Case Study: 2-D Hydraulic Modelling of Proposed Fish Ramp to Design for Fish Passage Potential

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The design teams and governing authorities involved with the rehabilitation of creeks and streams in urban centers are part of an evolving field of work. While much is now known about restoration strategies to achieve multiple and sometimes specific objectives, the benefit of proposed works in a particular location in achieving stated objectives requires analyses. A common impetus for local channel works is to provide increased fish passage potential for target species. In urban creek settings, there are often anthropogenic limitations that must be overcome, requiring creative and innovative methods/approaches to achieve project objectives.

A case study was completed to determine how, and if, the specific objective of fish passage could be achieved given the limitations imposed upon an urban rehabilitation project. The objective of the project was to mitigate a 1.2 m vertical barrier at the outlet of an existing dam, to enable upstream movement of fish. Typical of urban settings, spatial constraints existed in the study area due to a bridge structure situated downstream of the dam; this limited the design of an instream structure to a length of 19 m. These constraints required a maximum 10 (hor.): 1 (vert) slope ratio.

The proposed design for the project was to implement a fish ramp, similar to that of a rock ramp fish ladder that is often used to mitigate vertical drops in spatially constrained areas. The proposed fish pass structure incorporated a series of rock weirs to mimic a step-pool morphology. Provision of a concentrated low-flow channel was achieved through placing the rocks within each weir in a staggered pattern to allow for fish passage potential at typical fish migration flows.

The design intended to induce vortex wakes downstream of the armourstones of the weirs which have been shown to improve fish passage potential since fish extract energy from the vortices which allows them to swim upstream with less effort. The proposed fish ramp was modelled in HEC-RAS using a 2-D hydraulic model. The focus of the model was to determine the degree to which the design can provide these vortex wakes to improve fish passage potential. Iterations of the design were completed to determine an optimal configuration that provided the greatest potential for fish passage.