



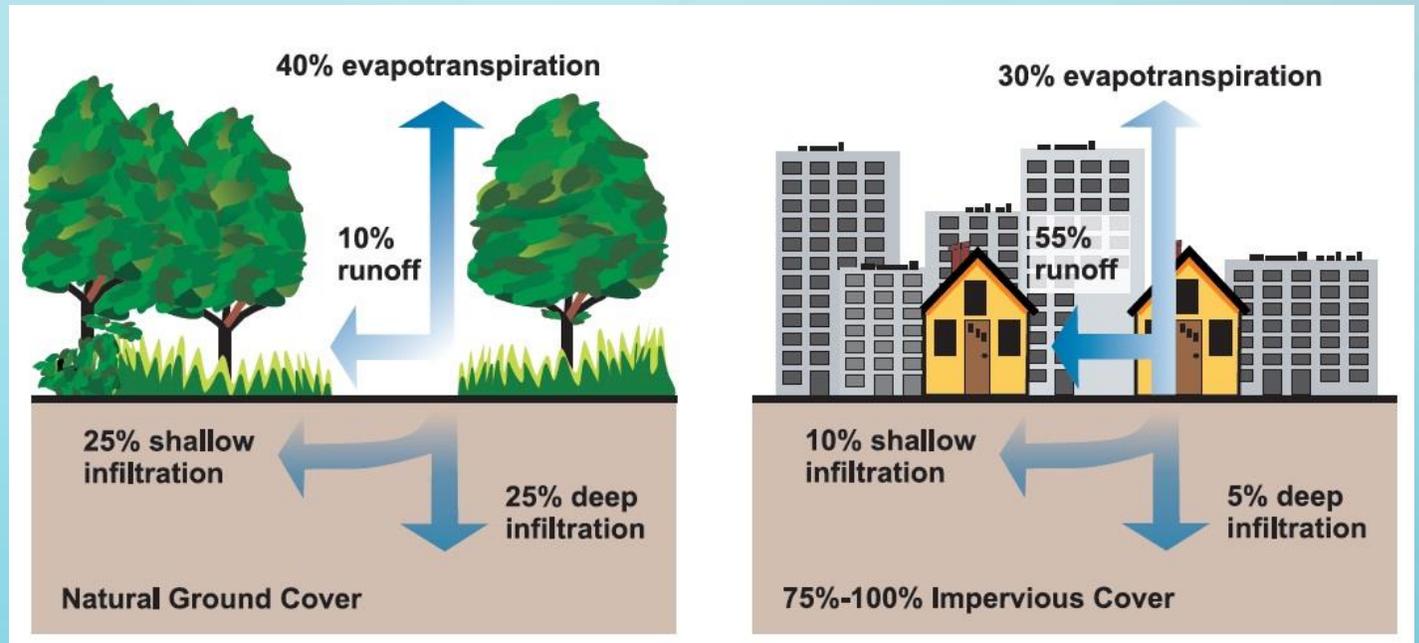
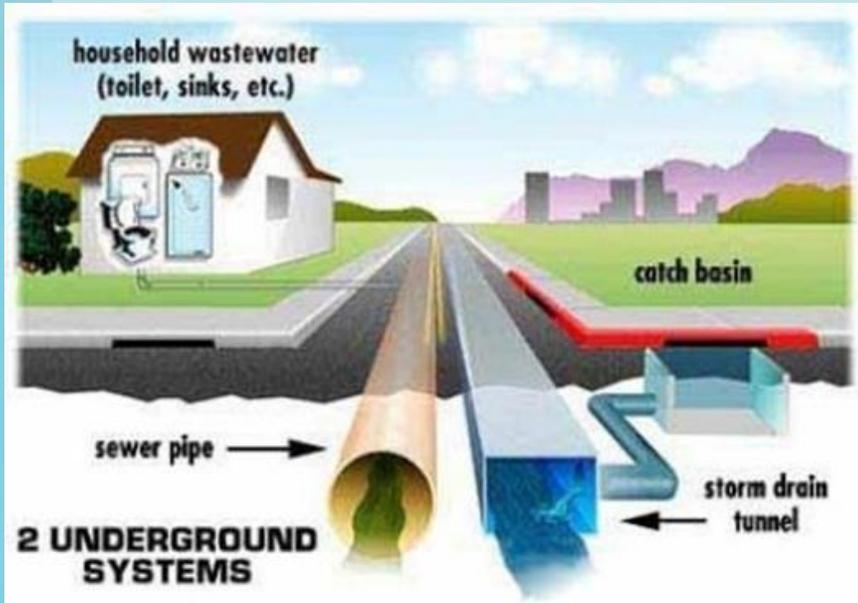
# Stormwater Management Planning and Design

Beth Lucas, Senior Planner  
Broome County Planning

# What is stormwater?

- Rainwater or snow melt that doesn't get absorbed and runs off into water bodies.
- In urban and suburban areas:  
More paved areas = more runoff
- That runoff is typically diverted into storm sewers where it flows directly to local water bodies.
- **MS4 = Municipal Separate Storm Sewer System**
  - A conveyance or system of conveyances used to collect or convey stormwater (includes gutters, pipes, ditches)

# What is stormwater?



# Why is this a problem?

As stormwater flows from rooftops, over paved areas, bare soil and lawns it picks up pollutants.

