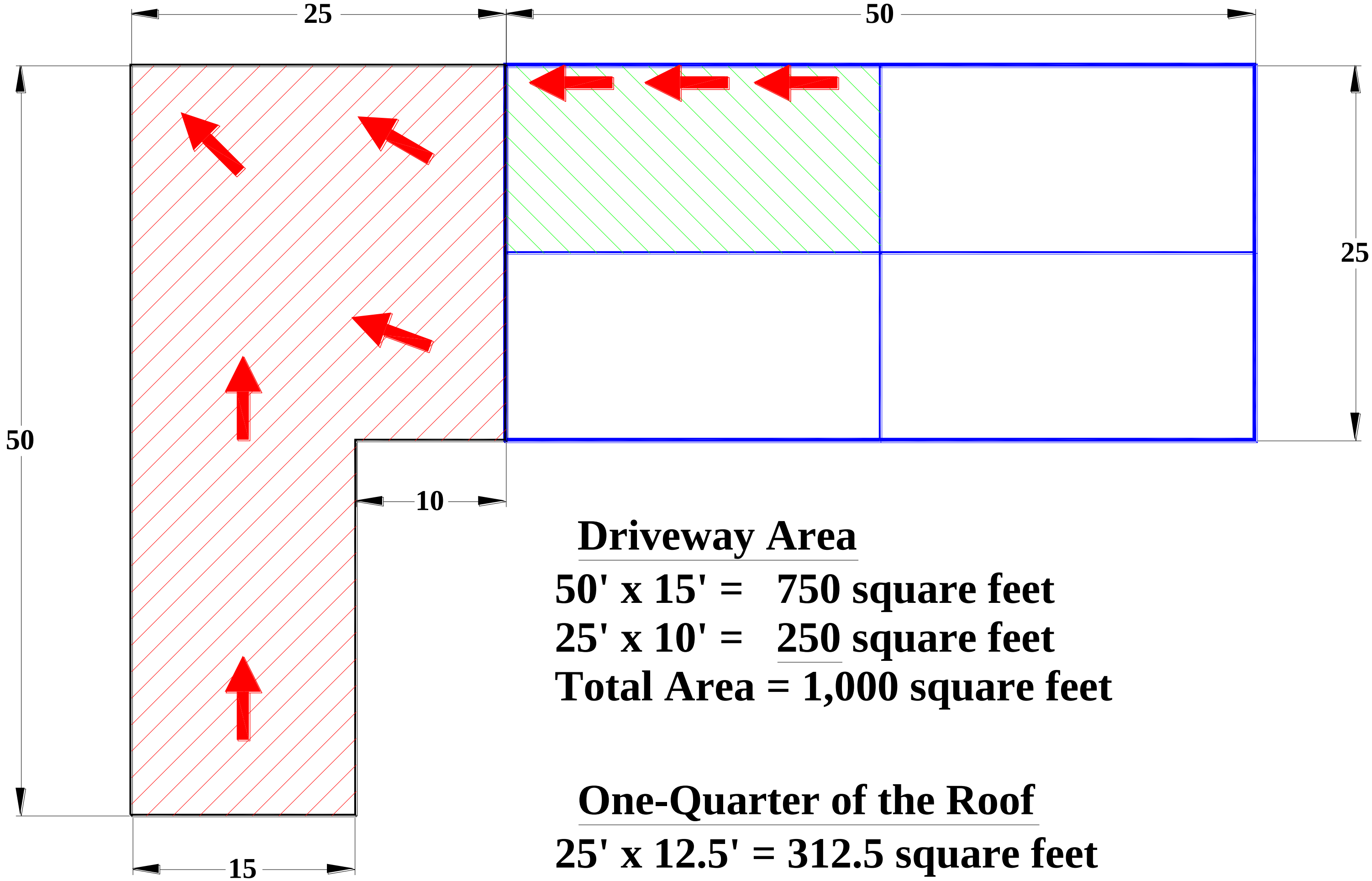
Design Criteria

- The size of the rain garden is a function of volume of runoff to be treated and recharged.
- Typically, a rain garden is sized to handle the water quality design storm: 1.25 inches of rain over two hours.
- A typical residential rain garden ranges from 100 to 300 square feet.



Design Problem

How big does a rain garden need to be to treat the stormwater runoff from my driveway?



Driveway Area

50' x 15' = 750 square feet

25' x 10' = 250 square feet

Total Area = 1,000 square feet

One-Quarter of the Roof

25' x 12.5' = 312.5 square feet

Design Problem

- Drainage Area = 1,000 square feet
- 1.25 inches of rain = 0.1 feet of rain
- 1,000 sq. ft. x 0.1 ft. = 100 cubic feet of water for the design storm
- Let's design a rain garden that is 6 inches deep

Answer:

10 ft wide x 20 ft long = 200 square feet

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Rain Garden Sizing Table for NJ's Water Quality Design Storm

Area of Impervious Surface to be Treated (ft^2)	Size of 6″ deep Rain Garden (ft^2) or [w x d]	Size of 12″ deep Rain Garden (ft^2) or [w x d]
500	100 or 10′x10′	50 or 10′x5′
750	150 or 15′x10′	75 or 10′x7½′
1,000	200 or 20′x10′	100 or 10′x10′
1,500	300 or 30′x10′	150 or 15′x10′
2,000	400 or 20′x20′	200 or 20′x10′

How much water does this treat?

- 90% of rainfall events are less than 1.25”
- New Jersey has approx. 44” of rain per year
- The rain garden will treat and recharge:

  0.9 x 44” = 40”/year = 3.3 ft/year
- The rain garden receives runoff from 1,000 sq.ft.
- Total volume treated and recharged by the rain garden is 1,000 sq. ft. x 3.3 ft. = 3,300 cubic feet, which is 25,000 gallons per year
- **Build 40 of these and we have treated and recharged 1,000,000 gallons of water per year!**

Enabling Students to Model and Design their Schoolyard

- Involve the students with designing their schoolyard
- Build a rain garden using the NJ Rain Garden Manual (available online to download for free)
- Use the rain garden as an outdoor classroom
- Use the Rain Garden App (FREE) to engage students to design other rain gardens!

