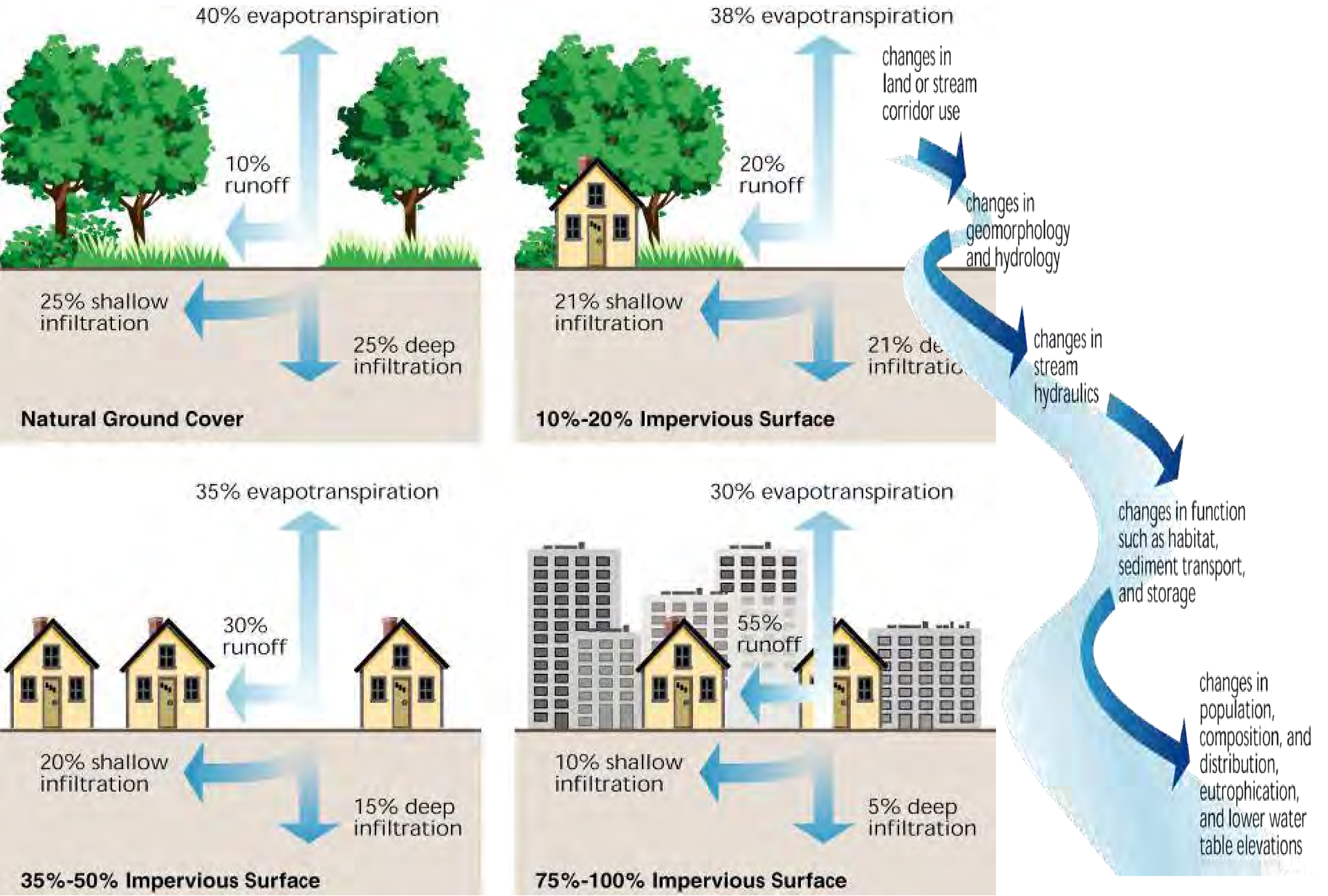


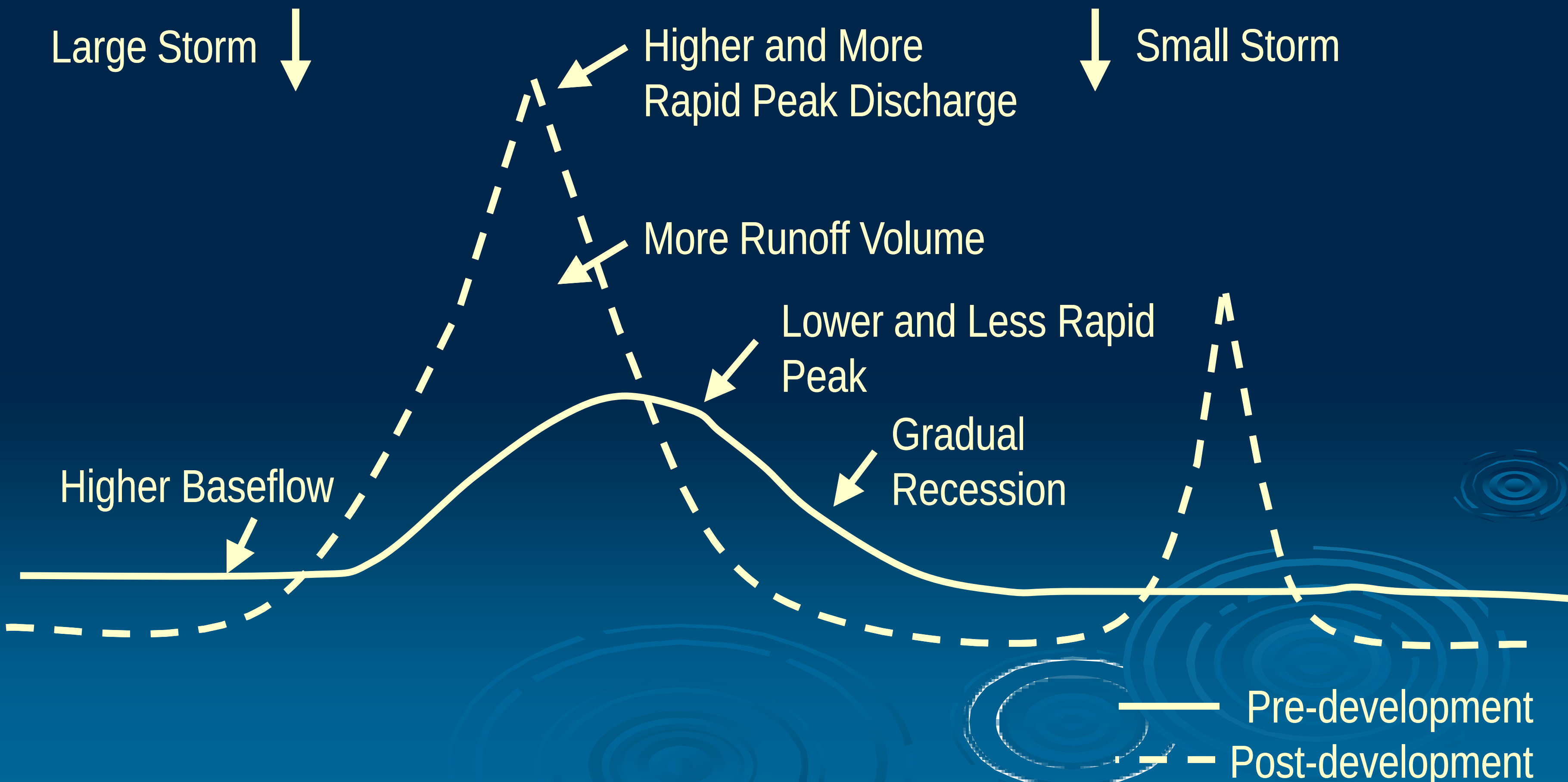


Managing Wet Weather with Green Infrastructure



Source: FISRWG 2001

Consequences of Development to Urban Streams

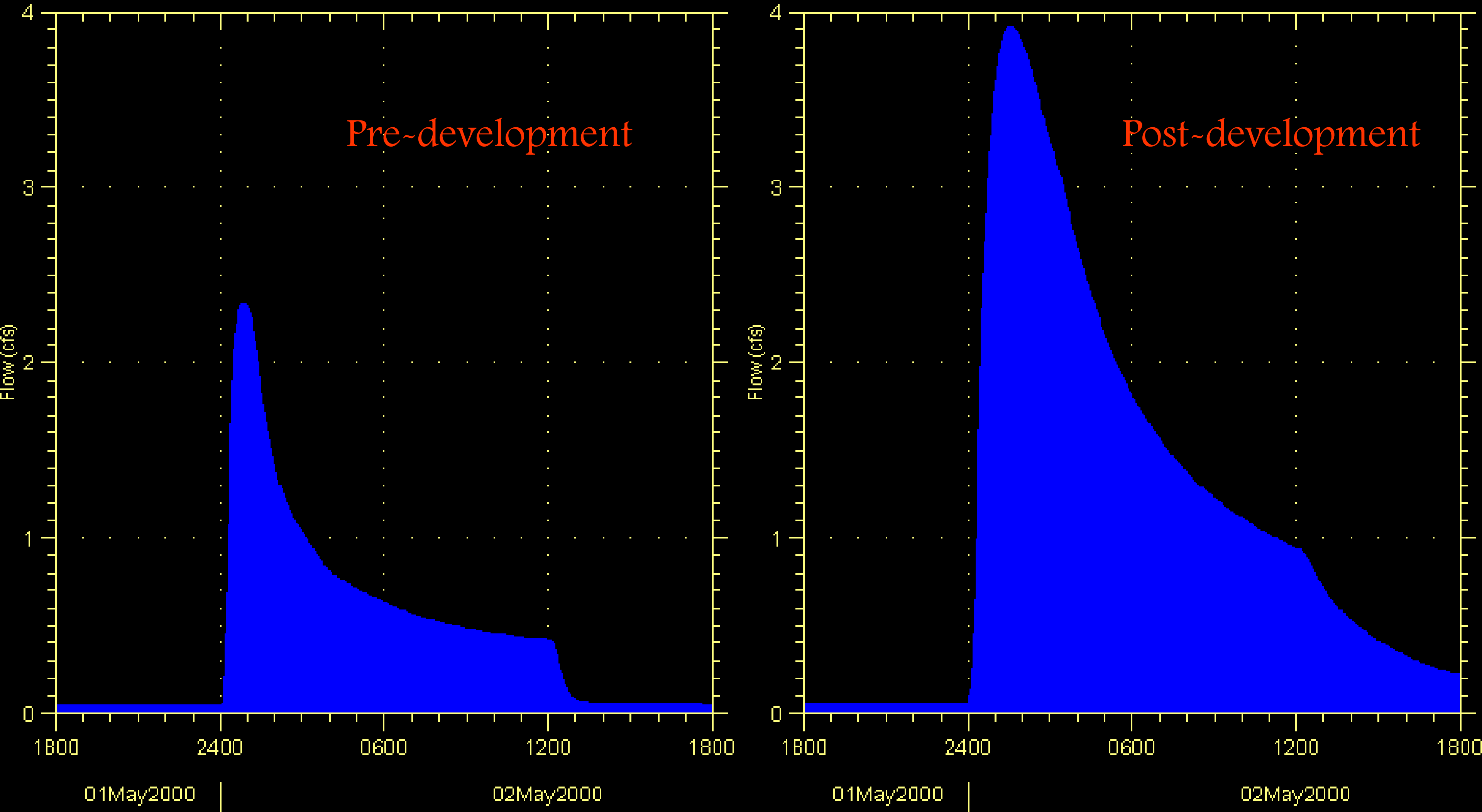


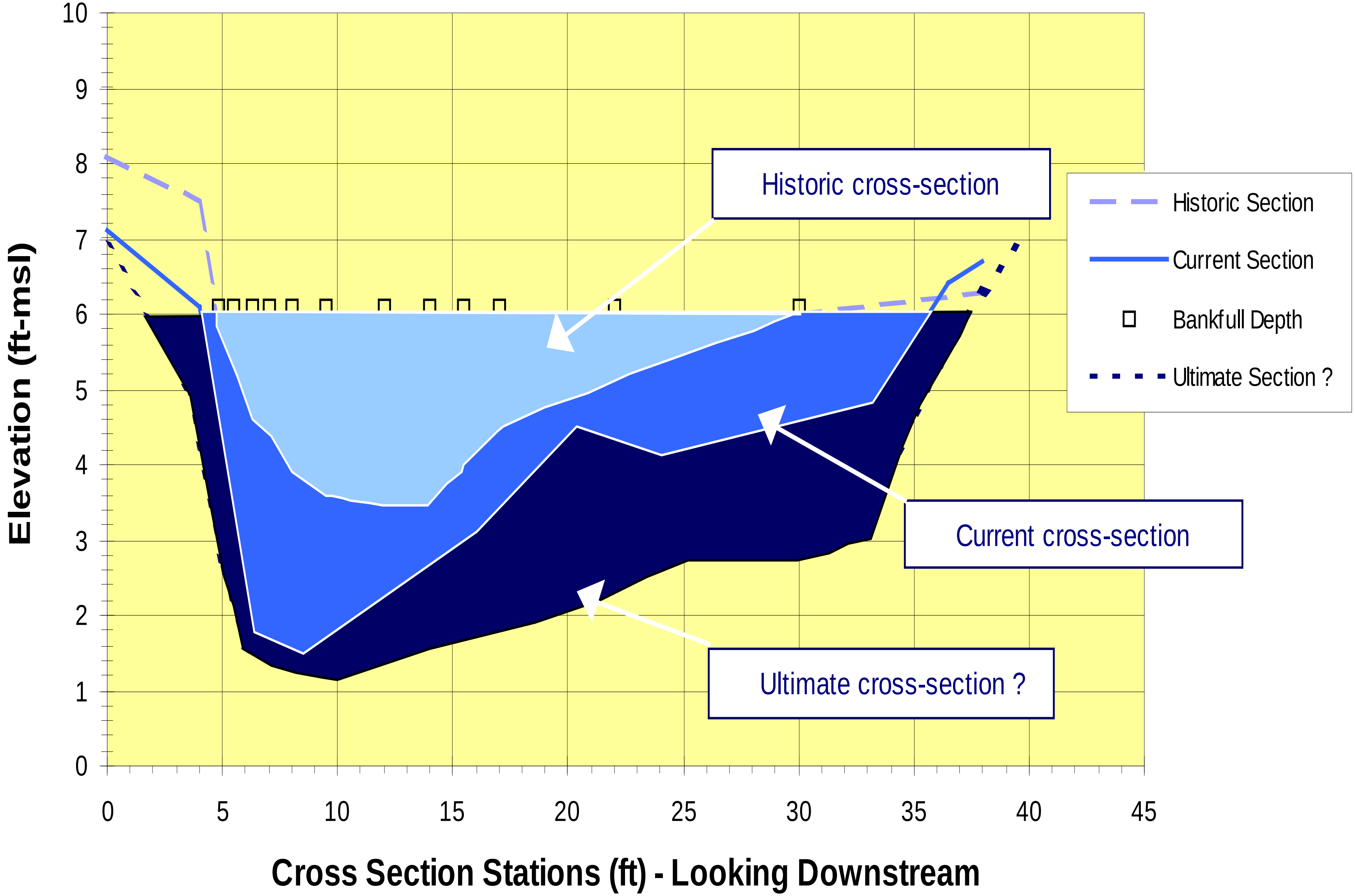
Blakeslee Creek, Michigan

70% increase in peak flow.

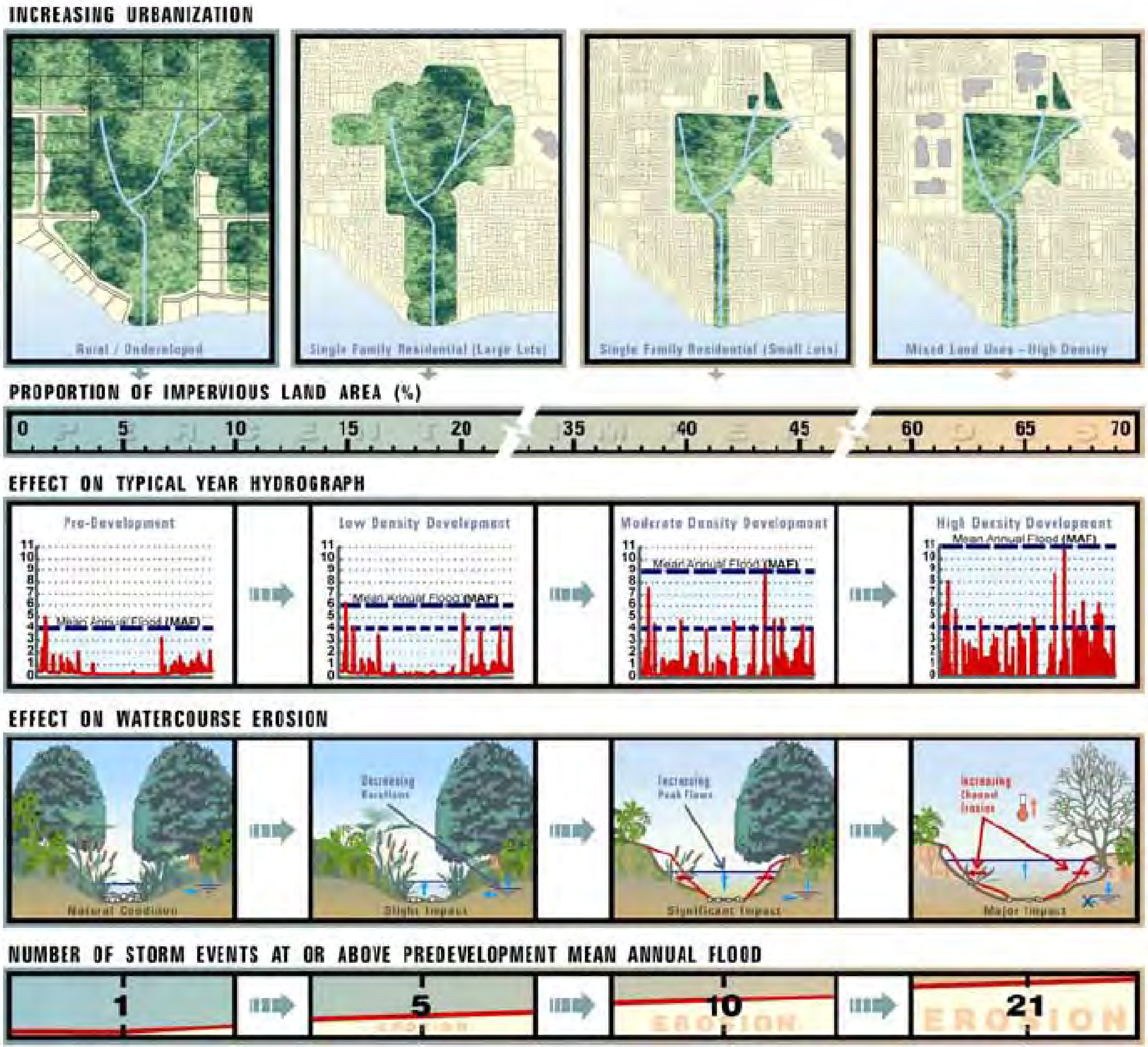
170% increase in runoff volume.

