Assessment of Fluvial Geomorphology Projects at Abandoned Mine Sites in the Anthracite Region of Pennsylvania

Presented at the 2014 OSM National Technical Forum: Advances in Geomorphic Reclamation on Mined Land
May 20-22, 2014
Albuquerque, New Mexico
PROJECTS IN NORTHEASTERN PENNSYLVANIA

Wilkes-Barre
Hollars Hill
LACKAWANNA
Scranton
Keyser Avenue
Pardeesville
Hazleton
SCHUYLKILL
Pottsville
Middle Creek

Jessup Cemeteries

Shamokin

c pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION
1. Entrenchment Ratio (ER) - \( \frac{W_{fpa}}{W_{b kf}} \)
2. Width/Depth Ratio - \( \frac{W_{b kf}}{d_{b kf}} \)
3. Sinuosity (K) - \( \frac{SL}{VL} \)
4. Channel Materials (pebble count) – Gravel, Cobbles, Bedrock, etc.
5. Slope (S) – Channel Slope
# Rosgen Stream Classification

## Single-Thread Channels

<table>
<thead>
<tr>
<th>Entrenchment Ratio</th>
<th>Single-Thread Channels</th>
<th>Multiple Channels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrenched</td>
<td>Entrenched (Ratio: &lt; 1.4)</td>
<td></td>
</tr>
<tr>
<td>Moderately Entrenched</td>
<td>Entrenched (1.4-2.2)</td>
<td></td>
</tr>
<tr>
<td>Slightly Entrenched</td>
<td>Slightly Entrenched (&gt; 2.2)</td>
<td></td>
</tr>
</tbody>
</table>

## Width/Depth Ratio

<table>
<thead>
<tr>
<th>Width/Depth Ratio</th>
<th>Low Width/Depth Ratio</th>
<th>Moderate to High W/D</th>
<th>Moderate Width/Depth Ratio</th>
<th>Very Low Width/Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>(&lt; 12)</td>
<td>(&lt; 12)</td>
<td>(&gt; 12)</td>
<td>(&gt; 12)</td>
<td>(&gt; 12)</td>
</tr>
</tbody>
</table>

## Sinuosity

<table>
<thead>
<tr>
<th>Sinuosity</th>
<th>Low Sinuosity</th>
<th>Moderate Sinuosity</th>
<th>Very High Sinuosity</th>
</tr>
</thead>
<tbody>
<tr>
<td>(&lt; 1.2)</td>
<td>(&lt; 1.2)</td>
<td>(&gt; 1.2)</td>
<td>(&gt; 1.5)</td>
</tr>
</tbody>
</table>

## Slope Range

<table>
<thead>
<tr>
<th>Slope Range</th>
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<th>Slope Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 0.10</td>
<td>0.04-0.099</td>
<td>0.02-0.039</td>
<td>&lt; 0.02</td>
</tr>
<tr>
<td>&lt; 0.02</td>
<td>&lt; 0.02</td>
<td>&lt; 0.02</td>
<td>&lt; 0.02</td>
</tr>
</tbody>
</table>

## Channel Material

<table>
<thead>
<tr>
<th>Bedrock</th>
<th>Boulders</th>
<th>Cobble</th>
<th>Gravel</th>
<th>Sand</th>
<th>Silt/Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1a+</td>
<td>A2a+</td>
<td>A3a+</td>
<td>A4a+</td>
<td>A5a+</td>
<td>A6a+</td>
</tr>
<tr>
<td>A1</td>
<td>A2</td>
<td>A3</td>
<td>A4</td>
<td>A5</td>
<td>A6</td>
</tr>
<tr>
<td>G1</td>
<td>G2</td>
<td>G3</td>
<td>G4</td>
<td>G5</td>
<td>G6</td>
</tr>
<tr>
<td>G1c</td>
<td>G2c</td>
<td>G3c</td>
<td>G4c</td>
<td>G5c</td>
<td>G6c</td>
</tr>
<tr>
<td>F1b</td>
<td>F2b</td>
<td>F3b</td>
<td>F4b</td>
<td>F5b</td>
<td>F6b</td>
</tr>
<tr>
<td>F1</td>
<td>F2</td>
<td>F3</td>
<td>F4</td>
<td>F5</td>
<td>F6</td>
</tr>
<tr>
<td>B1a</td>
<td>B2a</td>
<td>B3a</td>
<td>B4a</td>
<td>B5a</td>
<td>B6a</td>
</tr>
<tr>
<td>B1</td>
<td>B2</td>
<td>B3</td>
<td>B4</td>
<td>B5</td>
<td>B6</td>
</tr>
<tr>
<td>B1c</td>
<td>B2c</td>
<td>B3c</td>
<td>B4c</td>
<td>B5c</td>
<td>B6c</td>
</tr>
<tr>
<td>C1b</td>
<td>C2b</td>
<td>C3b</td>
<td>C4b</td>
<td>C5b</td>
<td>C6b</td>
</tr>
<tr>
<td>C1</td>
<td>C2</td>
<td>C3</td>
<td>C4</td>
<td>C5</td>
<td>C6</td>
</tr>
<tr>
<td>C1c-</td>
<td>C2c-</td>
<td>C3c-</td>
<td>C4c-</td>
<td>C5c-</td>
<td>C6c-</td>
</tr>
<tr>
<td>C1c-</td>
<td>C2c-</td>
<td>C3c-</td>
<td>C4c-</td>
<td>C5c-</td>
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</tr>
</tbody>
</table>