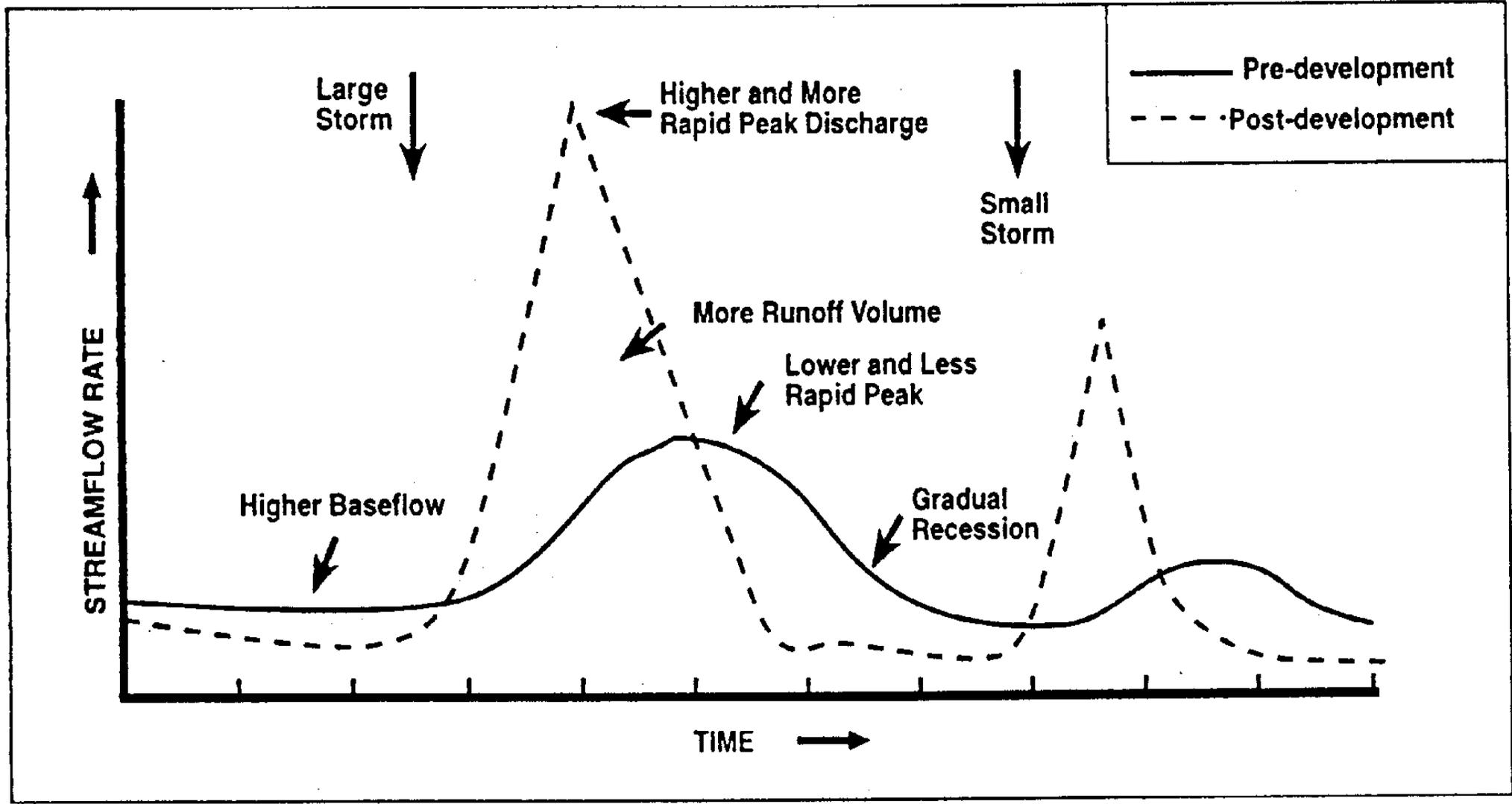
- Nonpoint Sources
  - Silt/sediment
  - Nutrients (N/P)
  - Pathogens
  - Organic Debris
  - Thermal
  - Floatables (dumping, litter)
  - Toxic Substances (Oil/Grease, Metals, Road salts, E Waste, HHW)
- Illicit discharges
  - Septic systems
  - Sanitary sewer cross-connections
  - Floor drains
  - Industrial waste
  - Dumping into catch basins



# Why is this a problem?

- Flooding and Erosion
  - No percolation, Higher volume and rate of runoff, Higher water levels and velocity
  - Flash flooding, property and infrastructure damage, Public health and safety concerns, Expensive repair and maintenance
- Drought
  - No opportunity for groundwater recharge





# Managing Stormwater

## Benefits of proper stormwater management

- Public health
  - Protect drinking water supplies & recreational waterways
  - Reduce the physical hazards of flooding and erosion
- Environment
  - Reduced sedimentation and increased groundwater recharge
  - Healthier and more productive natural habitats and ecosystems
- Local Economy
  - Enhance property values and savings from flood loss prevention
  - Improved tourism and quality of life
- Infrastructure protection

# Managing Stormwater

- Intent to ensure that development doesn't impact neighboring or downstream properties or water resources.
- Stormwater should be retained or absorbed on-site
- Quantity, rate and quality of runoff should not be different from before the site was developed.