Former instantaneous peak flow now lasts ~4 hours.





Increased rates and volumes of storm water discharges lead to stream widening and down-cutting, or incision.



Metropolitan North Georgia Water Planning District (2003) District-Wide Watershed Management Plan

Era of the Big Basin

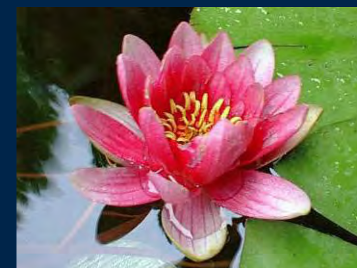
Stormwater management designs that manage only discharge rates often exacerbate the problem.

Natural systems respond to runoff volumes, frequencies, durations and temperatures as well.

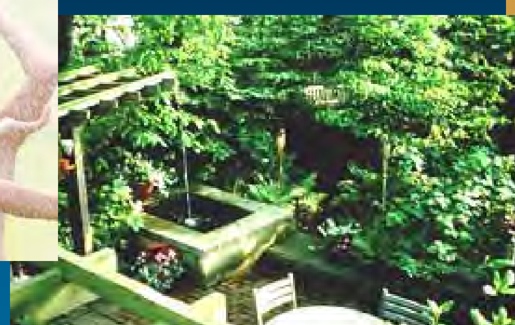
What needs to change?

Paradigm Shift:
Rain is a Resource, Not a Waste

- Drinking water
- Ground water recharge
- Stream baseflow
- Trees & other plants
- Aesthetic qualities





Paradigm Shift:

Get away from the curb and gutter, big basin approach

- Shift from the concept of moving stormwater as far away as quickly as possible in large, buried collection and conveyance systems.

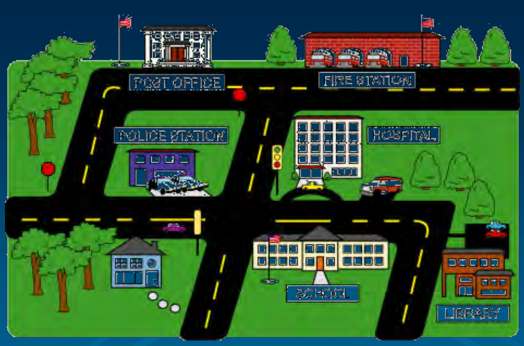
- Shift towards the concept of managing stormwater the way mother nature would do it: where it falls; plants & soils.

Paradigm Shift:

Trifocal Approach to Stormwater Management

Region or Watershed

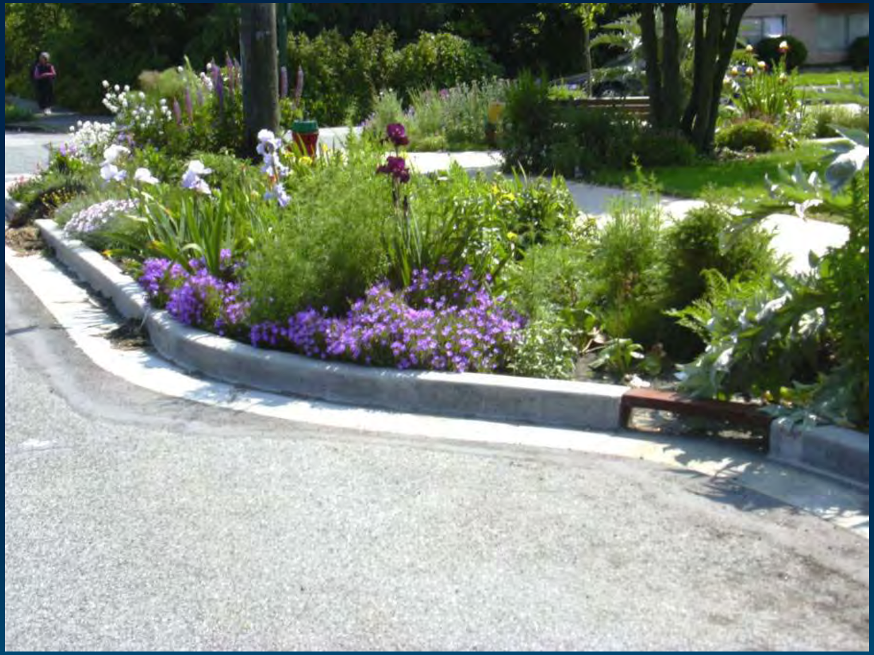
Neighborhood



Site

Green Infrastructure Approaches
Mimic Natural Hydrologic Conditions

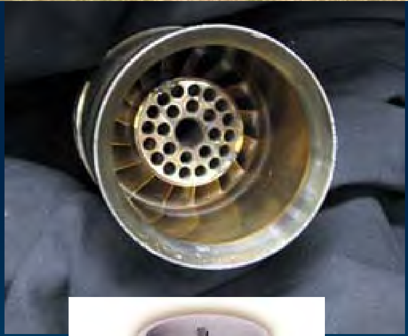
Infiltration ~ Evapotranspiration ~ Capture & Use



- Protecting areas with natural ecological functions
- Amended soils
- Impervious cover removal
- Bioretention
- Permeable pavements
- Green roofs
- Cisterns & rain barrels
- Trees & expanded tree boxes
- Reforestation & restoration
- Infill & Redevelopment
- Parking & street designs
- Water Conservation

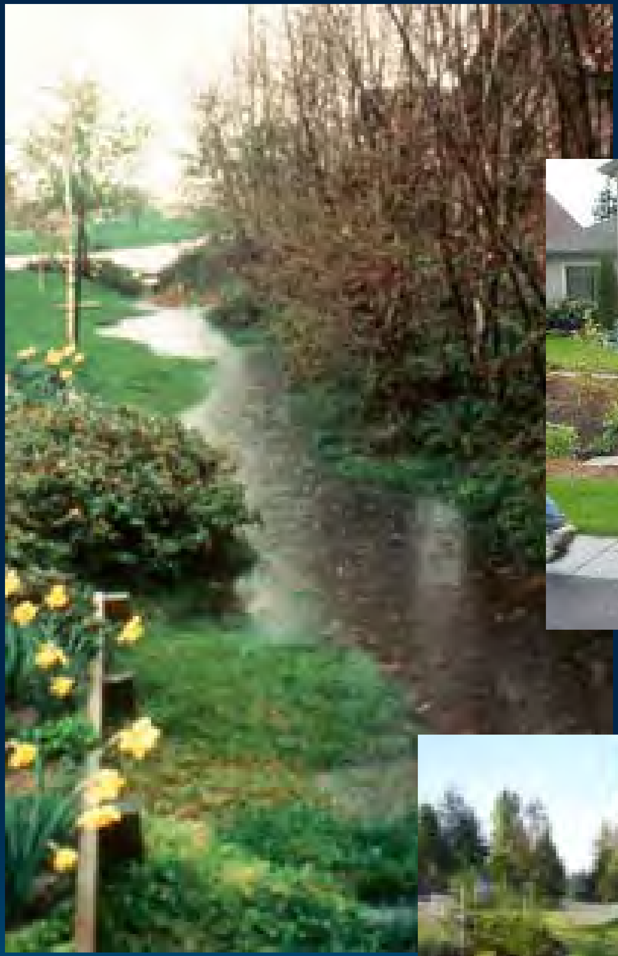
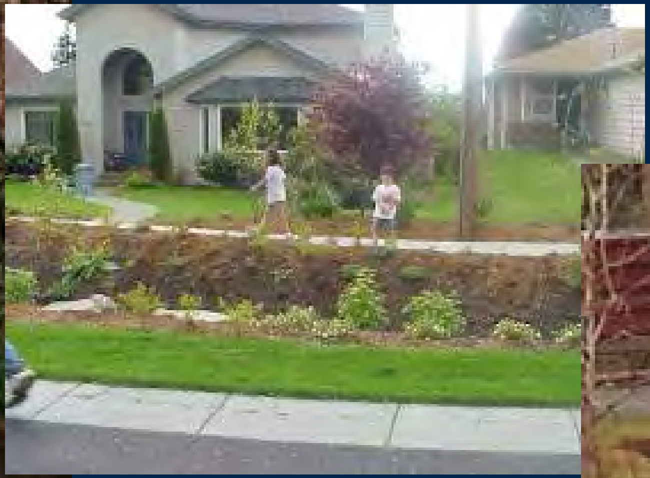
Many wet weather management practices ARE NOT green infrastructure

- Extended detention practices such as stormwater basins, CSO tunnels and underground proprietary devices
- Catch basin inserts such as swirl and vortex devices
- End-of-pipe treatment devices such as sand filters and oil & grease separators

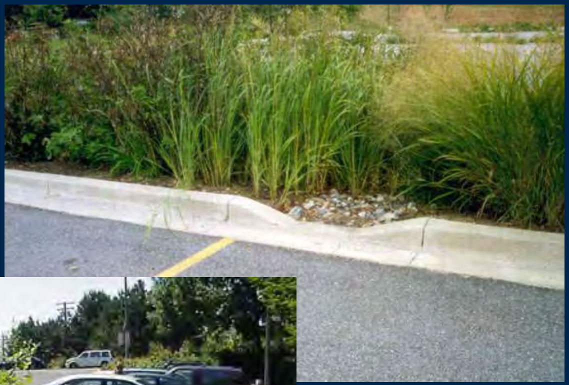


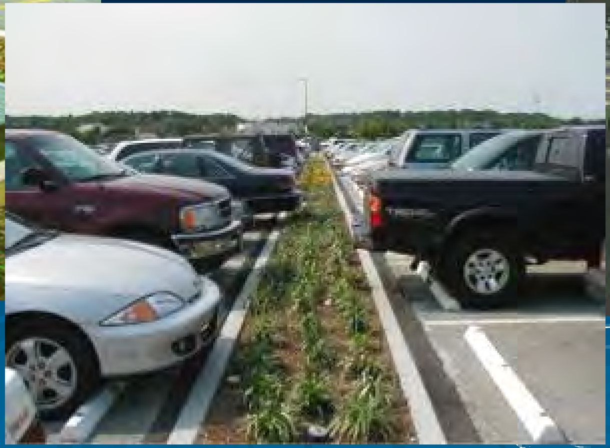
Bioinfiltration

Open Swales

Parking Lot Island Infiltration Areas

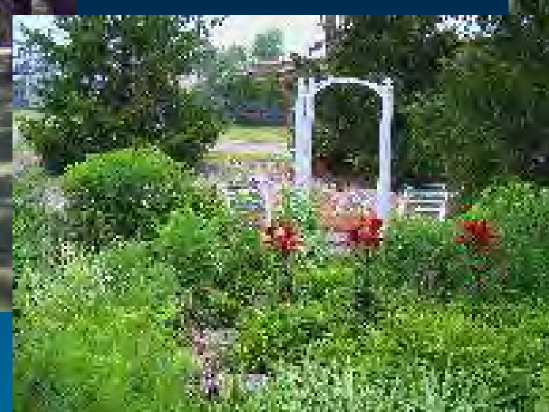



Rain Gardens



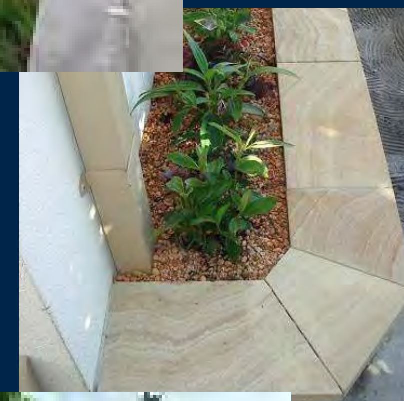


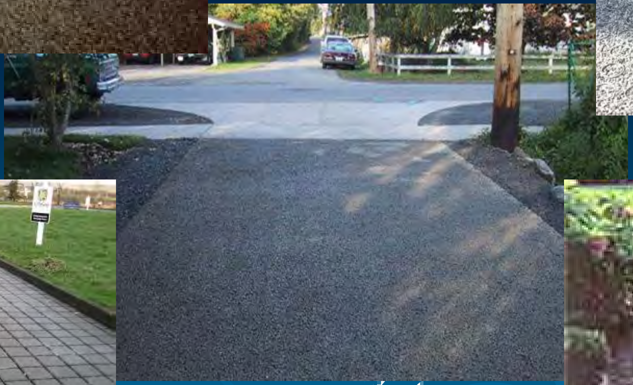

Planters







Permeable and Porous Pavements



Green Roofs

Green Walls

Pocket Wetlands

Vegetated Buffers & Landscaping

Rainwater Harvesting & Use

Infill Development

- Takes advantage of areas that are already served by transportation and infrastructure
- Accommodates development that might otherwise occur on greenfield sites

- Can be coupled with site design practices such as green roofs to effectively manage stormwater

Redevelopment

Sites for redevelopment are already typically covered by impervious surfaces. Redevelopment offers an opportunity to significantly reduce runoff from the existing condition.

Atlantic Station, Atlanta Georgia

Former industrial area redeveloped with mixed use and open space. Pond used not only to help manage stormwater, but is also an amenity.

Innovative Parking

- Structured parking provides the same amount of parking using less land
- Modifying size & configuration
- Reducing number of spaces/perviousness through:
  - Shared parking
  - Parking lifts
  - Unpaved overflow lots

- Can be coupled with site design practices such as infiltration trenches, pervious pavement or green roofs to effectively manage stormwater

Street Design

- Connectivity to reduce car trip lengths
- Multiple modes of transportation
- Narrower roads/ less pavement
- Sidewalks to facilitate more walking

Tree & Canopy Programs

- Trees intercept, and evapotranspire significant amounts of water
- Trees filter pollutants
- Canopies shade and cool paved surfaces

Water Conservation

- High efficiency fixtures and appliances (low-flow toilets, urinals, showerheads, faucets)
- Water recycling and reuse of wastewater from sinks, kitchens, tubs, washing machines, and dishwaters for landscaping, flushing toilets, etc.
- Waterless technologies (composting toilets, waterless urinals)
- Rain harvesting (rain barrels, cisterns)

National Research Council Stormwater Study 2008

National Research Council 2008 Stormwater Study Findings

- Even though "pollutant" is defined broadly in the Act to include virtually every imaginable substance added to surface waters, including heat, it has not traditionally been read to include water volume.
- A more straightforward way to regulate stormwater contributions to waterbody impairment would be to use flow or a surrogate, like impervious cover, as a measure of stormwater loading …. Flow from individual stormwater sources is easier to monitor, model, and even approximate as compared to calculating the loadings of individual contaminants in stormwater effluent. Efforts to reduce stormwater flow will automatically achieve reductions in pollutant loading. Moreover, flow is itself responsible for additional erosion and sedimentation that adversely impacts surface water quality.

National Research Council 2008 Stormwater Study Findings

- SCMs that harvest, infiltrate, and evapotranspirate stormwater are critical to reducing the volume and pollutant loading of small storms.
- "It should be noted that there are important, although indirect, water quality benefits of all runoff-volume-reduction SCMs—

  (1) the reduction in runoff will reduce streambank erosion downstream and the concomitant increases in sediment load, and

  (2) volume reductions lead to pollutant load reductions, even if pollutant concentrations in stormwater are not decreased.

Benefits

Air Quality

- One square meter green roof can remove .2 kg particulates per year
- 5 square meters = capture from 10,000 vehicle miles traveled

Sydney Conservatorium of Music

Energy Savings

- Chicago citywide projection: $100 million energy savings and 720 megawatts (= 3 coal fired power plants)

Data source: Weston Design Consultants

Urban Cooling

- Trees:

  10% canopy increase →5~10% energy savings from shading, windblocking
- Toronto study: permeable pavements reduce heat island

Urban Cooling and Energy Savings

- 15% Green Roof Coverage
- 5-9 degree heat island reduction
- .5 - 1 **Gigawatt** peak power savings

Lawrence Berkely Labs Heat Island Group, 2000

Water Supply

- Cook County Estimate: Apply Various Green Infrastructure →
- 40% runoff reduction
- Aquifer & lake recharge equivalent to additional supply for >1 million people

Crime Prevention

Compared with areas that had little or no vegetation, buildings with high levels of greenery had 52% fewer crimes

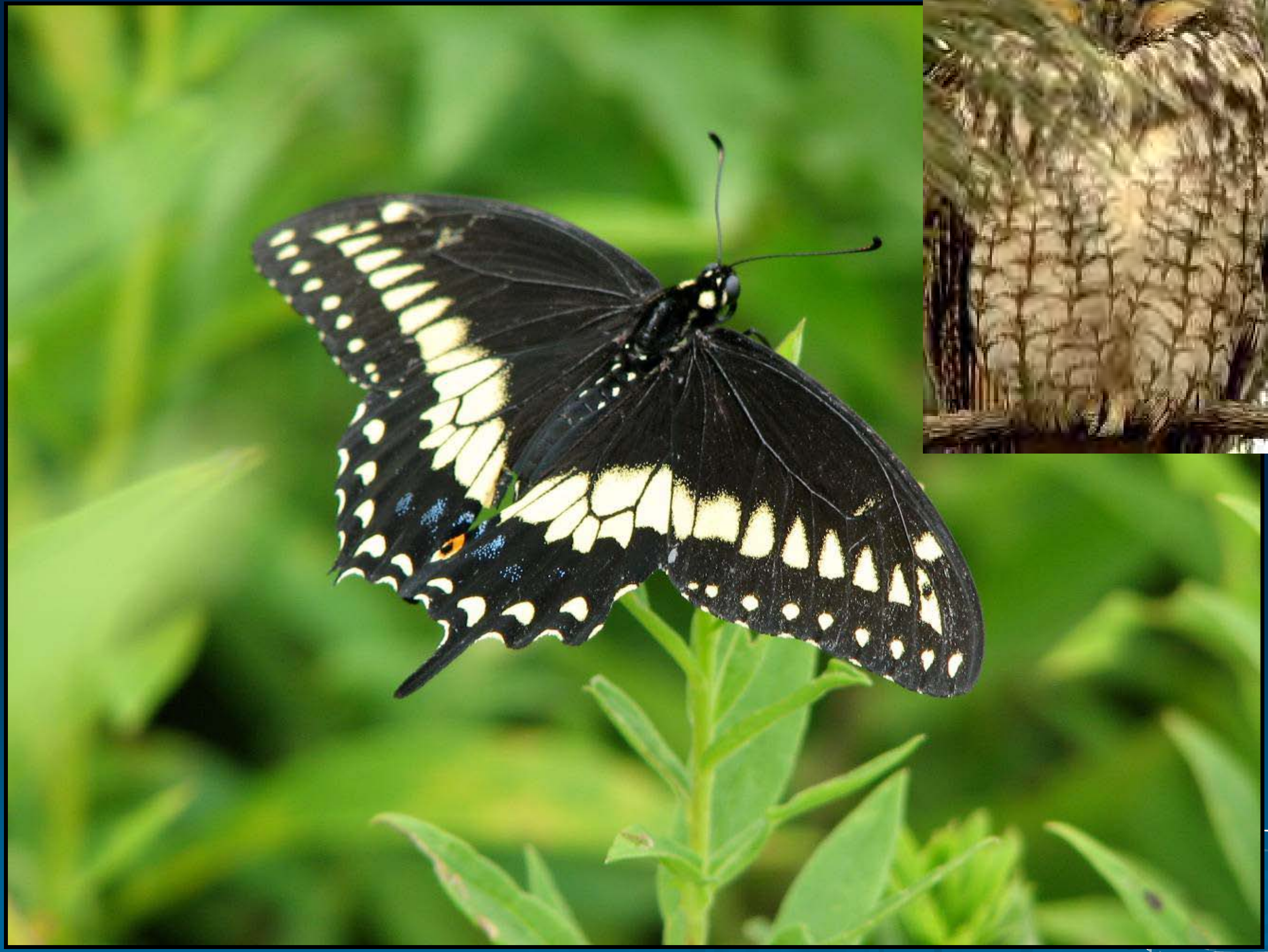
Landscape and Human Health Laboratory
University of Illinois at Urbana-Champaign

