STORMWATER SOLUTIONS
Building Blue Communities
Through Wise Water Management

12 Lessons on Applying Stormwater Management to Transportation Projects

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Environmental, Cultural & Engineering Services

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Overview | *The 12 Lessons*

1. Basic Background
2. Pollution found on Transportation Projects
3. Obstacles Facing Linear Projects
4. Advantages Facing Linear Projects
5. Post Construction Stormwater Management vs. Erosion & Sediment Pollution Control for Roadways
6. Old Best Management Practice (BMP's) – "The Old Way"
7. Low Impact Design
8. Stormwater Management options for Linear Projects
9. The Permit Process
10. Cost and Maintenance
11. The importance of Education & Community Involvement
12. The Future

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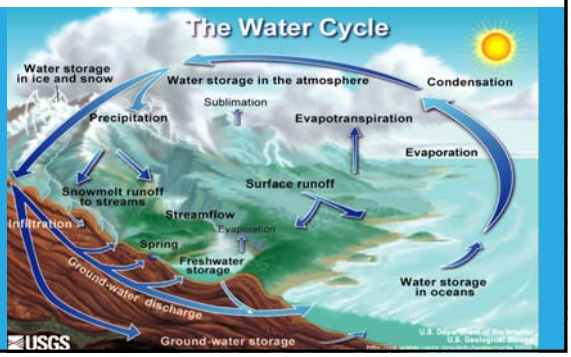
Lesson 1 | *Basic Background*



Lesson 1 | *Basic Background*

What Percentage of American's still believe that industry is to blame for pollution in our waterways?

a. 20%

b. 30%

c. 60%

d. 100%

Lesson 2 | *Basic Background*

Industry is not completely innocent

Industrial pollution dumped into North American lakes, rivers, and streams rose by 26% from 1995 – 1999, overshadowing an almost equal reduction in toxic air emissions.

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Lesson 1 | *Basic Background*

Pollution includes not just toxic chemicals but other stressors as well

a. Flow Modification

b. Excessive Siltation

c. Nutrient enrichment

d. Volume Changes

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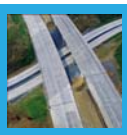
Lesson 1 | *Basic Background*

Where is all the pollution coming from?

Non-point source pollution is the leading cause of water pollution in America today and it is expected to increase.



Lesson 1 | *Basic Background*

What are the two most common non-point Source Pollutants?

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Lesson 1 | *Basic Background*

Sediment and Nutrients

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Lesson 1 | *Basic Background*

One Significant Source of Sediment is Construction Site Runoff

This is due to lack of or improper application of erosion and sediment control practices .

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Lesson 1 | *Basic Background*

What's being done about all this pollution to our waterways?

Municipal, State and Federal Stormwater regulations are addressing non-point source pollutant problems though implementation of Best Management Practices.

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Lesson 2 | *Pollution Found on Transportation Projects*

1. *Nutrients*
2. *Sediments*
3. *Oil and grease hydrocarbons*
4. *Organics*
5. *Insecticides*
6. *Byproducts of petroleum processing*
7. *Metals*

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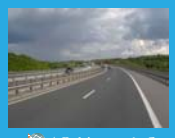
Lesson 2| *Pollutants found on Transportation projects*

CHANGE IN WATERSHED CONDITION	WATERSHED RESPONSE
Increased Imperviousness	• Increased storm flow volume and peak flow • Increased fine sediment and Urban Water Pollutant Loads • Reduced groundwater recharge
Increased drainage density due to roads networks.	• Increased storm flow volume and peak flow • Increased fine sediment and urban water pollutant loads • Increased fish passage barriers
Increased fine sediment deposition	• Reduced inter-gravel dissolved oxygen levels • Loss of fish spawning and macro invertebrate habitat
Loss or Fragmentation of riparian areas	• Reduced delivery of large woody debris • Reduced bank stability • Reduced shading and Temperature Control
Increased pollutant and concentration and loads	• Synthetic organic compounds and trace elements found in fish • Tumors found on fish • Spawning and migration behavior changes • Excessive aquatic plant and algae growth.

