12 Lessons on Applying Stormwater Management to Transportation Projects

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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

Lesson 1 | Basic Background

Overview of the Water Cycle:
- Water storage in ice and snow
- Water storage in the atmosphere
- Condensation
- Sublimation
- Evaporation
- Evapotranspiration
- Precipitation
- Snowmelt runoff
- Streamflow
- Groundwater storage
- Water storage in oceans
- Surface runoff
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.

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
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.

What are the two most common non-point source pollutants?

Sediment and Nutrients
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.

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 through implementation of Best Management Practices.

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
Lesson 2 | Pollutants found on Transportation projects

<table>
<thead>
<tr>
<th>CHANGE IN WATERSHED CONDITION</th>
<th>WATERSHED RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased imperviousness</td>
<td>• Increased storm flow volume and peak flow</td>
</tr>
<tr>
<td></td>
<td>• Reduced fine sediment and urban water pollution load</td>
</tr>
<tr>
<td></td>
<td>• Reduced groundwater recharge</td>
</tr>
<tr>
<td>Increased drainage density due to road networks</td>
<td></td>
</tr>
<tr>
<td>Increased fine sediment deposition</td>
<td></td>
</tr>
<tr>
<td>Loss of spawning and rearing habitat to fish</td>
<td></td>
</tr>
</tbody>
</table>

Lesson 3 | Obstacles facing Linear Projects

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

Lesson 4 | Advantages of Linear Projects

• Comprehensive Design Team
  – Roadway Engineers
  – Bridge Engineers
  – Landscape Architects
  – Environmental Scientists
  – Water Resource Engineers
  – Traffic Engineers
Lesson 5 | Post Construction Stormwater Management vs. Erosion & Sediment Pollution Control for Roadways

PCSWM vs ESC
Both are required when submitting an NPDES permit.

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

Erosion & Sediment Pollution Control
Controls the pollution during construction.

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

Pollutants During Construction
a. Sediment
b. Oil
c. Gas
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. Controls 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.

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.
Lesson 6 | Old Best Management Practices (BMP’s)

Detention Basin

Lesson 6 | Old Best Management Practices (BMP’s)

Vegetative Swale

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

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

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.
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.

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.

Lesson 7 | Low Impact Development

How do we incorporate LID into Transportation Projects??
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

Bio-retention
Lesson 8 | Stormwater Management Options for Linear Projects

Pavement Reduction

Soil Amendment

Traffic Calming

Figure 3.14

Figure 8.10

11/19/2013
Lesson 8 | Stormwater Management Options for Linear Projects

Trench Drains

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Lesson 8 | Stormwater Management Options for Linear Projects

Permeable Pavement

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Lesson 8 | Stormwater Management Options for Linear Projects

Permeable Pavement
Lesson 8 | Stormwater Management Options for Linear Projects

Shared Driveway

Lesson 8 | Stormwater Management Options for Linear Projects

Tree Protection

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.
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.

Lesson 9 | The Permit Process

NPDES
National Pollutant Discharge Elimination System permit program controls discharges.

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.
Lesson 9 | *The Permit Process*

Counties

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

Lesson 9 | *The Permit Process*

Municipalities

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

Lesson 10 | *Cost and Maintenance*

Cost Considerations

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

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.

Lesson 10 | Cost and Maintenance

Standard Roadway Sections

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit Cost</th>
<th>Quantity</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt</td>
<td>$75/CY</td>
<td>256 CY</td>
<td>$19,200</td>
</tr>
<tr>
<td>Gravel</td>
<td>$37/CY</td>
<td>484 CY</td>
<td>$18,108</td>
</tr>
<tr>
<td>Curb &amp; Gutter</td>
<td>$15/lf</td>
<td>2,000 lf</td>
<td>$30,000</td>
</tr>
<tr>
<td>Millwork</td>
<td>$90/lf</td>
<td>3,131 lf</td>
<td>$28,179</td>
</tr>
<tr>
<td>Inlet</td>
<td>$700/each</td>
<td>8 EA</td>
<td>$5,600</td>
</tr>
<tr>
<td>Storm Drain</td>
<td>$360/lf</td>
<td>900 lf</td>
<td>$324,000</td>
</tr>
<tr>
<td>Treatment Volume</td>
<td>$4.50/CY</td>
<td>223 CY</td>
<td>$1,003.50</td>
</tr>
<tr>
<td>Detention Volume</td>
<td>$4.50/CY</td>
<td>2,000 CY</td>
<td>$9,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$10,003.50</td>
</tr>
</tbody>
</table>

$109,333.50
Lesson 10 | Cost and Maintenance

**LID Road Section**

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit Cost</th>
<th>Quantity</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silt fence</td>
<td>$2/lin ft</td>
<td>1800 lin ft</td>
<td>$3600</td>
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<tr>
<td>Gravel</td>
<td>$2/lin ft</td>
<td>2000 lin ft</td>
<td>$4000</td>
</tr>
<tr>
<td>Med filter</td>
<td>$2/lin ft</td>
<td>300 lin ft</td>
<td>$600</td>
</tr>
<tr>
<td>Gravel</td>
<td>$2/lin ft</td>
<td>3000 lin ft</td>
<td>$6000</td>
</tr>
<tr>
<td>Excavation</td>
<td>$2/cubic yd</td>
<td>15 cubic yd</td>
<td>$30</td>
</tr>
<tr>
<td>Permeable</td>
<td>$4/linear ft</td>
<td>20 linear ft</td>
<td>$80</td>
</tr>
<tr>
<td>Driveway</td>
<td>$3/linear ft</td>
<td>10 linear ft</td>
<td>$30</td>
</tr>
<tr>
<td>Underground</td>
<td>$1/linear ft</td>
<td>20 linear ft</td>
<td>$20</td>
</tr>
<tr>
<td>Washed Rock</td>
<td>$2/cubic yd</td>
<td>1 cubic yd</td>
<td>$2</td>
</tr>
<tr>
<td>Detention</td>
<td>$4/linear ft</td>
<td>40 linear ft</td>
<td>$160</td>
</tr>
<tr>
<td>Volume</td>
<td>$1/linear ft</td>
<td>10 linear ft</td>
<td>$10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>$10,381.00</strong></td>
</tr>
</tbody>
</table>

Lesson 10 | Cost and Maintenance

**Maintenance in the Real World**

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

Lesson 10 | Cost and Maintenance

**What can be done?**

1. Begin with a Better Design
   - Design BMP's that require low maintenance
   - Provide access
   - Reduce the chance of failure
2. Require Ordinances to Enforce
   - Specify who is responsible
   - Maintenance Agreements
   - Inspections
3. Provide Training
Poor Community Participation was the second most commonly identified barrier when delivering successful stormwater management.

Lesson 11 | Importance of Education & Community Involvement

BMP Failures Due to Lack of Education and Involvement

Rain Gardens

Why did this happen?

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 12 | The Future
...Thank You