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Pollutant Removal Mechanisms – Evidence to Collect/Analyze

- Absorption to soil particles
  - *Removes dissolved metals and soluble phosphorus*
- Plant uptake
  - *Removes small amounts of nutrients*
- Microbial processes
  - *Removes organics and pathogens*
- Exposure to sunlight and dryness
  - *Removes pathogens*
- Infiltration of runoff
  - *Provides flood control, groundwater recharge, and nutrient removal*
- Sedimentation and filtration
  - *Removes total suspended solids, floating debris, trash, soil-bound phosphorus, some soil-bound pathogens*

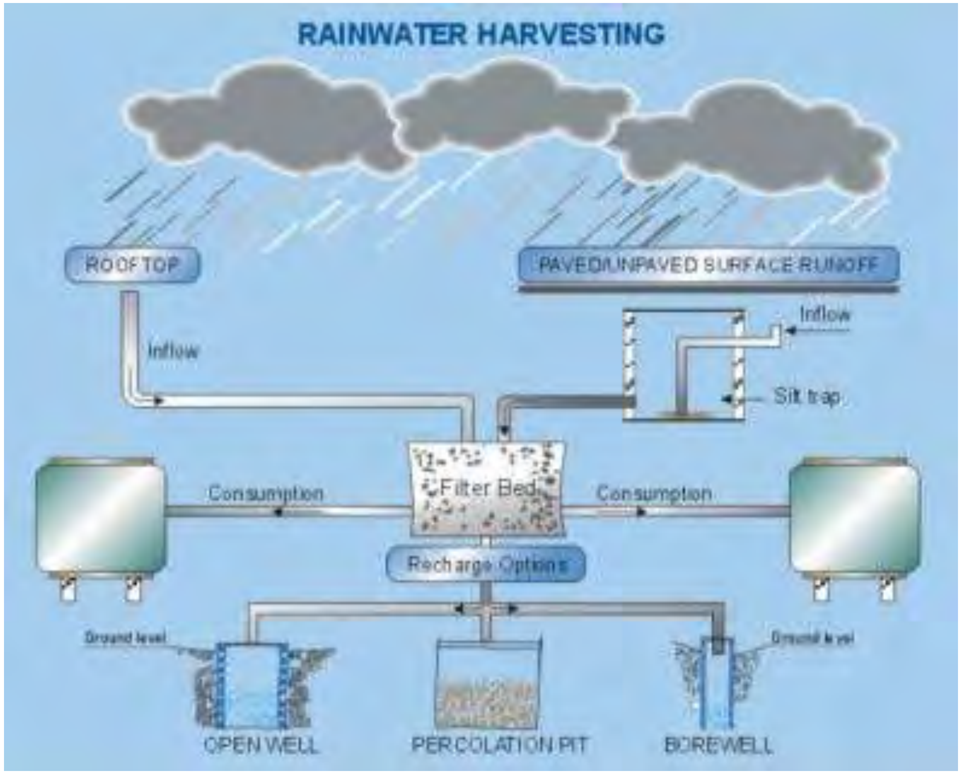
NOTE: 90% of all storm events produce less than 1 inch of rain. Therefore, the key to reducing pollutant loads is to treat the runoff associated with the first 1 inch of rain (Claytor & Schueler, 1996).

Rainwater Harvesting Systems

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.

COMPONENTS



Rainwater Harvesting Systems

Sizing

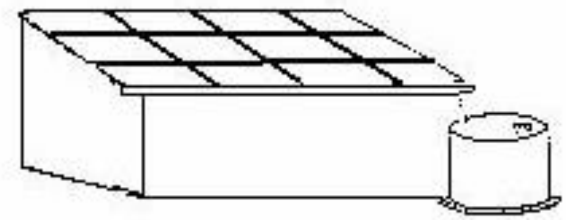
- The rule of thumb is 600 gallons of water per inch of rain per thousand square feet of catchment area.
- Not all the rain that falls can actually be collected. Efficiency is usually presumed to be 75% depending on system design and capacity.

Sizing Formula

Here is the basic formula for calculating the potential amount that can be collected:

$$\frac{\textit{(Catchment area) x (inches of rain) x (600 gallons) x (.75)}}{\textit{1000 square feet}}$$

Design Example



The sample roof shown below has a catchment area that is 40 feet wide and 30 feet long. Hence, it has a 1200 square feet roof (40 feet wide x 30 feet long). Assume that it rains 2 inches. We can now plug this information into our general formula.

Catchment Area = 1200 square feet

Amount of Rain = 2 inches

Gallons of water collected per inch of rain per 1000 square feet = 600 gallons

Percent Efficiency = 75% or .75

(1200 square feet) x (2 inches of rain) x (600 gallons) x (.75)
-- = 1080 gallons
1000 square feet

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Experiment Station

QUESTIONS?

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RUTGERS
THE STATE UNIVERSITY
OF NEW JERSEY

PASSAIC VALLEY SEWERAGE COMMISSION
EST. 1902
"Protecting Public Health and the Environment"

