Douglas Highwall Project

Wetland – Anoxic Limestone Drain (WALD)

Jeff Skousen
West Virginia University
North Fork of Blackwater River
Douglas Project 1990
Push back spoil to cover highwalls - 1992
Mostly reclaimed and seeded - 1993
North Fork of Blackwater River
#29 Portal Water
#29 Portal
#29 Portal Water – 1990
Flow?
#29 Portal Water
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow</td>
<td>200 - ?? ?? gpm (3,000 max)</td>
</tr>
<tr>
<td>pH</td>
<td>2.8 - 3.7</td>
</tr>
<tr>
<td>Acidity</td>
<td>400 - 600 mg/l</td>
</tr>
<tr>
<td>Total Iron</td>
<td>25 - 40 mg/l</td>
</tr>
<tr>
<td>Ferric Iron</td>
<td>11 - 17 mg/l</td>
</tr>
<tr>
<td>Ferrous Iron</td>
<td>14 - 23 mg/l</td>
</tr>
<tr>
<td>Manganese</td>
<td>5 - 11 mg/l</td>
</tr>
<tr>
<td>Aluminum</td>
<td>30 - 55 mg/l</td>
</tr>
<tr>
<td>Sulfates</td>
<td>700 - 800 mg/l</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>&lt;1 - 4 mg/l</td>
</tr>
</tbody>
</table>
WALD – Alkalinity-Producing System

Idea to push the Water down through Organic compost then into Limestone.
Construction Specs

Topview shows overall dimensions.

Cross-section of

Phase I (8-ft wide) (Organic)

Phase II (30-ft wide) Limestone
#29 Portal Wet Seal
#29 Portal Wet Seal
#29 Portal Wet Seal
19,000 tons LS
5,000 yd³ Organic

WALD

Phase II
30-ft Section

Phase I
8-ft Section
Phase I
8-ft Section
1,225 ft long
5 ft OM
1 ft LS
Phase I
8-ft Section
Phase I
8-ft Section
1994
Phase I
8-ft Section
2012
Ports in Phase I
8-ft Section 2015
Phase II
30-ft Section
1,375 ft long
1 ft OM
6 ft LS
Phase II
30-ft Section
Phase II
30-ft Section
Phase II
30-ft Section
1994
Phase II
30-ft Section
2012

08/22/2012
Evaluation and Redesign of Wetland/ALD Passive System in North Fork of the Blackwater River, WV

Robert Hedin¹, Katherine Linnell², George Watzlaf¹, Naomi Anderson¹

¹Hedin Environmental, Pittsburgh PA
²Langan Engineering and Environmental Services, Canonsburg, PA
WALD Passive Treatment Redesign

- Section 319 grant to Friends of Blackwater
- Contract with Langan Engineering (2018)
  - Treatment system design: Hedin Environmental
  - Permitting: FOB with Langan assistance
  - Construction package: Langan Engineering
WALD influent acidity

<table>
<thead>
<tr>
<th>Year</th>
<th>Flow</th>
<th>pH</th>
<th>Acid</th>
<th>Al</th>
<th>Fe</th>
<th>Mn</th>
<th>SO4</th>
<th>Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-18</td>
<td>169</td>
<td>3.3</td>
<td>105</td>
<td>10.7</td>
<td>2.2</td>
<td>2.9</td>
<td>340</td>
<td>208</td>
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</tbody>
</table>
Characterize Mine Water

<table>
<thead>
<tr>
<th>Flow</th>
<th>pH</th>
<th>Acid</th>
<th>Al</th>
<th>Fe</th>
<th>Mn</th>
<th>SO4</th>
<th>Acid</th>
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<td>340</td>
</tr>
</tbody>
</table>

Modified from, Hedin, R and Nairn, R. 1992 WV Task Force Meeting
Characterize Mine Water

Net alkaline

- DO, Fe$^{3+}$, Al all < 1 mg/L (high Fe$^{2+}$)

  Anoxic Limestone Bed

    - Net Alkaline

  Wetland

  Ponds

  Modified from, Hedin, R and Nairn, R. 1992 WV Task Force Meeting

Net acid

- DO, Fe$^{3+}$, Al any > 1 mg/L

  High Fe$^{2+}$

  Oxic Limestone Bed (drainable)

