Optimisation of Fishway Entrance and Exit Conditions Using Physical Modelling: SARFIIP Pike Floodplain Regulator and Fishway Designs

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SARFIIP Pike Floodplain Regulator and Fishway Designs

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Aims of this Presentation

• Pike SARFIIP – Overview of the Tanyaca Creek and Pike River structures and fishway designs.
• Overview of fishway physical modelling at the UniSA AFMG facilities.
• Requirements for positioning the downstream fishway entrance in the right location and maintaining integrity of attraction flows to the fishway entrance, emphasising:
  – Entrance attraction, and
  – Fishway passage
• Discussion of the costs and benefits of physical modelling.
Pike Floodplain, Renmark, SA

Rainbowfish

Source: Google Maps
Project aims:
1. Restore floodplain health through managed inundation watering.
2. Restore fish passage connectivity.
Fishway Designs

• Regulator designs at Tanyaca Creek and Pike River the same therefore one physical model to suit both sites.

• Vertical slot fishways at each site:
  – Tanyaca Creek fishway design $\Delta H = 2.55$ m
  – Pike River fishway design $\Delta H = 1.55$ m

• Fishways designed to pass small, medium and large-sized native fish (20 to 800 mm long).
Fish of the Pike Floodplain

- Unspecked hardyhead
- Golden perch
- Australian smelt
- Silver perch
- Murray cod
Physical Modelling Aims

1. Identify and / or confirm optimal arrangement of the downstream fishway entrance in relation to the regulator gate positions at the ‘limit of upstream fish migration’
   - Normal flows, managed inundation and flood flows
2. Assess the suitable flow conditions for fish attraction and if required, design solutions to achieve ideal conditions.
3. Confirm optimal location for upstream exit to avoid fish recirculation back over the regulator gates.
4. Confirm the capacity of the fully opened regulator gates at 3,000 ML/d.
5. Confirm potential operational requirements.
6. Assess any potential safety issues.
Primary flow to 3,000 ML/d (regulator gates)

Secondary flow to 30 ML/d (fishway attraction)

Fishway entrance
In abutment

‘Flow straightening’ wall

Lay-flat gates x6

Piers

1:15 scale based on Froude No. similarity

Steel plate construction

AFMG Hydraulics Laboratory at Mawson Lakes UniSA Campus
Model Features

Flap gate controls D/S water level

Regulator gates control U/S water level

Secondary flow to 30 ML/d (fishway attraction)

Surge tank

Primary flow to 3,000 ML/d (regulator gates)

1:15 scale based on Froude No. similarity

Steel plate construction
Basis of Entrance Design (Successful Design Precedent)

Deep Creek Regulator & VS Fishway (Pike)

Lay-flat regulator gates

VS fishway entrance

1 m offset

High turbulence
Submerged nib wall

Fish shelter in quiet area below nib wall

20,700 fish (7 native species) trapped 03 to 12 Nov 2016
Basis of Flow Straightening Wall Design (Successful Design Precedent)

Bank J Regulator & VS Fishway (Katarapko)

‘Flow straightening wall’ (AKA the ‘brick paver’) D/S of first pier near Fishway entrance

Recirculation removed D/S of fishway entrance = positive attraction flow
Normal Conditions (Flow = 400 ML/d and $\Delta H = 1.15$ m)

- High water velocity over top of nib wall and turbulence behind = ‘limit of upstream fish migration’
- Flow through 3 gates closest to fishway entrance
- Fishway entrance set back 1 m
- Flow straightening wall
- 600 mm high nib wall below gates aligns with fishway entrance (quiescent below nib wall)

Safety Issue: Lay-flat gates created surface back-flow to the gates. Poor for fish attraction but also a drowning hazard. The nib wall created positive surface flows away from the gates. Good for fish attraction and mitigates potential drowning hazard.
Maximum Managed Inundation (Flow = 400 ML/d, ΔH = 2.55 m)

- High water velocity over top of nib wall and turbulence behind = ‘limit of upstream fish migration’
- Flows through 3 gates closest to fishway entrance
- 600 mm high nib wall below gates aligns with fishway entrance (quiescent below sill)
- Flow straightening wall
- Fishway entrance set back 1 m
Flooding ($\text{Flow} = 3,000 \ \text{ML/d}, \ \Delta \text{H} = 100 \ \text{mm}$)

- 5 gates fully opened
- $V = 0.9 \ \text{m/sec}$
- 1st gate raised to provide shallow depth and low velocity over gate
- Flow straightening wall
- 600 mm high nib wall below gates aligns with fishway entrance (quiescent below sill)
- Fishway entrance set back 1 m
Flooding
Tools of the trade: Velocity Meter and Dye
Assessing Integrity of Attraction Flows
Benefits of Scaled Fishway Physical Modelling in Sheet Metal Plate

1. Opportunity for design engineers to work directly with fish biologists and clients.
2. Ability to get the fishway entrance (and exit) in the right locations.
3. ‘Real time’ assessment of regulator / fishway hydraulics and ability to quickly adjust the model.
4. Determination of operational requirements.
5. Cost competitive with CFD modelling:
   - Pike model cost (AFMG at UniSA) = $28k
   - Engineering plus biology = $12k
   - Total = $40k (Note: all costs subject to design requirements)
     • 4 weeks construction time + 2 days testing
6. Modelling represents 0.01% of total construction cost.
Pike and Tanyaca structures currently being built

Fishway here!
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