The Costs and Benefits of Green Infrastructure and Retention Practices

Presentation Outline

- Benefits of green infrastructure
- Case studies
- EPA post-construction cost analysis

Benefits by type of practice

Green Roofs

- Have a longer lifespan than traditional roofs
- Reduce energy costs
- Buildings with green roofs can command rental premiums
- Vegetation provides habitat for urban wildlife

Trees

- Reduce urban heat island
- Provide shade in summer and block wind in winter
- Reduce greenhouse gases by absorbing CO_2
- Capture urban air pollutants (dust, O_3, CO)

Rain Barrels and Cisterns

- Reduce water consumption and associated costs
- Reduce demand for potable water
- Increase available water supply for other uses

Bioswales and Rain Gardens

- Improve property and neighborhood aesthetics
- Reduce localized flooding
- Promote infiltration and groundwater recharge
- Enhance pedestrian safety when used in traffic calming applications

Permeable Pavements

- Reduce stormwater runoff
- Reduce standing water
- Promote infiltration and groundwater recharge
- May have lower maintenance than traditional pavements

Green Space

- Reduces stormwater runoff volume
- Reduces peak stormwater flows
- Helps reduce the risk of flooding

Potential Benefits of Green Infrastructure (By Practice; CNT, 2010)

Benefit	Reduces Stormwater Runoff											Improves Community Livability						
Practice	Reduces Water Treatment Needs	Improves Water Quality	Reduces Grey Infrastructure Needs	Reduces Flooding	Increases Available Water Supply	Increases Groundwater Recharge	Reduces Salt Use	Reduces Energy Use	Improves Air Quality	Reduces Atmospheric CO_2	Reduces Urban Heat Island	Improves Aesthetics	Increases Recreational Opportunity	Reduces Noise Pollution	Improves Community Cohesion	Urban Agriculture	Improves Habitat	Cultivates Public Education Opportunities
Green Roofs	●	●	●	●	○	○	○	●	●	●	●	●	◒	●	◒	◒	●	●
Tree Planting	●	●	●	●	○	◒	○	●	●	●	●	●	●	●	●	◒	●	●
Bioretention & Infiltration	●	●	●	●	◒	◒	○	◒	●	●	●	●	●	◒	◒	◒	●	●
Permeable Pavement	●	●	●	●	○	◒	●	◒	●	●	●	○	○	●	○	○	○	●
Water Harvesting	●	●	●	●	●	◒	○	◒	◒	◒	○	◒	○	○	○	◒	○	●

● Yes ◒ Maybe ○ No

Green infrastructure has many benefits

Green infrastructure…

- Can be **cost-effective** (can be lower cost than grey infrastructure; volume reduction can reduce CSO costs)
- **Increases energy efficiency and reduces energy costs** (green roofs, street trees increase energy efficiency; retention increases aquifer storage and reduces cost of transporting water)
- Can **reduce the economic impacts associated with flood events**
- **Protects public health and reduces illness-related costs** (reduced CSO events decrease incidents of waterborne illness and shellfish closures; increased trees and plants improve air quality)

- Source: Banking on Green, 2012

Social and economic benefits of green infrastructure

- Increased enjoyment of surroundings
  - Increased use of green space (Hastie 2003; Kuo 2003).
- Increased safety and reduced crime
  - 7 to 8 percent of the variance in crimes (Kuo 2001)
  - Reduce road rage, increase safety, decrease vehicle speeds (Wolf 1998; Kuo 2001).
- Increased sense of well-being
  - Enhances people's sense of well-being. (Northeastern Illinois Planning Commission 2004) and reduces mental fatigue (Wolf 1998).
- Increased property values
  - 0.7 to 30% increase in property values

Green Infrastructure Can Save Money

- Retaining stormwater with green infrastructure practices can reduce or eliminate the need for other water infrastructure that is currently required (e.g., pipes, detention ponds)
  - For example, developments in Maryland that can match natural conditions for the one-year storm using green infrastructure do not have to provide any additional stormwater management. This compliance option eliminates the need for the pipes and detention ponds otherwise required.
- Minimizing impervious surfaces and preserving existing green space reduce construction costs and decrease the total amount of stormwater discharges

How Green Infrastructure Can Save Money – Boulder Hills, NH (UNH Stormwater Center)

- 24-unit active adult condominium community built in 2009
- Makes use of porous asphalt for road, driveways, and sidewalks
- The use of green infrastructure practices resulted in project costs 6% lower than conventional approaches

Boulder Hills, NH (UNH Stormwater Center)