Lesson 3 | *Obstacles facing Linear Projects*

- *Right-of-Way*
- *Maintenance*
- *Public Acceptance*
- *Proprietary Items*
- *Soils*



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Lesson 4 | *Advantages of Linear Projects*

- *Comprehensive Design Team*
  - *Roadway Engineers*
  - *Bridge Engineers*
  - *Landscape Architects*
  - *Environmental Scientists*
  - *Water Resource Engineers*
  - *Traffic Engineers*

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Lesson 5 | *Post Construction Stormwater Management vs. Erosion & Sediment Pollution Control for Roadways*

PCSWM vs ESC

Both are required when submitting an NPDES permit.

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Lesson 5 | *Post Construction Stormwater Management vs. Erosion & Sediment Pollution Control for Roadways*

Erosion & Sediment Pollution Control

Controls the pollution during construction.

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Lesson 5| *Post Construction Stormwater Management vs. Erosion & Sediment Pollution Control for Roadways*

Pollutants During Construction

a. Sediment

b. Oils

c. Gas

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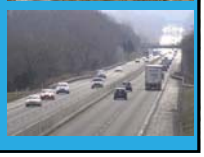
Lesson 5 | *Post Construction Stormwater Management vs. Erosion & Sediment Pollution Control for Roadways*

Post Construction

Stormwater Management

a. *Controls the pollution after construction and during the "life" of the road .*
b. *Control the increased volume and flow of water due to changes in the surface (i.e. addition of pavement).*



Lesson 6 | *Old Best Management Practices (BMP's)*

The Old Way

Conventional tools to manage stormwater are mitigation-based and flood control focused. This strategy emphasizes the efficient collection and rapid conveyance of runoff from roadways to central control ponds.

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Lesson 6 | *Old Best Management Practices (BMP's)*

Factors that Led to this Approach

1.Stormwater has been perceived as a liability and applications have evolved from wastewater technology
2.Hard conveyance structures and central control ponds are considered reliable and relatively simple to maintain
3.The conveyance and collection approach is relatively simple to model for regulatory requirements
4.Construction costs are readily estimated

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Lesson 6 | *Old Best Management Practices (BMP's)*

Detention Basin

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Lesson 6 | *Old Best Management Practices (BMP's)*

Vegetative Swale

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Lesson 7 | *Low Impact Design*

The New Way

Low Impact Development (LID) is an approach to land development and stormwater management that emphasizes conservation, retention, and infiltration through the use of distributed, small-scale facilities integrated with natural features.

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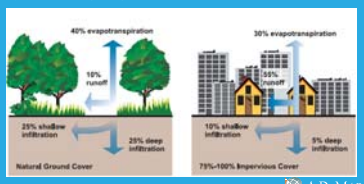
Lesson 7 | *Low Impact Design*

The New Way

The primary goal of LID is to mimic natural hydrology by managing stormwater at its source.



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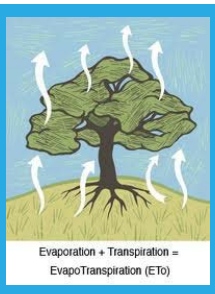
Lesson 7 | *Low Impact Development*

The New Way

LID designs typically focus on reducing impervious surfaces and maximizing on-site stormwater detention, infiltration, and evaporation.



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Lesson 7 | *Low Impact Development*

LID is Simple and Effective

Instead of large investments in complex and costly centralized conveyance and treatment infrastructure, LID allows for the integration of treatment and management measures into urban site features.

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Lesson 7 | *Low Impact Development*

LID is Economical

It costs less than conventional stormwater management systems to construct and maintain, in part, because of fewer pipes, fewer below-ground infrastructure requirements, and less imperviousness.

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Lesson 7 | *Low Impact Development*

LID is Flexible

It offers a wide variety of structural and nonstructural techniques to provide for both runoff quality and quantity benefits. LID works in highly urbanized constrained areas, as well as open regions and environmentally sensitive sites.

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Lesson 7 | *Low Impact Development*

How do we incorporate LID into Transportation Projects??

