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Case Study

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HARVIE PASSAGE ON BOW RIVER: USING A PHYSICAL MODEL TO EVALUATE POST-FLOOD REHABILITATION OPTIONS

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The "Calgary Weir" (Figure 1, left image) on the Bow River in Calgary, Alberta has been a major component of the Western Headworks and is bounded by Pearce Estate Park on the right (south) bank and Deerfoot Trail on the left bank. Transforming the Calgary Weir into an attractive and navigable component of the City's parks system involved redeveloping the weir to: (i) eliminate the extreme drowning hazard that it created; and (ii) enable passage for fish and non-motorized boats while maintaining the weir's primary function of facilitating diversion from the Bow River to the Western Irrigation District (Figure 1, middle image). This transformation allowed safer passage for river users in non-motorized boats, improved fish passage, and created a more natural-looking river. Harvie Passage is comprised of a High Water Channel (HWC) located in the centre and left side of the river and a Low Water Channel (LWC) on the right side.

Figure 1: Aerial photo of the Calgary weir (left) and Harvie Passage before the 2013 flood (middle) and after the 2013 flood (right). *Imagery source: Google Earth.*

The unprecedented flood of June 2013 resulted in the near 1:100-year flood discharge being conveyed through Harvie Passage, which caused major infilling of the LWC, minor damage to the HWC drop structures, and reduced tailwater levels below HWC Drop #4 (Figure 1, right image). Rehabilitation measures currently

underway include repairing damaged areas, eliminating unsafe hydraulic conditions, re-establishing fish passage, and construction of a new LWC.

A 1:14 scale physical model was utilized to evaluate the existing design of HWC Drop #4 and to develop modifications to its geometry that will: (i) eliminate the safety hazard that resulted from tailwater reductions within the Bow River; (ii) re-establish upstream fish passage; and (iii) not be adversely impacted by future changes in tailwater levels. The study objectives were expanded during the model testing phase to include the development of potential design modifications to HWC Drops #3L and #3R, all of which were intended to improve their recreational hydraulic performance.

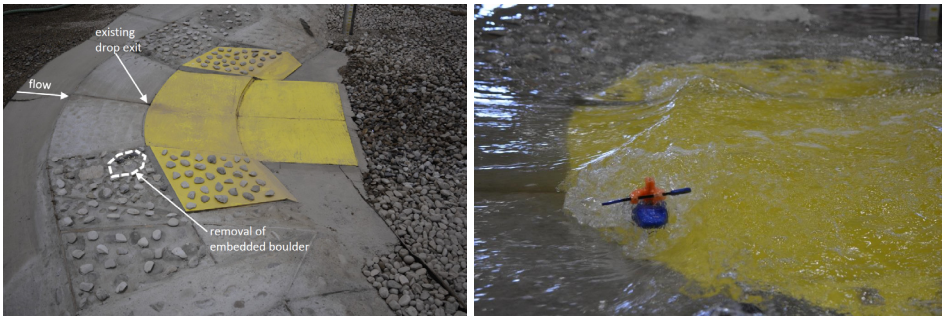

Figure 2: Side view looking at the recommended design of the rehabilitation of HWC Drop #4 (left) and the wave forming on this drop at a river discharge of 150 m^3/s (right).

Different geometric modifications to HWC Drop #4 were evaluated in the physical model. The recommended final design modifications included: (i) adding a 16H:1V sub-plate below the existing drop exit followed by a horizontal sub-plate; and (ii) extending the high-flow channels downstream to the Bow River (Figure 2). The recommended final design of HWC Drop #4 performed satisfactorily over the range of flow conditions examined in the model. The safety hazard below HWC Drop #4 was eliminated and replaced by non-retentive hydraulic features that are expected to flush boaters and other types of river users downstream. Furthermore, the proposed extensions to the high-flow channels of HWC Drop #4 are expected to re-establish upstream fish passage at this drop structure.

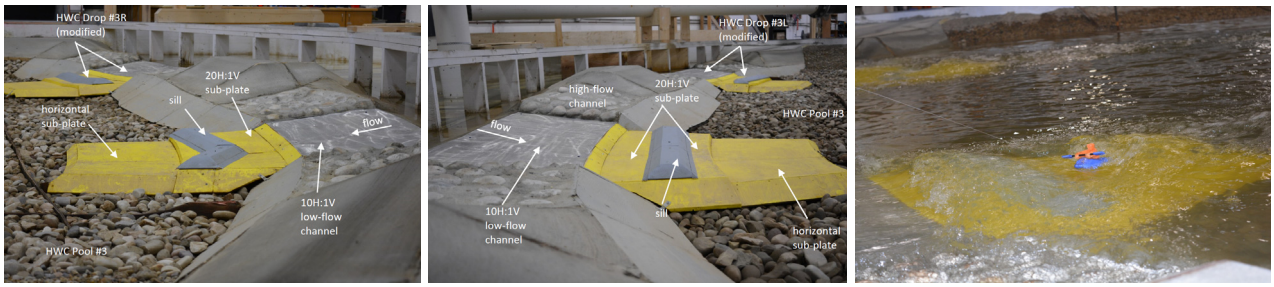

Figure 3: View looking downstream at the recommended design of HWC Drop #3L (left) and HWC Drop #3R (middle); and the playwave forming on HWC Drop #3R at a river discharge of 150 m^3/s (right).

Different design modifications were also evaluated on HWC Drops #3L and #3R. The recommended final design modifications to these drops consisted of: (i) reducing the longitudinal slope of the existing low-flow channel from 8H:1V to 10H:1V; (ii) installing two sub-plates in series below the low-flow channel, the first one comprised of a 20H:1V longitudinal slope and the downstream one set horizontal; and, (iii) installing a sill (V-shaped in planform on HWC Drop #3L and linear on HWC Drop #3R) across the width of the 20H:1V sub-plate near its downstream end (Figure 3). Model testing confirmed that the recommended design modifications successfully improved the hydraulic conditions at the drops by making them less retentive, thus more appealing to a wider range of recreational users. An enhancement to the existing design of these two drop structures included the formation of a secondary hydraulic that may be suitable for recreational usage under certain flows.