# Managing Stormwater Regulations

- Federal and state laws regulate stormwater from urbanized areas and construction activities
- State law requires:
  - Municipalities must have a Stormwater Program Plan and local law in place to minimize stormwater impacts.
  - Municipalities must assess the use of stormwater pollution prevention techniques in development proposals and ensure their implementation
  - Designers are required to incorporate these principles into Stormwater Pollution Prevention Plans (SWPPPs)
    - Stormwater Pollution Prevention Plan - Describes control of runoff during construction and afterward, as applicable and details of Best Management Practices (BMPs)

# Managing Stormwater Pollution Prevention

- Pollution More expensive and difficult to remove end-of-pipe.
- Control contamination at source, where contaminants can be identified, reduced or contained.
- Public education/participation ([www.waterfromrain.org](http://www.waterfromrain.org))
- Employing best management practices (BMPs) – “Good Housekeeping”
  - Residents, Businesses, Industries, Municipal Operations



# Managing Stormwater Land Use and Design

- The “old way” – How most existing infrastructure is designed
  - “End-of-pipe” treatment
  - Large structures to manage stormwater (ponds, wetlands, infiltration basins, etc.)
  - Focus on engineered structures rather than natural processes.
- New design paradigm – New development (and retrofits)
  - “Slow it down, Spread it out, Soak it in” – using natural landscape
  - Runoff reduction
  - Reduction in contributing area
  - Reduction in contributing volume
  - Green Infrastructure

# Conventional Stormwater Site Design

Collect

Convey

Concentrate

Centralized

Control



“Good Drainage” Paradigm

Credit: HWG

# Green Infrastructure Treatment Train Approach



**Storm Drain  
(Overflow) System**

**Rain Garden**

**Grass Swale**

**Grass  
Filter  
Strip**

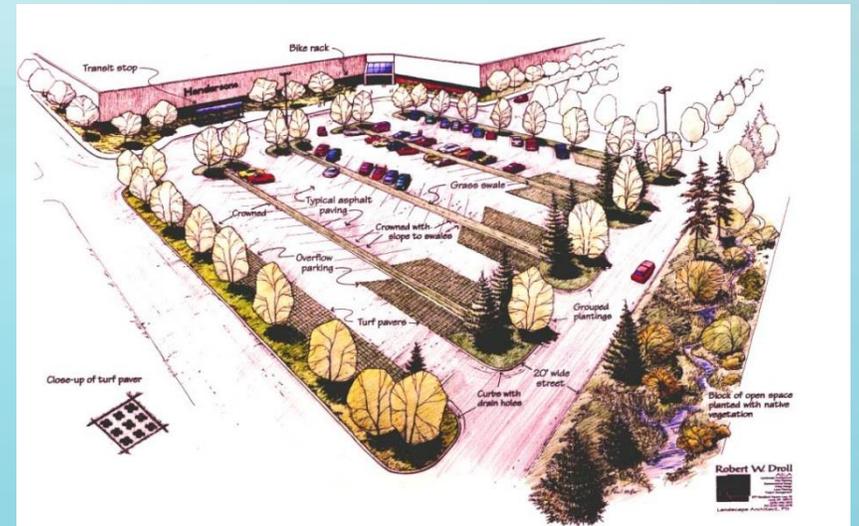
Credit: HWG

# Better Site Design and Green Infrastructure Approach

- NYS requires that designers use a five-step planning process to integrate the new design paradigm
  1. Site Planning - Preserve natural features and reduce impervious cover
  2. Determine Water Quality Volume
  - 3. Runoff Reduction by applying Green Infrastructure techniques**
  4. Application of standard stormwater management practices to address remaining Water Quality Volume
  5. Application of water quantity control practices if still needed.

# Project Review

- Ensuring that the planning process is followed is the responsibility of the local municipality.
- Municipal boards generally do not have the expertise.
- May defer to municipal planner or may retain expertise of a professional engineer or landscape architect
- May require review of local codes and regulations to ensure that they are consistent with runoff reduction practices

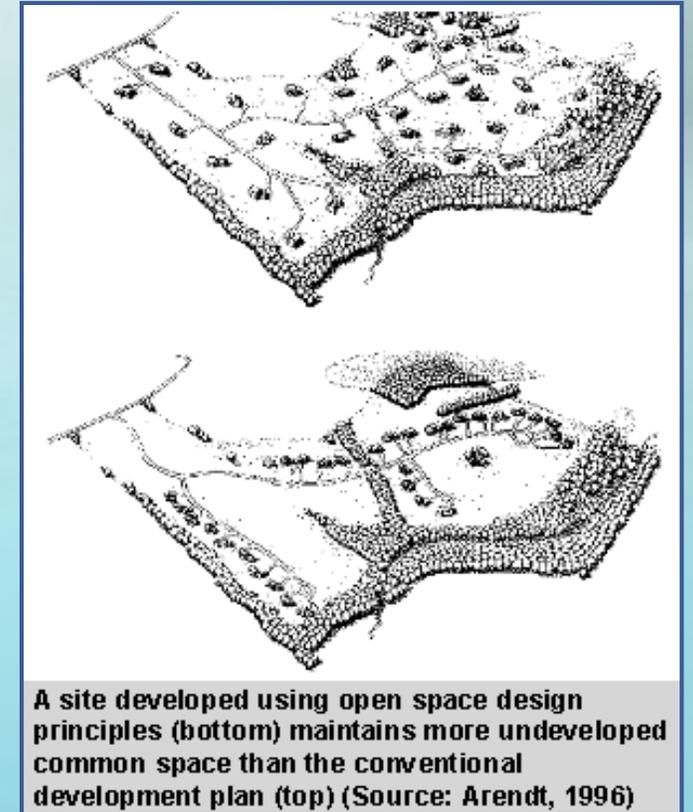


# Land Use Tools to Address Stormwater Issues

- **Comprehensive Plan** – Identify and protect natural features and open space and promote development that minimizes impacts (smart growth/low impact development)
- **Site Plan Review/Subdivision Review** - Include drainage considerations, ensure that stormwater management techniques are implemented
- **Environmental Review** – Intent of SEQR is to determine any a project's impacts on the environment, including water quality impacts.
- **Local Laws** - Wetland Preservation, Open Space Preservation, Water Resource Protection, Sanitary codes
  - Prohibit potentially polluting land uses in groundwater recharge areas, watersheds, and near surface waters

