Restoration and Rehabilitation of the Big Slackwater Section of the Historic C&O Canal Along the Potomac River

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History of the C&O Canal

• Importance of Waterways to Colonial America
  • Chesapeake Bay
  • Potomac un-navigable due to Piedmont.
• George Washington’s Patowmack Company 1785.
• Erie Canal Success (1817-1825)
History of the C&O Canal

• Construction on Chesapeake & Ohio Canal began July 4, 1828
  • 1831: Seneca, MD
  • 1834: Harpers Ferry, WV
  • 1839: Woodmont, MD
  • 1850: Cumberland, MD

• Baltimore & Ohio Rail Road
  • Started at same time as C&O Canal
  • Completed in 1842 along same route and C&O canal.

Photos courtesy of C&O National Historical Park
History of the C&O Canal

- Transported Coal from Cumberland MD
- Trip took 4.5 Days from Cumberland to Georgetown (D.C).
- Mules towed 92 foot long barge loaded weight 120 tons.
- 540 boat trips a year peak performance.

Photos courtesy of C&O National Historical Park
History of the C&O Canal

• Fall of the C&O Canal
  • Started with the 1889 Johnstown, PA Flood.
  • A series of large floods ruined the canal
  • No money to repair the damage
  • 1924: B&O Railroad bought and operated the canal until when floods damaged and drained parts of the Canal
  • U.S. Government was given the canal by B&O to overlook $2 Million in debt.
  • 1950: Justice William Douglas stopped the plan to turn it into a scenic highway.
  • 1961: Designated a National Monument by President Eisenhower.
  • 1971: Designated a National Park by President Nixon.

Photos courtesy of C&O National Historical Park
Geologic Setting of the C&O Canal

- Crosses five physiographic provinces (three major)
  - Coastal Plain – **Piedmont** (Potomac and Westminster Terrane, Culpepper Basin, Fredrick Valley, Blue Ridge)– **Valley and Ridge** – Appalachian Plateaus.

![Geologic Setting Map](OFR-01-188B)

*After Southworth et al., 2001*
Study Area: Big Slackwater

USGS Quadrangle: Williamsport, MD
Conococheague Formation, a massive Upper Cambrian limestone
Advanced Karst Topography
Toe Path (Circa 1989)
Value Engineering

- Original Design
  - Rock Socketed Caissons
  - Difficulty in construction

- Value Engineering
  - Rock Anchored Spread footing
  - 8 Bridges
  - 121 Piers
  - Loads
    - Uplift, river flow, flood, ice flow

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Top of Rock

- Minimal Subsurface investigation.
- 4 borings, 4 test pits
- 2 mile long project
- Gaps in Information
Bridging the information Gap: Electrical Resistivity
Foundation Excavation
Foundation Preparation
Anchor Installation Issues

- Flooding stopping progress
- Hole collapse after drilling
- Highly eroded rock
- Fractures
- Solution cavities
- Artesian well conditions
Rock Anchors

- 121 Piers (849 anchors total)
  - 7 Anchors per pier
    - 6 vertical
    - 1 angled down
  - Loads
    - Uplift, river flow, flood, ice

<table>
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<tr>
<th>Type</th>
<th>Diameter</th>
<th>Tensile Load</th>
<th>Depth</th>
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<tbody>
<tr>
<td>I</td>
<td>1 in.</td>
<td>77 kips</td>
<td>20’ deep</td>
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<tr>
<td>II</td>
<td>1 3/8 in.</td>
<td>142 kips</td>
<td>28’ deep</td>
</tr>
<tr>
<td>III</td>
<td>1 ¾ in.</td>
<td>240 kips</td>
<td>40’ deep</td>
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Flooding
Anchor Testing Issues

- Flooding
- Incorrectly calibrated jack
  - Load Cell Fix
- Two Failures.
  - 1: Manufacturing flaw
  - 2: Initial anchor failure
  - Redesign of Pier.
Super Structure/ Jet Grouting
Final Product
Thanks!

- National Park Service
- Cianbro
- Richard Lawrie & Assoc.