  Repeat As Needed

  Ponds

  Final Discharge

  Modified from, Hedin, R and Nairn, R. 1992 WV Task Force Meeting
Drainable Limestone Bed Passive System

- Bed of limestone aggregate, open to atmosphere
- Formation of Al, Fe, and Mn oxyhydroxides is encouraged
- Bed is regularly drained empty which removes portion of solids
- Draining eliminates permeability issues and prolongs the reactivity of the limestone by years
- Eventually the limestone must be cleaned
Drainable Limestone Bed

- Minewater
- Limestone Aggregate
- Water Level Control Structure
- Polishing Pond
- Final Effluent
- Gate Valve (Closed)
- Settling Pond
- Limestone Aggregate
- Water Level Control Structure
- Gate Valve (Open)
- Combined Polishing and Settling Pond
- Final Effluent
Distributed influent

Distributed effluent (bottom)
AgriDrain Smart Drainage System
Agri Drain Smart Drainage System
(solar powered computer controlled gate valve)
Pittsburgh Botanic Garden DLB solids basin

65-70% of the Al retained in the DLB during routine operations released during draining
# Performance of Existing DLB systems

<table>
<thead>
<tr>
<th></th>
<th>Flow</th>
<th>pH</th>
<th>Alk</th>
<th>Acid</th>
<th>Fe</th>
<th>Al</th>
<th>Mn</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WALD</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw water</td>
<td>250</td>
<td>3.3</td>
<td>0</td>
<td>105</td>
<td>2.2</td>
<td>10.7</td>
<td>2.9</td>
</tr>
<tr>
<td><strong>Scootac #1: 1,000 tons limestone, one DLB, installed 2010</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DLB in</td>
<td>na</td>
<td>4.0</td>
<td>0</td>
<td>88</td>
<td>0.2</td>
<td>10.7</td>
<td>24.4</td>
</tr>
<tr>
<td>DLB out</td>
<td>43</td>
<td>6.9</td>
<td>192</td>
<td>-164</td>
<td>0.1</td>
<td>0.2</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>PBG Lotus Pond: 450 tons limestone, one DLB, installed 2013</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DLB in</td>
<td>3.3</td>
<td>0</td>
<td>144</td>
<td>0.6</td>
<td>17.9</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>DLB out</td>
<td>6.7</td>
<td>208</td>
<td>-193</td>
<td>0.1</td>
<td>0.6</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td><strong>Greene: 4,700 tons limestone, four DLBs, installed 2015</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DLB in</td>
<td>3.4</td>
<td>0</td>
<td>105</td>
<td>3.4</td>
<td>3.9</td>
<td>31.7</td>
<td></td>
</tr>
<tr>
<td>DLB out</td>
<td>134</td>
<td>7.2</td>
<td>88</td>
<td>-74</td>
<td>0.2</td>
<td>0.1</td>
<td>1.6</td>
</tr>
<tr>
<td>Final</td>
<td>7.8</td>
<td>111</td>
<td>-59</td>
<td>0.7</td>
<td>0.1</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td><strong>Sterrett: 3,500 tons limestone, two DLBs, installed 2015</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DLB in</td>
<td>109</td>
<td>3.4</td>
<td>0</td>
<td>99</td>
<td>9.7</td>
<td>9.1</td>
<td>18.5</td>
</tr>
<tr>
<td>DLB out</td>
<td>107</td>
<td>6.9</td>
<td>146</td>
<td>-120</td>
<td>0.3</td>
<td>0.6</td>
<td>4.1</td>
</tr>
<tr>
<td>Final</td>
<td>7.4</td>
<td>125</td>
<td>-75</td>
<td>0.4</td>
<td>0.7</td>
<td>4.8</td>
<td></td>
</tr>
</tbody>
</table>
Acidity, mg/L
Cleaning the Scootac #1 DLB. 1,000 ton DLB was cleaned in one day.
WALD Rehabilitation Design

- Settling/polishing Pond
- 5 DLBs (parallel)
- Distribution structure
- Pipeline
- Water box
DLB Unit Profile

No Scale

- Limestone aggregate
- Concrete barrier (see detail)
- Water Level Control Structure (WLCS)
- Effluent pipe
- Influent pipe
- Proposed liner
- Existing liner

2’ Suitable fill placed on existing liner

6’

100’

5’