# Land Use Tools to Address Stormwater Issues

- **Zoning**
  - Environmental protection overlay districts
  - Incentive zoning
  - Special use permits
  - Performance zoning
  - Area variances
  - Cluster development
- **Form-based code**
  - Focus on design, not use
  - Allows integration of stormwater management practices without restrictions of traditional zoning



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# Runoff Reduction Concept

- Avoid the Impacts
  - Avoid or minimize disturbance by preserving natural features
- Reduce the Impacts
  - Reduce impervious cover and use conservation design techniques
- Mitigate the Impacts
  - Use natural features and runoff reduction practices (green infrastructure)



# Avoiding the Impacts

- Avoid or minimize disturbance by preserving natural features
- Reduce construction footprints
  - Minimize grading
- Preserve hydrology to extent possible
  - Avoid flattening hills and changing drainage channels
  - Preserve natural stream and floodplain functions
- Preserve riparian buffers
- Locate development in less sensitive areas
  - Fit development to site conditions not vice versa

# Avoiding the Impacts



# Reducing the Impacts

- Open Space Design
- Narrower Streets and Sidewalks
- Reduce Parking Requirements
- Relax height restrictions



# Mitigating the Impacts

- Green Infrastructure
  - A range of techniques that maintain or restore natural flow pattern by allowing water to slowly permeate into the ground and eventually back to the sewer system or water bodies. The goal is to:
    - Promote infiltration into the ground
    - Store stormwater and remove through evapotranspiration
    - Capture runoff and reuse it
  - One or a combination of these techniques can be integrated at a site to manage stormwater

# Downspout Disconnection

- Disconnection of impervious surfaces
  - Important consideration in existing sites where roof downspouts may be directly connected to storm sewer.
  - Direct downspouts to vegetated area, stormwater planter, rain garden, rain barrel, etc. for storage or infiltration



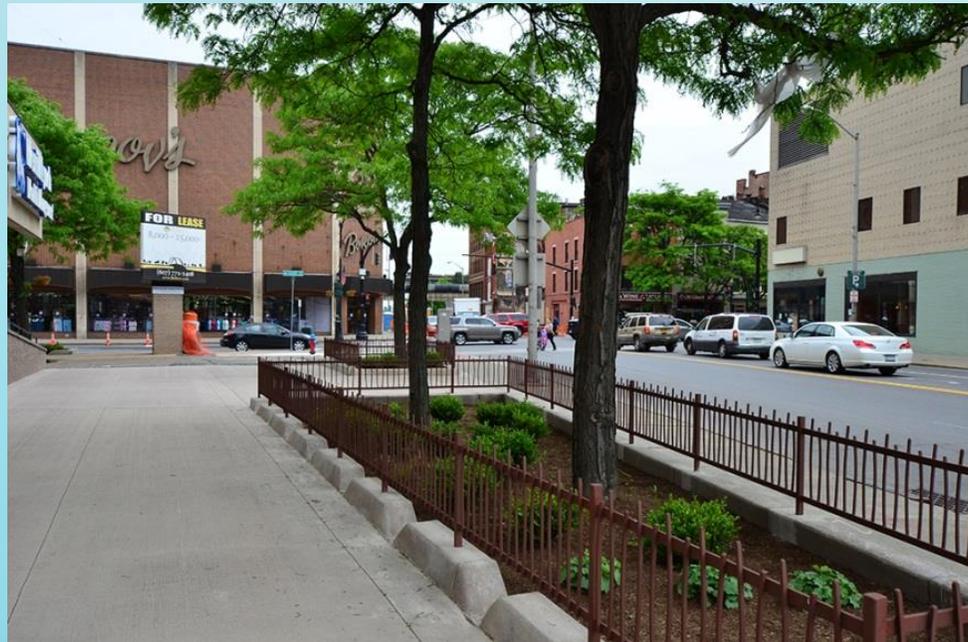
# Filter Strips and Buffers

- Areas of grass or other dense vegetation placed strategically between an area that creates runoff and a stormwater reception site
- Vegetation mitigates the impacts of runoff by
  - Slowing runoff velocity
  - Removing nutrients
  - Storing water in natural depressions
  - Promoting groundwater recharge



# Tree Planting and Tree Pits

- Promote uptake of water and nutrients
- Tree planting – concentrated groupings of trees
- Tree pits or tree boxes – individually planted trees in sidewalk cut-outs or curbed islands



2 Court Street



Southside commons –  
Southside of Binghamton,  
runs along South Washington  
Street between Vestal Avenue  
and Mary Street

# Rain Barrels and Cisterns

- Capture and store runoff for alternate use
- Reduce runoff and flow
- Reduce water consumption
- Use where high impervious cover
- Must have a use for water



BU Center for Excellence



Syracuse Oncenter

# Stream Daylighting

- Conversion of channelized stream to more natural state
- Can help with localized flooding at overburdened culverts