ITEM	CONVENTIONAL	LOW IMPACT	DIFFERENCE
Site Preparation	$23,200.00	$18,000.00	–$5,200.00
Temp. Erosion Control	$5,800.00	$3,800.00	–$2,000.00
Drainage	$92,400.00	$20,100.00	–$72,300.00
Roadway	$82,000.00	$128,000.00	$46,000.00
Driveways	$19,700.00	$30,100.00	$10,400.00
Curbing	$6,500.00	$0.00	–$6,500.00
Perm. Erosion Control	$70,000.00	$50,600.00	–$19,400.00
Additional Items	$489,700.00	$489,700.00	$0.00
Buildings	$3,600,000.00	$3,600,000.00	$0.00
PROJECT TOTAL	**$4,389,300.00**	**$4,340,300.00**	**–$49,000.00**

How Green Infrastructure Can Save Money – Greenland Meadows, NH(UNH Stormwater Center)

- Three, 1-story retail units on 56 acres (25 acres of impervious surface) built in 2008
- 4.5 acres of porous asphalt and gravel wetland used for stormwater management
- The use of green infrastructure practices were estimated to save 9% in overall project development costs

Greenland Meadows, NH (UNH Stormwater Center)

TABLE 1: Comparison of Unit Costs for Materials for Greenland Meadows Commercial Development

ITEM	CONVENTIONAL OPTION	LID OPTION	COST DIFFERENCE
Mobilization / Demolition	$555,500	$555,500	$0
Site Preparation	$167,000	$167,000	$0
Sediment / Erosion Control	$378,000	$378,000	$0
Earthwork	$2,174,500	$2,103,500	–$71,000
Paving	$1,843,500	$2,727,500	$884,000
Stormwater Management	$2,751,800	$1,008,800	–$1,743,000
Addtl Work-Related Activity (Utilities, Lighting, Water & Sanitary Sewer Service, Fencing, Landscaping, etc.)	$2,720,000	$2,720,000	$0
Project Total	**$10,590,300**	**$9,660,300**	**–$930,000**

*Costs are engineering estimates and do not represent actual contractor bids.

TABLE 2: Conventional Option Piping

	TYPE	QUANTITY	COST
Distribution	6 to 30-inch piping	9,680 linear feet	$298,340
Detention	36 and 48-inch piping	20,800 linear feet	$1,357,800

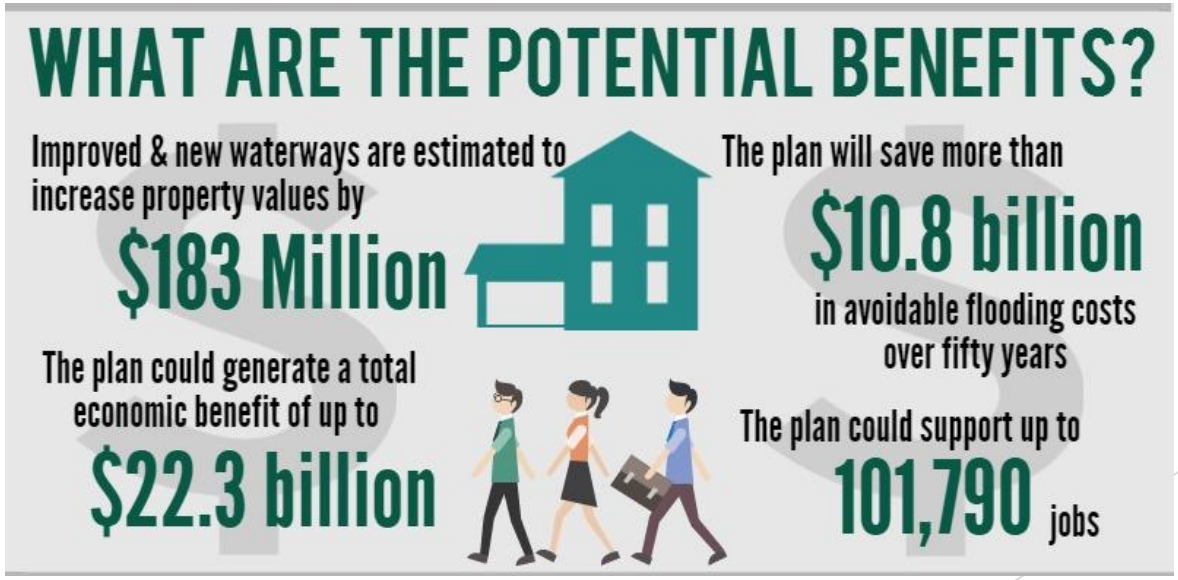
TABLE 3: LID Option Piping

	TYPE	QUANTITY	COST
Distribution	4 to 36-inch piping	19,970 linear feet	$457,780
Detention*	—	0	$0

*Costs associated with detention in the LID option were accounted for under "earthwork" in Table 1.

