Green Infrastructure Training for Public Works Employees, Engineers, and Planners

Presented at the library in Westfield, NJ

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water.rutgers.edu
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.
Our mission is to identify and address community water resources issues using sustainable and practical science-based solutions.
The Natural Hydrologic Cycle

- Precipitation
- Sublimination
- Condensation
- Transpiration
- Evaporation
- Infiltration
- Stormwater Runoff

Diagram showing the cycle of water movement through the natural environment.
The Impact of Development on Stormwater Runoff

- More development
- More impervious surfaces
- More stormwater runoff
The Urban Hydrologic Cycle

- Precipitation
- Sublimation
- Condensation
- Limited Transpiration
- Roof Runoff
- Stormwater Runoff
- Limited Infiltration
- Road Runoff
- Evaporation
- Increased Stream Volumes & Erosion

Unfiltered Storm Sewer Discharge
Original ICM developed based on 200+ reports and papers

Impervious Cover Model

Stream Quality

Good

Sensitive

Fair

Impacted

Poor

Non-Supporting

Urban Drainage

Watershed Impervious Cover

10% 25% 40% 60% 100%

Hydrologic Impacts of Urbanization

- Disruption of natural water balance
- Increased flood peaks
- Increased stormwater runoff
- More frequent flooding
- Increased bankfull flows
- Lower dry weather flows
What happens to the rain in our watersheds?

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

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

- Sediment
- Toxics like mercury, metals, pesticides, herbicides, and petroleum hydrocarbons
- Nutrients like phosphorus and nitrogen
- Litter
- Pathogens from pets, waterfowl, failing septic systems
- Biochemical oxygen demand from leaves, grass clippings and other organic wastes
- Thermal stress
Uncontrolled stormwater runoff can also result in flooding
How are we dealing with these issues?

- Municipal Separate Storm Sewer System (MS4) Permit
- New Jersey Stormwater Management Regulations (N.J.A.C. 7:8)
  - Municipal Stormwater Management Plan
  - Municipal Stormwater Control Ordinance
  - Stormwater Mitigation Plan
- Clean Stormwater and Flood Reduction Act (Stormwater Utility Act)
MS4 Permit

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

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

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

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

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

NJ.com, August 28, 2011
The approval of a developer’s stormwater management plans lies solely with the municipality.
Requirements cannot be waived unless there the municipality has a "Stormwater Mitigation Plan"
Clean Stormwater and Flood Reduction Act

- Authorizes municipalities, counties, and certain authorities to establish stormwater utilities
- Recognizes problems due to inadequate stormwater infrastructure and management
- These problems affect the health, safety, economic well-being, and quality of life of New Jersey residents
- Recognizes that stormwater infrastructure in New Jersey lacks a dedicated source of funding for upgrades and maintenance
- Allows stormwater utilities to assess fees that are based on a fair and equitable approximation of the proportionate contribution of stormwater runoff from real property
Clean Stormwater and Flood Reduction Act

- The Act encourages the use of green infrastructure, where appropriate, required to help decrease pollutant loads and runoff volumes to receiving waters.
Bottom Line - Stormwater Utility will focus on:

• Maintaining and repairing existing stormwater infrastructure
• Constructing new stormwater infrastructure
It is all about controlling runoff from impervious surfaces.
Step 1: Depave
Step 2: Simple 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

Runoff Direction

Stormwater Inlet
For 1.25 inch storm, 581 cubic feet of runoff = **4,360 gallons**
<table>
<thead>
<tr>
<th>Design Storm</th>
<th>Connected (gallons)</th>
<th>Disconnected (gallons)</th>
<th>Percent Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25 inches (water quality storm)</td>
<td>28,500</td>
<td>4,360</td>
<td>85%</td>
</tr>
</tbody>
</table>
Disconnect your downspout by installing a rain barrel.

Impervious area is now “disconnected” from flowing directly into the storm sewer system.
So Many Barrels to Choose From...
Or Larger Rainwater Harvesting Systems...
Rooftop runoff is now "disconnected" from flowing directly into the storm sewer system.
Bioretention Systems/Rain Gardens

**BERM**
The berm is constructed as a barrier to control, slow down, and contain stormwater.

**PONDING AREA**
The ponding area is the lowest, deepest visible area of the garden. When designed correctly, this area should drain within 24 hours.