Community Health

"exposure to green surroundings reduces mental fatigue and the feelings of irritability that come with it. The ability to concentrate is refreshed by green views, along with the ability and willingness to deal with problems thoughtfully and less aggressively. And, in this study, ***even small amounts of greenery—a few trees and a patch of grass—helped inner city residents have safer, less violent domestic environments****."*

Landscape and Human Health Laboratory
University of Illinois at Urbana-Champaign

Habitat

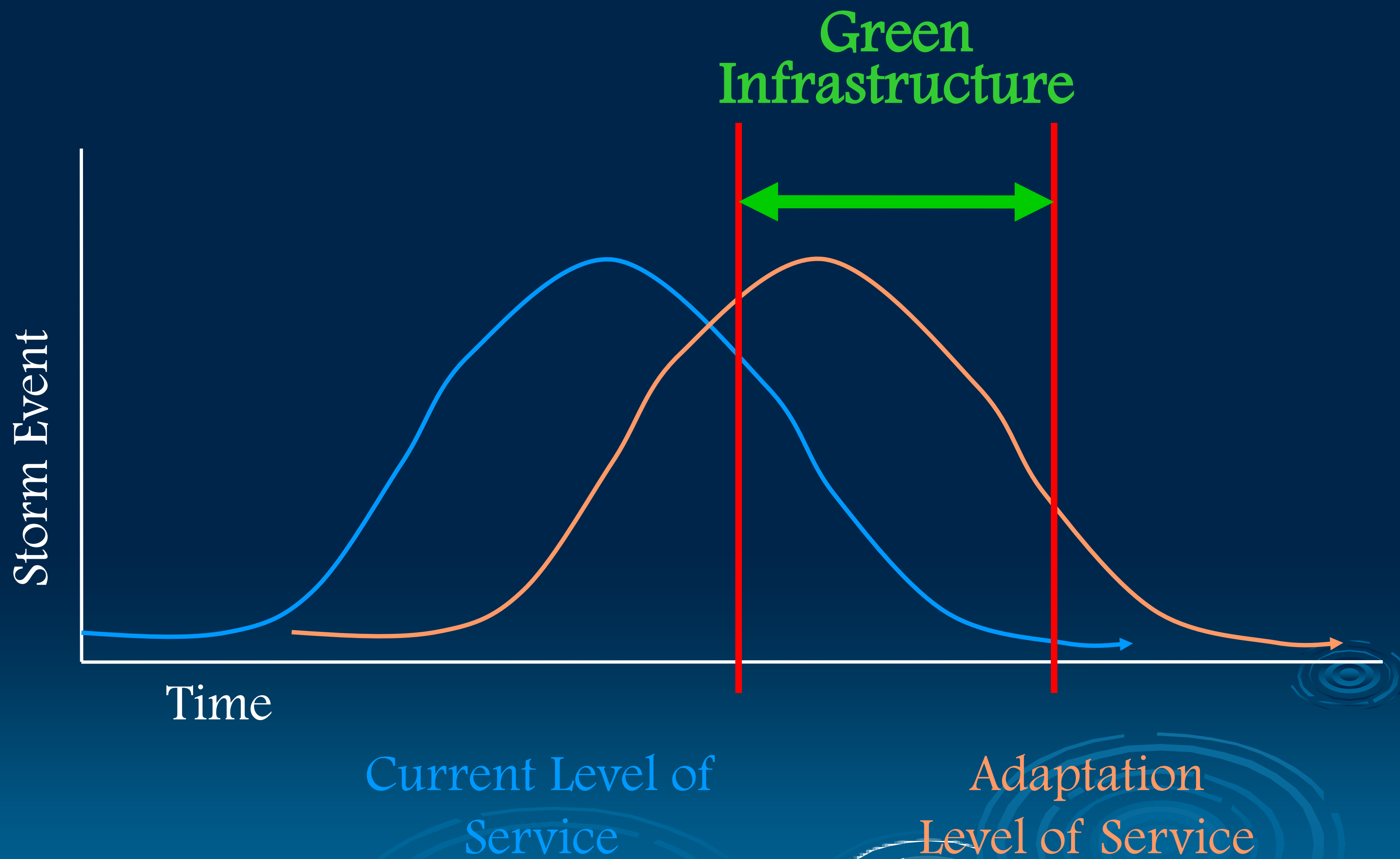


Climate Change Mitigation

- Approximately 800 million tons of carbon are stored in U.S. urban forests with a $22 billion equivalent in control costs.
- Planting trees remains one of the cheapest, most effective means of drawing excess CO2 from the atmosphere.
- A single mature tree can absorb carbon dioxide at a rate of 48 lbs./year and release enough oxygen back into the atmosphere to support 2 human beings.
- A healthy tree stores about 13 pounds of carbon annually -- or 2.6 tons per acre each year. An acre of trees absorbs enough CO2 over one year to equal the amount produced by driving a car 26,000 miles.

Compiled by Colorado Tree Coalition

Climate Change Adaptation



Source: Chicago Dept of Transportation

Recreation

Jobs Strategy

- Certified installers
- Operation & Maintenance
- High skilled engineering, landscape architecture, monitoring
- Washington, DC, via a labor demand analysis of implementation of an intensive green roof program, estimates the creation of 1769 full time jobs per year for 10 years.

Cost Savings

Table 2. Summary of Cost Comparisons Between Conventional and LID Approaches[a]

Project	Conventional Development Cost	LID Cost	Cost Difference[b]	Percent Difference[b]
2nd Avenue SEA Street	$868,803	$651,548	$217,255	25%
Auburn Hills	$2,360,385	$1,598,989	$761,396	32%
Bellingham City Hall	$27,600	$5,600	$22,000	80%
Bellingham Bloedel Donovan Park	$52,800	$12,800	$40,000	76%
Gap Creek	$4,620,600	$3,942,100	$678,500	15%
Garden Valley	$324,400	$260,700	$63,700	20%
Kensington Estates	$765,700	$1,502,900	–$737,200	-96%
Laurel Springs	$1,654,021	$1,149,552	$504,469	30%
Mill Creek[c]	$12,510	$9,099	$3,411	27%
Prairie Glen	$1,004,848	$599,536	$405,312	40%
Somerset	$2,456,843	$1,671,461	$785,382	32%
Tellabs Corporate Campus	$3,162,160	$2,700,650	$461,510	15%

[a] The Central Park Commercial Redesigns, Crown Street, Poplar Street Apartments, Prairie Crossing, Portland Downspout Disconnection, and Toronto Green Roofs study results do not lend themselves to display in the format of this table.

[b] Negative values denote increased cost for the LID design over conventional development costs.

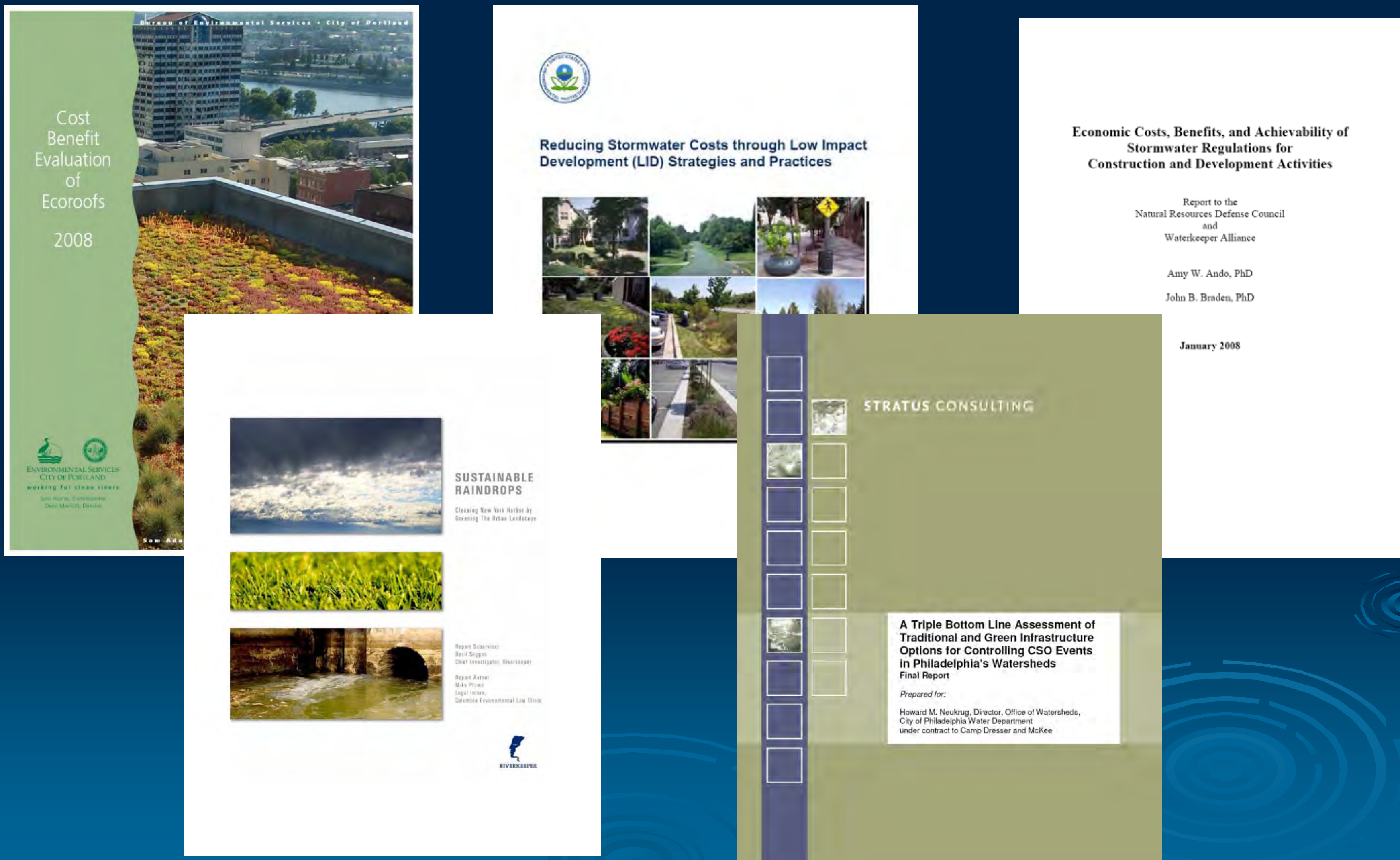
[c] Mill Creek costs are reported on a per-lot basis.

Reducing Stormwater Costs through LID Strategies and Practices, EPA 2007

2009 Philadelphia Triple Bottom Line Analysis
Citywide Present Value Benefits: Cumulative through 2049

Benefit Categories	50% LID option (2009 million USD)	30' tunnel option (2009 million USD)
Increased recreational opportunities	$ 524.5	
Improved aesthetics/property value (50%)	$ 574.7	
Reduction in heat stress mortality	$ 847.1	
Water quality / aquatic habitat enhancement	$ 336.4	$ 189.0
Wetland services	$ 1.6	
Social costs avoided by green collar jobs	$ 124.9	
Air quality improvements from trees	$ 131.0	
Energy savings / usage	$ 26.6	$ (7,324.1)
Reduced (increased) damage from SO_2 and NO_x emissions	$ 43.8	$ (2,838.9)
Reduced (Increased) damage from CO_2 emissions	$ 11.1	$ (745.8)
Disruption costs from construction and maintenance	$ (5.6)	$ (10,524.5)
TOTAL	**$ 2,616.0**	**$ (21,244.3)**

Studies on Benefits and Costs




Municipal Case Studies

Chicago, Illinois

- More than 80 green roofs totaling over 1 million square feet.
- A 2003 study found green roof runoff volume was less than half that of conventional roofs.
- Temperatures above the Chicago City Hall green roof average 10 to 15 F lower than a nearby black tar roof. August temperature difference can be as much as 50 F. Estimated annual energy savings of $3,600.

Chicago, Illinois

- Subsidized rain barrel program used to reduce basement flooding and CSO volume.
- Downspout disconnection projected to reduce CSO peak flow in target area by 20%.

Chicago Green Alleys

- 13,000 alleys – more than 1,900 miles.
- 3,500 acres of impervious surface.
- 20% unimproved; 20% need repair.
- Alleys not connected to storm sewers, cause of flooding.

Chicago Green Alleys

- Pilot projects address stormwater, urban heat island, recycled materials, energy efficiency and light pollution.
- Early pilot alley retains the volume of a 3-inch, 1-hour event.
- Created a market for permeable concrete - $145/yd to $45/yd one year later (regular concrete $50/yd).

Milwaukee, Wisconsin

- Green roofs, bioretention and rain barrels used to reduce combined sewer inflow.
- Green infrastructure expected to reduce CSO volume by 14-38%.

MMSD Green Roof. ***Photo courtesy of MMSD.***

Portland, Oregon

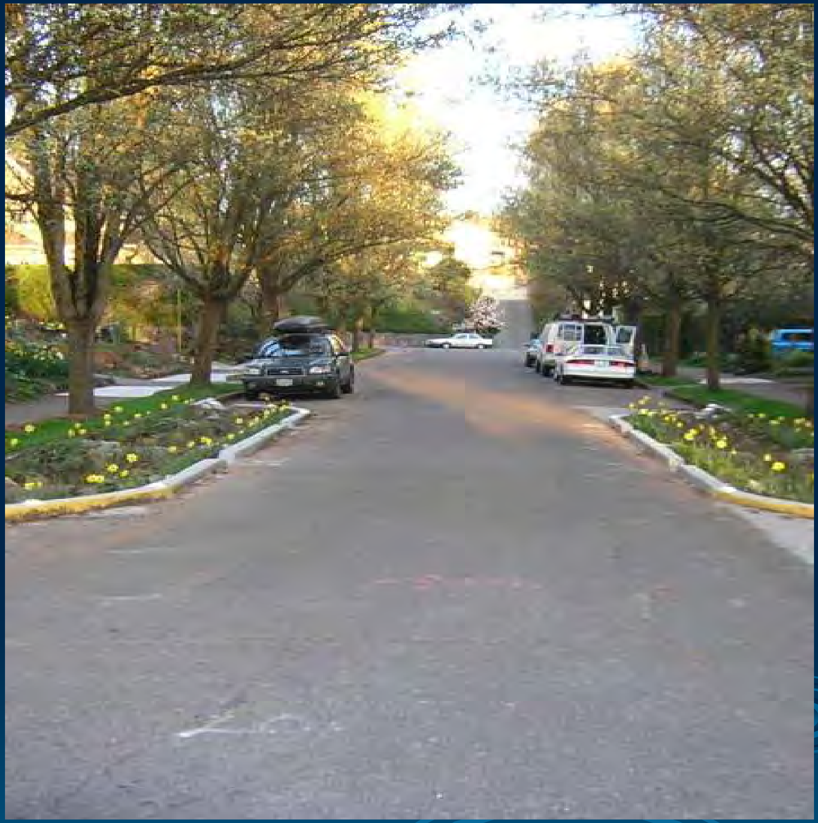
Vegetated Planter at
Portland State University.

- City code requires on-site stormwater management for new and re-development.
- Subsidized downspout disconnection program.
  - 45,000 participating households.
  - Infiltrates 1 billion gallons of rainwater annually.

Portland, Oregon

Vegetated Curb Extensions

- Flow testing demonstrated 88% reduction in peak flow and 85% reduction in CSS inflow for 25-year storm event.
- Sufficient to protect local basements from flooding.
- Project cost $15,000 and required two weeks to install.



Vegetated Curb Extensions.

Portland, Oregon

Permeable Paver Blocks

- Used in a similar manner to curb extensions to manage street runoff.
- Allow hardscape function to be retained.
- Have virtually eliminated runoff from the street.

Portland, Oregon

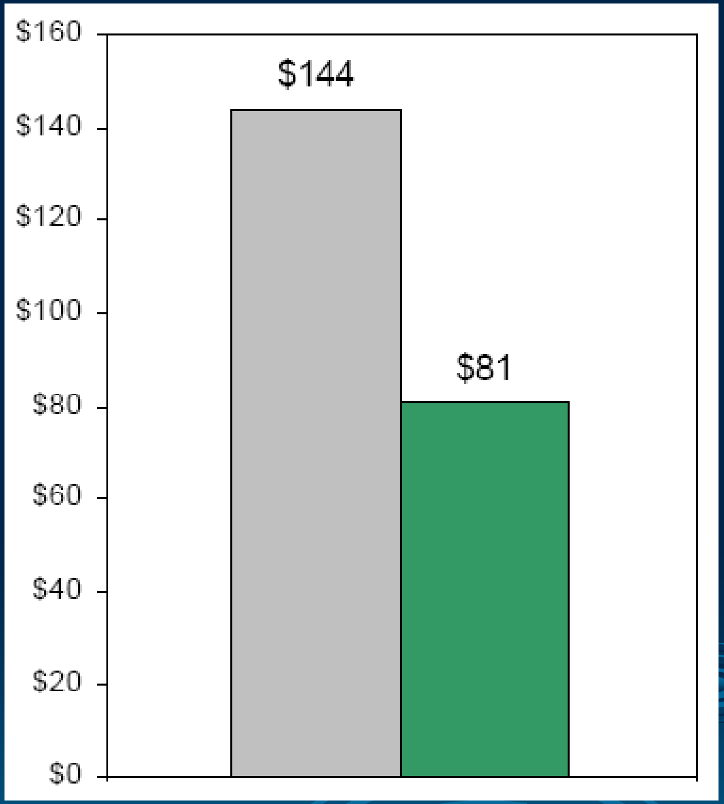
Green Roofs

- Zoning bonus allows additional building square footage for buildings with a green roof.
- Two years of monitoring demonstrated that 58% of annual and nearly 100% of warm season rainfall was retained.
- Modeling of 300 block downtown area with ecoroofs showed 32% stormwater reduction, 6.5% energy reduction, and 1% heat island effect reduction.

Hamilton Apartments Ecoroof.

Portland, Oregon

- Brooklyn Creek Basin
- $63 million cost savings in going from grey to green infrastructure wet weather control



Seattle, Washington

Natural Drainage Systems

- Stormwater source control.
- Monitoring has demonstrated 99% reduction in stormwater runoff.
- No measured runoff since December 2002.

2nd Avenue SEA Street.

Seattle, Washington

Cascade Channels

- End-of-Pipe Control
- Monitoring demonstrates 75% reduction in stormwater runoff volume and 60% reduction in peak flow.
- Modeling estimates that cascade system retains three times as much stormwater and held stormwater 2.5 times longer than original drainage ditch.

