Computational Fluid Dynamic Modeling of Headpond Hydraulics and Bed Shear Stress at Aberfeldie Dam on the Bull River, British Columbia

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Abstract

The upstream flow regime induced by hydropower operations at dams is physically complex and is inferred to be one of the key aspects effecting fish entrainment. It is important to assess the forebay hydraulics for fish entrainment risk assessment. This can be done using a three dimensional numerical simulation to predict upstream hydraulics under varying operating conditions.

Aberfeldie dam, located on the Bull River, upstream of its confluence with the Kootenay River, operates as a run-of-the-river facility, which operates by two intake units and a spillway. A computational fluid dynamic (CFD) model was constructed for this facility using the Reynolds Averaged Navier Stokes equations and κ-ε turbulence model to assess the forebay hydraulics under a variety of discharges and operational scenarios. This model has been validated against acoustic field measurements upstream of the facility. Additionally, the model has been used to predict the induced bed shear stress throughout the forebay to assess the likelihood of sedimentation and sediment mobilization, which is of particular importance for this dam. The model has been able to accurately predict eddy formation and flow structure under the field measurement scenario and has been extended to other operations. The model suggests that over the size range of bed particles measured in the field, that the form of the bed is dynamic, and fluctuates based on the river discharge throughout the year. This presentation will focus on the numerical model development and the simulated effects of the dam on the upstream hydraulics and bed shear stress.