**NATIVE PLANTS**
A rain garden is planted with a variety of grasses, wildflowers, and woody plants that are adapted to the soil, precipitation, climate, and other site conditions.

**DRAINAGE AREA**
This is the area of impervious surface that drains stormwater runoff to the rain garden.

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

**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.
Lots of Rain Gardens
Step 3: Convert to Permeable Pavement

POROUS ASPHALT
It is common to design porous asphalt in the parking stalls of a parking lot. This saves money and reduces wear.

DRAINAGE AREA
The drainage area of the porous asphalt system is the conventional asphalt cartway and the porous asphalt in the parking spaces. Runoff from the conventional asphalt flows into the porous asphalt parking spaces.

SUBGRADE
Porous pavements are unique because of their subgrade structure. This structure includes a layer of choker course, filter course, and soil.

UNDERDRAIN
Systems with low infiltration rates due to soil composition are often designed with an underdrain system to discharge the water.

ASPHALT
This system is often designed with conventional asphalt in areas of high traffic to prevent any damage to the system.
Permeable 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
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
Grass Pavers
Other Green Infrastructure Practices

• Bioswale
• Stormwater Planters
• Enhanced Tree Filters
• Downspout Planters
• Green Roofs
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 blankets for stabilization.

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

- Transports stormwater
- Filters stormwater
- Infiltrates stormwater
- Aesthetically pleasing
- Creates wildlife habitat
DISADVANTAGES

• Maintenance including sediment and trash removal
• High flow can cause erosion
• Hazard for vehicles
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.

INLET
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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.

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.
ADVANTAGES

- Combines settling with physical filtering and absorption processes
- Provides very high pollutant removal efficiencies
- More aesthetically pleasing and can be incorporated into the landscapes of most streetscapes
- Provided wildlife habitat
- Sequesters carbon
- Produces oxygen
DISADVANTAGES

• Requires maintenance (weeding, pruning, mulching)
• Collects trash
• Can release nutrients from bioretention soil mix
• May not be aesthetically appealing to everyone
• Can be expensive due to curbing and sidewalk removal
• Utilities can be a problem to work around
• Possible tripping hazard
TREE FILTER BOXES IN A STREETSCAPE

PERVIOUS CONCRETE
Pervious concrete is installed to act as an additional storage system to increase the stormwater capacity treated by the system.

UNDERDRAIN
Systems with low infiltration rates due to soil composition are often designed with an underdrain system to discharge the water.

ASPHALT
This system is often designed with conventional asphalt in areas of high traffic to prevent any damage to the system.
ADVANTAGES

• Easy to incorporate into streetscapes
• Provides shading and helps with heat island effect
• Enhance aesthetics
• Provided wildlife habitat
• Sequesters carbon
• Produces oxygen
DISADVANTAGES

• Can be expensive
• Tree filter box has little storage capacity unless incorporated into an enhanced tree pit system
• Maintenance – trees need pruning
• Wildlife habitat – too many birds; can stimulate local car wash business
**Downspout Planters**

**CONNECTION**
The system is designed to overflow into adjacent boxes using a connecting pipe that is sealed with silicon.

**PLANTER BOXES**
The downspout planter box can be wooden or concrete. However, all boxes must be reinforced to hold soil, stone, and the quantity of rainfall it is designed to store.

**SUBGRADE**
The system is designed to overflow using a perforated pipe located at the bottom of the downspout planter box.