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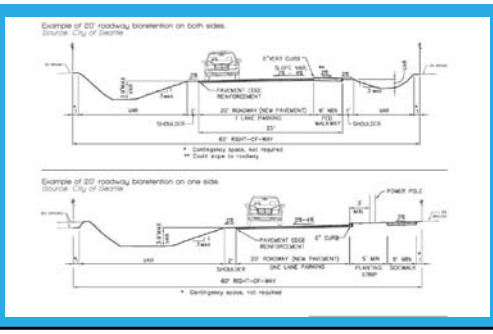
Lesson 8 | *Stormwater Management Options for Linear Projects*

Design Steps

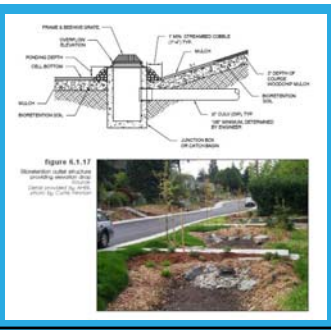
1. *Choose BMP's that require less Right-of-Way*
2. *Choose BMP's where an engineered soil can be used*
3. *Choose BMP's that have the least required Maintenance*
4. *Choose the location wisely*

Lesson 8 | *Stormwater Management Options for Linear Projects*



Lesson 8 | *Stormwater Management Options for Linear Projects*

Bio-retention



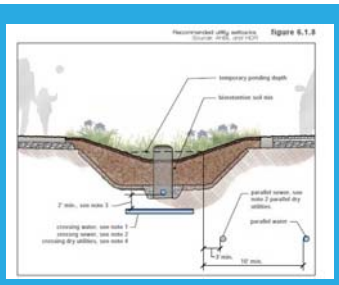
Lesson 8 | *Stormwater Management Options for Linear Projects*

Bio-retention

figure 6.1.6

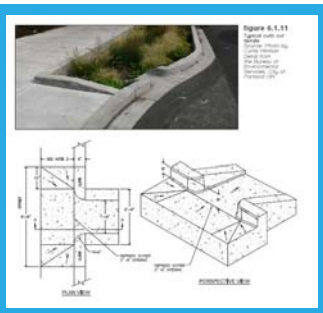
Lesson 8 | *Stormwater Management Options for Linear Projects*

Bio-retention



Lesson 8 | *Stormwater Management Options for Linear Projects*

Bio-retention



Lesson 8 | *Stormwater Management Options for Linear Projects*

Check Dams and Weirs

Lesson 8 | *Stormwater Management Options for Linear Projects*

Pavement Reduction

figure 3.26

SEA streets sidewalk and swale, Seattle, WA
Source: City of Seattle

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Lesson 8 | *Stormwater Management Options for Linear Projects*

Pavement Reduction

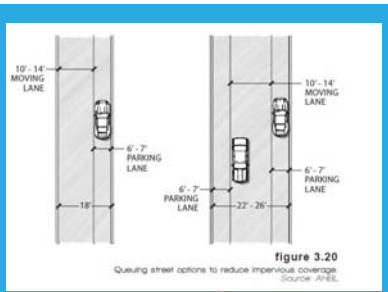

figure 3.20

Queuing street options to reduce impervious coverage
Source: AHBL

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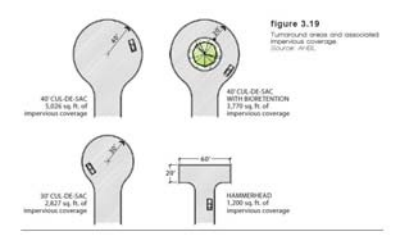
Pavement Reduction



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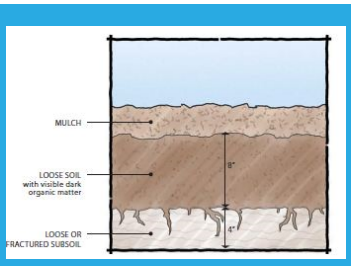
Lesson 8 | *Stormwater Management Options for Linear Projects*

Soil Amendment



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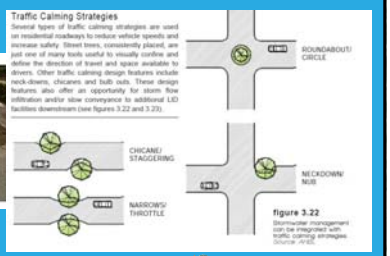
Lesson 8 | *Stormwater Management Options for Linear Projects*

