Restoration of Abandoned Channels

Prepared for KICT, South Korea

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Statement of Work

1. Classification and analysis of abandoned channel restoration
2. Long-term channel changes after restoration
3. Technical reviews – (no report required for this component)
Abandoned Channel Processes – Natural cutoffs

- **Chute cutoffs**
  - Occur when river cuts through the point bar, thus decreasing sinuosity
  - Channel forms a middle bar.

- **Neck cutoffs**
  - Lateral migration increases sinuosity of the channel until two bends connect
  - Sedimentation plug forms an abandoned channel called oxbow lake.

Examples of Natural Cutoffs

- **Chute Cutoff**
  - Williams River, AK
  - (Photo by N.D. Smith)

- **Neck Cutoff**
  - Owens River, CA
  - (Photo by Marli Bryant Miller)
Abandoned Channel Processes – Engineered Cutoffs

- **Designed for Navigation and/or Flood Control**
- **Protect river path by constructing revetment upstream and downstream of outer side of meander**
- **Excavate small trench and build revetment on inside at meander neck**
- **Excavate pilot channel at meander neck from downstream to near upstream (1V:3H Side Slope, 15 to 60 m bottom width, 2 to 4 m below low-water reference plane)**

Examples of Engineered Cutoffs

- Earth plug separating pilot channels
- Dynamite removal of earthen plug
- One hour after opening cutoff
- Greenville Bends, Ashbrook, Tarpley and Leland Cutoffs

Abandoned Channel Restoration
Analysis of Key Factors

Problems

- Contaminated Runoff from Non-Point Sources
  - Turbidity
  - Sediment
  - Nitrogen
  - Phosphorous
  - Dissolved Oxygen
- Reduction in Water Level
  - Dewatering
  - Lack of Connectivity to main channel

Effect

- Loss of Aquatic Habitat
  - Fish Kill
- Reduction in Recreational Value
- Hypoxic Conditions with Lake

Abandoned Channel Restoration Classification

<table>
<thead>
<tr>
<th>Type of Restoration</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riparian Wetlands</td>
<td>Improved Water Quality, Enhance Wildlife Habitat</td>
</tr>
<tr>
<td>Agronomics</td>
<td>Reduced Sediment, Nitrogen and Phosphorous</td>
</tr>
<tr>
<td>Edge-of Field Practices</td>
<td>Reduced Sediment</td>
</tr>
<tr>
<td>Stream Buffer Strips</td>
<td>Reduced Sediment, Nitrogen and Phosphorous</td>
</tr>
<tr>
<td>Bank Stabilization</td>
<td>Reduced Sediment</td>
</tr>
<tr>
<td>Weir Construction</td>
<td>Increase flow interaction, improve water quality, navigation</td>
</tr>
<tr>
<td>Dam and gate</td>
<td>Increase flow interaction and improve water quality</td>
</tr>
<tr>
<td>Pump to divert flow out of lake</td>
<td>Improve Water quality</td>
</tr>
<tr>
<td>Dredging</td>
<td>Remove organics, nutrient rich sediment and deepen lake</td>
</tr>
<tr>
<td>Adding Water from Power Plant</td>
<td>Increase flow depth</td>
</tr>
<tr>
<td>Riparian Buffer</td>
<td>Prevent channel migration</td>
</tr>
</tbody>
</table>
Best Management Practices
Analysis and Evaluation Examples

- Mississippi River
  - Beasley (Edge of Field)
  - Deep Hollow (Edge of Field and Agronomics)
  - Thighman (Agronomics)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Beasley Pre BMP</th>
<th>Beasley Post BMP</th>
<th>Deep Hollow Pre BMP</th>
<th>Deep Hollow Post BMP</th>
<th>Thighman Pre BMP</th>
<th>Thighman Post BMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secchi (cm)</td>
<td>14</td>
<td>17</td>
<td>12</td>
<td>25</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>Total Solids (mg/L)</td>
<td>482</td>
<td>265</td>
<td>351</td>
<td>143</td>
<td>505</td>
<td>334</td>
</tr>
<tr>
<td>Suspended Solids (mg/L)</td>
<td>429</td>
<td>202</td>
<td>289</td>
<td>70</td>
<td>405</td>
<td>169</td>
</tr>
<tr>
<td>Dissolved Solids (mg/L)</td>
<td>58</td>
<td>65</td>
<td>52</td>
<td>75</td>
<td>115</td>
<td>166</td>
</tr>
<tr>
<td>Nitrate (mg/L)</td>
<td>0.534</td>
<td>0.553</td>
<td>0.393</td>
<td>0.387</td>
<td>1.157</td>
<td>0.85</td>
</tr>
<tr>
<td>Ammonium-Nitrogen (mg/L)</td>
<td>0.123</td>
<td>0.139</td>
<td>0.189</td>
<td>0.116</td>
<td>0.168</td>
<td>0.224</td>
</tr>
<tr>
<td>Total Phosphorous (mg/L)</td>
<td>0.496</td>
<td>0.344</td>
<td>0.522</td>
<td>0.233</td>
<td>0.437</td>
<td>0.299</td>
</tr>
<tr>
<td>Ortho Phosphorous (mg/L)</td>
<td>0.032</td>
<td>0.049</td>
<td>0.019</td>
<td>0.046</td>
<td>0.018</td>
<td>0.044</td>
</tr>
<tr>
<td>Chlorophyll (μL)</td>
<td>16.6</td>
<td>118.9</td>
<td>24.4</td>
<td>61</td>
<td>9.9</td>
<td>72.2</td>
</tr>
</tbody>
</table>