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

**DOWNSPOUT**
The downspout is the main source of water for the downspout planter.

**DIVERTER**
A downspout diverter is installed to prevent freezing during the winter months.

**OVERFLOW**
This mechanism is designed to act as a discharge for the water when the planter is full or saturated.

**OVERFLOW**
The overflow is the point where water discharges from the downspout planter.
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
• Great for new construction

COMPONENTS

- Vegetation
- Growing Medium
- Drainage, Aeration, Water Storage and Root Barrier
- Insulation
- Membrane Protection and Root Barrier
- Roofing Membrane
- Structural Support
Modular System Specifications

SIDE VIEW

- LiveRoof Standard Module
- Moisture Portals™
- LiveRoof Engineered Soil
- LiveRoof Green Roof Plants (Minimum 95% Soil Coverage at Installation)
- Minimum 40-mil Polyethylene or EPDM Slip Sheet, Edges Overlapped & Seamed
- EPDM, TPO or PVC Waterproofing Membrane
- Bonding Adhesive
- Insulation
- Insulation Adhesive

TOP VIEW

- Drainage Holes
- Ergonomic Handles

Parker Urban Greenscapes.
DISADVANTAGES

• Very expensive
• Minimal stormwater management (up to ½ inch of rain)
• Very heavy and hard to retrofit on existing roof
• Facility managers tend to not be very supportive – “roof will leak”
• Did I mention – very expensive
DISADVANTAGES

• Very expensive
• Minimal stormwater management (up to ½ inch of rain)
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We need a plan!

**Impervious Cover Reduction Action Plan (RAP)**
OCEAN TOWNSHIP: GREEN INFRASTRUCTURE SITES

SITES WITHIN THE DEAL LAKE SUBWATERSHED:
1. Municipal Garage of Ocean Township
2. Northern Shore District United Methodist Church

SITES WITHIN THE POPLAR BROOK SUBWATERSHED:
3. Monmouth County Library, Ocean Township Branch
4. Ocean Township Little League
5. Ocean Township Municipal Office / Police Department

SITES WITHIN THE WHALE POND BROOK SUBWATERSHED:
6. First United Methodist Church
7. Oakhurst Independent Hose Co No. 1
8. Ocean Township Community Pool
9. Township of Ocean Senior Center
10. US Post Office
11. Wayside United Methodist Church
WAYSIDE UNITED METHODIST CHURCH

Subwatershed: Whale Pond Brook

Site Area: 113,949 sq. ft.

Address: 1229 W Park Avenue
Ocean, NJ 07712

Block and Lot: Block 1, Lot 30

Two rain gardens can be installed off of the west side of the church to capture, treat, and infiltrate roof runoff by disconnecting and redirecting downspouts it to them. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

<table>
<thead>
<tr>
<th>Impervious Cover</th>
<th>Existing Loads from Impervious Cover (lbs/yr)</th>
<th>Runoff Volume from Impervious Cover (Mgal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>sq. ft.</td>
<td>For the 1.25” Water Quality Storm</td>
</tr>
<tr>
<td>14</td>
<td>16,372</td>
<td>0.013</td>
</tr>
<tr>
<td></td>
<td>TP 0.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TN 8.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TSS 75.2</td>
<td></td>
</tr>
</tbody>
</table>

Recommended Green Infrastructure Practices

<table>
<thead>
<tr>
<th>Recommended Green Infrastructure Practices</th>
<th>Recharge Potential (Mgal/yr)</th>
<th>TSS Removal Potential (lbs/yr)</th>
<th>Maximum Volume Reduction Potential (gal/storm)</th>
<th>Peak Discharge Reduction Potential (cu. ft./second)</th>
<th>Estimated Size (sq. ft.)</th>
<th>Estimated Cost</th>
</tr>
</thead>
</table>
Implement a Green Infrastructure Project
Funding Implementation

- Leverage existing projects
- Build partnerships
- Write grants
Who should I partner with?

Locally
- RCE Environmental County Agents
- Municipal Green Teams (Sustainable Jersey)
- Green Teams for Schools (Sustainable Jersey)
- Environmental Commissions
- Boy Scouts and Girl Scouts

Statewide
- The Nature Conservancy
- Association of Environmental Commissions
- Trust for Public Lands
- New Jersey Tree Foundation
Grant/Funding Opportunities

- Sustainable Jersey ($2k, $10k and $35k)
- ANJEC (Association of NJ Environmental Commissions)
- NJDEP
- NJ American Waters
- Home and School Associations
Educate!
References

Green Infrastructure Guidance Manual for New Jersey
http://water.rutgers.edu/GreenInfrastructureGuidanceManual.html
QUESTIONS?