Morning Break

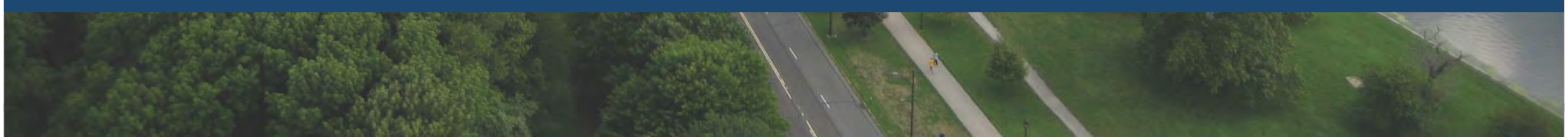
15 minutes…

We'll resume at 11am

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

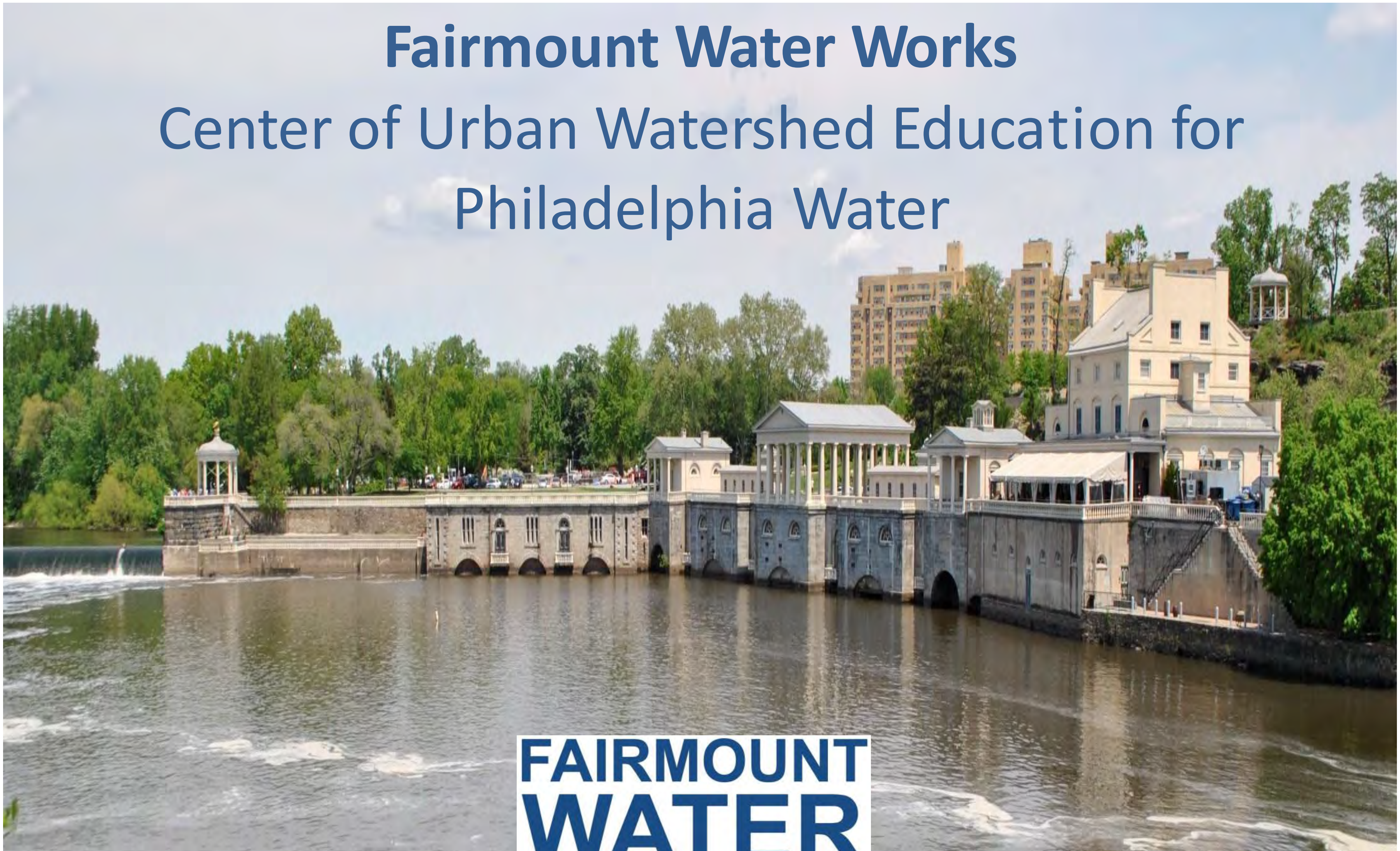
Understanding the Urban Watershed Curriculum

Making Connections



Fairmount Water Works

Center of Urban Watershed Education for Philadelphia Water



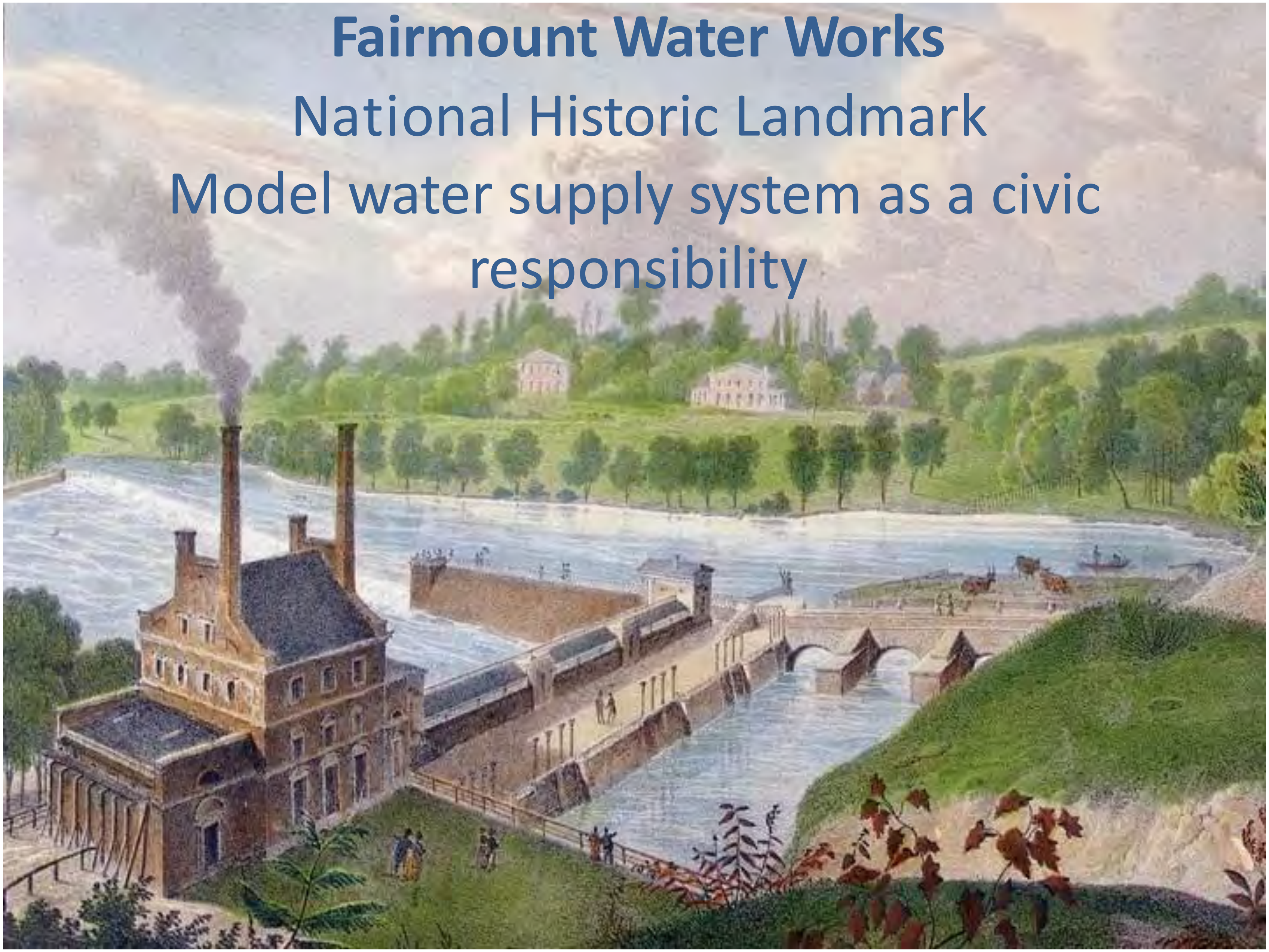
FAIRMOUNT WATER WORKS

DISCOVER • CONNECT • ACT

Fairmount Water Works

National Historic Landmark

Model water supply system as a civic responsibility



Fairmount Water Works Mission

- **Foster** stewardship of our shared water resources by encouraging informed decisions about the use of land and water
- **Educate** citizens about Philadelphia's urban watershed, its past, present and future, and collaborate with partners to instill an appreciation for the connections between daily life and the natural environment
- **Transform** the way people think and live by making them aware of how individual actions on the land impact the quality of water for all living things