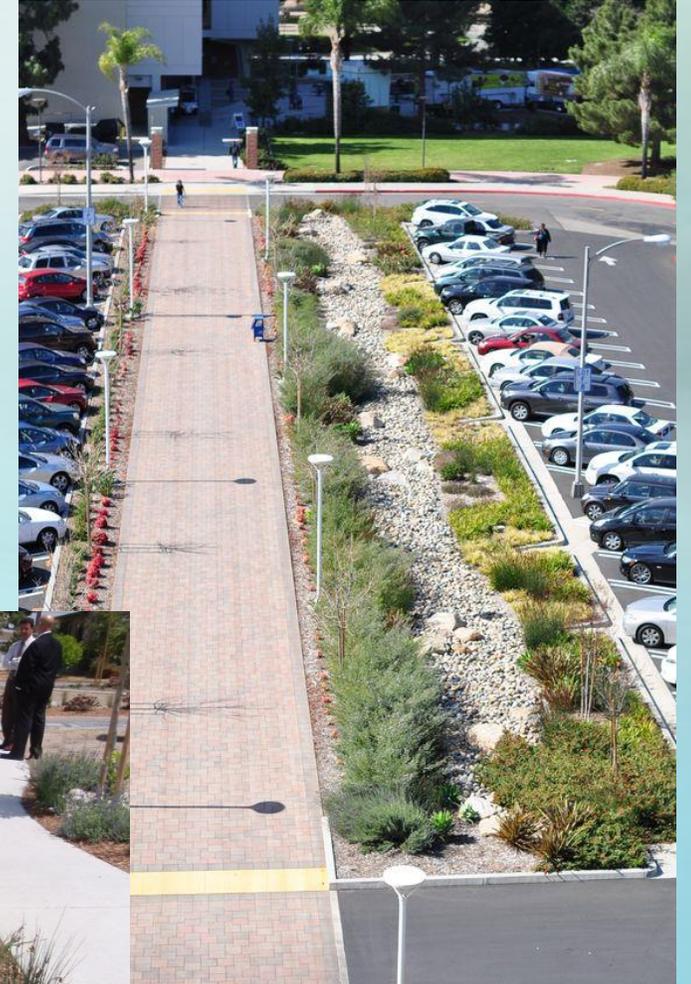
Cheong Gye Cheon, Seoul, South Korea



Cheong Gye Cheon, Seoul, South Korea

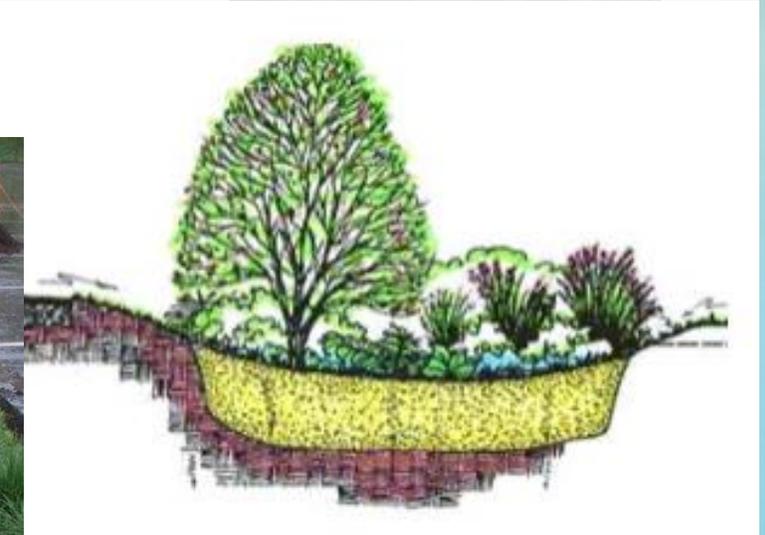
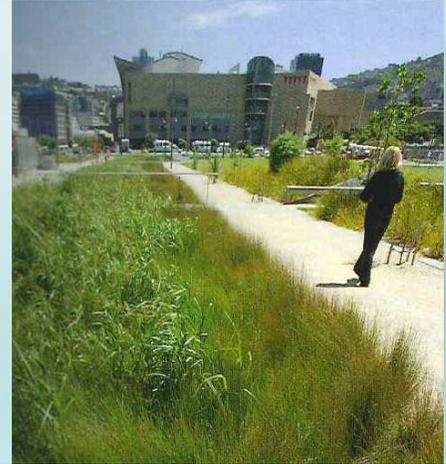
# Vegetated Swales/Bioswales

- Turf lined swales
- Slow velocity and promote infiltration
- Street right-of-ways



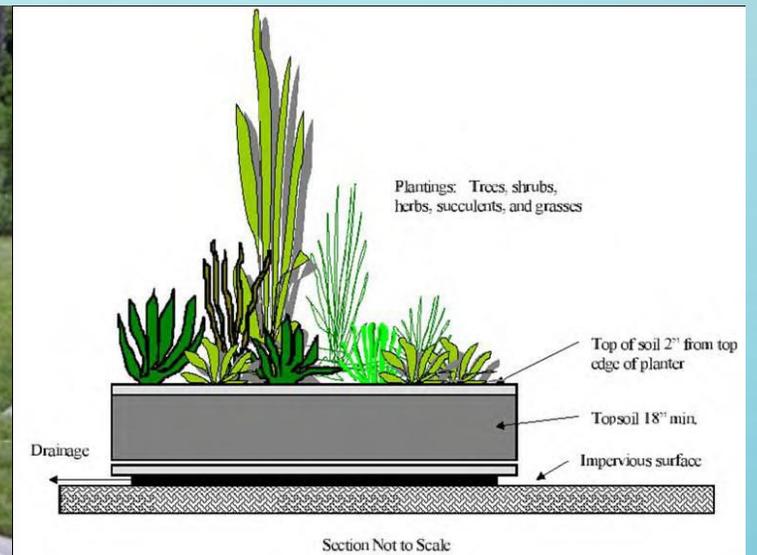
# Rain Gardens and Bioretention

- Manage and treat small volumes of runoff using a conditioned soil bed and vegetation within a shallow depression



