What is a Pool and Chute Fishway?

- Hybrid type fishway that operates in two flow regimes, plunging and streaming flow
- Low flow – Pool and Weir
- High Flow - Chute
Low Flow – 0.5 cfs

Medium Flow – 15 cfs
High Flow – 35 cfs

Background

- Rainbow Creek
- WDFW Model Study
- Town Dam
- Bates, 1991 AFS Paper

Photos by Ken Bates
Pool and Chute - Definition

- Side Walls
- Baffle
- Weir
- Port
- Floor

Pool and Chute - Cross Section

- \( W \)
- \( \theta/2 \)
- \( X_{pc} \)
- \( d \)
- \( b \)
- \( P_b \)
- \( P_w \)
Pool and Chute – Profile – Plunging Flow
Pool and Chute – Profile – Streaming Flow

Equations

\[ Q = CLH^2 \] Flow over a weir

\[ V = C\sqrt{RS_0} \] Open channel flow Chezy Eq.

\[ EDF = \gamma QH/Volume \]
Research on streaming/plunging flow regimes


\[ Q_t = 0.25 \sqrt{gbS_o L^2} \]

Streaming/Plunging Flow Regimes

Transition

Streaming

Plunging
Streaming/Plunging Flow Regimes
Streaming Flow – High Design Flow

Plunging
Streaming
EDF

Good/Fair Passage Corridor
Streaming transition flow calculations

\[ Q_t = 0.25 \sqrt{gbS_o \frac{3}{L^2}} \]

Example: \( b = 6 \text{ ft} \) \( S_o = 10\% \)

\( L = 4 \text{ ft} \) \( Q_t = 7 \text{ cfs} \)

\( L = 6 \text{ ft} \) \( Q_t = 12 \text{ cfs} \)

\( L = 8 \text{ ft} \) \( Q_t = 19 \text{ cfs} \)

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Case Studies - Parameters

<table>
<thead>
<tr>
<th>Site</th>
<th>W</th>
<th>L</th>
<th>b</th>
<th>( P_b )</th>
<th>S_o</th>
<th>theta/2</th>
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<td>(ft)</td>
<td>(ft)</td>
<td>(ft)</td>
<td>(ft)</td>
<td>(ft/ft)</td>
<td>(deg)</td>
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<td>76</td>
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Case Studies - Results

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<th>d or H (ft)</th>
<th>Q (cfs)</th>
<th>$Q_t$ (cfs)</th>
<th>C (ft)</th>
<th>$X_{pc}$ (ft)</th>
<th>EDF</th>
<th>Passage Rating</th>
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Fairchild Trib: W = 12 ft

- Q = 44 cfs
- D = 1.75 ft
- $Q_t$ = 5.3 cfs
- Chezy C = 31.5
- $X_{pc}$ = 1.2
- EDF = 2.4
- Passage Rating: Fair
Fairchild Creek: $W = 12 \text{ ft}$

- $Q = 27 \text{ cfs}$
- $D = 1.65 \text{ ft}$
- $Q_t = 5.3 \text{ cfs}$
- Chezy $C = 20.5$
- $X_{pc} = 1.6$
- EDF = 2.1
- Passage Rating
  - Good

Percival Creek: $W = 10 \text{ ft}$

- $Q = 24 \text{ cfs}$
- $D = 1.5 \text{ ft}$
- $Q_t = 5.3 \text{ cfs}$
- Chezy $C = 22.3$
- $X_{pc} = 1.5$
- EDF = 1.3
- Passage Rating
  - Good
Fairchild Comparison

Chezy C vs $Q_{st}$

Unit $Q_{st}$ (cfs/ft)
Design Parameters

- **Overall Drop:** maximum 4 to 5 feet
- **Fishway Width:**
  - 10 cfs = 8 feet, 25 cfs = 10 feet
  - 50 cfs = 14 feet, 120 cfs = 20 feet
- **Slope/Drop per Weir = 0.5 to 1.0 feet**
  - Most u/s weir 0.2 ft less
- **Pool Length = 45 to 55% of width**
- **Weir Length = 17 to 20% of width**
- **Weir Height = minimum 2.5 feet**

Design Parameters

- **Baffle Height =** $WS @ 0.75Q_{st}$
- **Baffle Slope = 76°**
- **Fish Passage Corridor: 2 feet**
- **EDF: 2**
- **Submerged Ports: Only 16 cfs min flow**
Design Steps

- Calculate high $Q_{fp}$
- Select: $W$, baffle slope, drop, $L$, $b$, $P_w$
- Calculate: $Q_t$
- Select $d$ and $C$
- Trial and error until $Q = Q_{fp}$
- Check: EDF, $X_{pc}$

Design Spreadsheet: powerpdp@dfw.wa.gov

Limitations/Potential Research

- Number of weirs and fishway length
- Alignment (half Pool and Chute)
- Roughness values (weir/baffle crest shape)
- EDF – juvenile passage studies
- Scour potential at outlet
Summary

- Applicable to low head dams and some culvert retrofits with drops 4 to 6 feet.
- Improved attraction flows over other fishway types
- Many are self cleaning (gravel/small cobbles)
- Diverse passage routes for all life stages of salmonids