Level Spreaders and Off-Site Discharges of Stormwater to Non Surface Waters

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Disclaimer

• Neither a proponent nor an opponent to the use of level spreaders.
• Decision to use is typically left with the designer.

Purpose

• To provide comprehensive guidance on the applicability and proper use of level spreaders. (for both designers and reviewers)
• To encourage better design, construction, and monitoring*.
• To get beyond the notion that they don’t work.
• To establish logical limitations.
Collaborative Effort

- White Paper
- Started in 2004.
- Technical Work Group
- Inspected ~24 sites and documented their conditions.
- Substantial Research
- Peer Review
Why?

• It was needed!
• Guidance was lacking or inappropriate.
• Observed misuse and poor design.
• Several complaints and inquiries.
• Observed numerous failures*
Failure: Poor siting or geometry
Failure: Choice of materials

- TIMBER
- GABION
- PRE-CAST CONCRETE

Source: Umstead Coalition, 2005.
Failure: Sedimentation
Failure: Construction Practices
Common Level Spreader Failures

- Unlevel
- Short Circuiting
- Overtopping

- Undercutting
- Failed Joint
What’s Not a Level Spreader?

STANDARD CONSTRUCTION DETAIL #33
Riprap Aprons At Pipe Outlets With Flared End Sections

- Riprap Aprons
- Outlet Protection
- Energy Dissipators
Types of Level Spreaders*

- Inflow vs. Outflow
- Typical vs. Atypical
- Surface vs. Subsurface
Inflow vs. Outflow

Inflow

BMP

Outflow

Source: Cahill Associates
Typical vs. Atypical
Surface vs. Subsurface Discharge

Profile View
N.T.S.

Suitable rigid measures and protective geofabric (TRM)- min. 3 ft. or as needed.

Profile View
N.T.S.

Turf Reinforcement Mat (3' Typ.)

Bedding Material
No. 3 Stone (clean)

Geotextile Lining (non-woven)

Optional Drain.
2" ductile iron Driven horizontally

Inflow

Outflow

X

Y

h

Plunge Pool

Undisturbed Ground

Level Spreader

Optional Drain.
2" ductile iron Driven horizontally

Inflow

Outflow

Lip

Geotextile Lining (non-woven)
Existing PA DEP Guidance

- Paper compliments existing guidance.
- E&S Manual requires:
  - 1 LF per CFS
  - Temporary use only.
  - Do not use for permanent/structural level spreaders.
- SWM BMP Manual – BMP 6.8.1 requires:
  - 13 LF per CFS (grass)
  - 100 LF per CFS (woods)
- Beware of rules of thumb: You need to know where these numbers come from.**
Sneak Peek: Technical Paper

Paper is organized into several sections:

- **Practical Considerations:**
  - avoidance and minimization.
- **Legal Considerations:**
  - analysis of off-site discharge*, easements.
- **Engineering Considerations:**
  - DA < 5ac, S < 6%, materials, siting, sizing
- **Outfall Design:**
  - for areas unsuitable for level spreaders
- **Remedial Actions:**
  - for areas experiencing problems
- **Length of Level Spreader***

Source: NCSU
Computing Length of Level Spreader
(Surface Discharge)

• Based on many factors, but the most critical factor is down slope condition
  – Allowable velocity

• Solve continuity equation and the weir equation simultaneously.

\[
Q = VA \\
Q = C_w LH^{3/2}
\]

• Solve for V:

\[
V = 1.5 \ C_w \ H^{1/2}
\]
Allowable velocity, where?

- Not the allowable velocity at the level spreader, but at the effective distance.
- Flow uses approx. one-third of available land.
- Therefore, divide erosive velocity of ground cover by 3.

- For **thick grass**:
  \[ V_{\text{allow}} = \frac{5 \, \text{fps}}{3} = 1.67 \, \text{fps} \]
- For **woods/no cover**:
  \[ V_{\text{allow}} = \frac{2 \, \text{fps}}{3} = 0.67 \, \text{fps} \]

Source: NCSU
With $V_{allow}$ – Find Head ($H$)

$V = 1.5C_wH^{1/2} \rightarrow$ solve for $H$

Weir Equation:
$Q = C_wLH^{3/2} \rightarrow$ solve for $L$

N.T.S.

