A Computational Fluid Dynamics Approach to Assessing and Limiting Scour from Complex Spillway Flows

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Mitchell Dam, which is owned and operated by Alabama Power Company, is a 1,264-foot long concrete gravity dam on the Coosa River, in Alabama. As originally constructed, the spillway included 26 radial gates, each 30 feet wide and 15 feet tall. During the 1985 redevelopment of the project, three of the original spillway gates were removed to accommodate the construction of a second powerhouse on the west riverbank. To offset the loss of discharge capacity, three larger (30 feet wide and 25 feet tall) spillway gates were added at the east end of spillway, replacing a portion of the original abutment section. Operation of the three larger spillway gates raised a concern that flow through the gates could scour the east riverbank, or the relatively shallow channel bottom downstream of the East Spillway structure. Subsequently, operation of these three has been limited to high flow events, after the remaining 23 original gates have already been opened. Following a personnel safety incident in 2013 involving the original gates, Alabama Power determined that alternatives for operations needed to be explored. The most favorable alternative was deemed to be safe utilization of the large gates. Due to the configuration of the hoist mechanisms, operation of the three new gates is simpler and earlier operation would provide more flexibility in passing high flows. In light of these operational factors and the recent Oroville spillway incident, Alabama Power undertook a project to safeguard against scour during operation of the East Spillway and maintain safe operability of the spillway during high flow events. Because of the complex geometry of the East Spillway section, including a cross-channel sloping spillway apron and associated variation in the elevation of the curved transition from the ogee crest to the apron, assessment of flow velocities and associated scour potential downstream of the spillway could not be adequately performed using simplifying assumptions or simplified hydraulic modeling approaches. Therefore, a computational fluid dynamics (CFD) model was developed to assess the flow conditions due to the existing spillway configuration and perform the hydraulic design for a modification of the spillway including energy dissipation structures. Following construction of the modifications, additional model runs were made to evaluate potential alternative operations of the spillway to increase flexibility in operations. This presentation will explore the unique problems encountered in evaluating the hydraulic conditions during spillway operations and the approaches used to address those issues.