(Knight, 2004)

Example of Wetland Restoration
Rouge River, Dearborn, Michigan

Example of Cross Section

(O’Meara 2002-2003)
Examples of Restoration

Best Management Practices

- Edge of Field BMP
- Riparian Buffers
- Crop Cover
- Broad-based conservation banks
  - Controls Runoff and Soil Erosion
- Conservation Tillage

Various websites

Examples of Restoration

Engineered Solutions

- Dredging
- Dike Construction
- Bearing Creek, Georgia
- Collins Lake, NY – After Dredging
- Google Maps
- Waal River, Netherlands

Long Term Studies of Abandoned Channels - Engineered Cutoff

• Greenville Reach

<table>
<thead>
<tr>
<th>Location</th>
<th>Construction Date</th>
<th>Cutoff Length</th>
<th>Bend Length</th>
<th>Change in Slope</th>
<th>Initial Dimensions</th>
<th>Post Construction Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashbrook Cutoff</td>
<td>Aug-35</td>
<td>4,530 ft</td>
<td>13.3 miles</td>
<td>15.5 Times Steeper</td>
<td>15 feet to 23 feet below low water</td>
<td>River widened causing formation of bars which required dredging</td>
</tr>
<tr>
<td>Tarpley Cutoff</td>
<td>Jan-35</td>
<td>13,000 ft</td>
<td>12.2 miles</td>
<td>5 Time Steeper</td>
<td>Cutting occurred from the downstream to upstream initially. The width was from 250 to 300 feet. The flow depth was 15 feet below low water level.</td>
<td>Soil was sandy and resulted in the development of bars which caused the river tendency to be braided. Dredging was needed for many years.</td>
</tr>
<tr>
<td>Leland Cutoff</td>
<td>Jul-33</td>
<td>4,600 ft</td>
<td>11.2 miles</td>
<td>13 Times Steeper</td>
<td>Not Available</td>
<td>Dredging due to braiding of river and excessive sediment transported by the upstream cutoffs.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Construction Requirements to Maintain Navigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior to 1934</td>
</tr>
<tr>
<td>Number of times crossings were dredged to maintain navigation</td>
</tr>
<tr>
<td>Length of revetment to hold channels</td>
</tr>
<tr>
<td>Length of dikes in reach</td>
</tr>
<tr>
<td>Length of river from upstream end of construction to lower end</td>
</tr>
</tbody>
</table>

Mississippi River - Greenville Reach

(Winkley 1977)
Mississippi River
Leland and Tarpley Cutoffs

Long Term Studies of Abandoned Channels – Chute Cutoff

- Choctaw Bar
  - Stabilization the river for navigation and flood protection
  - Flow is divided due to a chute cutoff
  - 1968 a stone dike system was constructed
  - 1973 a large section of the main closure dike degraded, creating a weir, which allows significant flow in the secondary channel and caused sedimentation within the main channel requiring dredging.
  - Vegetation on the islands is natural and provide bar stabilization and wildlife habitat.
Summary

1. Classification and analysis of abandoned channel restoration projects
   - Abandoned channel processes
   - Natural and engineered cutoffs
   - Identification and analysis of key factors
   - Classification for restoration of abandoned channels
   - Type of restoration and benefits
   - Analysis and evaluation example
   - Examples of wetlands, BMP's and engineered solutions

2. Long-term channel changes after restoration
   - Review and analysis of engineered neck cutoffs
   - Review and analysis of an engineered chute cutoff