Cascade Drainage System.

Seattle, Washington

Table 7. Citywide Management Unit (MU) Data*

Statistic	Citywide	
	Current	*30-year Goal*
Acres in MU	54,324	
MU as % of city land base	100%	
Canopy coverage	18%	30%
Number of trees	1,377,500	2,026,600
Plantings needed		**649,100**
One-time cost of plantings		**$114,200,000**
Maintenance Costs (yr)	$14,054,300	$21,116,300
Benefits (yr)		
Stormwater Mitigation Value (yr)	$20,643,000	**$30,215,000**
Air Cleaning Value (yr)	$4,894,000	**$7,047,000**
Carbon Sequestration (Tons CO_2)	52,400	**77,066**
Carbon Sequestration (Value $)	$1,584,000	**$2,331,000**
Other Benefits (Energy, Aesthetics, & etc)	$17,237,300	$26,342,300
Net Benefit (All Benefits - All Costs) (yr)	$30,304,000	$44,585,000

**All values are based on estimates and currently accepted models (McPhearson et al. 2002).*

12 % more Canopy:

Stormwater +

Air Quality +

Carbon +

Other Benefits =

$15 million annual net benefit

(Seattle Urban Forest Management Plan 2007)

Seattle, Washington

Rainwater Harvesting

- More than 16,000 gallons of storage at 327,000 ft^2 King Street Center used for toilets and irrigation.
- Provides 60% (1.4 million gallons) of toilet flushing water annually.

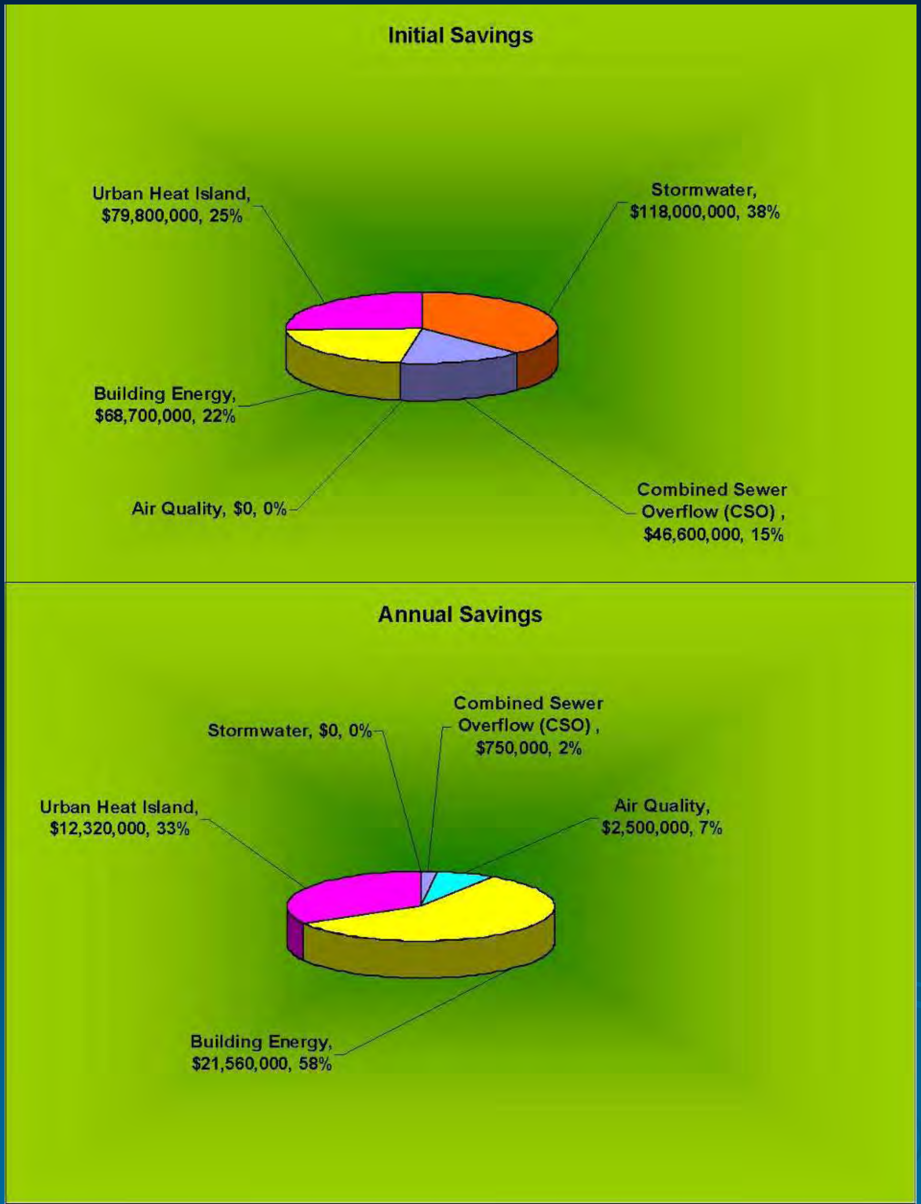
King Street Center.

Toronto, Ontario

- City provides free downspout disconnection
- Extensive stream restoration efforts include rehabilitating wetlands and vegetated areas.
- More than 100 green roofs have been installed in the city, which reduce roof runoff by more than 50%.

Chester Springs Marsh.

Toronto, Ontario



- Study modeled impacts of installing green roofs on all city roofs >3,750 ft^2.
  - Would result in 12,000 acres of green roofs – 8% of total city land area.
  - Estimated nearly $270 million in municipal capital cost savings and more than $30 million of annual savings.

Vancouver, British Columbia

- Uses naturalized streetscapes, infiltration bulges and Country Lanes to manage stormwater from roadways.
- Street design projected to reduce annual runoff 90%.
- Installed natural biofiltration systems to manage and treat stormwater before it enters sensitive salmon waters.

Lansing, Michigan

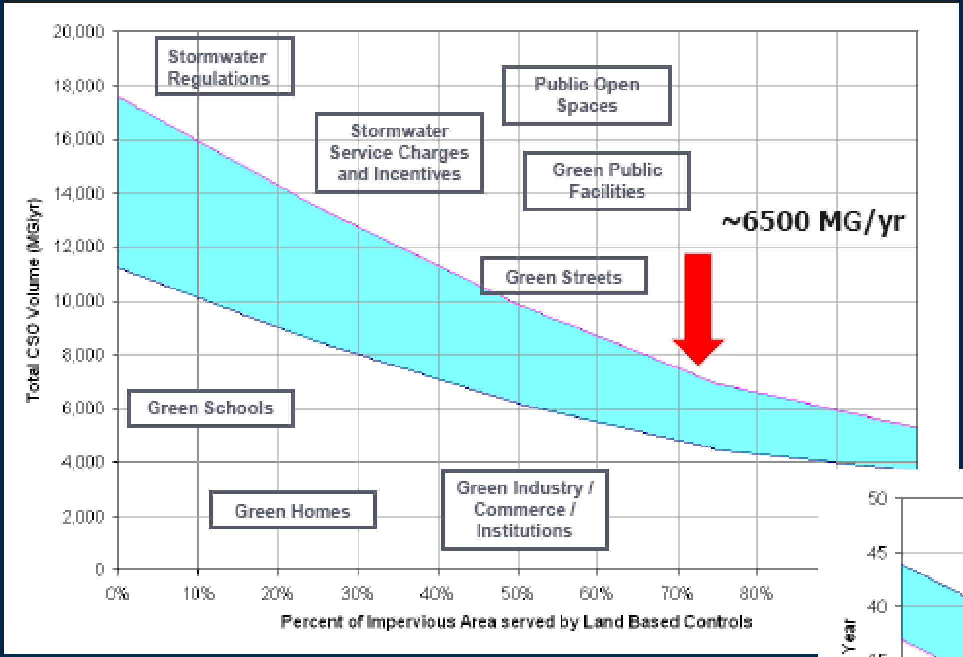
- Creation of attractive, walkable streetscapes as part of the City's combined sewer overflow (CSO) project
- Six downtown blocks included in initial project
- Captures rain up to 90th percentile storms

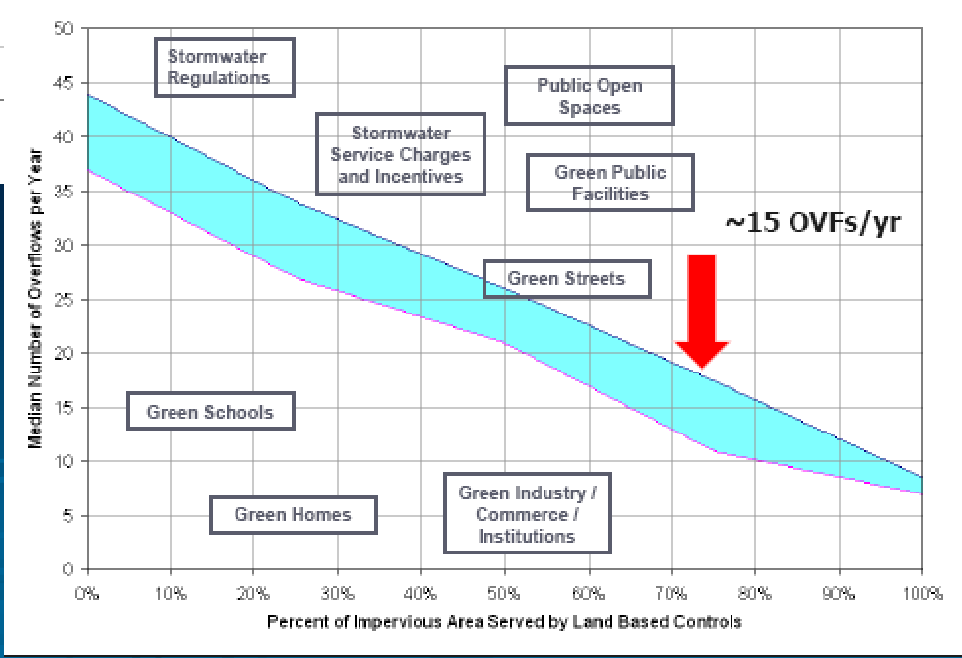
Philadelphia, Pennsylvania

Potential Impact of Stormwater Regulations
First Inch Capture

	2006		20 years
Re-development Rate (1 mi^2/ yr)	1 mi^2		20 mi^2
Captured Runoff (per 1" event)	17 MG		340 MG
Avoided Tank Costs (@ $2/gal)	$34 M		$680 M

Philadelphia, Pennsylvania





Philadelphia, Pennsylvania

- Vacant land improvements increased surrounding housing values by as much as 30%
- New tree plantings increased surrounding housing values by approximately 10%

(University of PA data)

(Philadelpia Watersheds Office photos))

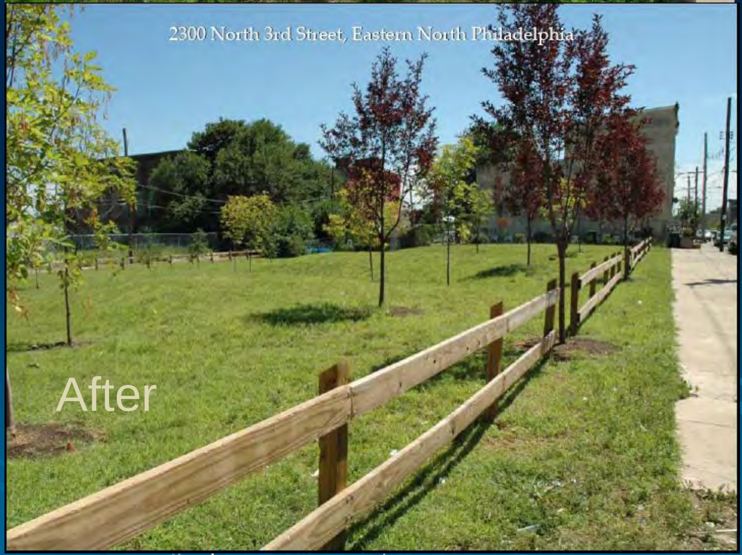
Philadelphia, Pennsylvania

Tree Plantings:

- $4 million property value gain
- 20 years taxed at 2.64% = $2,112,000

Lot Improvements:

- $12 million gain through
- 20 years taxed at 2.64% = $6,336,000



PA Horticultural Society photos

Louisville, Kentucky

- Overflow Abatement Plan (CSOs & SSOs)
- Green infrastructure investments estimated to reduce initial costs of grey infrastructure projects by $40 million

- Potential future savings could be triple this amount

New York, New York

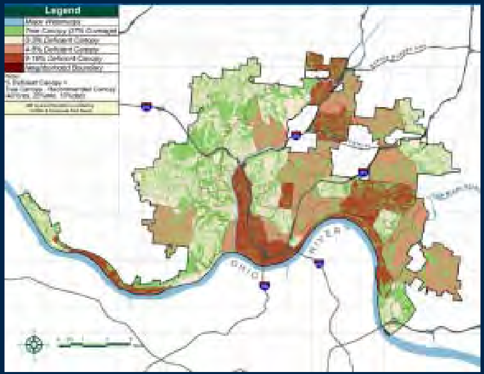
The Solaire green roof.

- Study projects that redirecting 50% of $2.1 billion projected costs for hard infrastructure to control 5.1 billion gallons of CSO to rain gardens, street trees, green roofs, and rain barrels would:
  - capture an additional billion gallons of CSO
  - reduce annual stormwater treatment costs by 50%
  - reduce air pollution, including 3,000 tons of carbon dioxide
  - increase property values, aesthetics, and sense of community

Lenexa, Kansas

- $25 million dollars saved or approximately 25% of capital costs
  - Regional stormwater infrastructure with watershed approach
  - Flood mitigation and prevention
  - Cost avoidance with fewer curbs, gutters and pipes

Cincinnati, Ohio



Pilot Project: Deer Park and Silverton

- $13.2 million of green facilities will provide an equivalent level of CSO volume reduction as $29.9 million of previously proposed storage facilities and sewer separation. Net Green Savings: $16.7 million

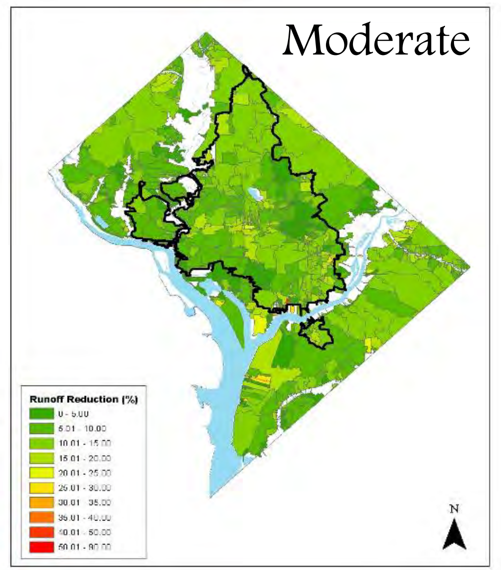
Opportunities Project: East Ohio

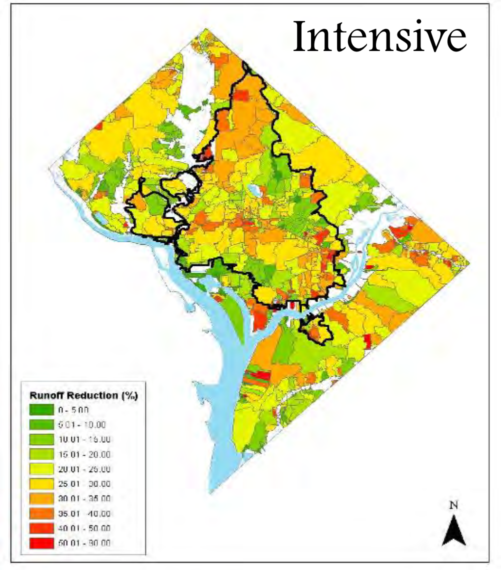
- $7.2 million in green infrastructure in this area approaches the effectiveness of $13.6 million of sewer separation. Net Green Savings: $6.4 million

Washington, D.C.

Green Build-Out Model

- Moderate Scenario: 1.3 billion gallon (12%) collective reduction in discharges from both sewer systems. Nearly 400 million gallons (17%) reduction in CSS discharges.
- Intensive Scenario: 3 billion gallon (30%) collective reduction in discharges from both sewer systems. Nearly 1 billion gallons (43%) reduction in CSS discharges.
- Reductions in stormwater runoff volume of up to 26% across the city, with greater than 50% reductions in individual sewersheds.






Part 438 of the Energy
Independence and Security Act,
2007

Energy Independence and Security Act of 2007

"Sec. 438. Storm Water Runoff Requirements for Federal Development Projects. The sponsor of any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow."