Environmental Education

EPA Definition:

Environmental education enhances critical-thinking, problem-solving, and effective decision-making skills. It also teaches individuals to weigh various sides of an environmental issue to make informed and responsible decisions. Environmental education does not advocate a particular viewpoint or course of action. (Federal Register, Tuesday, December 10, 1996, p. 65106)

(See page 4 of Curriculum Guide)

Using the Watershed as an Integrated Context for Learning

Because the environment is connected to everything around us – from science to history and social science to literature – it offers an authentic and dynamic context for teachers and students to tie together teaching and learning across the core disciplines

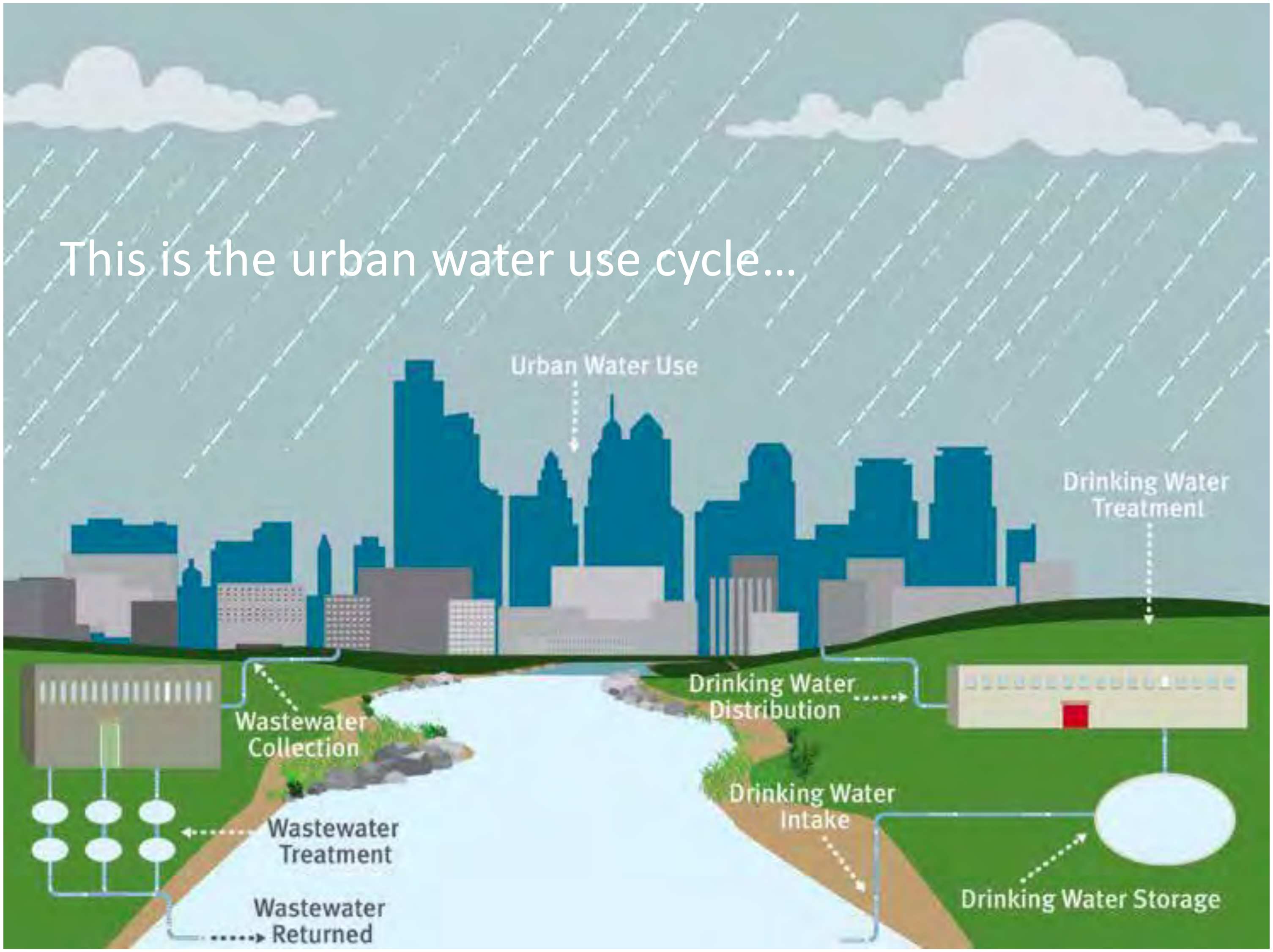
Gerald Lieberman, founding director of the State Education and Environment Roundtable and author of *Education and The Environment: Creating Standards Based Programs in Schools and Districts* (Harvard Ed Press, 2013)

FWW Curriculum based on the idea of Water for the City

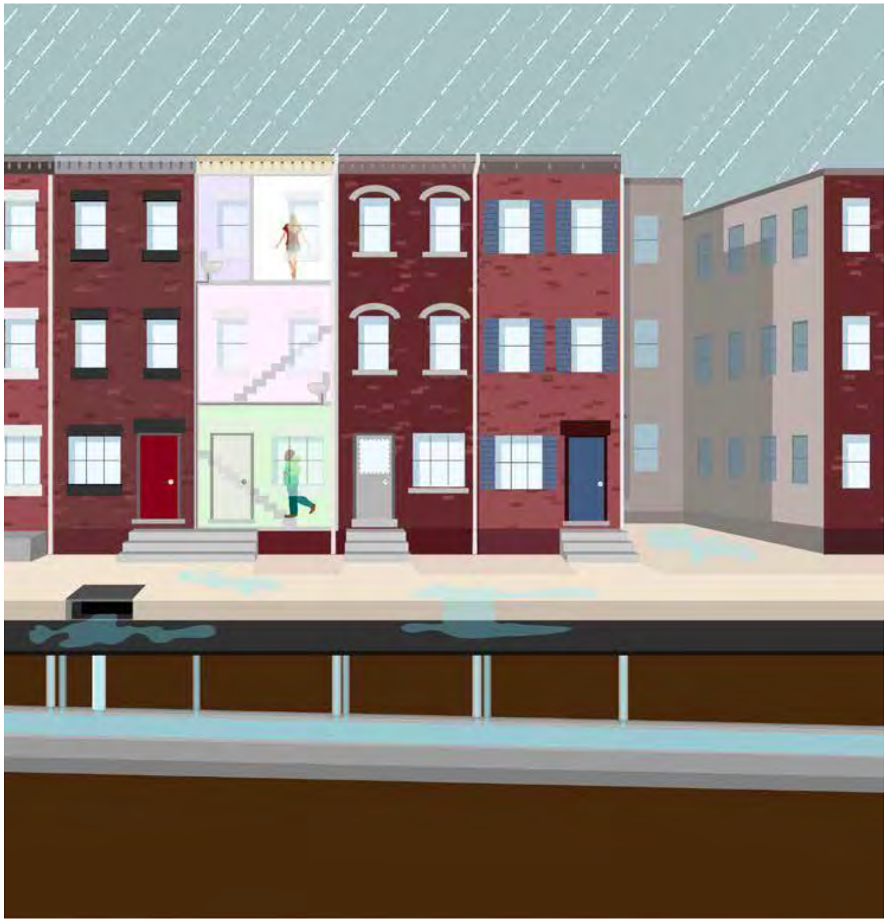
- Need/Love of water
- Public health
- Urban Water Supply and Drainage requires an engineered system
- Pollution from stormwater runoff requires a managed system that is both economical and sustainable

