Trap Efficiency for Road Storm Runoff Detention in Southern Appalachian Watersheds

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Presentation Outline

- Background
- Methods
- Results
  - Storm Runoff
  - Sediment Control
- Conclusions
Background

- Roads are commonly identified as risk areas for accelerated erosion losses.
- Characteristics of unpaved roads are not optimal for erosion prevention and sediment control.
Background

- Road BMPs have incorporated erosion, sediment, and runoff control principles to minimize road impacts.
  - The lead-off ditch is commonly used to divert and disperse runoff from forest roads.
- Sediment deposition zones can extend into the buffers without some form of sediment control structure.
Background

- Structures can trap sediments at the road edge (primary) and reduce the quantity of sediment reaching the forest floor (secondary).

- However, limited work has been undertaken to investigate the influence of road sediment control BMPs on sediment delivery.
Objective

• The objective of this investigation was to determine the trap efficiencies of three sediment control basin designs on an Appalachian road network.
Study Site

- Located within the southern Appalachian Mountains on Chattahoochee National Forest near Dillard, GA
- Elevation = 900 m
- Annual precipitation is 1800 mm
- 25 yr-24hr storm = 220 mm
- Soils were Hayesville series, a fine, kaolinitic, mesic Typic Kanhapludults, surface soil overlaying a clay loam subsoil.
Study Road Sections

- Road Width = 4-6 m.
- Plot length = 50 m.
- Lead-off constructed to drain the road section lengths.
- Peak flow 60 m$^3$ hr$^{-1}$. 
Monitoring Grading
Site in Winter, With lead-off breached
Sediment Basin Designs

- Hay-bale check (HB) – bales located perpendicular to the flow path.

- Sediment basin (SB) with rock weir – 25 yr - 24hr design capacity.

- Sediment basin w/ riser control (SBR) – 25 yr - 24 hr design capacity w/ 150 mm riser

- Treatment areas seeded and fertilized
Storm Monitoring (Inlet)

➢ Structures

➢ Trapezoidal Flume: 0.3 m $60^\circ$ V with a 1.8-m approach section.

➢ Inlet Flow Measurement

- Level recorded at 5 min. intervals.
- Inlet storm water sampler activated with a flow depth of 1 cm to collect composite runoff samples.
Sediment Basin with Rocked weir outlet

Pressure Transducer

Pump sampler
Storm Monitoring (Outlet)

Outlet Flow Measurement

- 5-to-1 flow divider in combination with a runoff tipping bucket.
- Accumulated tips recorded at 5-min. intervals with a event logger connected to a magnetic switch mounted at bucket pivot point.
- Storm water samplers activated with a flow depth of 1 cm to collect composite runoff samples.
Hay bale treatment
Observed Precipitation

Exceeded capacity of instruments

Hurricanes Hugo & Ivan

Intensity, mm hr$^{-1}$

Cumulative Precipitation, mm

Oct 1, '03

Feb 1, '08
## Results: Runoff

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Road Runoff</th>
<th>Inlet Runoff m³</th>
<th>Outlet Runoff m³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Precip</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HB</td>
<td>0.17 (0.26)a</td>
<td>12.9 (104)a</td>
<td>0.39 (2.1)a</td>
</tr>
<tr>
<td>SB</td>
<td>0.17 (0.25)a</td>
<td>6.4 (34.8)b</td>
<td>0.54 (1.7)a</td>
</tr>
<tr>
<td>SBR</td>
<td>0.17 (0.27)a</td>
<td>4.8 (22.5)b</td>
<td>0.06 (0.3)b</td>
</tr>
</tbody>
</table>
Results: Concentration

Means with a different letter within a given column were detected as significant at the 0.05 significance level.
Results: Sediment Delivery

Means with a different letter within a given column were detected as significant at the 0.05 significance level.
Results: Sediment and Runoff Reduction (Inflow:Outflow)

Means with a different letter within a given column were detected as significant at the 0.05 significance level.
Results: Trap Efficiency

Means with a different letter within a given column were detected as significant at the 0.10 significance level.

- HB: 97 ab
- SB: 94 b
- SBR: 99 a, the lowest runoff
Conclusions

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- Outflow from the sediment basins was less than 2 percent of the inflow.
- Trap efficiencies greater than 90 % were observed on all treatments.
- We conclude that all designs did an outstanding job of reducing road runoff and sediment loads to forest buffers.
What’s Next?

- What is needed now?
  - Some modeling support.
  - Sources of runoff
  - Effectiveness of WEPP’s sediment basin routines
Questions?