United States Environmental Protection Agency | Office of Water (4503T) Washington, DC 20460 | EPA 841-B-09-001 December 2009 www.epa.gov/owow/nps/lid/section438

Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act

EPA, in consultation with the ISWG and other federal agencies, developed Technical Guidance, issued December 2009

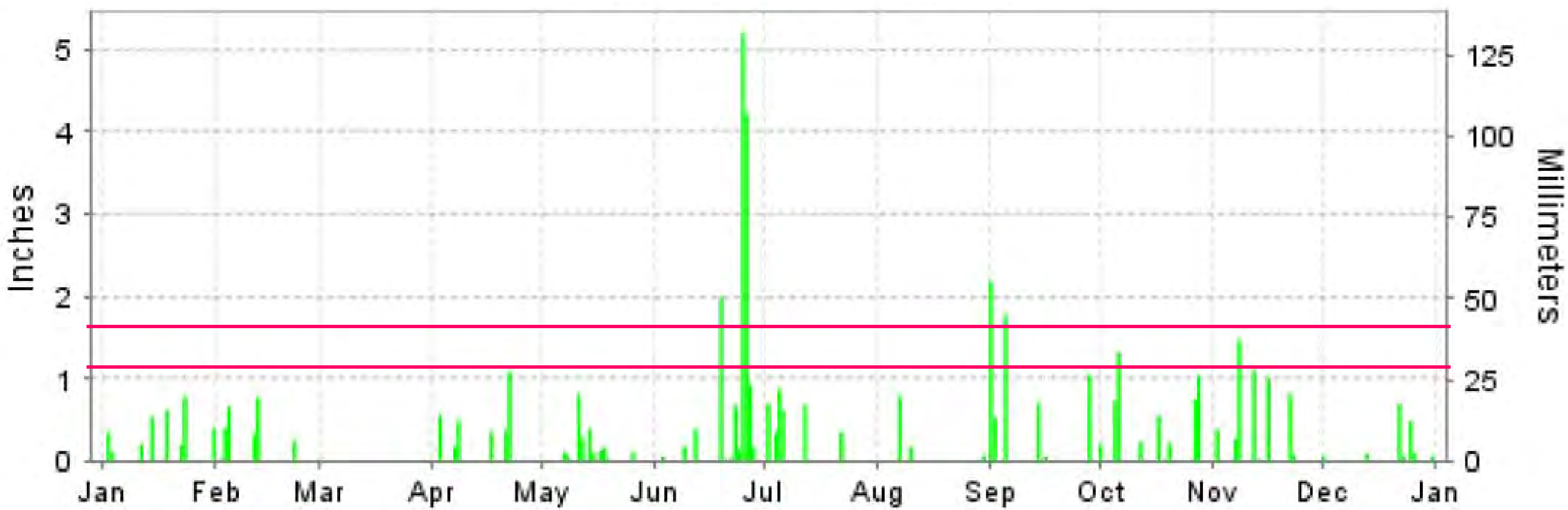
Performance Options

Option 1: Control 95th Percentile Rainfall Event

- Manage rainfall onsite
- Infiltrate, Evapotranspire, Harvest and Use Runoff

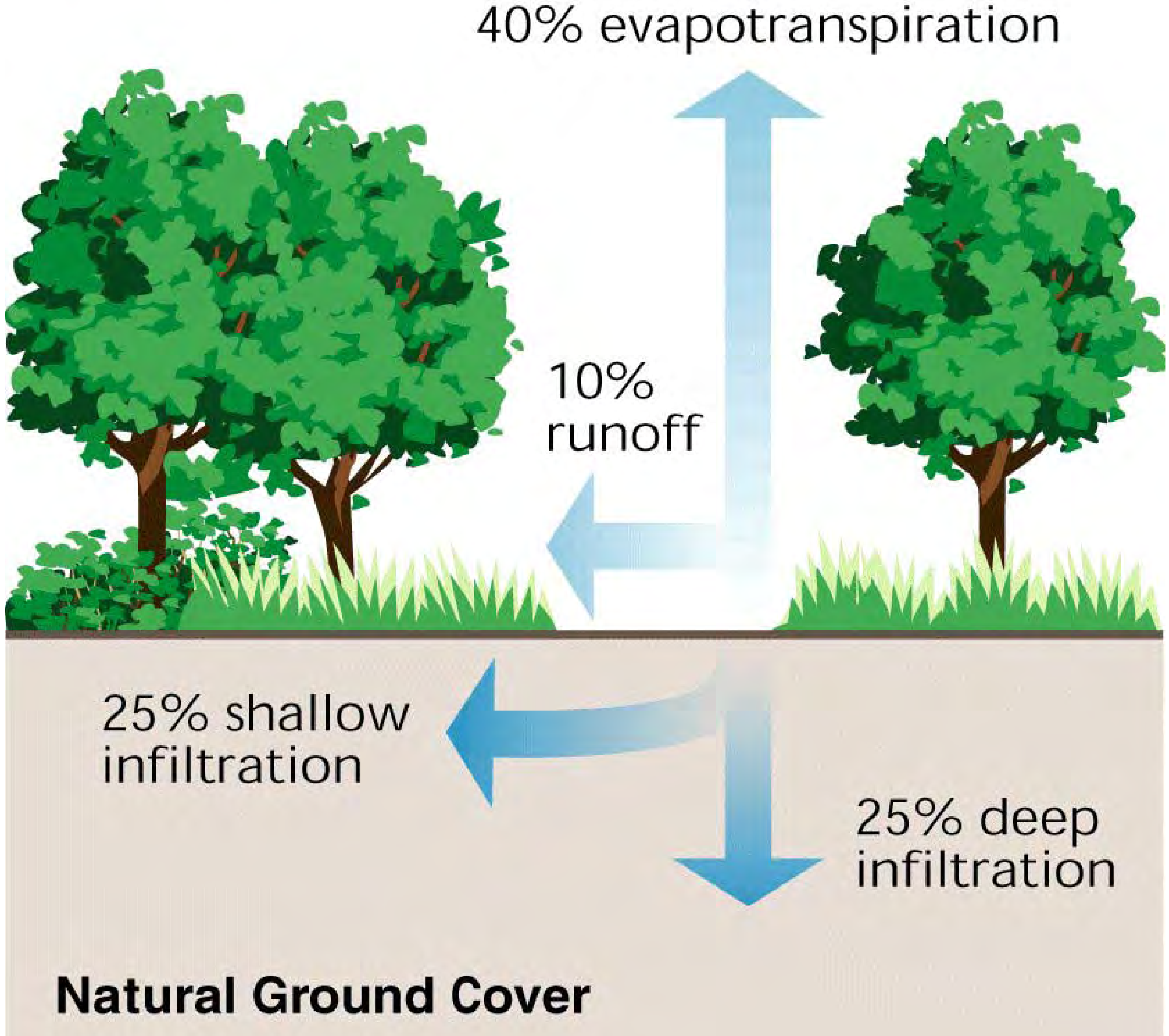
Note: The 95th percentile rainfall event is the event whose precipitation total is greater than or equal to 95 percent of all 24-hour storms on an annual basis.

2006 Precipitation
Washington DC



90^{th} Percentile Event = 1.2”

95^{th} Percentile Event = 1.7”


40% evapotranspiration
10% runoff
25% shallow infiltration
25% deep infiltration
Natural Ground Cover

Example 95th Percentile Storms

City	95th Percentile Event Rainfall Total (in)	City	95th Percentile Event Rainfall Total (in)
Atlanta, GA	1.8	Kansas City, MO	1.7
Baltimore, MD	1.6	Knoxville, TN	1.5
Boston, MA	1.5	Louisville, KY	1.5
Buffalo, NY	1.1	Minneapolis, MN	1.4
Burlington, VT	1.1	New York, NY	1.7
Charleston, WV	1.2	Salt Lake City, UT	0.8
Coeur D'Alene, ID	0.7	Phoenix, AZ	1.0
Cincinnati, OH	1.5	Portland, OR	1.0
Columbus, OH	1.3	Seattle, WA	1.6
Concord, NH	1.3	Washington, DC	1.7
Denver, CO	1.1		

Performance Options

Option 2: Preserve predevelopment hydrology (rate, volume, duration & temperature)

- Conduct hydrologic and hydraulic analyses
- Quantify post-construction hydrographs for the following storm sizes:
  - 1, 2, 10 and 100 year 24 hour storm events
- Maintain pre-development hydrographs for these storm events

1. Determine applicability

Requirement: apply to all federal projects with a footprint greater than 5,000 square feet

2. Establish design objective

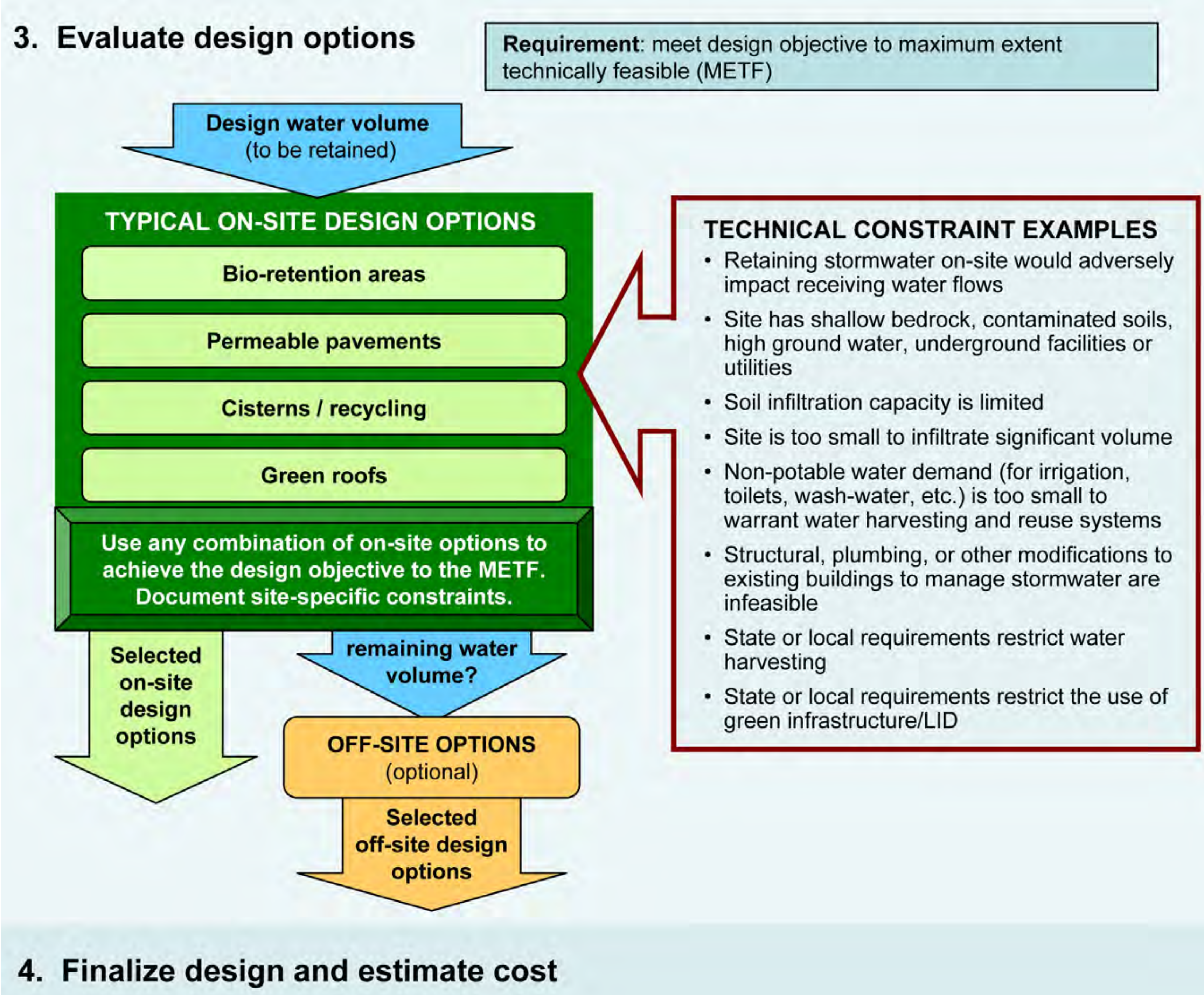
Requirement: maintain or restore pre-development hydrology

OPTIONS

1
Total volume of rainfall from 95th percentile storm is to be managed on-site

2
Determine pre-development hydrology based on site-specific conditions and local meteorology by using continuous simulation modeling techniques, published data, studies, or other established tools. Determine water volume to be managed on-site.

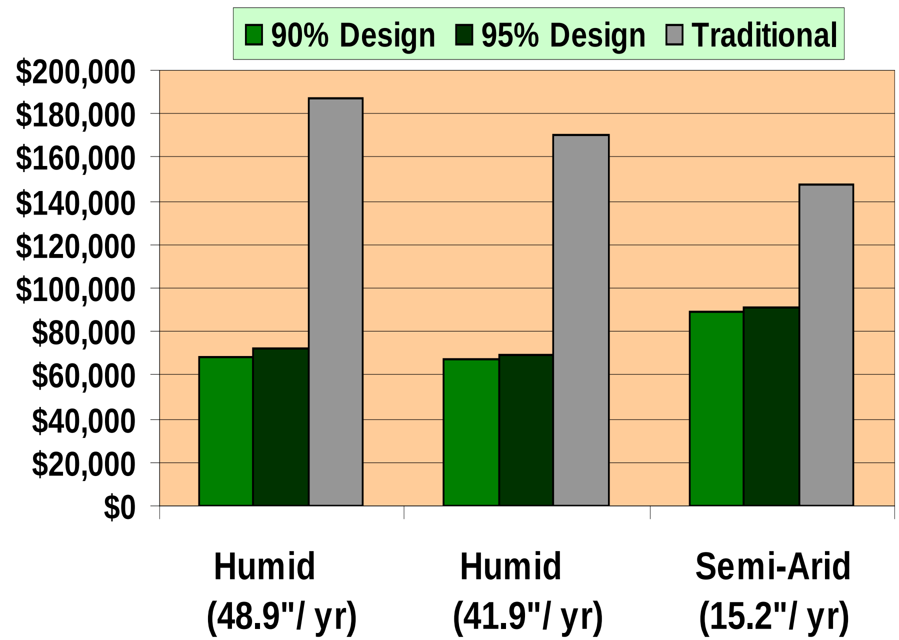
Design water volume
(to be retained)


3. Evaluate design options
Requirement: meet design objective to maximum extent technically feasible (METF)
Design water volume (to be retained)
TYPICAL ON-SITE DESIGN OPTIONS
Bio-retention areas
Permeable pavements
Cisterns / recycling
Green roofs
Use any combination of on-site options to achieve the design objective to the METF. Document site-specific constraints.
Selected on-site design options
remaining water volume?
OFF-SITE OPTIONS (optional)
Selected off-site design options
TECHNICAL CONSTRAINT EXAMPLES
• Retaining stormwater on-site would adversely impact receiving water flows
• Site has shallow bedrock, contaminated soils, high ground water, underground facilities or utilities
• Soil infiltration capacity is limited
• Site is too small to infiltrate significant volume
• Non-potable water demand (for irrigation, toilets, wash-water, etc.) is too small to warrant water harvesting and reuse systems
• Structural, plumbing, or other modifications to existing buildings to manage stormwater are infeasible
• State or local requirements restrict water harvesting
• State or local requirements restrict the use of green infrastructure/LID
4. Finalize design and estimate cost

Site A: Single Family Residential Development (40% imperviousness)

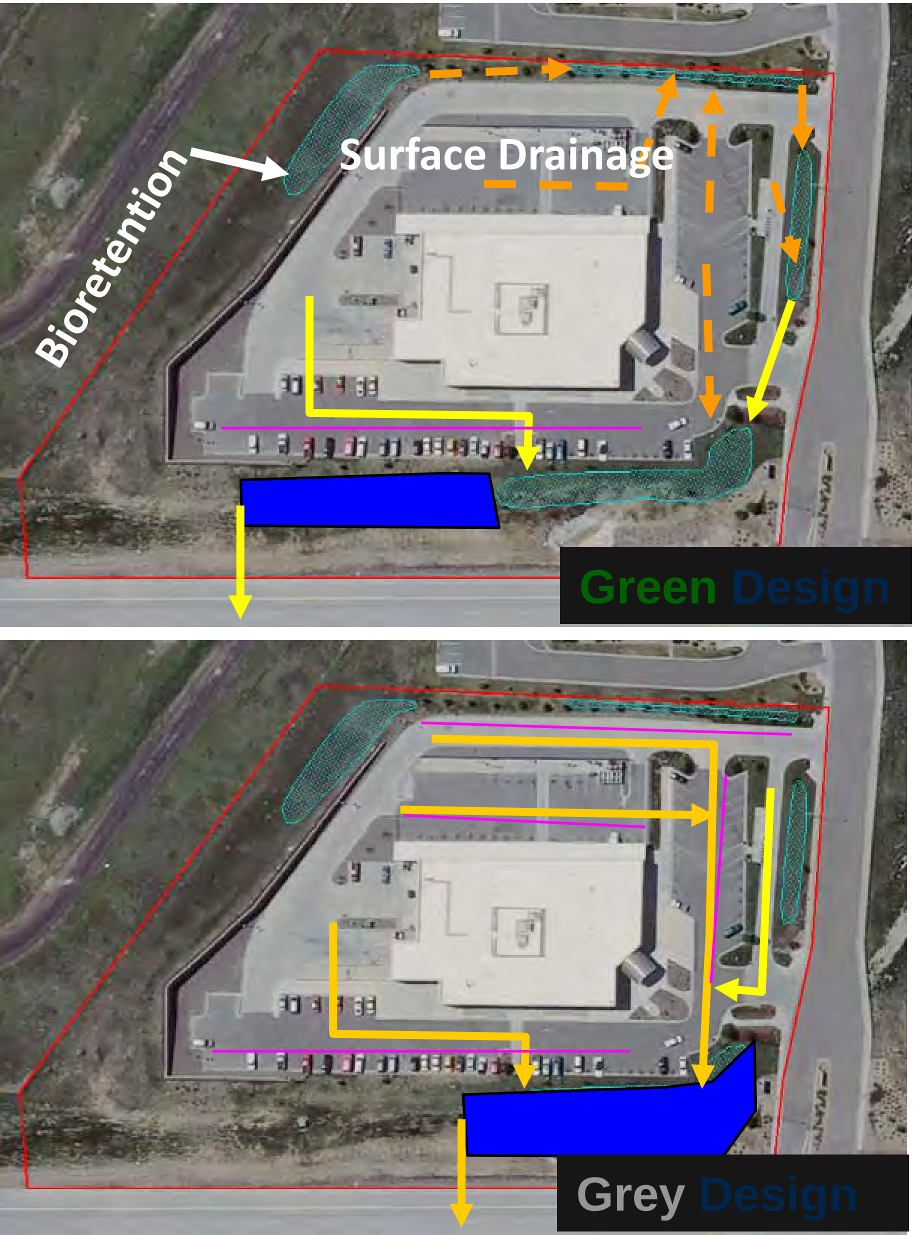
Cost Comparison

(capital costs for entire site)



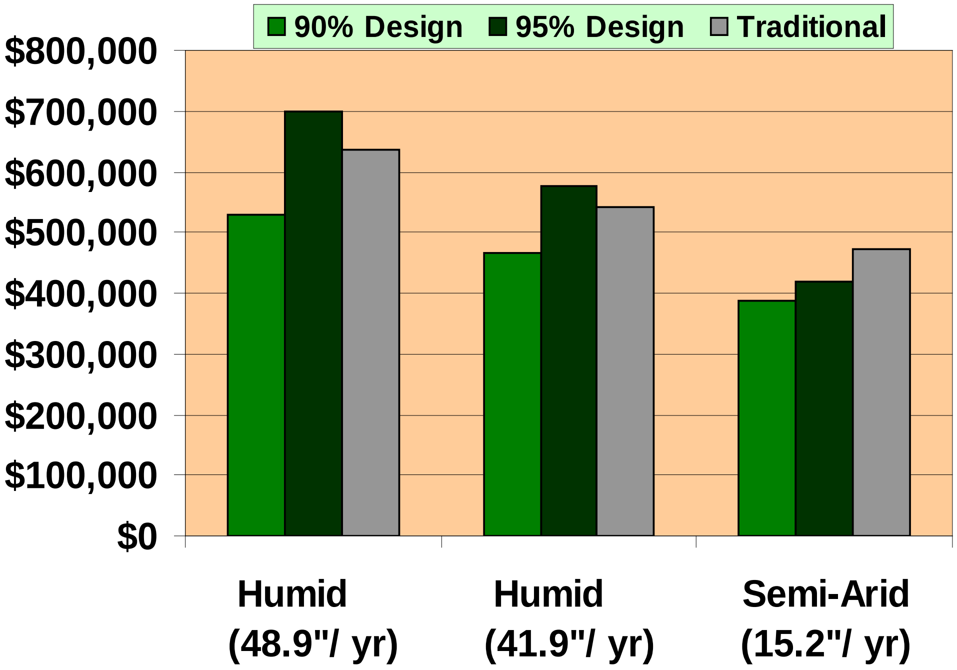
Note: All sites use traditional development patterns and do not represent innovative green designs

Site B: Commercial Development (55% imperviousness)