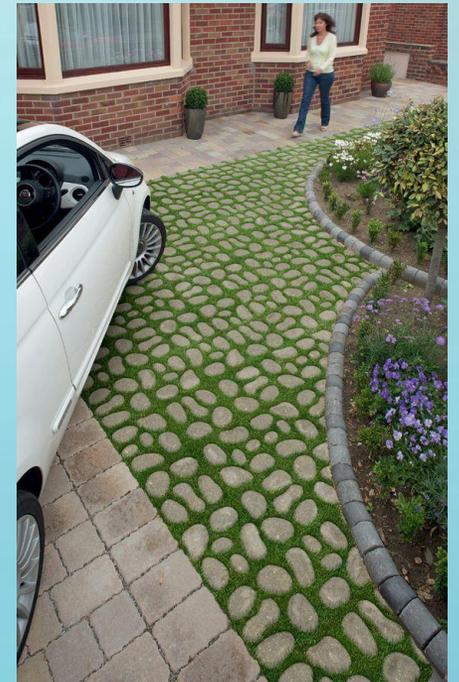
# Stormwater Planters

- Attractive design element
- Infiltration planter, contained planter, flow-through planter
- Use in locations that may not be conducive to rain gardens or bioretention areas



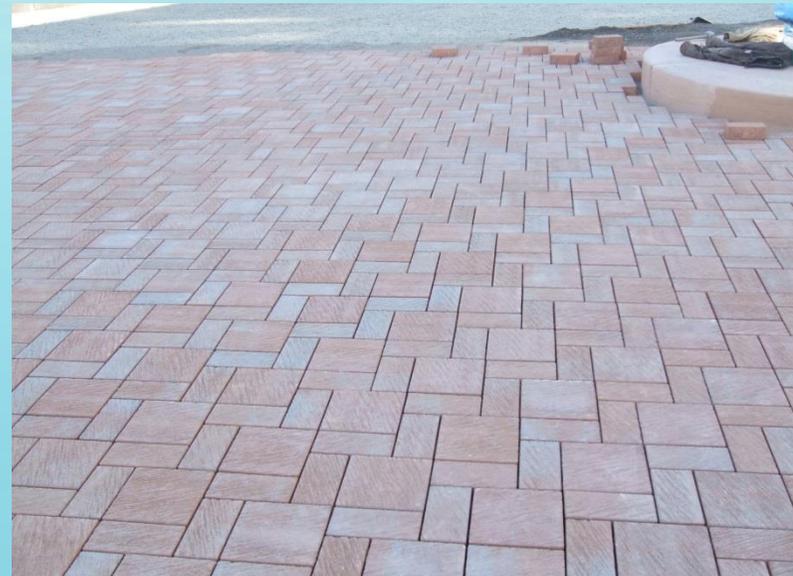
# Permeable Pavement

- Materials allow water to infiltrate through pavement underlain by a storage reservoir
- Porous Pavement – permeable asphalt or concrete
- Permeable Pavers – brick paver blocks, interlocking modules





Southside Commons – Southside of Binghamton  
Kennedy Park – Downtown Binghamton (near bus station)



# Green Roofs

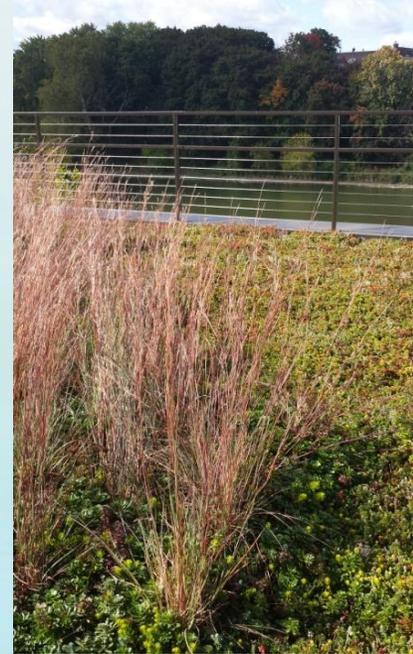
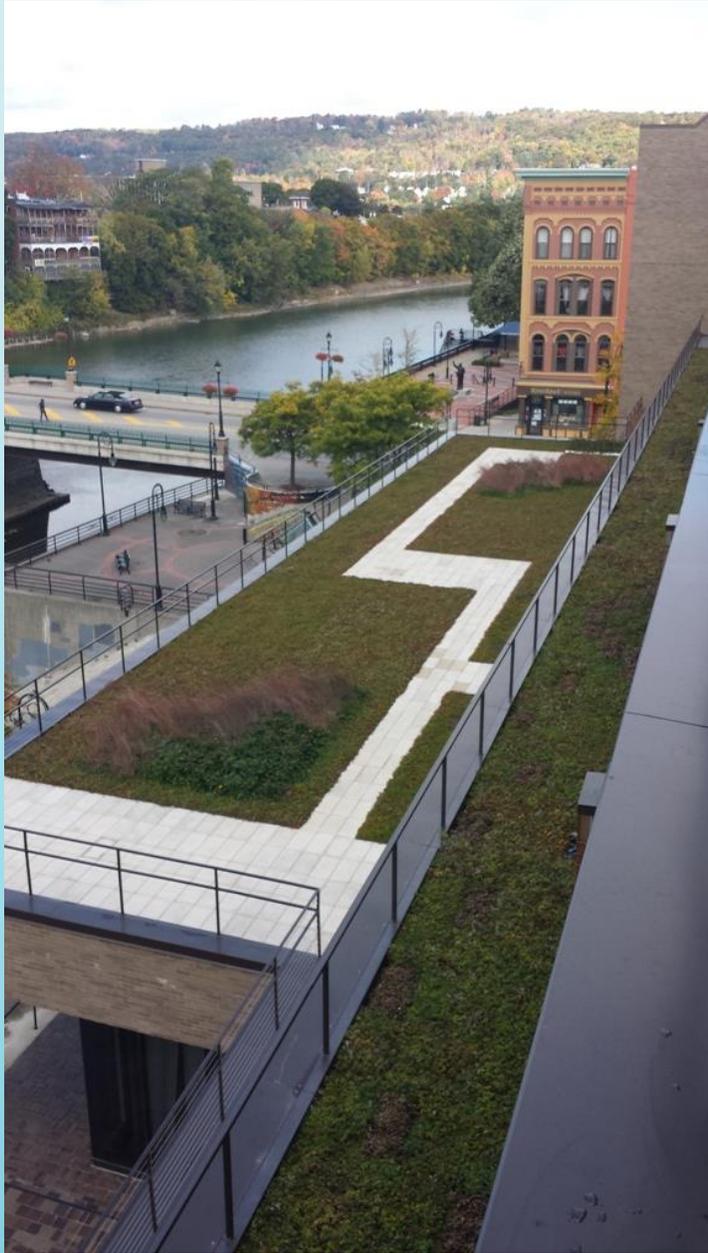
- Layers of vegetation and soil installed on a roof
- Vegetation captures rainwater
- Provides insulation, conserve energy
- Extensive – Thin soil layer, lighter, less expensive, low maintenance
- Intensive – Deeper soil layer, heavier, higher cost, increased plan diversity and maintenance





