MILLTOWN RESTORATION
Lessons Learned

River Restoration Northwest
Stream Restoration Symposium
February 2013

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Presentation Overview

1. Summarize the project design
   - Describe design elements and approach
   - Discuss evolution of design through implementation phases

2. Review project performance following three years of above-average floods
   - Share observations and monitoring data
   - Discuss lessons learned
   - Reflect on initial project uncertainty and peer review comments
Integrated Remediation & Restoration

- EPA Record of Decision
- Settlement Agreement
- Bypass channel
- March 2008: dam removal

2005-2007: Data collection and feasibility analysis
2008-2011: Design and bid documents
2008-2012 Implementation

- Peer review
- Restoration Plan
- Repositories & reclamation

2007-2009: Sediment removal
2.2M cubic yards
Grading Plan

Restoration Plan for the Clark Fork River and Blackfoot River near Milltown Dam

Features
- Main Channel
- Secondary Channel
- Point Bar
- Wetland
- Bankfull Floodplain (bankfull elevation to 2 ft. above bankfull)
- Low Terrace (2 to 3 ft. above bankfull)
- High Terrace (greater than 3 ft. above bankfull*)
- Existing Floodplain Surface (to remain undisturbed)
- Deer Creek Tributary (pending final design)
- Existing Spring
- Existing Secondary Channel

*Final elevation to be determined based on final cut/fill quantities.
Multi-stage Hydraulic Geometry

Geomorphic features tied to river stage

- High terraces contain 500-year flood (up to one mile wide)
- Low terraces contain moderate floods less than 10-year flood
- 150-ft active channel contains $\sim Q_{1.5}$ (3,200 cfs)
- Baseflow channel defined within bankfull channel for fish passage (bull trout migration)
Riverbed Construction

Engineered riffles and grade controls

• Allow mobile gravel bed
• Maintain floodplain connection
• Channel gradient ~ 0.003 ft/ft
Streambank Construction

**Lower stress/straight banks**

- Bioengineering techniques on constructed toe
- Short term bank protection
- Reduce erosion
- Promote vegetation
Streambank Construction

High stress banks & outer bends

- Large woody debris structures
- Emulate naturally occurring stable accumulations of woody debris
- Bank protection
- Pool development
- Energy dissipation/flow steering
Floodplain Construction

- Wetlands & swales
- Roughness elements
- Growth media
- Planting
Side Channel Construction

- 5-10% of mainstem flow
- Activate at flows above baseflow
- Inlet/outlet geometry
- Structures only at inlet
Designing for Failure

- Select hydraulic criteria from flood events less than 100-yr
- Design bank toe protection at depths less than scour
- Maintain floodplain connection at less than $Q_2$
- Allow bed mobility up to measured size classes in bedload samples
- Use biodegradable fabrics, plant material and wood
- Specify round versus angular rock
2010-2011 Floods and Project Performance
2010 peak flow 5,900 cfs ~ $Q_4$

One month above $Q_{b kf}$
2010 Runoff ~ 3,200 cfs Bankfull
2010 Runoff ~ 6,000 cfs
2011 peak flow 13,300 cfs \sim Q_{32}

Two months above $Q_{b kf}$
August 2011

Photo: Gary Matson
November 2011

Photo: Gary Matson
Project Performance

- Discharge exceeded design criteria
- Localized changes in channel geometry
- Engineered riffles & grade control damaged
- Meander and LWD structures intact
- Bioengineering and toe damage
1. Document visual inspections of changes and identify potential maintenance sites.