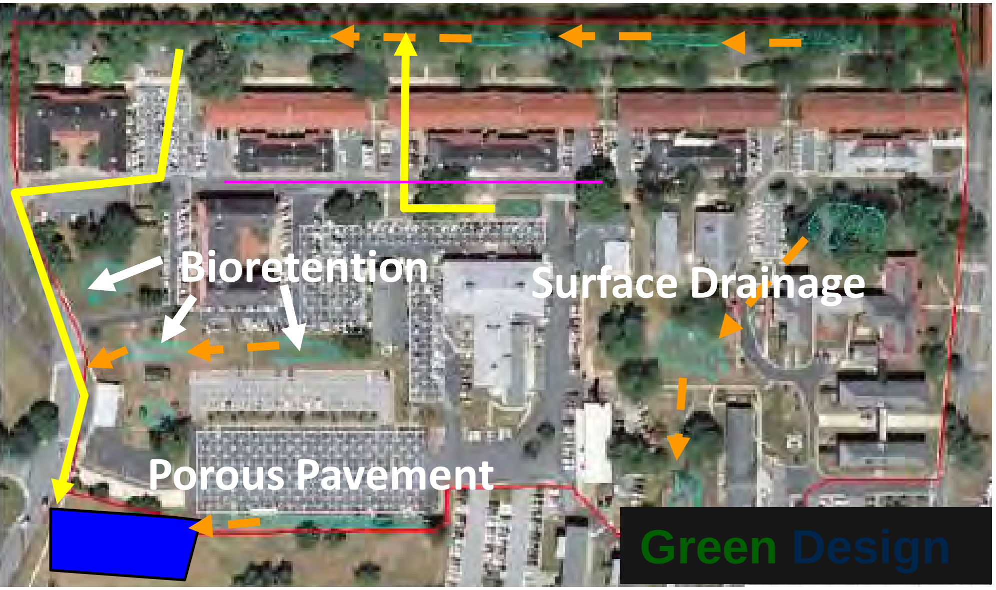


Cost Comparison

(capital costs for entire site)

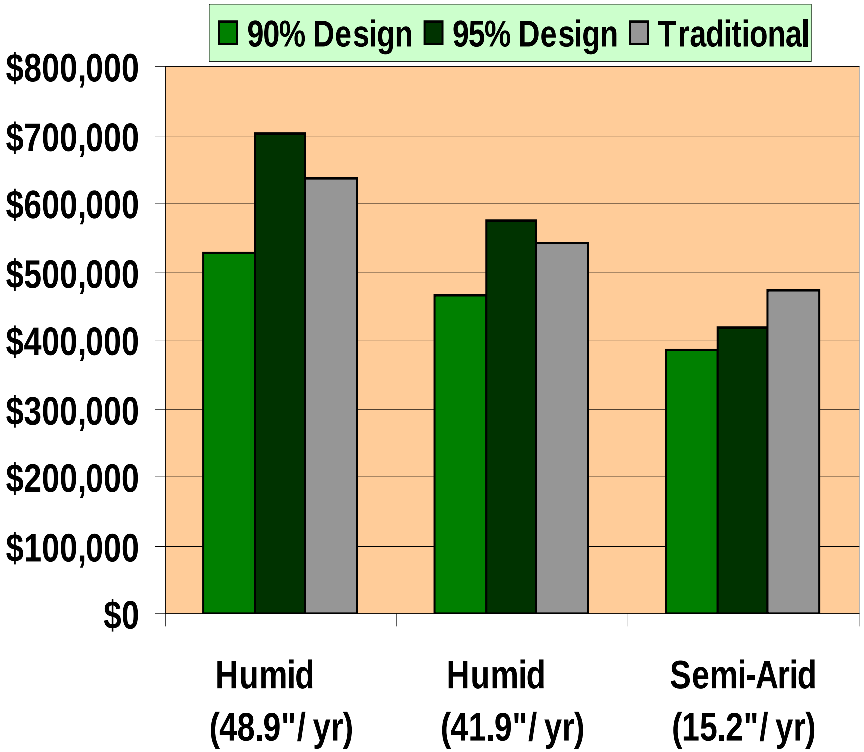


Site C: High Density Residential Development (70% imperviousness)

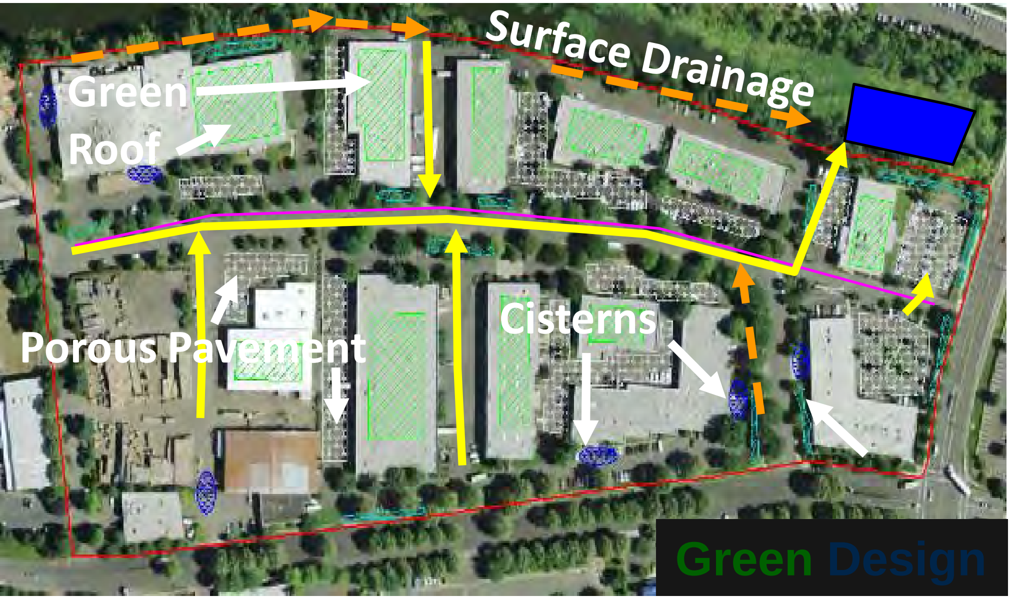


Cost Comparison

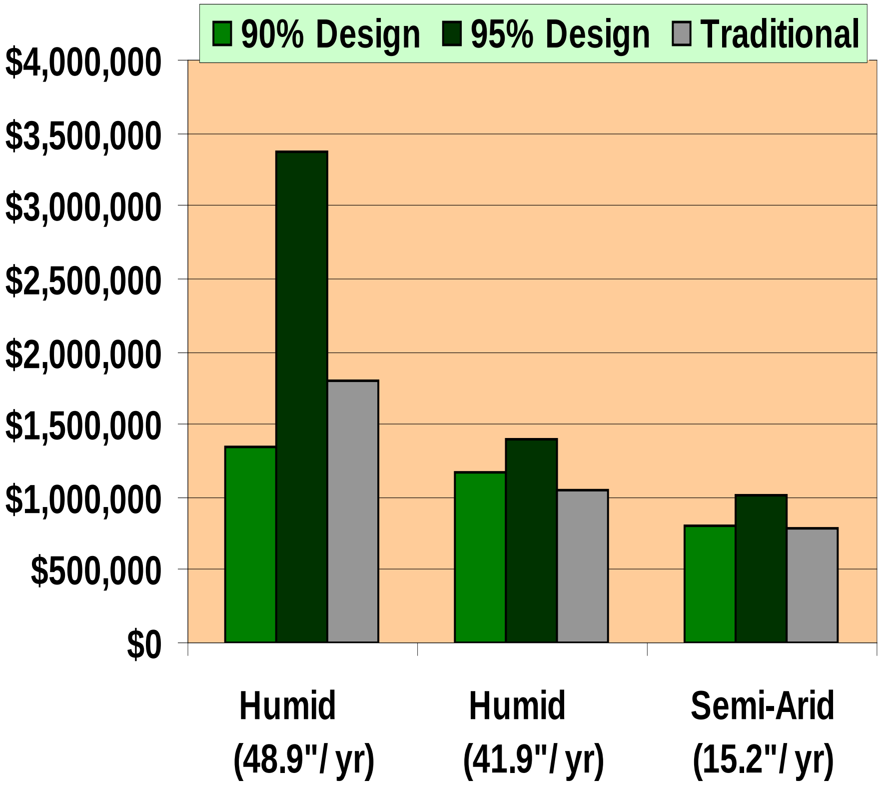
(capital costs for entire site)



Site D: Industrial Development
(95% imperviousness)



Cost Comparison
(capital costs for entire site)



Stormwater Permits with Performance Standards for Stable Hydrologic Condition

West Virginia

In July 2009 West Virginia DEP issued a small MS4 permit with the following:

Performance Standards. The permittee must implement and enforce via ordinance and/or other enforceable mechanism(s) the following requirements for new and redevelopment:
Site design standards for all new and redevelopment that require, in combination or alone, ***management measures that keep and manage on site the first one inch of rainfall*** *from a 24-hour storm preceded by 48 hours of no measurable precipitation. Runoff volume reduction can be achieved by canopy interception, soil amendments, evaporation, rainfall harvesting, engineered infiltration, extended filtration and/or evapotranspiration and any combination of the aforementioned practices. This first one inch of rainfall must be 100% managed with no discharge to surface waters, except when the permittee chooses to implement the conditions in paragraph 4 below.*

Paragraph 4 outlines options for off-site mitigation and payment-in-lieu. Analysis of 60 years of rainfall data in the state indicated that, on average, 90% of the rainfall events in West Virginia are 1 inch or less. Rainfall patterns do not vary significantly across the state.

West Virginia

The 2009 West Virginia small MS4 permit also includes the following very specific incentives for certain types of development and for redevelopment:

When considered at the watershed scale, certain types of development can either reduce existing impervious surfaces, or at least create less 'accessory' impervious. Incentive standards may be applied to these types of projects. A reduction of 0.1 inches from the one inch infiltration/evapotranspiration/reuse standard may be applied to any of the following types of development. Reductions are additive such that a maximum reduction of 0.5 inch is possible for a project that meets all five criteria.

Redevelopment
Brownfield redevelopment
High density (>7 units per acre)
Vertical Density, (Floor to Area Ratio (FAR) of 2 or >18 units per acre)
Mixed use and Transit Oriented Development (within ½ mile of transit)

The fact sheet for the proposed permit provides information on how these 5 types of development and redevelopment configurations link to water quality.

California

The California Los Angeles Regional Water Quality Control Board has included the following standard in the MS4 permit for Ventura County:

New Development and Redevelopment Performance Criteria
1. Integrated Water Quality/ Flow Reduction/ Resources Management Criterion
(a) Permittees shall require that all New Development and Redevelopment projects identified in subpart 5.E.II control pollutants, pollutant loads, and runoff volume emanating from impervious surfaces ***through percolation, infiltration, storage, or evapo-transpiration, by reducing the percentage of Effective Impervious Area to less than 5 percent of total project area***

North Carolina

The North Carolina permit To Construct, Operate and Maintain Impervious Areas and BMPs Associated with Residential Development Disturbing Less Than 1 Acre, includes the following:

Stormwater runoff shall be managed using any one or combination of the following practices:
a. Install rain cisterns or rain barrels designed to collect all rooftop runoff from the first one and one-half inches of rain. Rain barrels and cisterns shall be installed in such a manner as to facilitate the reuse of the collected rain water on site and shall be installed in such a manner that any overflow from these devices is directed to a vegetated area in a diffuse flow. Construct all uncovered driveways, uncovered parking areas, uncovered walkways, and uncovered patios out of permeable pavement or other pervious materials.
b. Direct rooftop runoff from the first one and one-half inches of rain to an appropriately sized and designed rain garden. Construct all uncovered driveways, uncovered parking areas, uncovered walkways, and uncovered patios out of permeable pavement or other pervious materials.
c. Install any other stormwater best management practice that meets the requirements of 15A NCAC 02H .1008 to control and treat the stormwater runoff from all built upon areas of the site from the first one and one-half inches of rain.

New Jersey

The New Jersey Stormwater Management Rules at N.J.A.C. 7:8 require that a "major development" project, which is one that disturbs at least 1 acre of land or creates at least 0.25 acres of new or additional impervious surface, must comply with one of the following two groundwater recharge requirements:

- *Demonstrate through hydrologic and hydraulic analysis that the site and its stormwater management measures* ***maintain 100 percent of the average annual preconstruction groundwater recharge volume for the site****; or*
- *Demonstrate through hydrologic and hydraulic analysis that the* ***increase of stormwater runoff volume from pre-construction to post-construction for the two year storm is infiltrated****.*

The State has a spreadsheet for documenting how the recharge rate requirement is being met. Chapter 6 of the New Jersey Stormwater Best Management Practices Manual discusses the groundwater recharge methodology, the groundwater recharge design storm, and the details of the New Jersey Groundwater Recharge Spreadsheet.

Ohio

The Ohio construction general permit for the Big Darby Creek Watershed near Columbus, where significant growth is projected, includes post-construction infiltration requirements. This permit requires that ***post-development groundwater recharge be equal to or exceed the pre-construction groundwater recharge***. The permit specifies that the SWPPP must describe the conservation development strategies, stormwater control measures and other practices deemed necessary by the permittee to maintain or improve pre-development rates of groundwater recharge. The permit includes a formula and standard values for gauging groundwater recharge rates, and includes provisions to ensure preservation of open space where infiltration will occur. Protection of open space (infiltration areas) is to be achieved by binding conservation easements that identify a third party management agency, such as a homeowners association, condominium association, political jurisdiction or third party land trust. If the post-development recharge volume will be less than the pre-construction recharge volume, mitigation is required.

Anchorage, Alaska

EPA Region 10 has included the following provision in the MS4 permit for Anchorage:

… to control storm water runoff from new development and redevelopment projects that result in a land disturbance of 10,000 square feet or more

… (i) The updated ordinance or regulatory mechanism must include site design standards for all new and redevelopment that require, in combination or alone, management measures <u>that keep and manage onsite the first 0.52 inches of rainfall</u> from a 24 hour event preceded by 48 hours of no measureable precipitation. Runoff volume reduction can be achieved by canopy interception, soil amendments, evapotranspiration, rainfall harvesting, engineered infiltration, extended filtration, and/or any combination of such practices.

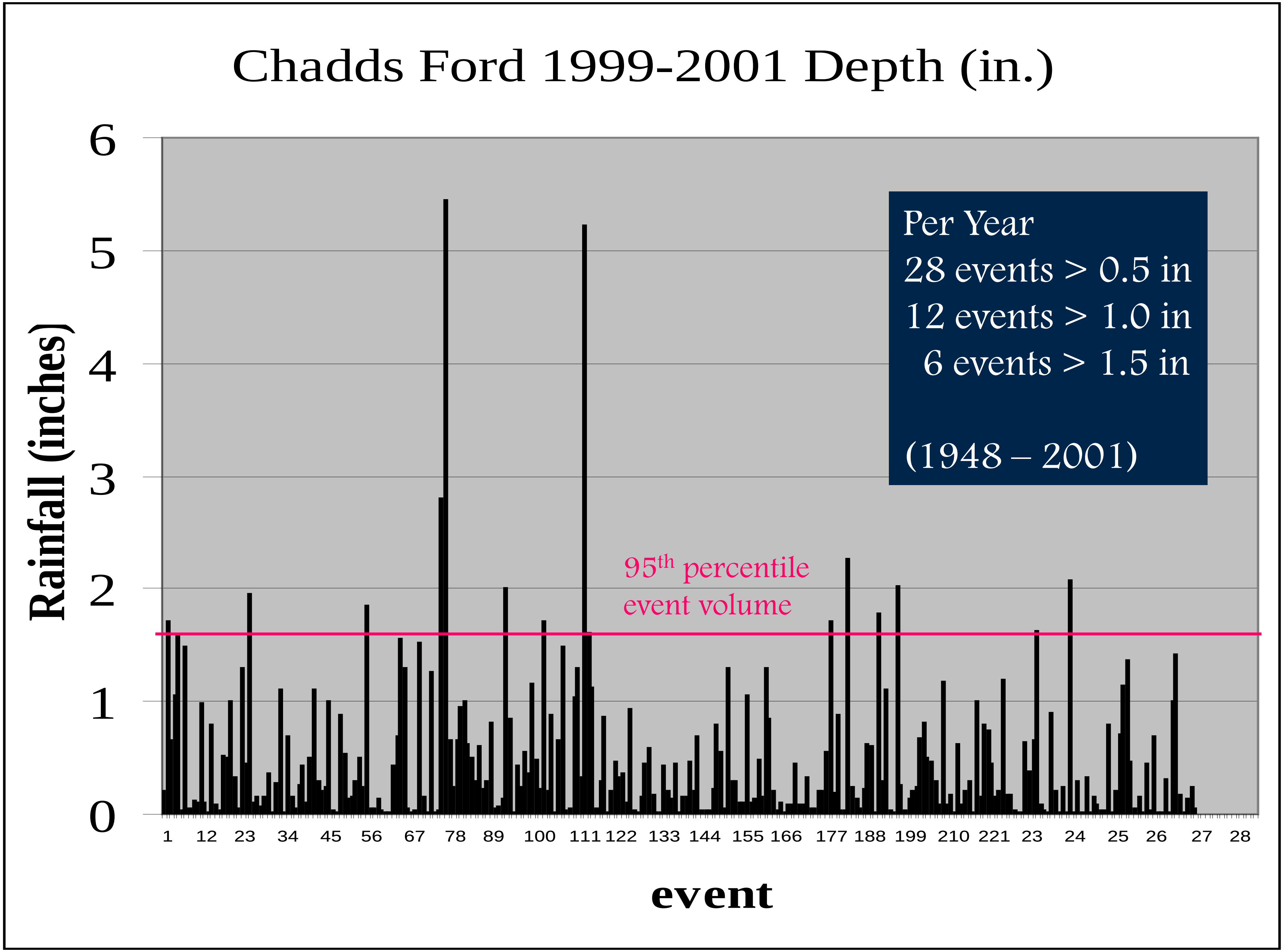
Analysis of 45 years of rainfall data in Anchorage indicated that 90% of all precipitation events are 0.52 inch or less.

Montana

Montana the Montana Department of Environmental Quality issued their small MS4 permit, effective January 1, 2010, with the following provision:

*For new development or redevelopment projects greater than or equal to one acre, the program shall include a process, where such practices are practicable, to require the implementation of low impact development practices that **infiltrate, evapotranspire, or capture for reuse the runoff generated from the first 0.5 inches of rainfall** from a 24-hour storm preceded by 48 hours of no measurable precipitation. This process must be in place by January 1, 2012.*

0.5 inches is the approximate average 90th percentile storm event across the areas of the state with regulated MS4s.