2’
Limestone collected from WALD (Jan 2019)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CaCO₃</td>
<td>90.5%</td>
</tr>
<tr>
<td>MgCO₃</td>
<td>3.2%</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>0.3%</td>
</tr>
<tr>
<td>MnO₂</td>
<td>&lt;0.1%</td>
</tr>
<tr>
<td>SiO₂</td>
<td>0.4%</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>0.1%</td>
</tr>
</tbody>
</table>
### Limestone particle size is important

<table>
<thead>
<tr>
<th>Site</th>
<th>Classification</th>
<th>Size range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scootac #1 and Greene DLBs</td>
<td>AASHTO 5</td>
<td>0.5 – 1.0 inch</td>
</tr>
<tr>
<td>PBG and Sterrett DLBs</td>
<td>AASHTO 3</td>
<td>1.0 – 2.0 inch</td>
</tr>
<tr>
<td>Existing WALD</td>
<td>AASHTO 1?</td>
<td>2 – 4 inch</td>
</tr>
</tbody>
</table>
Limestone choices

Proposed system needs 5,000 tons
WALD contains ~12,000 tons limestone

Remove and Clean limestone
  a) Use in DLB as-is (larger particle size)
  b) Use on other projects in area, purchase new stone
  c) Crush stone
     a) Create AASHTO 3 or 5 stone
     b) Use fines produced for trail maintenance
What’s Next?

- Determine permitting requirements: spring 2019
- Deliver construction plans: spring 2019
- Obtain permits: spring/summer 2019
- Phase I: bid, install settling pond, limestone removal, install several VFPs: summer/fall 2019(?)
- Phase II: install remaining VFPs: 2020(?)
- Present results to WVMDTF: 2021
Questions or Comments?
White Ash site (Sullivan County PA)

• Three ALDs installed in 1999 that contained 4,500 ton LS; ALDs lined

• Failed within 2 years due to plugging (inadequate plumbing; input of dirty surface water; poor quality limestone)

• 2017 the system was opened and ~2,000 tons limestone was cleaned; new collection system installed; new influents/effluents

• System is treating 600 gpm flow.
The limestone in Cell C was severely fouled but it was all cleaned. Moving all of the solids out of the bed was a challenge.
Limestone cleaning. The mini excavator on the left directed flow as the 315 on the right mixed the stone. Water flowed out of the bed through the flush pipes on the bottom.
<table>
<thead>
<tr>
<th></th>
<th>WALD</th>
<th>Pond 4 in</th>
<th>Pond 4 out</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flow, average</strong></td>
<td>169</td>
<td></td>
<td>106</td>
</tr>
<tr>
<td><strong>Flow, max</strong></td>
<td>413</td>
<td></td>
<td>300</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>3.3</td>
<td>3.4</td>
<td>7.6</td>
</tr>
<tr>
<td><strong>Alkalinity</strong></td>
<td>0</td>
<td>0</td>
<td>112</td>
</tr>
<tr>
<td><strong>Acidity</strong></td>
<td>119</td>
<td>96</td>
<td>-57</td>
</tr>
<tr>
<td><strong>Fe</strong></td>
<td>2</td>
<td>3</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Al</strong></td>
<td>12</td>
<td>4</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Mn</strong></td>
<td>3</td>
<td>31</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Number DLBs</strong></td>
<td>five</td>
<td>four</td>
<td></td>
</tr>
<tr>
<td><strong>DLB arrangement</strong></td>
<td>parallel</td>
<td>parallel</td>
<td></td>
</tr>
<tr>
<td><strong>Ton LS per DLB</strong></td>
<td>1,000</td>
<td>1,500</td>
<td></td>
</tr>
<tr>
<td><strong>Ton LS, total</strong></td>
<td>5,000</td>
<td>4,700</td>
<td></td>
</tr>
<tr>
<td><strong>Stone size</strong></td>
<td></td>
<td></td>
<td>AASHTO 5</td>
</tr>
<tr>
<td><strong>Stone CaCO₃</strong></td>
<td>94% @ CaCO₃</td>
<td>92% @ CaCO₃</td>
<td></td>
</tr>
<tr>
<td><strong>Settling</strong></td>
<td>Single pond</td>
<td>Single pond</td>
<td></td>
</tr>
</tbody>
</table>
Flow distribution structure