…and that everyone lives in a watershed

..and that everyone uses water



…and we all rely on the fact that "used" water goes down the Drain: Is it Out of Sight, Out of Mind?



Connect to Green City, Clean Waters

Philadelphia’s 25 Year plan to protect and enhance the watershed

Where do we/you start?

- Build an understanding of water in our world
- The natural environment and systems thinking
- What is a watershed and how the natural water cycle interacts with the watershed
- Understand ecological diversity and abundance, interdependence

(Thematic Unit 1…)

Classroom Learning =

Thematic Unit 1:
Water in Our World

Thematic Unit 3:
Drinking Water and You

Thematic Unit 3:
Down the Drain, or Out of Sight, Out of Mind

Thematic Unit 4:
Land and Water: A delicate balance (or Can't We All Just Get Along?)

Thematic Unit 5:
Green Plan for the Future: Playing a Part

Thematic Unit 6:
Environmental Stewardship

Students make it rain to help understand what a watershed is

Students test their engineering skills

Students explore the relationship of plants, soil and water

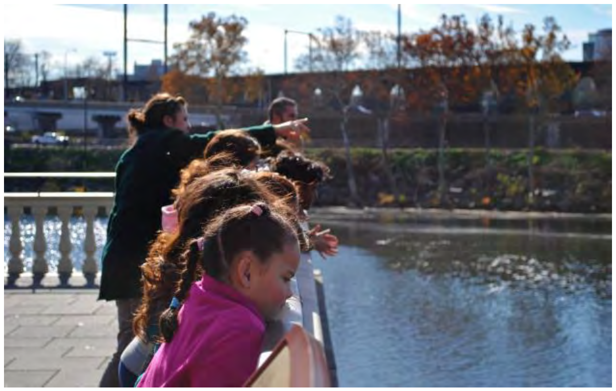
Student view: Where's the watershed now?


Utopian vision!

Real world classroom to schoolyard connections

Field Trips are experiential and place-based learning

Field Trips include the sensory experience– taking it outside along the waterways



Students on and around the river provide opportunities for art and science

Middle Years Curriculum Program

Understanding the Urban Watershed

- 3-year Teacher Fellowship Program supported in large part by the William Penn Foundation Teacher written–teacher driven curriculum
- Powerful learning
- Content support/pedagogy/lesson planning and testing in the classroom
- Connect to real world learning /Resources of PWD and Partners
- Standards-based (Common Core/NGSS)
- Progressive and innovative

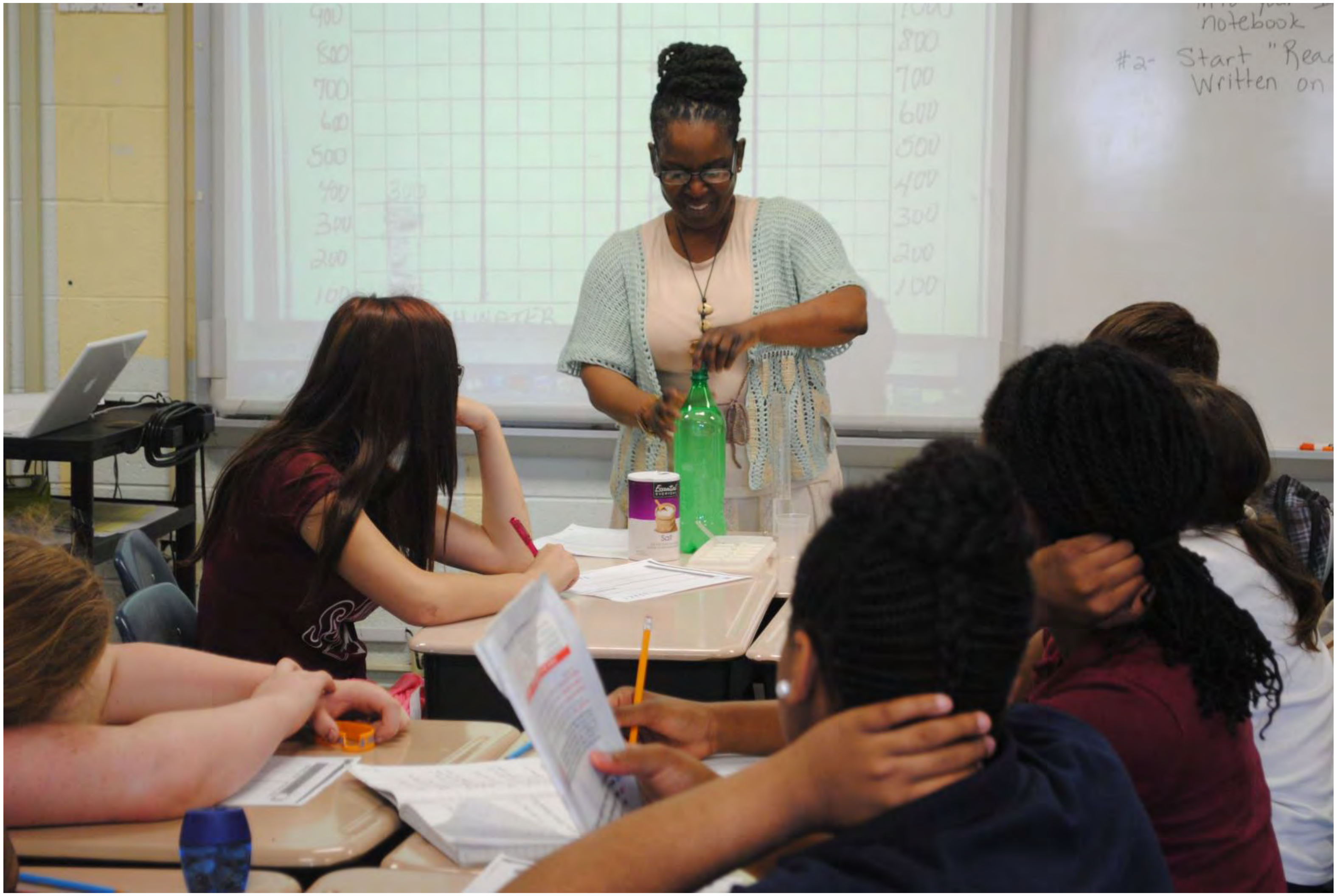
6th grade teachers Year 1 at one of a series of Saturday professional development sessions (60 hours in total)