Chadds Ford 1999-2001 Depth (in.)
Rainfall (inches)
6
5
4
3
2
1
0
event
1 12 23 34 45 56 67 78 89 100 111 122 133 144 155 166 177 188 199 210 221 23 24 25 26 27 28
95th percentile
event volume
Per Year
28 events > 0.5 in
12 events > 1.0 in
6 events > 1.5 in
(1948 – 2001)

Establishing Target Condition

Hydrologic Fate	Average Amount	Percent of Total
Precipitation	1770 mm (70 in)	100%
Runoff	80 mm (3 in)	5%
Evapotranspiration	890 mm (35 in)	50%
Infiltration	800 mm (31 in)	45%
Shallow Interflow	770 mm (30 in)	44%
Deep Seepage	30 mm (1 in)	2%

All values rounded to the nearest 10 mm or 1 in.
Infiltration is the sum of Shallow Interflow and Deep Seepage
Based on 50-years of Monitoring Data

First Flush Capture

Mean Mass Capture (%)		
	½ inch	¾ inch
32 Events	16	7
TSS	81	90
TP	86	96
TKN	85	89
NO_2, NO_3	82	94, 89
Pb, Cu, Zn	86	96, 94, 92

Flint & Davis, J. Env. Eng. 2007

Performance Standards

- Regulations and standards need to be specific about what the objectives of the relevant provisions are, and will be most successful when stipulating a specific standard.
- In general performance standards are preferable because they leave less room for 'gaming' the system (e.g., creative interpolation of runoff curves), and also focus on an outcome that can be linked to receiving water integrity.
- Performance standards also provide more flexibility for innovation since often a variety of combinations of technologies and approaches can be used to meet a stipulated performance standard.

Importance of Design

- Design is crucial with respect to whether or not performance standards can be met.
- Not all 'green' is created equal: some practices look green, but do not necessarily function green.
- Maximizing retention is important, so think about design details for each application.
- Simple designs often mean simple construction and maintenance.

CSO Long-term Control Plans with Green Elements to Date

- Cincinnati OH
- Kansas City MO
- Louisville KY
- Sanitation District #1 KY
- Philadelphia PA


National Stormwater
Rulemaking

Rule-Making Process

- October 30, 2009 EPA published an ICR Federal Register Notice
- Docket for comments has been established: EPA–HQ–OW–2009–0817
- Goal is to propose a rule in late 2011, and finalize in late 2012.
- Next 18 months data gathering, economic analyses, etc.
- EPA is/will be soliciting feed-back from all interested parties

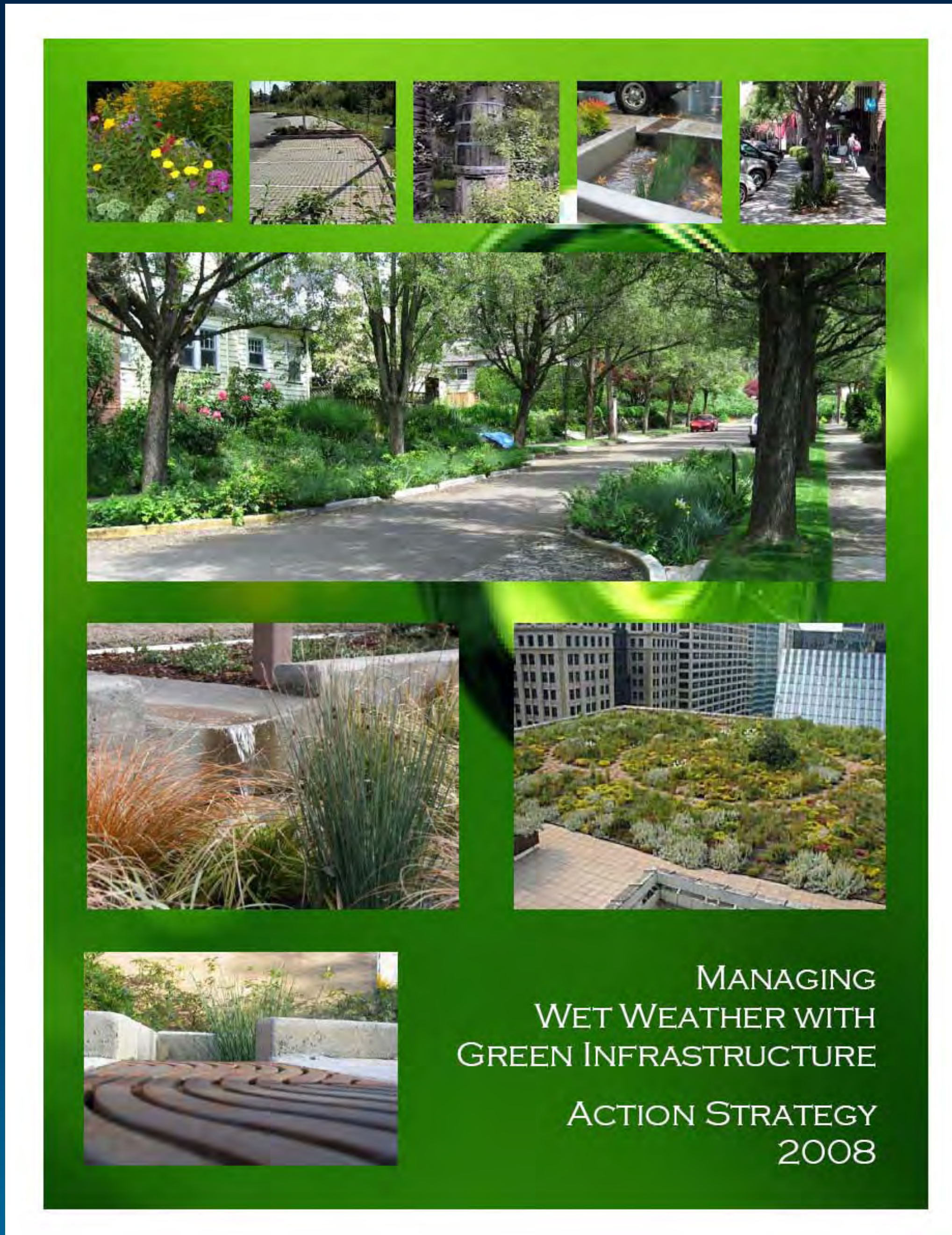
For More Information on Stormwater Rule-making

www.epa.gov/npdes/stormwater/rulemaking.cfm

Major Options

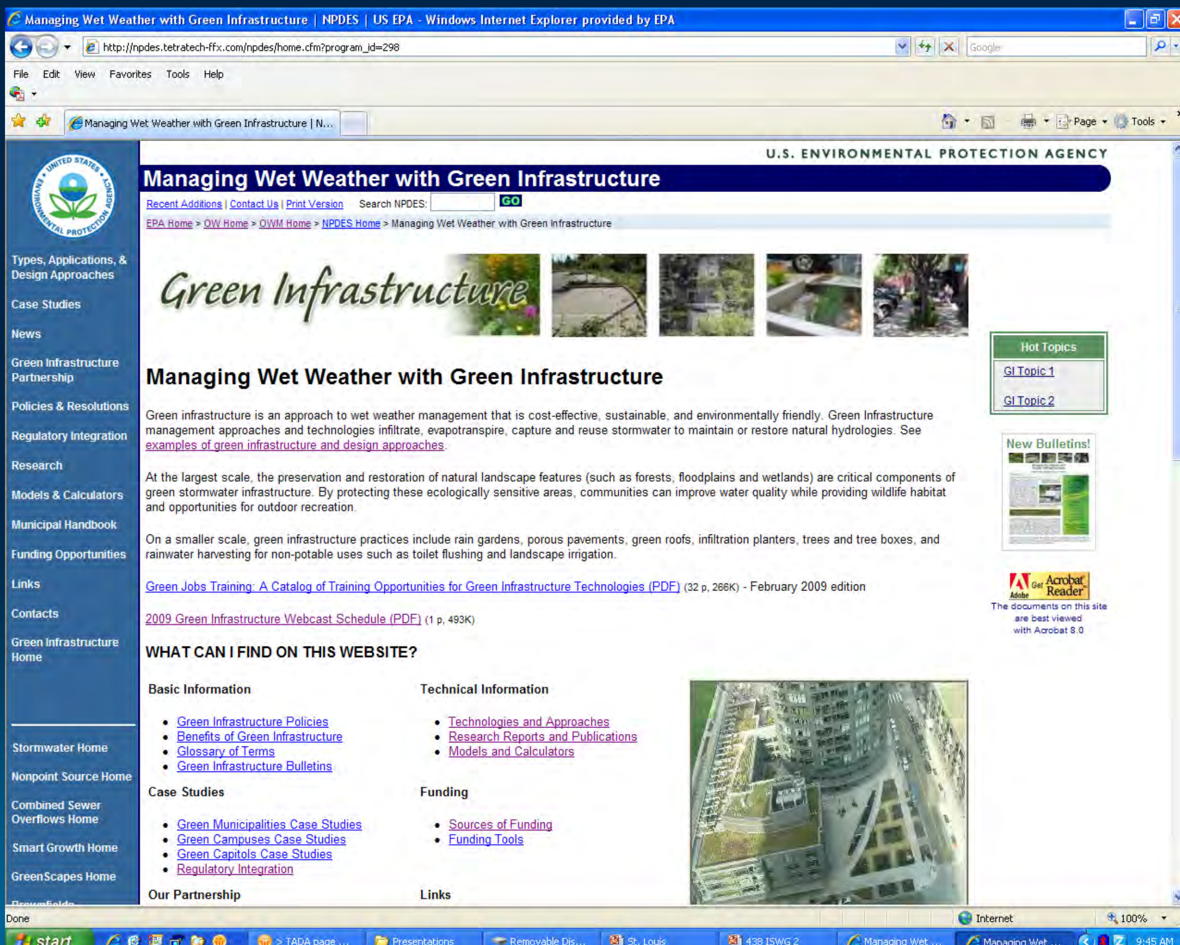
- Performance standards for "post-construction" (new and redevelopment) that aim for stable, natural hydrologic condition
- Expanding the universe of regulated stormwater discharges to areas with rapid development
- Provisions for existing discharges, i.e., planning for retrofits
- Permitting and non-permitting alternatives
- Special provisions for Chesapeake Bay and *maybe* other sensitive waters

Guidance, Tools & Ongoing Activities



Released
January 17, 2008

Green Infrastructure Website
www.epa.gov/greeninfrastructure



- General & Technical Information
- Key Resources
- Case Studies
- Guidance
- Partnership
- Contacts

Green Infrastructure Periodicals

- Relevant activities, events, conferences, publications, partner profiles
- Issued approximately every 2 months
- Distributed electronically and on the website


Managing Wet Weather with
Green Infrastructure
a periodic update on activities

Volume 2007, Issue 2 October 2007

Managing Wet Weather with
Green Infrastructure
a periodic update on activities

Volume 2008, Issue 3 July 2008

Milwaukee's Stormwater Park, a brownfield redevelopment project designed to handle runoff from 100 year storms in the Menomonee River Valley, was recently put to the test. In June the area experienced a 100 year event, and the park performed as it was designed to do. The large bioretention basins, normally full of native wildflowers, filled with stormwater. However, within a few days all of the water had infiltrated into the soils. Stormwater Park, designed to keep water out of the sewer system, features natural areas, open space, playing fields and a trail, and captures rain falling on the valley business park. The park was selected by the Sierra Club in 2006 as one of America's Best New Development Projects.

On June 13, 2008 EPA released a memo, *Clarification on which stormwater infiltration practices/technologies have the potential to be regulated as "Class V" wells by the Underground Injection Control Program*. There has been some confusion surrounding the applicability of the UIC requirements (under the Safe Drinking Water Act) for a variety of infiltration practices, including rain gardens, swales, planters, permeable pavements and other controls. The memo and accompanying guide clarify the intent of the Act, and also indicate which types of practices are generally considered Class V wells and which are not. In general, EPA does not consider typical green infrastructure or low impact development practices to qualify as Class V wells. However, EPA is committed to protection of groundwater and also provides clarification on which practices may qualify as Class V wells. The memo and guide are available at: http://www.epa.gov/npdes/pubs/memo_gi_classvwells.pdf

Contacts

EPA Headquarters
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Robert Goo, OW/OWOW
Gary Hudiburgh, OECA

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Jim Giattina, R4
Joan Karnauskas, R5
Brent Larsen, R6
Pradip Dalal, R7
Elaine Lai, R8
John Tinger, R9
Krista Mendelman, R10

Steering Committee Partners
Nancy Stoner, NRDC
Nathan Gardner-Andrews & Keith Jones, NACWA
Chris Kloss & Neil Weinstein, LID Center
Katherine Baer, American Rivers
Linda Eichmiller, ASIWPCA

For more information on managing wet weather with green infrastructure see the website at: www.epa.gov/npdes/greeninfrastructure. To be added to an e-mail distribution list for future issues of this bulletin, or if you have items of interest to be considered for inclusion in future issues of this bulletin send an e-mail request to molloy.jennifer@epa.gov.

Partnership Statement of Support

- To-date approximately 90 organizations have signed the *Statement of Support for Green Infrastructure*

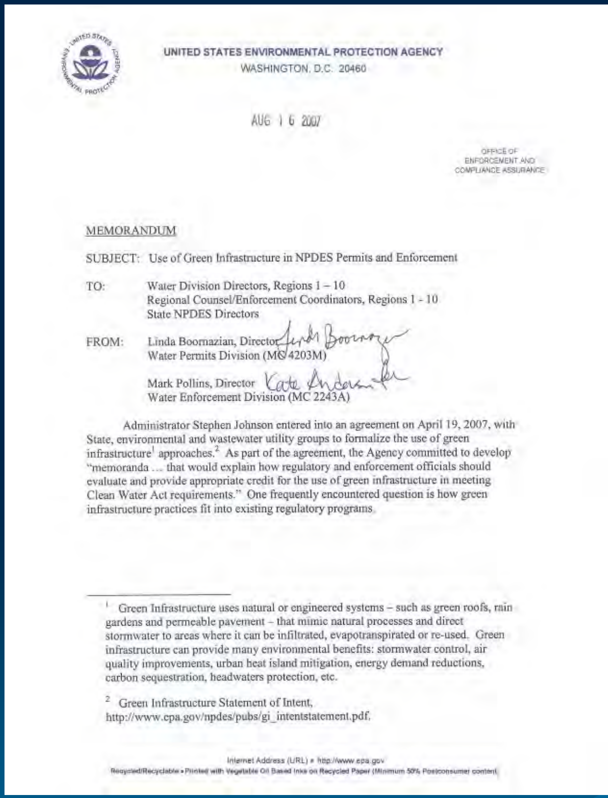
Stakeholder Statement of Support for Green Infrastructure

Purpose
To bring together organizations that recognize the benefits of using green infrastructure in mitigating overflows from combined and separate sewers and reducing stormwater pollution and to encourage the use of green infrastructure by cities and wastewater treatment plants as a prominent component of their Combined and Separate Sewer Overflow (CSO & SSO) and municipal stormwater (MS4) programs.

Goals
Green infrastructure can be both a cost effective and an environmentally preferable approach to reduce stormwater and other excess flows entering combined or separate sewer systems in combination with, or in lieu of, centralized hard infrastructure solutions. The undersigned organizations support:

- Use of green infrastructure by cities and utilities where it is an effective and feasible means of reducing stormwater pollution and sewer overflows;
- Development of models to quantify stormwater detention, retention, and filtration potential of green infrastructure to better identify opportunities to successfully use green infrastructure in CSO, SSO, MS4 and nonpoint source programs;
- Monitoring to verify the amount of CSO, SSO, and stormwater discharge reduction that cities obtain through using green infrastructure;
- Measurement of economic and environmental benefits realized from the use of green infrastructure in sewer systems and quantification of its life-cycle costs;
- Increased federal, state, and local funding for green infrastructure initiatives;
- Elimination of barriers to the incorporation of green infrastructure in stormwater and sewer system programs;
- Development and funding of a plan to identify research needs to further green infrastructure;
- Preparation of guidance documents to assist cities and wastewater treatment plants in developing green infrastructure initiatives in their CSO, SSO, and MS4 programs; and
- Development of model provisions to incorporate green infrastructure into CSO and MS4 permits; SSO capacity, management, operations, and maintenance plans; and consent decrees and other enforcement vehicles.

Use of Green Infrastructure in NPDES Permits and Enforcement



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 1 6 2007

OFFICE OF
ENFORCEMENT AND
COMPLIANCE ASSURANCE

MEMORANDUM

SUBJECT: Use of Green Infrastructure in NPDES Permits and Enforcement

TO: Water Division Directors, Regions 1 – 10
Regional Counsel/Enforcement Coordinators, Regions 1 - 10
State NPDES Directors

FROM: Linda Boornazian, Director
Water Permits Division (MC 4203M)

Mark Pollins, Director
Water Enforcement Division (MC 2243A)

Administrator Stephen Johnson entered into an agreement on April 19, 2007, with State, environmental and wastewater utility groups to formalize the use of green infrastructure[1] approaches.[2] As part of the agreement, the Agency committed to develop "memoranda … that would explain how regulatory and enforcement officials should evaluate and provide appropriate credit for the use of green infrastructure in meeting Clean Water Act requirements." One frequently encountered question is how green infrastructure practices fit into existing regulatory programs.

[1] Green Infrastructure uses natural or engineered systems – such as green roofs, rain gardens and permeable pavement – that mimic natural processes and direct stormwater to areas where it can be infiltrated, evapotranspirated or re-used. Green infrastructure can provide many environmental benefits: stormwater control, air quality improvements, urban heat island mitigation, energy demand reductions, carbon sequestration, headwaters protection, etc.

[2] Green Infrastructure Statement of Intent, http://www.epa.gov/npdes/pubs/gi_intentstatement.pdf.

Internet Address (URL) • http://www.epa.gov
Recycled/Recyclable • Printed with Vegetable Oil Based Inks on Recycled Paper (Minimum 50% Postconsumer content)

- Memo issued August 16, 2007
- Jointly issued by WPD and WED
- Clarifies that green infrastructure controls can be implemented within current regulatory framework

Underground Injection Control Clarification

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUN 13 2008

OFFICE OF WATER

MEMORANDUM

SUBJECT: Clarification on which stormwater infiltration practices/technologies have the potential to be regulated as "Class V" wells by the Underground Injection Control Program

TO: Water Division Directors, Regions 1-10

FROM: Linda Boornazian, Director
Water Permits Division (MC 4203M)

Steve Heare, Director
Drinking Water Protection Division (MC 4606M)

Over the past several years stormwater infiltration has become an increasingly effective tool in the management of stormwater runoff. Although primary stormwater management responsibilities within EPA fall under the Clean Water Act (CWA), the infiltration of stormwater is, in some cases, regulated under the Safe Drinking Water Act (SDWA) with the goal of protecting underground sources of drinking water (USDWs). Surface and ground water protection requires effective integration between the overlapping programs. This memorandum is a step forward in that effort and is meant to provide clarification on stormwater implementation and green infrastructure, in particular under the CWA, which is consistent with the requirements of the SDWA's Underground Injection Control (UIC) Program.