Driving Head (Weir Eq. Input)

Water Height at Weir (Continuity Eq. Input)

Level Spreader

Plunge Pool

Geofabric

$H^* = 2/3 \, H$
<table>
<thead>
<tr>
<th>Q (cfs)</th>
<th>Thick Grass</th>
<th>Woods or No Cover</th>
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<tr>
<td>0.50</td>
<td>6</td>
<td>59</td>
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<tr>
<td>1.00</td>
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<td>118</td>
</tr>
<tr>
<td>1.50</td>
<td>19</td>
<td>177</td>
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<tr>
<td>1.70</td>
<td>21</td>
<td>200</td>
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<tr>
<td>2.00</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>3.00</td>
<td>37</td>
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<td>4.00</td>
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<td>16.00</td>
<td>198</td>
<td></td>
</tr>
<tr>
<td>16.20</td>
<td>200</td>
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</table>
**Level Spreader Length**

- Thick Grass: **13** LF/CFS
- Woods / **No cover**: **100** LF/CFS
- Difference: Order of magnitude
  - Dependent on d/s ground cover condition*. 

<table>
<thead>
<tr>
<th>E&amp;S</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass</td>
<td></td>
</tr>
<tr>
<td>Woods</td>
<td></td>
</tr>
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</table>
Adequate Ground Cover

Filter Strip - Buffer

Meadow

Forest
Inadequate Ground Cover
Flow Path

- **Know your flow path!!**
  - From the point of discharge to the receiving stream.
  - Design to the worse-case ground cover along the flow path.

- Consider alternative discharge points

- Site visit is imperative.
  - Design can’t be done solely from the desktop.
Analysis of Off-site Discharge

- Analyze downslope conditions:
  - soils, geology, ground cover, properties, conveyances, receiving stream.
- Monitor level spreader and flow path for up to two years
- Municipal coordination
- Authorization from off-site property owners
Analysis of Off-site Discharge
Forested Ground Cover

• Relook at forested ground cover revealed that there were some significant factors that needed to be considered.

• Width of Wooden Riparian Buffer
  – Absorption by mulch cover
  – Infiltration in underlying (undisturbed) soil

<table>
<thead>
<tr>
<th>Wooded Riparian Buffer Width (ft)</th>
<th>HSG A or B</th>
<th>HSG C or D</th>
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</thead>
<tbody>
<tr>
<td>50</td>
<td>65</td>
<td>80</td>
</tr>
<tr>
<td>100</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>150</td>
<td>40</td>
<td>55</td>
</tr>
</tbody>
</table>

Source: NCSU
Examples
Porter Tract
West Vincent Twp., Chester Co.

- Concrete sill.
- Pulled back at ends to prevent erosion
- Area downslope appears stable
- Level spreader, in this instance, appears to have E&S function as well.
Alice Grim Blvd.
Newtown Twp., Del. Co.

- DA = **26.27** acres
- Installed: 2 years
- Some erosion noted but relatively stable.
Arbor Lea
Concord Twp., Del. Co.

- DA = 9.1 ac
- Installed: 4.5 years
- Detail similar to Alice Grim
- D/S Stable
- Can hardly notice it.
Dickinson Dev.
Bethel Twp., Del. Co.

- DA = 4.5 ac
- Installed: 1.5 years
- D/S looks stable
- Creek within reasonable distance.
Claridan Court
Richland Twp., Bucks Co.

- Fairly long Level spreader
- Built within the berm.
- D/S stable (no photos)
Hopewell Estates
Upper Macungie Twp., Lehigh Co.

- Uses ½ sections of 24” HDPEP
- Encased in concrete footing. (3 ft deep)
- Erosion noted downslope - along side at end of riprap apron.
• For more information, read the paper.
  – DEP

• Questions?