Enviro Auto  
Wash

Watson Blvd,  
Endwell



2 Court  
Street,  
Downtown  
Binghamton



# Green Walls

- AKA Living Walls and Landscape Walls
- Provide similar benefits to green roofs
- Can include specially designed planters, panels that include a growing medium



# Challenges

- Performance concerns - perceived as emerging technologies with a limited track record
- Climate concerns – Performance on cold/snow, will “get in the way of snow removal
- Cost concerns - Up-front costs/Maintenance
- Regulatory concerns – Acceptable for meeting envi requirements?
- Prohibitive codes/ordinances
- New Development vs. Redevelopment/Property Upgrades
- Used to the “traditional” way/unfamiliar with maintenance
- Private Development – will go somewhere else
- Politics – Projects for show, not for effectiveness



# Solutions

- **Expand knowledge base**
  - Learn about national and local experience
  - Integrate info into training
  - Recognize multiple benefits of GI (envi, social, and health)
  - Learn about design variations
  - Know how GI is supported by regulatory agencies
- **Outline costs**
  - Recognize avoided costs
  - Consult whole life cost tools (includes maintenance)
- **Build community support**
  - Develop outreach materials for private property owners
  - Develop pilot programs
- **Make it easier to implement**
  - Audit/Amend Codes and Ordinances
  - Develop Design Guidelines (for development and for municipal facilities)

# Solutions (in practice)

- Find out what concerns will help justify it, speak their language
  - Flooding, Stormwater compliance, Wastewater management, Efficiency/Cost-savings
- Integrate green infrastructure seamlessly into planning documents
- How can green infrastructure meet existing needs?
  - Know the Capital Improvement Plan (CIP)
  - Identify opportunities and put the pieces in place
  - Push for integration into master planning and redevelopment plans
- Use grant funding
  - GIGP, Climate Smart Communities, Smart Growth Infrastructure Act
  - However, still must plan for a local match
- Be a champion
  - Pay attention
  - Be patient but persistent
  - Be creative
  - Build excitement

# Broome County Public Safety Facility



Upper and Lower Permeable Asphalt Parking Areas – 100% Complete



Handicap Ramp Installation and Close-Up of Permeable Asphalt

# Broome County Public Safety Facility



# Broome County Public Safety Facility



Upper Parking Lot  
Pre-Construction



Upper Parking Lot  
Pre-Construction

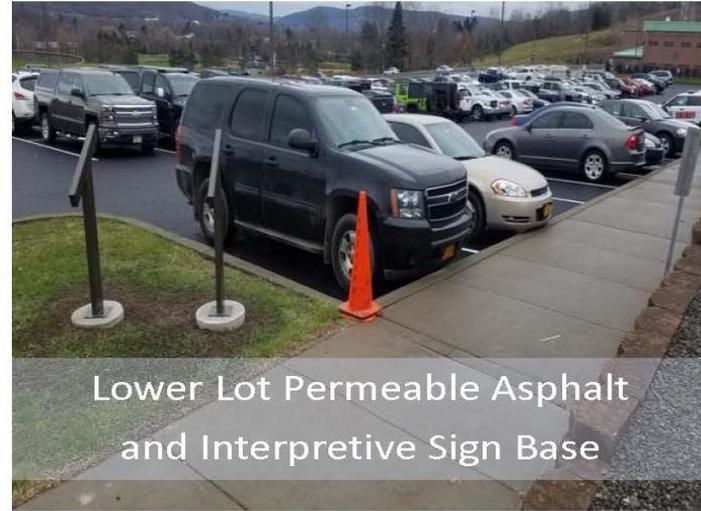


Lower Parking Lot  
Pre-Construction



Lower Parking Lot  
Pre-Construction

# Broome County Public Safety Facility



# STORMWATER PRACTICES

Improving water quality through green infrastructure.



PUBLIC SAFETY BUILDING  
STORMWATER WETLAND  
PERMEABLE PARKING LOT  
CUTLER POND

BROOME COUNTY PUBLIC SAFETY BUILDING

POROUS ASPHALT PARKING LOT A

YOU ARE HERE

POROUS ASPHALT PARKING LOT B

LT. VANWINKLE DR.

PARKING LOT PAVED WITH PERMEABLE RECYCLED PLASTIC GRID SYSTEM

WETLAND FRINGE

FOREBAY

HIGH MARSH

SHORELINE FRINGE

LOW MARSH

WETLAND FRINGE

MICROPOOL



## LOW MARSH



These ponded areas provide excellent habitat for frogs and dragonflies, which help limit mosquito populations.

