Restoring Floodplain Capacity and Hyporheic Function in an Urban Setting – Thornton Confluence and Kingfisher Projects

Mike (Rocky) Hrachovec, P.E.
Project Locations: Historic Map of Thornton Creek

- North Branch
- Confluence Site
- South Branch
- Mainstem
- Kingfisher Site
Project Locations: Current Map of Thornton Creek

- 7,400 Acre Basin
- 50% Impervious
- Channel width 2X historic
- Sediment 6-10X historic
## Project Stats

<table>
<thead>
<tr>
<th></th>
<th>Kingfisher Project (Completed 2014)</th>
<th>Confluence Project (Completed 2014)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stream Length</td>
<td>550 Ft.</td>
<td>950 Ft.</td>
</tr>
<tr>
<td>Area</td>
<td>2.5 Ac.</td>
<td>4.7 Ac.</td>
</tr>
<tr>
<td>Flood Benefit</td>
<td>4X flood storage</td>
<td>13X flood storage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No road closures</td>
</tr>
<tr>
<td>Stream Slope</td>
<td>1.6 %</td>
<td>0.7 %</td>
</tr>
<tr>
<td>Excavation Volume</td>
<td>8,700 CY</td>
<td>25,300 CY</td>
</tr>
<tr>
<td>Construction Cost</td>
<td>$ 1.4 million</td>
<td>$ 5.6 million</td>
</tr>
<tr>
<td>Stream Crossing</td>
<td>80’ Pedestrian Bridge</td>
<td>33’ X 60’ Culvert</td>
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</tbody>
</table>
Design Approach: Restore natural processes

- Maximize floodplain, engage @ Q1.2
- Avoid / relocate utilities
- Channel - over-excavate for hyporheic, wood!
- Incorporate surface and sub-surface flows
- Diverse planting – wetland, floodplain & upland
Plunge Pool Design for Hyporheic Exchange

- Log
- Surface Flow
- Subsurface Flow
- Downwelling
- Upwelling
Confluence: Pre-Project Conditions
**Confluence: Design**

- Groundwater!
- Neighbors
- Road Closure
- Utilities!!

South Branch

- Logs: 145
- Gravel: 1,800 CY
- Wetlands: 1 Ac
- Plants: 21,000
Confluence: Just Completed
- Dynamic Stability
Confluence: Flood Relief
Confluence: Jan, 2017
- Diverse vegetation
- Pools w/wood
- Active floodplain & wetlands
- Popular for walking
- Significant increase from pre-project
- Diverse hyporheic patterns
- Plunge pool driving exchange
Kingfisher: Pre-Project Conditions
Kingfisher: Design

- Groundwater!
- School access
- Steep Slopes
- Utilities

Logs: 130
Gravel: 1,800 CY
Plants: 10,000
Kingfisher: Just Completed
Kingfisher: Jan, 2017
Kingfisher: Hyporheic Exchange

- Hyporheic flux: up to $1 \text{ m}^3/\text{m}^2\text{-d}$
- Diverse hyporheic patterns

- Downwelling
- Upwelling
Hyporheic Temperature:
- As much as 2°C Celsius cooler in restored reaches
- Add’l cooling expected as veg grows (shade)

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**Hyporheic Temperature Chart**

*2014*

*2015*

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Water Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>REFERENCE</td>
<td>R: 6.2, 6.8, 8.4, 9.7, 10.4</td>
</tr>
<tr>
<td></td>
<td>TREATED</td>
<td>R: 6.2, 6.8, 8.4, 9.7, 10.4</td>
</tr>
<tr>
<td></td>
<td>CONTROL</td>
<td>R: 6.2, 6.8, 8.4, 9.7, 10.4</td>
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</tbody>
</table>

**Legend**
- REFERENCE
- TREATED
- CONTROL

**Locations**
- **KN** = Kingfisher
- **NF** = Confluence North Fork
- **SF** = Confluence South Fork

**Note**
(R) = Reference
Hyporheic Invertebrates (Food Supply):
- Density & Richness 2-3X higher in restored reaches

Forest
(R) = Reference

Urban
(KN) = Kingfisher
(NF) = Confluence
(SF) = Confluence
North Fork
South Fork
WHERE’S THE FISH???

- Most fish in pools
- Dot = 3 mo’s presence
- More full stomachs @ Kingfisher
Successful Floodplain Process Restoration

• INCREASED FLOOD STORAGE AND WETLANDS
• COMPLEX IN-CHANNEL HABITAT AND HYDRAULICS
• COOLER WATER
• INCREASED FOOD SUPPLY
• VIBRANT DIVERSE VEGETATION

• Stay Tuned – future monitoring, movie
Big Thanks To:

- **Paul Bakke, USFWS** – Hyporheic Concept & Monitoring
- **Sarah Morley, Linda Rhodes, Anne Baxter** - NOAA – Water Quality & Biological Monitoring
- **Katherine Lynch, Seattle Public Utilities** – Fish Monitoring
- **Shelly Solomon, Leaping Frog Films** – Images
- **Seattle Public Utilities** – $$ - Design & Construction