Traffic Calming



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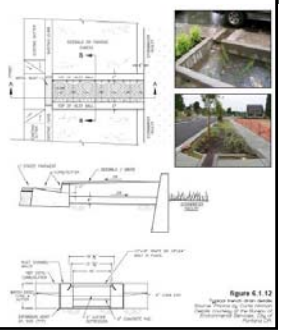
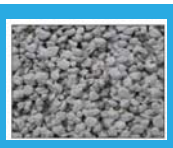
Lesson 8 | *Stormwater Management Options for Linear Projects*

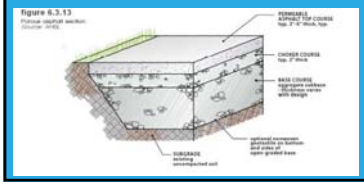
Trench Drains



Lesson 8 | *Stormwater Management Options for Linear Projects*

Permeable Pavement





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Lesson 8 | *Stormwater Management Options for Linear Projects*

Permeable Pavement

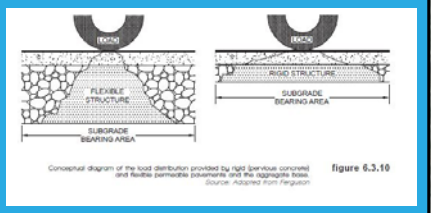

figure 6.3.10

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Lesson 8 | *Stormwater Management Options for Linear Projects*

Shared Driveway

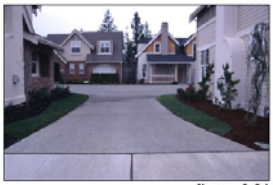

figure 3.24
Shared driveway in Issaquah Highlands, WA.
Source: Photo by Curtis Hinman

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Lesson 8 | *Stormwater Management Options for Linear Projects*

Tree Protection

figure 4.2

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Lesson 9 | *The Permit Process*

Thirty Years of Progress

We've made lots of progress in cleaning up American's waterways over the past 30 years since the Federal Water Pollution Control Act was amended in 1972.

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Lesson 9| *The Permit Process*

Overall Goal of the Clean Water Act

a. *Established the basic structure for regulating discharges of pollutants into the water of the US and Regulating quality standards.*

b. *The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained.*

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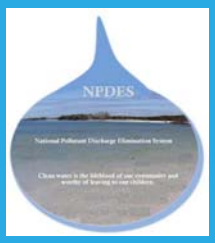
Lesson 9 | *The Permit Process*



NPDES

National Pollutant Discharge Elimination System permit program controls discharges.

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Lesson 9 | *The Permit Process*

State Permit

1.The EPA allows the states to issue NPDES permit – but all have to meet the regulation set forth by the Clean Water Act.

2.States issue regulations that must be followed by Counties and Municipalities

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Lesson 9 | *The Permit Process*

Counties

Counties implement ACT 167 plans to comply with the standards set forth by the states.

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Lesson 9 | *The Permit Process*

Municipalities

Municipalities implement Stormwater Management Codes and Regulations to comply with the Counties ACT 167 Plans.

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Lesson 10 | *Cost and Maintenance*

Cost Considerations

Low Impact Development cost is equivalent to the "old" BMP practices

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Lesson 10 | *Cost and Maintenance*

Cost Considerations

1. *Material costs;*
2. *Site specific constraints such as access, topography, soils, groundwater, and parcel area;*
3. *Land use;*
4. *Location;*
5. *Designer, reviewer, and contractor experience;*
6. *Local regulations; and*
7. *Overall economic climate*

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Lesson 10 | *Cost and Maintenance*

Standard Roadway Sections vs. LID Road Section

Comparison: Standard 24-Foot Asphalt pavement road section with curb and gutter, closed conveyance and an LID road section with 24 feet of pavement but bioretention swales replace the curb and gutter and closed Conveyance system. The analysis has been performed on a typical 1000 foot length of road. The analysis does not include site specific cost parameters such as clearing, grading or E&S or installation.