## HIGH MARSH



Cattails and tall grasses in provide habitat for small birds such as red-wing blackbirds.

## SHORELINE FRINGE



Shrubs and woody stemmed plants provide cover and food for waterfowl, songbirds, and other wildlife.

## WETLAND FRINGE



Larger shrubs and flood-tolerant trees help shade the wetland and provide habitat for woodland animals.

## WORKING WETLAND

Stormwater wetlands are critical to the removal of pollutants from rainwater that drains across parking areas. If left unfiltered, these pollutants would find their way into streams and rivers and threaten the habitats of many birds, fish and amphibians. Wetlands, both natural and the kind constructed here, will break down these pollutants through natural processes. Not only do wetlands filter water, they hold onto it during storms and lower the threat of flooding downstream.



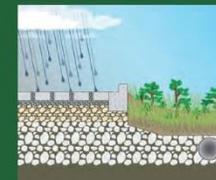
## GREEN INFRASTRUCTURE

Conventional stormwater infrastructure is primarily designed to rapidly move stormwater away from urban areas and directly into lakes and streams. Green infrastructure uses vegetation, soils, and natural processes to reduce and treat pollution in stormwater before it enters larger water systems. Benefits such as higher water quality, increased water supply, reduced flooding, and health benefits can all be a direct result of green infrastructure.



## PERVIOUS PAVING SYSTEMS

Pervious pavement incorporates a range of materials and techniques for paving that allow the movement of water and air through the paving material. This allows for water infiltration, removal of pollution, and contamination from runoff as well as reducing flooding and erosion.



Pervious paving is an environmentally friendly alternative to traditional impervious paving.

## POROUS ASPHALT



Buried pipes in Lot B collect excess runoff and carry it to the wetland system.

Gaps in the asphalt surface of the parking lot allow rainwater to pass through the deep layer of gravel below. The water then either seeps into the ground, or, in the case of heavy rainstorms, runs into perforated collection pipes that direct it into the wetland system.

## RECYCLED PLASTIC GRID SYSTEM

A mesh of rigid plastic filled with gravel creates a durable surface that rainwater can easily pass through on its way to the wetland. The permeable paving system is the first layer of filtration, greatly improving the health of the wetland it flows into.



This grid system was used in the parking area immediately above the wetland.



# Interactive Stormwater



# Interactive Stormwater



# Stormwater and Education



# Stormwater and Education



# Stormwater and Alternative Transportation

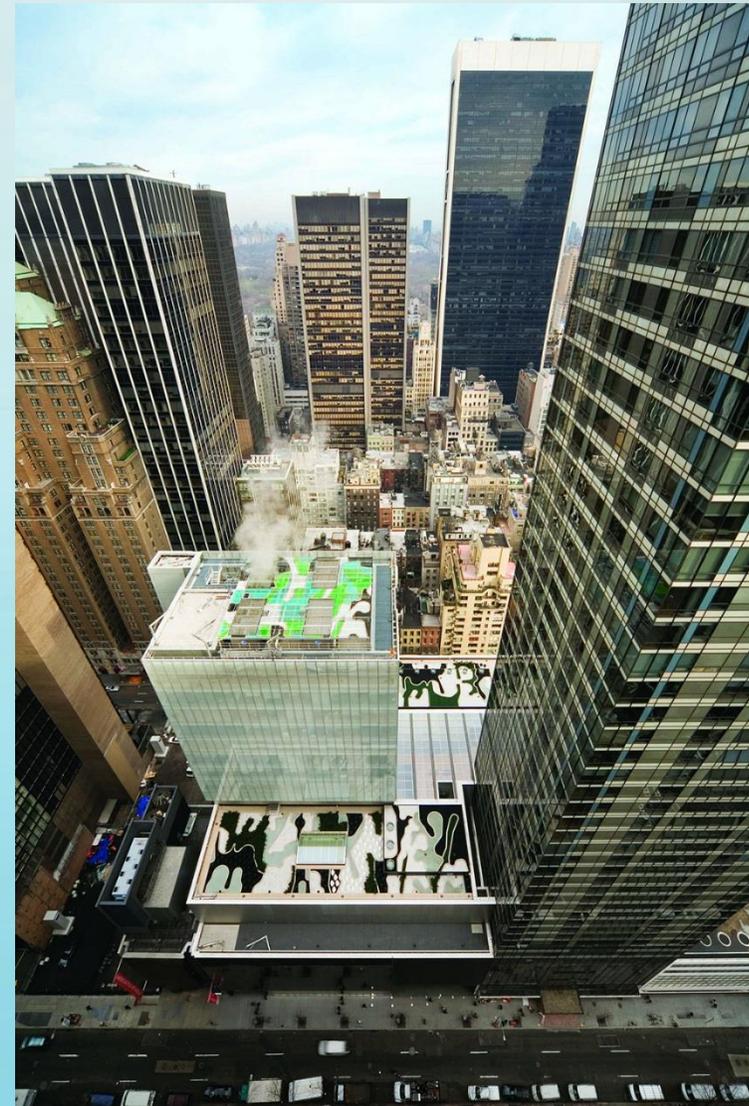
- “Green Streets” and “Complete Streets”



# Stormwater and Alternative Transportation



# Stormwater and Art



# Stormwater and Art



# Stormwater and Art



[https://vimeo.com/  
42864199](https://vimeo.com/42864199)



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NYS Department of Environmental Conservation - <http://www.dec.ny.gov/chemical/8468.html>  
US Environmental Protection Agency - [http://cfpub.epa.gov/npdes/home.cfm?program\\_id=6](http://cfpub.epa.gov/npdes/home.cfm?program_id=6)