Session C3 - Fish Passage Restoration at the Briggsville Dam: Using Sediment Transport Analysis for Natural Channel Design

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FISH PASSAGE RESTORATION AT THE BRIGGSVILLE DAM:
USING SEDIMENT TRANSPORT ANALYSIS FOR
NATURAL CHANNEL DESIGN

Presented to:
National Conference on Engineering and Ecohydrology for Fish Passage
University of Massachusetts Amherst

August 31, 2009

November 1, 2010

April 28, 2011

June 5, 2012

Presented by:
Jessica C. Louisos
Roy Schiff, Jim MacBroom
Milone & MacBroom, Inc.
Project partners include Cascade School Supplies, the USDA Natural Resources Conservation Service, American Rivers, the Town of Clarksburg, the Massachusetts Division of Ecological Restoration, the U.S. Fish and Wildlife Service, the Eastern Brook Trout Joint Venture, the Wildlife Conservation Society, Hoosuc Chapter of Trout Unlimited, the Corporate Wetlands Restoration Partnership, Proctor & Gamble, nationalgrid, the Hoosic River Watershed Association, MassWildlife, Sweet Water Trust and the Massachusetts College of Liberal Arts, Milone & MacBroom, Inc., Fuss & O’Neill, Inc.
PROJECT GOALS

- Remove Briggsville Dam
  - 15 feet high
  - 145 feet long
  - Concrete structure

- Reconnect 30 miles of headwater streams along the North Branch of the Hoosic River

- Improve Fish Passage and Local Habitat for:
  - Eastern brook trout
  - Longnose sucker
  - Slimy sculpin

- Reduce flood risks associated with possible dam failure
PROJECT CONSTRAINTS

- Cross Road Bridge – 750 feet upstream
- Impoundment full of coarse sediment
PROJECT TIMELINE

- 1848 – Dam Built

- 2006 – 2008 - Initial design by others based on traditional hydraulic design
  - Rigid bed design
  - Many structural elements

- 2009 - MMI began with peer review
  - Expanded Analysis
  - Final Design/Permitting

- Fall 2010 – Deconstruction of Briggsville Dam

- Spring 2011 – Final stage of site restoration

- Late Summer 2011 – Tropical Storm Irene
DEGRADATION ISSUES

- Will dam sediments erode?
- Will sediments become armored?
- Will erosion rate > deposition rate?
- Future base level?
- New equilibrium slope?
- Will future channel gradient undermine bridge?
FIELD WORK

- Multiple reach geomorphic inspection and classification
- Substrate identification
PROFILE & EQUILIBRIUM SLOPE

- Shields Resistance to Motion = 1.3 to 2.4%
- Sediment Transport Modeling = 2%
- Connection of Slope Transitions = 2%
- Proposed Slope = 2%
STABLE CHANNEL DIMENSIONS

- Estimated using HEC-RAS, Copeland Method
- Range of Sediment Concentrations (100-1000 ppm)
- Will need to reintroduce the low flow and bankfull channels and floodplain

<table>
<thead>
<tr>
<th>$C_{\text{sediment}}$ (ppm)</th>
<th>Width (ft)</th>
<th>Depth (ft)</th>
<th>EGL slope (%)</th>
<th>Velocity (ft/sec)</th>
<th>Shear (lb/ft$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ppm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>51.3</td>
<td>4.5</td>
<td>1.6</td>
<td>9.8</td>
<td>4.6</td>
</tr>
<tr>
<td>500</td>
<td>48.9</td>
<td>4.0</td>
<td>2.7</td>
<td>11.7</td>
<td>6.6</td>
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<tr>
<td>1000</td>
<td>46.5</td>
<td>3.8</td>
<td>3.5</td>
<td>12.9</td>
<td>8.3</td>
</tr>
</tbody>
</table>
TYPICAL CHANNEL SECTION

INSTALL FASCINE AT TOE OF SLOPE (SEE DETAIL)

MAINTAIN EXISTING VEGETATION OR REPLANT WITH SEED MIX FOR APPROPRIATE BANK SLOPE

EXISTING GRADE

PROPOSED GRADE

40°-60°

20°-25°

VARIATION

15°-36° ROUNDED STONE
USE NATIVE STONE WHEREVER POSSIBLE

NATIVE STREAMBED MATERIAL

POINTER OF APPLICATION OF GRADE

TYPICAL SECTION "B"
HYDRAULIC RUN WITH FLOODBENCH

NOT TO SCALE
SEDIMENT TRANSPORT – EXISTING 10-YEAR
LOCAL BRIDGE SCOUR

- Scour Analysis Followed Hydraulic Engineering Circular No. 18 (FHWA, 2001) using HEC-RAS
- Right Abutment Scour Calculated for both Existing and Proposed = No Change
- No Contraction Scour
DESIGN CONCLUSIONS

- Live bed design possible, without rock weirs
- Sediment source verified by modeling and history
- Minor degradation and aggradation anticipated in Post-dam Channel
- Pre-dam Slope = Equilibrium Slope = 2%
- Bridge Subject to Scour, Existing and Proposed
FINAL DESIGN
BRIDGE SCOUR COUNTERMEASURES

- Extend existing riprap to top of bank
- Add toe boulders to deflect and break up flow path
- Grout between existing riprap under bridge
RESTORATION
DEGRADATION MONITORING

- After spring floods:
  - upstream unchanged
  - downstream aggraded 0.5 feet

- After Tropical Storm Irene:
  - upstream degraded 1.5 feet
  - downstream degraded 3.5 feet

<table>
<thead>
<tr>
<th>Date</th>
<th>Upstream</th>
<th>Downstream</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>November 1, 2010</td>
<td>19.7</td>
<td>20.6</td>
<td>No change during next three weekly measurements.</td>
</tr>
<tr>
<td>November 29, 2010</td>
<td>20.2</td>
<td>20.3</td>
<td>Midway through dam removal process</td>
</tr>
<tr>
<td>December 2, 2010</td>
<td>20.0</td>
<td>20.3</td>
<td>After large December 1 flood.</td>
</tr>
<tr>
<td>December 6, 2010</td>
<td>19.8</td>
<td>22.0</td>
<td>End of river construction</td>
</tr>
<tr>
<td>April 8, 2011</td>
<td>19.7</td>
<td>22.0</td>
<td>Beginning of vegetation planting</td>
</tr>
<tr>
<td>May 31, 2011</td>
<td>19.7</td>
<td>21.5</td>
<td>After Spring Flooding</td>
</tr>
<tr>
<td>November 2011</td>
<td>21.2</td>
<td>25</td>
<td>After Tropical Storm Irene</td>
</tr>
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RIVER PROFILE CHANGE

Briggsville Dam (removed)

Cross Road Bridge

Legend

25SEP2009 00:00:00 Ch Invert El (ft)
26SEP2009 06:00:00 Ch Invert El (ft)
PROJECT CONCLUSIONS

- Sediment transport and expanding the spatial scale of the study was essential for a geomorphically compatible design and helped reduce construction costs.

- Channel bed degraded near bridge as predicted by sediment transport as well as aggradation over the project reach.

- Dam successfully removed.

- Project goals for improved fish passage and local habitat and reduced flood risk were met.