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Lesson 10 | *Cost and Maintenance*

Standard Roadway Sections

Standard Roadway Section	Item	Unit Cost	Quantity	Cost
	Asphalt	$35/CY	296 CY	$10,360
	Gravel	$12/CY	444 CY	$5,328
	Curb & Gutter	$15/LF	2,000 SF	$30,000
	Sidewalk	$30/SY	1,111 SY	$33,330
	Inlet	$700/Each	8 EA	$5,600
	Storm Drain	$18/LF	950 LF	$17,100
	Treatment Volume	$4.50/CY	223 CY	$1,003.50
	Detention Volume	$4.50/CY	1,025 CY	$4,612
				$107,333.50

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Lesson 10 | *Cost and Maintenance*

LID Road Section

LID Road Section	Item	Unit Cost	Quantity	Cost
	Soil Mix	$25/CY	160 CY	$4,000
	Swale Planting	$1/SF	2,880 SF	$2,880
	Mulch	$20/CY	30CY	$60
	Swale Excavation	$4.50/CY	760 CY	$3,420
	Asphalt	$35/CY	296 CY	$10,360
	Gravel	$12/CY	444 CY	$5,328
	Permeable Sidewalk	$40/CY	1,111 SY	$44,440
	Drive Pipes	$18/LF	720 LF	$12,960
	Underdrain	$8LF	2000 LF	$16,000
	Washed Rock	$20/CY	75 CY	$1,500
	Detention Volume	$4.50/CY	363 CY	$1,633.50
				$102,581.50

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Lesson 10 | *Cost and Maintenance*

Maintenance in the Real World

a. Too infrequent
b. Only major maintenance
c. Not completed, particularly when the BMP is privately owned
d. Improper maintenance decreased the efficacy and can in some cases increase pollutant loading
e. Lack of maintenance reduces aesthetic qualities
f. Operation and maintenance language not specified in stormwater ordinance
g. Level of maintenance varies

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Lesson 10 | *Cost and Maintenance*

What can be done?

1. Begin with a Better Design
   a. Design BMP's that require low maintenance
   b. Provide access
   c. Reduce the chance of failure
2. Require Ordinances to Enforce
   a. Specify who is responsible
   b. Maintenance Agreements
   c. Inspections
3. Provide Training

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Lesson 11 | *Importance of Education & Community Involvement*

Poor Community Participation was the second most commonly identified barrier when delivering successful stormwater management

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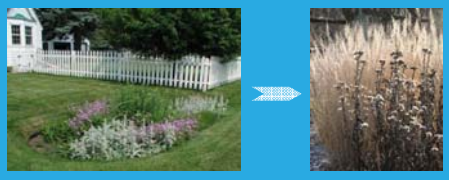
Lesson 11 | *Importance of Education & Community Involvement*

BMP Failures Due to Lack of Education and Involvement

Rain Gardens



Why did this happen?

Lesson 11 | *Importance of Education & Community Involvement*

BMP Failures Due to Lack of Education and Involvement

Permeable Pavement

Well Maintained

Poorly Maintained

Lesson 11 | *Importance of Education & Community Involvement*

BMP Failures Due to Lack of Education and Involvement

Rain Barrels

Lesson 11 | *Importance of Education & Community Involvement*

What Types of Community Education are Available?

a. Maintenance Workshops on LID

b. Online Media

c. Weekend Community Workshops

d. Utility Bill Inserts

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Lesson 12 | *The Future*

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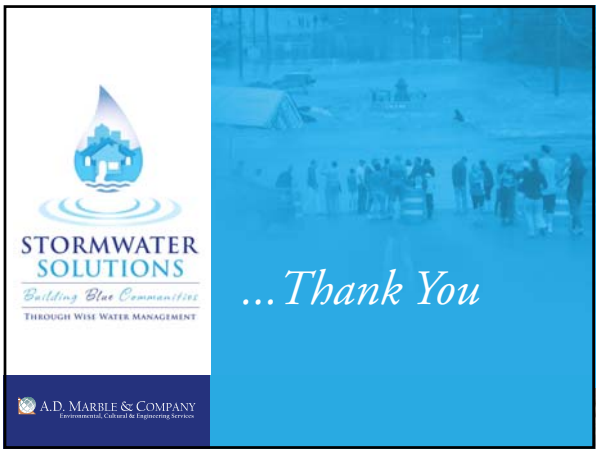
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...Thank You