Modeling student experiences
Take it outside, get your “feet” wet

Make a walk into an expedition

Sensory experiences

Curriculum includes *Engage* activities as well as *Demonstrations* along with student worksheets



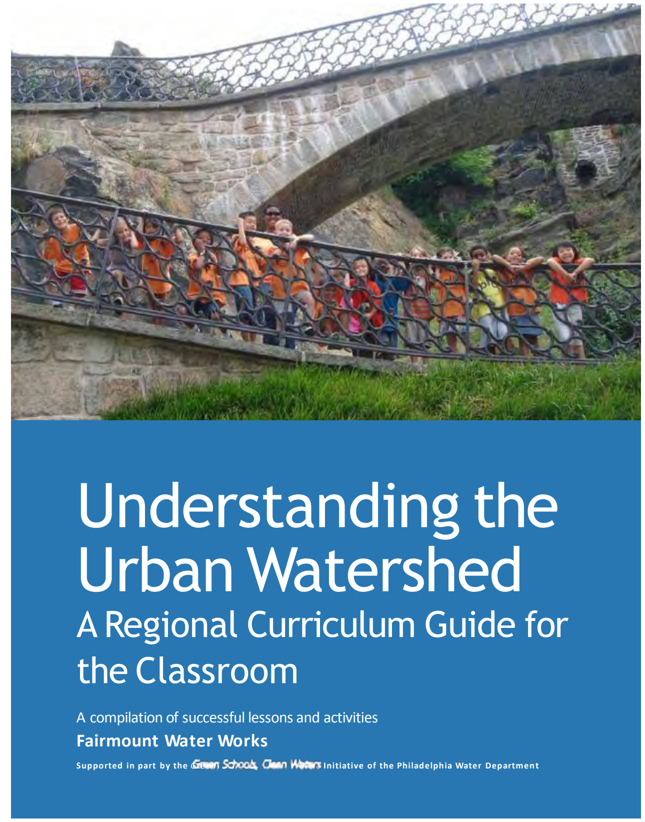
A bucket brigade lesson in and around the schoolyard

Connect to real projects, real people

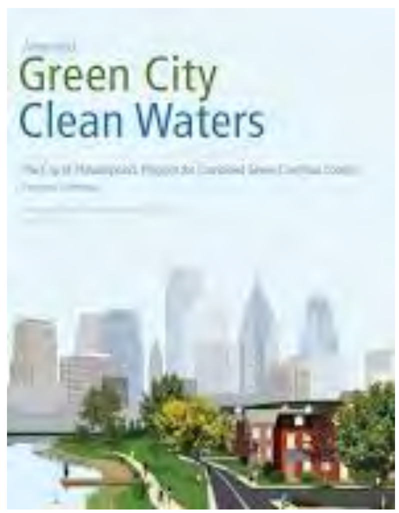
Make students part of the design process and schoolyard transformation

Resources

www.cdesignc.org/guides/schoolyards



Resourcewater.org



Phillywatersheds.org

For more information…

Ellen Freedman Schultz

Associate Director For Education

Fairmount Water Works

Fairmountwaterworks.org

Ellen.Schultz@phila.gov

215–710–0577

Passaic River /Newark Bay Restoration Program

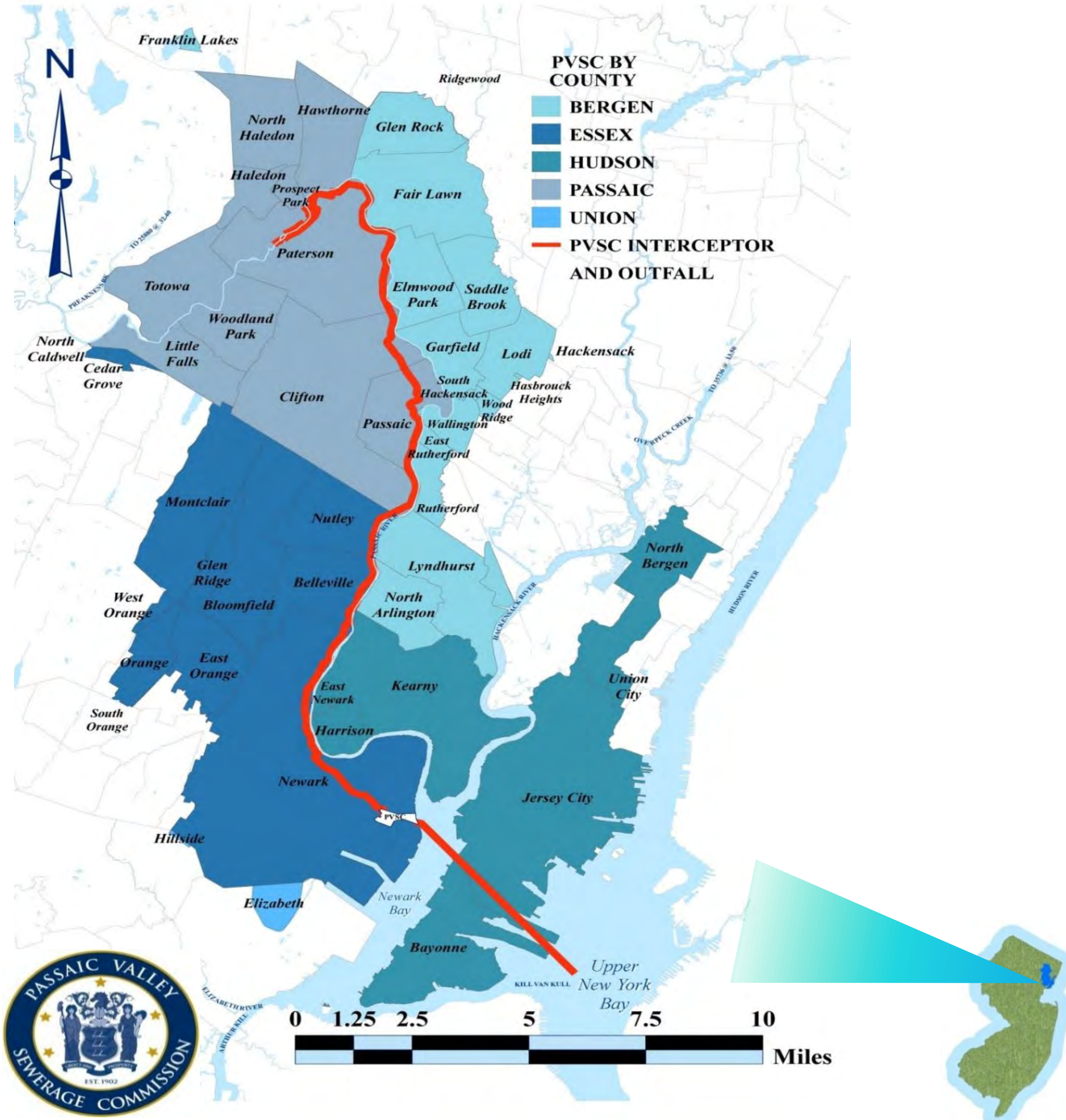
Kenneth J. Lucianin
Thomas Tucci, Jr.
Commissioners