In April 2007, EPA entered into a collaborative partnership with four national groups (the Association of State and Interstate Water Pollution Control Administrators,

	Infiltration Practice/Technology	Description	Is this Practice/Technology Generally Considered a Class V Well?
A	Rain Gardens & Bioretention Areas	Rain gardens and bioretention areas are landscaping features adapted to provide on-site infiltration and treatment of stormwater runoff using soils and vegetation. They are commonly located within small pockets of residential land where surface runoff is directed into shallow, landscaped depressions; or in landscaped areas around buildings; or, in more urbanized settings, to parking lot islands and green street applications.	No.
B	Vegetated Swales	Swales (e.g., grassed channels, dry swales, wet swales, or bioswales) are vegetated, open-channel management practices designed specifically to treat and attenuate stormwater runoff. As stormwater runoff flows along these channels, vegetation slows the water to allow sedimentation, filtering through a subsoil matrix, and/or infiltration into the underlying soils.	No.
C	Pocket Wetlands & Stormwater Wetlands	Pocket/Stormwater wetlands are structural practices similar to wet ponds that incorporate wetland plants into the design. As stormwater runoff flows through the wetland, pollutant removal is achieved through settling and biological uptake. Several design variations of the stormwater wetland exist, each design differing in the relative amounts of shallow and deep water, and dry storage above the wetland.	No.
D	Vegetated Landscaping	Self-Explanatory.	No.
E	Vegetated Buffers	Vegetated buffers are areas of natural or established vegetation maintained to protect the water quality of neighboring areas. Buffer zones slow stormwater runoff, provide an area where runoff can infiltrate the soil, contribute to ground water recharge, and filter sediment. Slowing runoff also helps to prevent soil and stream bank erosion.	No

UIC Class V Well Identification Guide
June 11, 2008
Page 2

- Memo & guide issued June 13, 2008 by WPD & DWPD
- Clarifies which infiltration practices are generally considered class V wells
- Notes procedures for complying with UIC requirements
- Typically most green infrastructure practices are not class V wells

Green Infrastructure Permitting & Enforcement Guide

- For NPDES permit writers and enforcement staff.
- Information on how to include and/or review green infrastructure components in permits and enforcement documents for stormwater, SSOs, CSOs.
- Is in final draft, and will be released soon.

Stormwater Management Model (SWMM)

- Extended SWMM to allow it to handle more green infrastructure options in a more efficient manner, including to overcome the problem of scaling up controls applied at the individual lot level to larger land area units.
- Version 5.0.015 released April 2009

National Green Values Calculator

- Estimates the amount of green infrastructure needed to achieve a runoff reduction goal.
- Provides ‘green’ vs ‘conventional’ costs.
- Runoff volume can be user-specified depth or predevelopment conditions.
- Includes a wide variety of controls, such as disconnected downspouts, amended soils, cisterns, reduced street widths, and elimination of curb & gutter.

Green LTCP-EZ

- Calculator tool for small communities to use in developing CSO long-term control plans, released on 2007.
- A ‘green’ component has been added to the tool to help estimate the capacity for using green infrastructure in CSO abatement.
- Tool is currently undergoing beta-testing in several small communities.

Life Cycle Cost Tool

- Expanded WERF's 2005 spreadsheet cost tool to create a standardized format for collecting and reporting capital and O&M cost information for green infrastructure projects.
- Released 2009.

Webcasts/Podcasts


2009 Webcasts

Managing Wet Weather with Green Infrastructure

Tuesday, March 3, 2009

The Many Benefits of Green Infrastructure .... Steve Wise, Center for Neighborhood Technology

Municipal Case Study: Philadelphia .... Marc Cammarato, Philadelphia

Tuesday, March 24, 2009

Revising Local Plans, Codes & Ordinances .... Abby Hall, U.S. EPA

Water Harvesting .... Chris Kloss, Low Impact Development Center
Bill Davis, Progressive Design and Planning

Tuesday, April 28, 2009

Models & Calculators .... Brian Busiek, LimnoTech

Municipal Case Study: Louisville .... John Lyons, Strand Associates

Tuesday, May 12, 2009

Site Planning & Design Considerations .... Dan Christian, Tetra Tech

Costs and WERF Cost Tool .... Lisa Hair, U.S. EPA, Dr. Christine Pomeroy
and Dasch Houdeshel, University of Utah

Tuesday, June 23, 2009

Funding & Incentives .... Abby Hall, U.S. EPA

Brownfield Redevelopment .... Stacy Swartwood, U.S. EPA

Tuesday, July 28, 2009

Retrofits: Green Streets .... Chris Kloss, Low Impact Development Center

Operation & Maintenance .... Tracy Tackett, Seattle Public Utilities

All webcasts are two hour audio web broadcasts held from 1:00 pm—3:00 pm Eastern time. Your computer must have the capability of playing sound in order to attend these webcasts.

Registration for these webcasts will open approximately two weeks before each scheduled event. Please visit www.epa.gov/npdes/training to register.

www.epa.gov/greeninfrastructure

- 6 two hour modules
- 12 topics
- Are available for web-based replay and podcast downloads.

Water Quality Scorecard

- Communities can evaluate local policies
- Can set goals or objectives for making modifications to local plans, codes or ordinances
- Provides information and suggestions on how plans, codes or ordinances may be improved

October 2009

Green Streets Guide

- Describes green approaches for:
  - Residential Streets
  - Commercial Streets
  - Arterial Streets
  - Alleys
- Includes concept designs
- Discusses functions and applications


EPA

GREEN RESERVE

The American Recovery and Reinvestment Act (ARRA), Green Reserve of 2009, through the State Revolving Fund, provides funding for a wide variety of qualifying projects in the categories of: *green infrastructure, energy efficiency, water efficiency, and other innovative projects.* For more information on ARRA, to find out if your current or future planned project meets the necessary criteria, and how to apply, visit www.Recovery.gov.

A CONCEPTUAL GUIDE TO EFFECTIVE GREEN STREETS DESIGN SOLUTIONS

Green Streets

Residential Streets
Commercial Streets
Arterial Streets
Alleys

Green Street designs provide better environmental performance while creating attractive, safer environments.

A Green Street is a street that uses natural processes to manage stormwater runoff at its source.

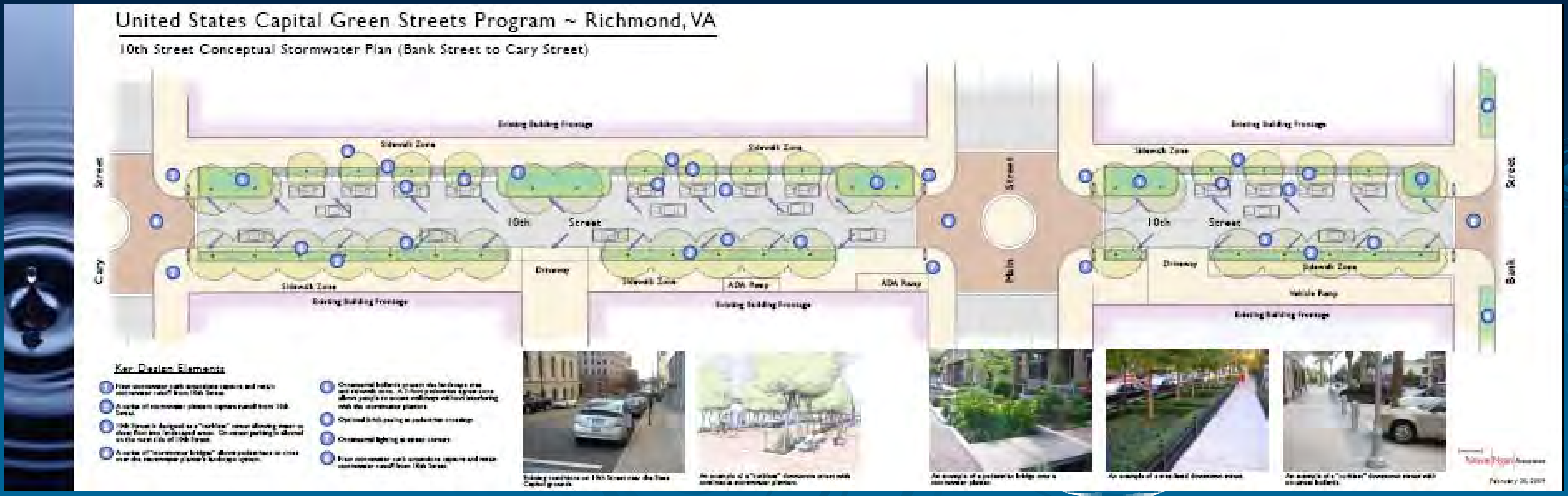
Streets comprise a significant percentage of publicly owned land in most communities, and thus offer a unique opportunity to manage for environmental outcomes. A Green Street uses a natural systems approach to reduce stormwater flow, improve water quality, reduce urban heating, enhance pedestrian safety, reduce carbon footprints, and beautify neighborhoods.

Through various combinations of plants and soils, these objectives—and several others—can be met on different types of streets in many settings. Green Street features include vegetated curb extensions, sidewalk planters, landscaped medians, vegetated swales, permeable paving, and street trees. This guide provides an overview of different strategies that can be employed in transportation rights-of-way at the local or neighborhood scale.

Green Streets | 1

Green Capitals

- Green right-of-way retrofits at/near state capitol buildings for high profile, visible, demonstration projects
- Offering design and mentoring services
- To date: Vermont and Virginia



Municipal Handbook

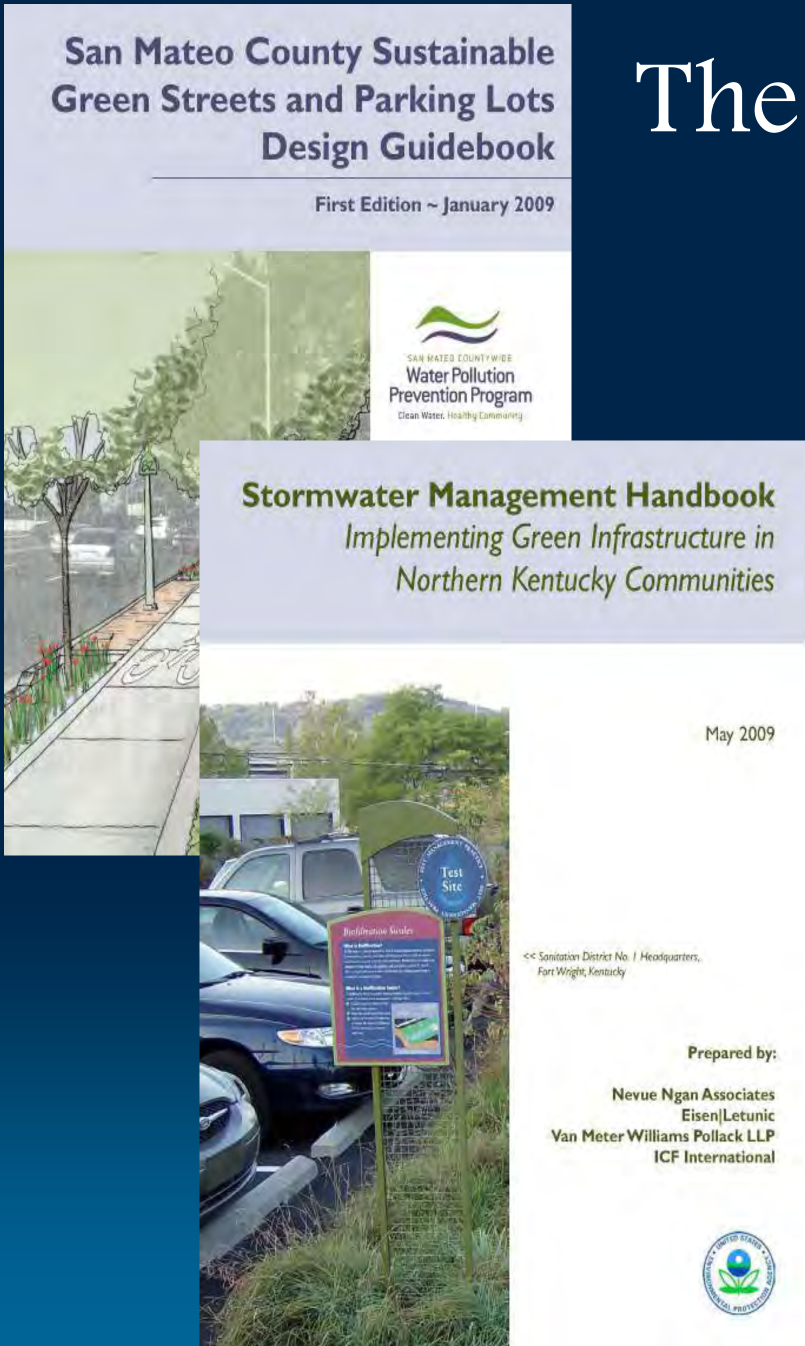
The Municipal Handbook is a series of guidance documents to help local officials implement green infrastructure in their communities. Modules will be released as completed, including:

- Rainwater Harvesting Policies
- Green Streets
- Funding Options
- Retrofit Policies
- Municipal Incentives

Green Jobs Training Catalog

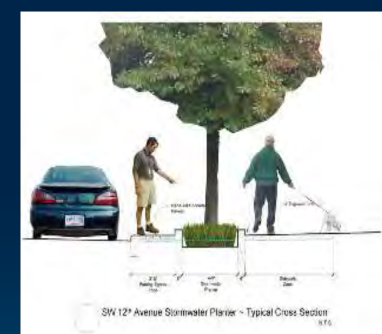
- A catalog of existing training and certification programs for design; construction & implementation; operation & maintenance of green infrastructure

The Design Guidebooks ~ A Balance of…



Inspiration that allows designers, developers, and city staff to learn about a variety of green street and parking lot projects already built.

Education that gives the user an understanding of both the general and technical issues associated with design, construction, as well as the long-term care of sustainable stormwater projects.



Innovation that provides the "toolbox" of design strategies and concepts for various conditions within San Mateo County.

Clean Water State Revolving Fund

- Fact sheet released explaining the use of CWSRF for green infrastructure projects

Clean Water State Revolving Fund

FACT SHEET

Green Infrastructure Approaches to Managing Wet Weather with Clean Water State Revolving Funds

This fact sheet identifies several ways in which states, communities, and individuals can use the Clean Water State Revolving Fund (CWSRF) to finance green infrastructure projects. A general overview of green infrastructure and the CWSRF program are provided, as well as case studies highlighting specific projects from across the country.

What is green infrastructure?

"Green infrastructure" is a relatively new and flexible term that has been used in a variety of contexts. For the purposes of this factsheet, the term "green infrastructure" refers to systems and practices that use or mimic natural processes to infiltrate, evapotranspire (the return of water to the atmosphere either through evaporation or transpiration), or reuse stormwater. Examples of green infrastructure approaches currently in use include green roofs, trees and tree boxes, rain gardens, vegetated swales, pocket wetlands, infiltration planters, permeable pavements, riparian buffers, and floodplains. Green infrastructure also includes decentralized harvesting approaches, such as the use of cisterns to capture water for flushing toilets or subsequent outdoor irrigation. These approaches reduce the amount of runoff discharging to surface waters and keep rainwater out of our sewer systems so it does not contribute to sewer overflows.

What are additional benefits of green infrastructure?

In addition to reducing the overall volume of stormwater runoff and the frequency of sewer overflows, green infrastructure can help communities enjoy a number of additional environmental and economic benefits, including:

- Cleaner Water
- Enhanced Water Supplies
- Cleaner Air
- Reduced Urban Temperatures
- Climate Change Benefits
- Increased Energy Efficiency
- Source Water Protection
- Community Benefits
- Cost Savings

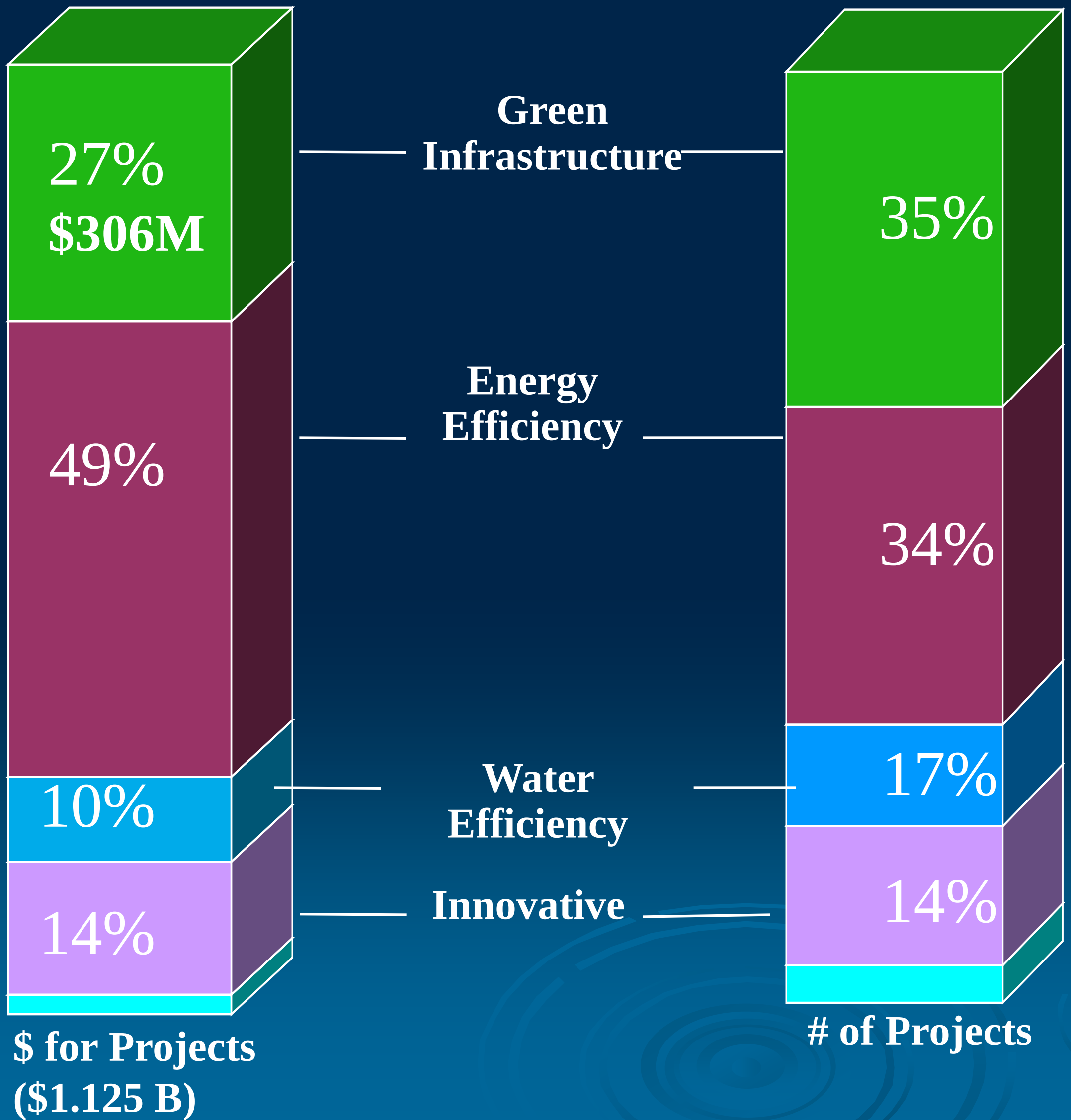
Vegetated swales capture and infiltrate runoff along this "green street" in Portland, Oregon.

These benefits make green stormwater development an attractive option for towns and cities looking to upgrade their infrastructure systems. Nevertheless, many local governments lack the financial resources needed to implement green infrastructure projects in their communities. This is where the CWSRF can help.

Read more about the benefits of green infrastructure at: www.epa.gov.npdes/greeninfrastructure

ARRA GPR Projects

As of 3/08/10



- Efforts now underway to augment state eligibility, change priority systems, outreach, partnerships
- 2010 GPR Guidance under development