U of MD Environmental Finance Center – Green Infrastructure Financing Map (http://efc.umd.edu/GIMap.html)

- Infographics used to share financing stories from 20 communities across the country.
- For example, New Orleans developed a stormwater management plan that includes green infrastructure:



Many examples of green infrastructure

- ASLA case studies (www.asla.org/stormwater)
- 479 case studies identified
- Half of the case studies were retrofits of existing properties, 31% were new developments and 19% were redevelopment projects
- 44% of case studies found a decrease in costs by using green infrastructure; 31% found green infrastructure did not influence costs while 25% found increased costs

Gap Creek Subdivision, Sherwood, AR

- Redesigned from conventional to LID layout
- Increased open space from 1.5 acres to 23.5 acres
- Street widths reduced from 36 to 27 ft
- Additional 17 lots added
- Lots sold for $3,000 more and cost $4,800 less to develop than comparable conventional lots
- For the entire development, the combination of cost savings and lot premiums resulted in an additional profit to the developer of $2.2 million

EPA, 2007, Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices

Large cost savings by using green infrastructure for volume control

- GI approaches in Chicago have diverted over 70 million gallons of stormwater per year from the CSO system
- New York City is implementing a plan that will use GI approaches to reduce discharges to their CSO, saving $1.5 billion over 20 years.
- Sanitation District No. 1 in Northern Kentucky uses GI to annually reduce 12.2 million gallons to the CSO and save $800 million.

Banking on Green, 2012

EPA Post-Construction Cost Analysis

- EPA conducted a study to estimate post-construction stormwater BMP costs for a variety of project types
- All costs are in 2012 dollars, and presented as costs/acre
- All data is specific to New Mexico

Retention Requirement

- EPA assumed a retention standard of 90th percentile rainfall event for new development, and 85th percentile for redevelopment
- Retention standard is applied statewide (inside and outside of MS4s)
- EPA also assessed impact of reducing impervious surfaces which includes:
  - Modest reductions to street widths and parking stall sizes
  - EPA did not change parking ratios, address shared parking or other changes that can more significantly reduce impervious surfaces

Commercial project type

- EPA projected 4,750 commercial projects in NM from 2020-2040 (most are redevelopment in MS4 areas)
- Median project size 4 acres (18 acres average)
- Average 43% impervious surface
- Most common BMPs are soil amendments and soil/vegetation conservation (100%) followed by downspout disconnection (86%), bioretention (45%), dry wells (54%), permeable pavement (23%) and infiltration trench (21%)

Single Family Residential project type

- EPA projected 3,700 SFR projects in NM from 2020-2040 (most are new developments in MS4 areas)
- Median project size 6 acres (14 acres average)
- Average 19% impervious surface
- Most common BMPs are soil amendments (100%), downspout disconnection (98%), rain gardens (80%), and bioretention (11%).

Retaining stormwater can save money on new commercial developments

	Current Regs	New Retention Standard	
	Current Cost	With imp. surface reduction	Without imp. surface reduction
New Development in MS4	$9,500/ac	- $2,700/ac	- $1,900/ac
Redevelopment in MS4	$15,000/ac	+ $200/ac	+ $1,300/ac

- Most cost savings are from impervious surface reduction and O&M savings.

Retaining stormwater saves money for single family home developments

	Current Regs	New Retention Standard	
	Current Cost	With imp. surface reduction	Without imp. surface reduction
New Development in MS4	$8,900/ac	- $5,500/ac	- $4,700/ac
Redevelopment in MS4	$15,000/ac	- $9,000/ac	- $8,000/ac

- Most cost savings are from capital cost savings and O&M savings.

Q and A

- Amenity and comfort ratings are _____% higher for a tree-lined sidewalk compared to a non-shaded street.
  - 20%
  - 60%
  - 80%

- Amenity and comfort ratings are _____% higher for a tree-lined sidewalk compared to a non-shaded street.
  - 20%
  - 60%
  - 80%

- Desk workers who can see nature from their desks experience approx ____% less time off sick.
  - 10%
  - 25%
  - 45%

- Desk workers who can see nature from their desks experience approx ____% less time off sick.
  - 10%
  - 25%
  - 45%

- Study of green space amenity values related to customers' price valuation, participants priced goods _____% higher in landscaped districts.
  - 3%
  - 9%
  - 12%

- Study of green space amenity values related to customers' price valuation, participants priced goods _____% higher in landscaped districts.
  - 3%
  - 9%
  - 12%

- Survey of one community, _____% of the public preferred to patronize commercial establishments whose structures and parking lots have trees and landscaping.
  - 50%
  - 75%
  - 100%

- Survey of one community, _____% of the public preferred to patronize commercial establishments whose structures and parking lots have trees and landscaping.
  - 50%
  - 75%
  - 100%

- People make more walking trips when they are aware of natural features, and judge distances to be greater than they actually are in less green neighborhoods.
  - True
  - False

- People make more walking trips when they are aware of natural features, and judge distances to be greater than they actually are in less green neighborhoods.
  - True
  - False

Questions and Discussion