Michael DeFrancisci
Executive Director

"Protecting Public Health and the Environment"

Education Program

- Date of inception 2003
- Staff of 2
- 90 Schools per year visited
- 170 Assemblies per year
- Average 24,000 to 30,000 students seen per year
- Multi National and Local Award Winning Program


PVSC BY COUNTY
BERGEN
ESSEX
HUDSON
PASSAIC
UNION
PVSC INTERCEPTOR AND OUTFALL
N
Franklin Lakes
Ridgewood
Hawthorne
North Haledon
Glen Rock
Haledon
Prospect Park
Fair Lawn
Paterson
Totowa
Elmwood Park
Saddle Brook
Woodland Park
North Caldwell
Little Falls
Garfield
Lodi
Hackensack
Cedar Grove
South Hackensack
Hasbrouck Heights
Clifton
Wood Ridge
Passaic
Wallington
East Rutherford
Montclair
Rutherford
Nutley
North Bergen
Glen Ridge
Lyndhurst
Belleville
West Orange
Bloomfield
North Arlington
Orange
East Orange
Union City
East Newark
Kearny
South Orange
Harrison
Newark
Jersey City
PVSC
Hillside
Newark Bay
Elizabeth
Bayonne
Upper New York Bay
KILL VAN KULL
0
1.25
2.5
5
7.5
10
Miles
PASSAIC VALLEY SEWERAGE COMMISSION
EST. 1902

Non-Point Source Pollution

Volunteering

GARBAGE REMOVED TO DATE: 11,000 TONS

THAT EQUALS

22,000,000 POUNDS


Living Classroom

Passaic Valley Sewerage Commission's 2014-15 River Restoration Program

"Protecting Public Health and the Environment"

Attention all 6th Grade through High School Students

Your School or Organization can participate in a shoreline cleanup and help the environment!

Teachers and Coordinators

We select the site, supply the bags and gloves, and remove the trash at the cleanups.

All we need is you!

Get involved and

"Make A Difference"

For clean up information and sponsorship contact:

Passaic Valley Sewerage Commission
c/o Donna Piscopo
River Restoration Department
Phone (973)466-2714
Fax (973)344-7114
E-Mail: cleanriver@pvsc.nj.gov

Greener, Healthier, Happier

Programs of Greater Newark Conservancy


GREATER NEWARK CONSERVANCY

Greater Newark Conservancy

Greater Newark Conservancy promotes environmental stewardship to improve the quality of life in New Jersey's urban communities.

- *Education*
- *Community Greening*
- *Environmental Justice*
- *Job Training*

Education

Field Trips to Urban Education Center

Outreach to Schools

Discovery Boxes

Demonstration Kitchen

PDW's

EDUCATION


HEALTHY VEGGIES
GREATER NEWARK CONSERVANCY
FRESH FRUITS
JUICY FRUIT
BEAUTIFUL FLOWERS

Living Lab School Gardens

Living Lab School Gardens

Living Lab School Gardens

Living Lab School Gardens

Living Lab School Gardens

Rainwater Recapture System at 13th Avenue School

Community Greening

Plot-It-Fresh

Community Gardens

Central Ward Project

Community Composting Program

Rain Cistern at School Garden

A small shed at the school athletic field—gutters collect rain to be used in irrigating the school garden.

Rain Cistern at School Garden


Community
Greening

Creating a Rain Garden

Urban Farms

Hawthorn Hawks Healthy Harvest Farm

Court Street Urban Farm

Urban Agriculture

Hawthorn
Hawks
Healthy
Harvest Farm

Court Street
Urban Farm

Job Training

Clean and Green

NYLP

Newark Youth Leadership Project


C
OLLEYBAL

Job Training

Clean and Green

Re-entry program for at-risk youth and adults


Clean & Green


RYOBI

Rain Barrel Building Workshop

Healthy Education for a Lifetime

NJ Tree Foundation
Newark Renaissance Trees Program

Stormwater Management in Your Schoolyard
June 8, 2015
Elena López

Who are we?

- NJ Tree Foundation is a state-wide non-profit organization dedicated to planting trees in NJ's most under-served neighborhoods.

- NJTF has planted over **2,100** trees in Newark since 2006 and over **201,706 trees** state-wide since 1998.

- With help from over 10,000 volunteers.

How it works:

Step-by-Step Guide for Communities

1. **Determine interest within your community.**
   Discuss trees with your neighbors! Have all interested households sign a Resident Tree Agreement (RTA). To be safe, use fliers from the NJ Tree Foundation to inform every neighbor about the chance to adopt a tree - we don't want to leave anyone out!

2. **Work with the NJ Tree Foundation to schedule a meeting with interested residents and volunteers.**
   Let's get everyone together to discuss your community tree planting. We will cover things like:
   - Basic tree care
   - "Right Tree, Right Place"
   - Tree planting date/time/details
   - Recruiting volunteers
   - Tree planting locations
   - Music, refreshments, etc - make the event yours!

3. **Promote your event.**
   We'll give you fliers and press release templates. You're also welcome to create your own promotional items.

   It's fun and easy to promote your event to:
   - Neighbors and friends
   - Local community groups
   - Girl Scouts, colleges, churches
   - Mayor's office, city council
   - Media (newspapers, social media)

4. **Plant your trees.**
   All of your hard work pays off on your tree planting day! Along with the NJ Tree Foundation, your neighbors, and volunteers, we will plant beautiful trees in your community.

   Events are usually three hours long. The NJ Tree Foundation provides tools, gloves, and planting supervision. You and your neighbors are encouraged to provide refreshments, music, etc.

5. **Care for your trees.**
   For the first two years, the trees need watering, weeding, mulching, and protecting. The NJ Tree Foundation will provide tree care instructions to all tree recipients. Please attend our free *TreeKeepers* workshops to learn more!

