Analysis & Design Techniques for Fish Passage in Urban Streams

Case Study:
South Fork Steele Creek
Kitsap County, WA

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Project Background

Key Groups:
- SCORE
- Kitsap County
- SRFB
- Parametrix

*Once you catch ‘em, you got to dip ‘em back out*
Project Overview

South Fork Steele Creek
Kitsap County, WA

• Project cost $1.5 Million
• Restored access to 1.9 miles of habitat for coho, chum, and sea-run cutthroat trout
• Restored 1,200 feet of channel
• Constructed two 24-foot box culverts
SF Steele Creek Watershed
- 1,185 acres
- 37% Impervious
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- 37% Impervious
Pre-Project Site Conditions
Objectives

- Fish Passage
- Channel Stability
- Cost Effective Design
- Improved Habitat
- Low Maintenance

Constraints

- Steep Gradient
- Brownsville Hwy
- Altered Hydrology
- Altered Sediment Regime
Stream Design: Hypothesis

- Site alterations and watershed position may result in a morphology that differs from the upstream reach
Geomorphic Analysis

• Data from stream surveys
  – Upstream reach of Steele Creek
  – Reference reach Dickerson Creek
  – Range of values for geomorphic parameters
  – Values used for design
Geomorphologic Analysis

Steele Creek Watershed

Chico Ck Watershed
Reference Reach: Dickerson Creek

Upstream Reach: SF Steele Creek
## Geomorphic Analysis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Upstream Reach: SF Steele Creek</th>
<th>Reference Reach: Dickerson Creek</th>
<th>Project Reach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradient</td>
<td>1.8%</td>
<td>3.6%</td>
<td>3.1 %</td>
</tr>
<tr>
<td>Bankfull Width (ft)</td>
<td>30</td>
<td>20.3</td>
<td></td>
</tr>
<tr>
<td>Entrenchment Ratio</td>
<td>2.2</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>Morphology</td>
<td>Pool-riffle</td>
<td>Forced Step-pool</td>
<td></td>
</tr>
</tbody>
</table>
## Design Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Average</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bankfull Width (ft)</td>
<td>30</td>
<td>25</td>
<td>34</td>
</tr>
<tr>
<td>Floodprone Width (ft)</td>
<td>77</td>
<td>65</td>
<td>88</td>
</tr>
<tr>
<td>Average Bankfull Depth (ft)</td>
<td>2.2</td>
<td>1.9</td>
<td>2.5</td>
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<tr>
<td>Pool Max Depth (ft)</td>
<td>5.1</td>
<td>3.2</td>
<td>6.9</td>
</tr>
<tr>
<td>Step-Pool Spacing (ft)</td>
<td>30</td>
<td>24</td>
<td>63.1</td>
</tr>
<tr>
<td>Morphology</td>
<td>Forced Step-pool</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Stream Design: Hypotheses

• Critical elements of the geology that would result in a stable step-pool morphology are not present at the site; but can be replicated with design elements.

• The “steps” can be designed to engage as the stream profile adjusts
Post Project Flood: “The Test”

- Storm: December 2007
  - 10-inches/24-hours
  - P100 = 5.5-inches/24 hours
- Erosion focused in the middle of the channel
- Large rocks shifted
- Pools enlarged
Four Year Follow-up

• Profile is stable
  – Aggregation
    • Medial bar formation
    • Sand bar formation
  – Scour
    • Pools are deeper and more frequent
• Rock weirs shifted
  – Preventing headcuts/vertical instability
Steele Creek Profile

4-Year Survey Slope = -0.0302
Design Slope = -0.0312
Steele Creek Profile

4-Year Survey Slope = -0.0302

Design Slope = -0.0312

Stream Length (ft)

Elevation (ft)
Steele Creek Profile

Graph showing the elevation and stream length with measurements:
- Bankfull: 55.0'
- Design: 34.8'
- Rock Weirs: 38.1'
- Field Work 2011: 24.6'
Pool Depth

Design

4-Yr

Avg = 2.7 ft

Avg = 3.1 ft

Avg = 5.1 ft

*calculated from dimensionless ratios
### Summary of Pools

<table>
<thead>
<tr>
<th>Pool Spacing (ft)</th>
<th>As-Built</th>
<th>Field</th>
<th>Geomorphic Prediction*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>55</td>
<td>36</td>
<td>30</td>
</tr>
<tr>
<td>Maximum</td>
<td>101</td>
<td>61</td>
<td>54</td>
</tr>
<tr>
<td>Minimum</td>
<td>36</td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td>Number of Pools</td>
<td>11</td>
<td>16</td>
<td>19</td>
</tr>
</tbody>
</table>

*calculated from dimensionless ratios*
Shifted Weirs
Hydraulic Analysis of Culvert

- USGS regression equations
- WDFW stream simulation
  - $1.2 \times WBKF + 2$ feet
  - Resulted in a 36-foot opening
- WDFW Hydraulic design option for the culverts
  - Resulted in a 24-foot opening
  - Met velocity and depth requirements
Post Construction Culvert
4-Years Later
Questions?

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