2. Hypothesize causes of changes, trends and risk in the context of project objectives.

3. Confirm/reject hypotheses with data and analyses, if needed.

4. Assign risk to potential maintenance sites based on judgment and/or performance criteria.

5. Solicit input from peer reviewers for critical uncertainties.

6. Identify maintenance alternatives and priorities.
<table>
<thead>
<tr>
<th>Metric</th>
<th>2010</th>
<th>2011</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width (ft)</td>
<td>159</td>
<td>169</td>
<td>6.3</td>
</tr>
<tr>
<td>Mean Depth (ft)</td>
<td>3.7</td>
<td>3.8</td>
<td>2.7</td>
</tr>
<tr>
<td>Maximum Depth (ft)</td>
<td>5.4</td>
<td>7.0</td>
<td>29.6</td>
</tr>
<tr>
<td>Width/Depth Ratio</td>
<td>43.4</td>
<td>44.2</td>
<td>1.8</td>
</tr>
<tr>
<td>Area (Sq ft)</td>
<td>579</td>
<td>644</td>
<td>11.2</td>
</tr>
</tbody>
</table>
Initial Uncertainty & Peer Review

- Elevation of pre-dam floodplain
- Alluvium characteristics of pre-dam floodplain
- Performance of floodplain transitions
- Performance of side channels
- Stability of Entrance Reach and upstream reach
- Sediment transport characteristics
- Confluence hydraulics
- Overall project performance??
Pre-dam Floodplain

- Stumps found at varying elevations
- Alluvium characteristics variable
- Unable to identify pre-dam channel
- Influence of earthwork quantities
- Groundwater correlated to river surface water
Side Channel Performance

- Multiple design configurations
- Discharge exceeded design criteria
- Variable performance
- Entrance damage and debris buildup
- Conveyed more flow than expected
- New side channels formed
- Provided relief valves for main stem
- Modified design criteria for maintenance
Phase Transitions

- Upstream buffer
- Changing conditions year-to-year
- Confirm tie-ins
- Consider temporary stability measures
Performance of Floodplain Transitions
Confluence Hydraulics
Conclusions

• Balancing stability and deformability is a challenge
• Floodplain stability deserves equal attention as channel stability
• Maintenance evaluation process is useful for putting observations in context of goals
• Peer review is helpful, but not a substitute for your own judgment
• Positive trends apparent, but more time needed to evaluate overall success
Acknowledgements

State of Montana Natural Resource Damage Program
Montana Fish, Wildlife and Parks
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U.S. Fish and Wildlife Service
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Geum Environmental Consultants, Inc.
Envirocon, Inc.
Project Goals

- Goal 1 - maintain water quality.
- Goal 2 - restore a naturally functioning system that is appropriate for the geomorphic setting and site constraints.
- Goal 3 – provide preferred habitat for native fish and wildlife.
- Goal 4 – establish floodplain conditions that will allow the development of wetlands and diverse native plant communities.
- Goal 5 – provide visual and aesthetic values consistent with restoring the natural condition.
- Goal 6 – provide safe recreational opportunities compatible with the other goals and objectives.
Performance Criteria

- **Goal 2** - restore a naturally functioning system that is appropriate for the geomorphic setting and site constraints.

- **Objective** – reconstruct a meandering channel and broad floodplain that gradually transitions to an confined channel with a narrow, sloping floodplain.

- **Performance Criteria** – range of natural variability; +/-20% of design metrics.

- **Design Criteria** – morphology is similar to reference conditions.

- **Metrics** – channel and floodplain geometry.
# Timeframes for Expectations

<table>
<thead>
<tr>
<th>Short Term Expectations (0-15 Years)</th>
<th>Long Term Expectations (15+ Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structures control channel form, which in turn, dictates lateral and vertical channel stability</td>
<td>Vegetation dictates lateral channel stability. Channel armoring processes dictate vertical stability</td>
</tr>
<tr>
<td>Vegetation provides stability on floodplain surface and along streambanks</td>
<td>Vegetation communities are established and provide habitat and other riparian/wetland functions</td>
</tr>
<tr>
<td>Structures are stable</td>
<td>Structures decompose &amp; become buried</td>
</tr>
<tr>
<td>Habitat enhanced by bank stabilization and grade control structures</td>
<td>Habitat created by bed forms &amp; vegetation</td>
</tr>
<tr>
<td>Bank erosion rates are low</td>
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</tr>
<tr>
<td>Natural processes are maintained</td>
<td>Natural processes govern</td>
</tr>
</tbody>
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