New Jersey TREE FOUNDATION

www.njtreefoundation.org

1) Determine Interest in your community

Target Area

Sample flyer to inform neighbors of trees coming to their block!

* **To receive trees, residents must sign a Resident Tree Agreement form, stating they will care for the tree, and participate in the event.**

2) Establish meetings with tree-recipients in the community to discuss:

- Basic Tree Care
- Right Tree, Right Place
- Tree Planting: Date/Time/Details
- Recruiting Volunteers
- Tree-planting locations
- Refreshments/music etc.

Make this event your own!

3) Promote your event

- It's fun to promote the event to everyone!
  - Local community
  - Family and Friends
  - Media and News
  - Local scout groups
  - Mayor/Council

4) Plant the Trees!

- Volunteers get together for a planting demonstration

- Volunteers go off in groups to plant trees on their own!

5) Care for the trees

We provide care cards and TreeKeepers workshops to teach proper maintenance

- Water
- Mulch
- Prune
- Weed
- Protect

6) Watch your block/school transform:


daily BUMPS


GAME
DAY

Trees & Stormwater

-Trees intercept rain before it hits the ground

-More urban trees = less impervious surfaces

-Tree roots can break toxins into less dangerous forms

- Tree pits catch stormwater runoff and allow it to naturally enter the water cycle!

- Elena López
  elopez@njtreefoundation.org
  (609) 439 – 1755

- www.njtreefoundation.org
- facebook.com/NJTreeFoundation
- Twitter: @njtrees

New Jersey TREE FOUNDATION

RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

"Protecting Public Health and the Environment"

Lunch Time

We'll resume at 1:30pm…

Icebreaker

- Let's go around the room and introduce ourselves by stating:
  - Name
  - School/School District
  - And complete the phrase "If I won the lottery today, I would…"

Logistics

- Please feel free to leave your belongings in the classroom, you will be returning here at the end of the afternoon
- Be sure to see Rosana or Hollie to pick up certificates at the end of the day at the registration table before leaving

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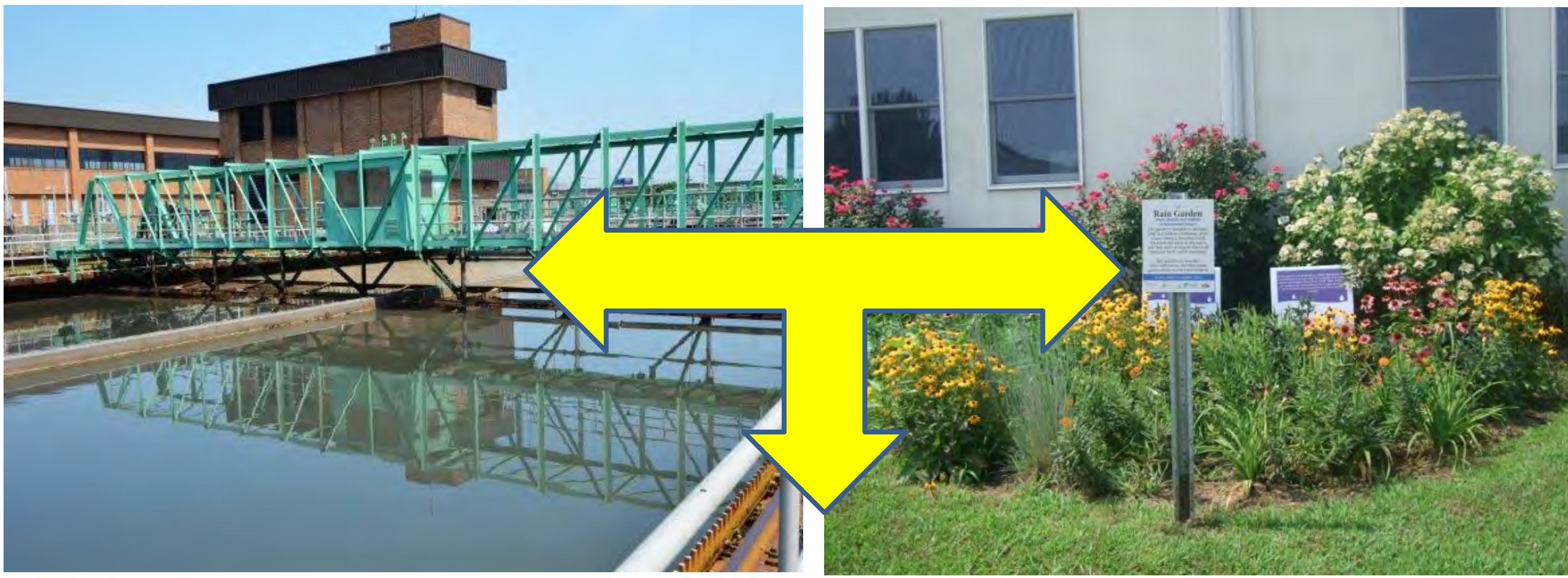
Afternoon Tours

Group A – PVSC

Group B – Rain Garden Design



Group C – Passaic River Tour

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Afternoon Tours Part I

- Group C to get on board the van to be dropped off the dock for the Passaic River Tour
- Group A to get on board the van for the PVSC Tour
- Group B to stay in the classroom for a Rain Garden Design Activity

Disconnect It!
Rain Garden Design

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Afternoon Tours Part II

- Group A to get on board the van to be dropped off the dock for the Passaic River Tour
- Group B to get on board the van for the PVSC Tour
- Group C to stay in the classroom for a Rain Garden Design Activity

Disconnect It!
Rain Garden Design

Afternoon Tours Part III

- Group B to get on board the van to be dropped off the dock for the Passaic River Tour
- Group C to get on board the van for the PVSC Tour
- Group A to stay in the classroom for a Rain Garden Design Activity

Disconnect It!
Rain Garden Design

Agenda

9:00 - 9:15	Introductions and Welcome
9:15 - 10:00	Introduction to Stormwater Management and Green Infrastructure
10:00 - 10:45	How Stormwater Management and Green Infrastructure fit's into the NGSS
10:45 - 11:00	**Break**
11:00 - 12:00	Keynote Speaker
12:00 - 12:30	Available Educational Partnerships and Programs
12:30 - 1:30	**Lunch**
1:30 - 1:45	Logistics for Afternoon Tours
1:45 - 2:15	Group A (PVSC) / Group B (Rain Garden Design) / Group C (Passaic River)
2:30 - 3:00	Group A (Passaic River) / Group B (PVSC) / Group C (Rain Garden Design)
3:00 - 3:30	Group A (Rain Garden Design) / Group B (Passaic River) / Group C (PVSC)
3:30	Certification Pick Up

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