Concurrent Sessions D: Designing Roughened Channels for Fish Passage - Selection, Design and Construction of Roughened Channels for Fish Passage

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DESIGN AND CONSTRUCTION OF ROUGHENED CHANNELS FOR FISH PASSAGE

Fish Passage 2013

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Roughened channels are man-made fish passage channels which are used to retrofit passage through culverts, over dams and other structures. They differ from natural channel designs in that they are usually steeper and/or narrower than adjoining channels. But, should include natural channel features.
Other Names?

Rock Ramps – No Change in Bed Form

Chutes and Pools – Step/Pool

Rock Weirs – Drop Structures

Nature Like Fishways – Mimicking Natural Systems
Nature Like Fishways

Bypass Channels

Rock Ramps

Riffle Pool
Step Pool
Weir and Pool
Riprap

Laura Wildman
Natural Channel Features

- Plan View
  *Straight Channels due to gradient*
- Cross Section
  *V or U shaped to create variable depth and reduced velocity boundary layer*
- Profile
  *Step/Pool*
- Fish or Habitat Boulders or LWD?
  *Resting/Cover*
Problem?

Streambed

Dam or Culvert

Roughened Channel
Roughened Channel/Stream Simulation

Stream simulation is more of a reference reach/geomorphic design process, where fish passage is assumed based on the presence and long term stability of maintaining a natural features within a defined range of slope.

As Slope Increases SS and RC are similar.
Data Collection For Roughened Channel Design

- Fish Species and Life Stage
- Hydrology – Fish Passage and Flood Flows
- Survey Profile and Channel Geometry
- Pebble Counts – Background Sediment
- Steep Reference Reaches
Important Design Aspects

- Velocity
- Bed Stability
- Turbulence
- Bed Porosity
- Foundation
- Fish Rocks
WDFW Juvenile Fish Passage Study

60 mm Coho
Carey Creek

Channel Construction: 2000

8.0% Slope @ 45'-long
Armor Layer = 12”-24” boulders
Energy Dissipation Factor @ High Fish Passage Flow = 30.0 ft-lb/ft³/sec.

Paul Tappel
Fisheries Engineering, Inc.
Slide Creek

Channel Construction: 2004

10.0% Slope @ 110'-long Armor Layer = 12”-36” boulders
Energy Dissipation Factor @ High Fish Passage Flow = 41.6 ft-lb/ft$^3$/sec.
Green Creek - Before
Green Creek Profile

Cross Section
Excavation

Riprap
Foundation

Roughened
Channel Mix
and Boulders
Green Creek - After
High Design Flow 320 cfs
Mill Creek – Plan View Layout
Mill Creek – Profile and Cross Section

Final Grade to be 6” thickness (3” Minus Pit Run Gravel with fines) washed into bed to seal at flows of 3 cfs.

Roughened Channel Mix, 18” Thickness

Habitat Boulders

Heavy Loose Riprap 2.5” Thickness

STA 117+80 Showing Rock Detail

SCALE 1”=10’

3.5%
Roughened Channel Design Equations

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<th>Design</th>
<th>Q Design</th>
<th>Channel Slope</th>
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Channel Stability Analyses

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Unit Q 135 cfs/ft

Fish Passage Analysis

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<th>Channel Width: 25 ft</th>
<th>Channel Slope: 0.028</th>
<th>Design Slope: 4 fps</th>
<th>Design Velocity: 29.0 f/s</th>
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<tbody>
<tr>
<td>Channel Width: 25 ft</td>
<td>Channel Slope: 0.028</td>
<td>Design Slope: 4 fps</td>
<td>Design Velocity: 29.0 f/s</td>
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<th>R““n”</th>
<th>F</th>
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<th>V (D50)</th>
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Roughened Channel Design Process

![Graph showing the relationship between Max Velocity (fps) and Mannings n. The graph includes a blue line for HEC RAS Design 0.085 and a red dashed line for Design for Trout. A black arrow points to the intersection of the two lines, labeled Ugarte and Madrid, 1994.]