## Stream Type

<table>
<thead>
<tr>
<th>A</th>
<th>G</th>
<th>F</th>
<th>B</th>
<th>E</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
</table>

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### Rosgen Stream Classification

- **Entrenchment Ratio**
  - Entrenched: Ratio < 1.4
  - Moderately Entrenched: 1.4-2.2
  - Slightly Entrenched: > 2.2

- **Width/Depth Ratio**
  - Low: (< 12)
  - Moderate to High: (> 12)
  - Moderate: (> 12)
  - Very Low: (> 12)

- **Sinuosity**
  - Low: (< 1.2)
  - Moderate: (> 1.2)
  - Very High: (> 1.5)

- **Slope Range**
  - > 0.10
  - 0.04-0.099
  - 0.02-0.039
  - < 0.02

- **Channel Material**
  - Bedrock: A1a+, A1, G1, G1c, F1b, F1, B1a, B1, B1c, C1b, C1, C1c-
  - Boulders: A2a+, A2, G2, G2c, F2b, F2, B2a, B2, B2c, C2b, C2, C2c-
  - Cobble: A3a+, A3, G3, G3c, F3b, F3, B3a, B3, B3c, E3b, E3, C3b, C3, C3c-, D3b, D3
  - Gravel: A4a+, A4, G4, G4c, F4b, F4, B4a, B4, B4c, E4b, E4, C4b, C4, C4c-, D4b, D4, D4c-
  - Sand: A5a+, A5, G5, G5c, F5b, F5, B5a, B5, B5c, E5b, E5, C5b, C5, C5c-, D5b, D5, D5c-
  - Silt/Clay: A6a+, A6, G6, G6c, F6b, F6, B6a, B6, B6c, E6b, E6, C6b, C6, C6c-, D6b, D6, D6c-
Pardeesville Project
- Bankfull Discharge – 30 cfs
- $W_{bkf}$ – 10 ft.
- $d_{bkf}$ – 1.5 ft.
- ER – 13.5
- W/D – 6.7
- K – 1.2
- S – 0.008 ft/ft
- C3/E3 classification
Construction Fall 1998
• Bankfull Discharge – 60 cfs
• $W_{bkf} – 16$ ft.
• $d_{bkf} – 2.5$ ft.
• ER – 1
• W/D – 6.4
• K – 1.2
• S – 0.086 ft/ft Step 18%, Pool 1%
• A2 classification
May 2002
Before and After
Before and After
Middle Creek Project
• Bankfull Discharge – 115 cfs
• $W_{b kf}$ – 22 ft.
• $d_{b kf}$ – 1.5 ft.
• ER – 3.2
• W/D – 14.7
• K – 1.15
• S – 0.06 ft/ft
• B3a classification
Jessup Cemeteries Project
Jessup Cemeteries Project

• Bankfull Discharge – 190 cfs
• $W_{bkf}$ – 28 ft.
• $d_{bkf}$ – 2.0 ft.
• ER – 3.6
• W/D – 14
• K – 1.2
• S – 0.03 ft/ft (B3), 0.02 ft/ft (C3b)
• B3 and C3b classifications
Temporary Diversion Channel
2005 Corrections to Floodplain
June 2013 – 5” Rainfall
Hollars Hill Project

- Bankfull Discharge – 250 cfs
- $W_{\text{b kf}}$ – 30 ft.
- $d_{\text{b kf}}$ – 2.5 ft.
- ER – 6
- W/D – 12
- $K$ – 1.5
- $S$ – 0.02 ft/ft
- C4 classification
Construction without PVC Liner
• 1) Proper Construction Methods
• 2) Vegetation – Quick as Possible
• 3) PVC Liner – No!
• 4) Repair Damaged Structures ASAP
• 5) Design – Should Include 100 yr. or Greater Storm Events
• 6) Floodplain – Proper Elevs. Essential
• 7) Steep Channel Design – C and E held up better than A or B
Dennis M. Palladino. P.E.
Pennsylvania Department of Environmental Protection
Bureau of Abandoned Mine Reclamation, Wilkes-Barre, PA
dpalladino@pa.gov