Channel Construction and Bioengineering: A Multi-Year Commitment for Fish Habitat Compensation on Beaver Creek

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ABSTRACT

Saskatchewan Ministry of Highways and Infrastructure's realignment and widening of Highway No. 219 resulted in the loss of a portion of Beaver Creek. An aging timber bridge was removed during the construction. The bridge was replaced by one 5.23 m diameter, 47 m long structural plate culvert, plus one 0.8 m diameter, 66 m long corrugated steel pipe culvert. Fisheries and Oceans Canada (DFO) authorized the harmful alteration, disruption or destruction (HADD) of fish habitat for the bridge-to-culvert project and required several mitigation measures during construction, compensation for the HADD, and three years of post-construction monitoring.

Compensation for the impacted fish habitat included the construction of a new channel with similar physical characteristics of the original channel and the preservation of a segment of the original channel as a back flood area for future spawning activities. Site stabilization with bioengineered methods was also a condition of the compensation efforts. The bioengineered features included willow staking, brush mattressing and brush layering. These combined efforts resulted in a net gain of approximately 64 square meters of fish habitat. All compensation efforts including the bioengineered features must be functioning as intended or remedial works will be required. All post-construction monitoring and any required remedial work must be done to the satisfaction of DFO; therefore, the Ministry's commitments may extend well beyond 2010.

This submission of this paper documents an innovative and creative approach to fish habitat compensation for a bridge-to-culvert project. The following pages highlight the key features of the compensation efforts and demonstrate the relationship between riparian habitat compensation and fish habitat compensation.

BACKGROUND

In 2007, the Saskatchewan Ministry of Highways and Infrastructure (MHI) upgraded the Beaver Creek crossing on Highway No. 219, located approximately 18 kilometers south of Saskatoon, Saskatchewan. MHI removed an aging timber bridge and installed one 5.23 m diameter, 47 m long structural plate culvert, plus one 0.8 m diameter, 66 m long corrugated steel pipe culvert. The bridge-to-culvert project was necessary due to the realignment and widening of Highway No. 219.

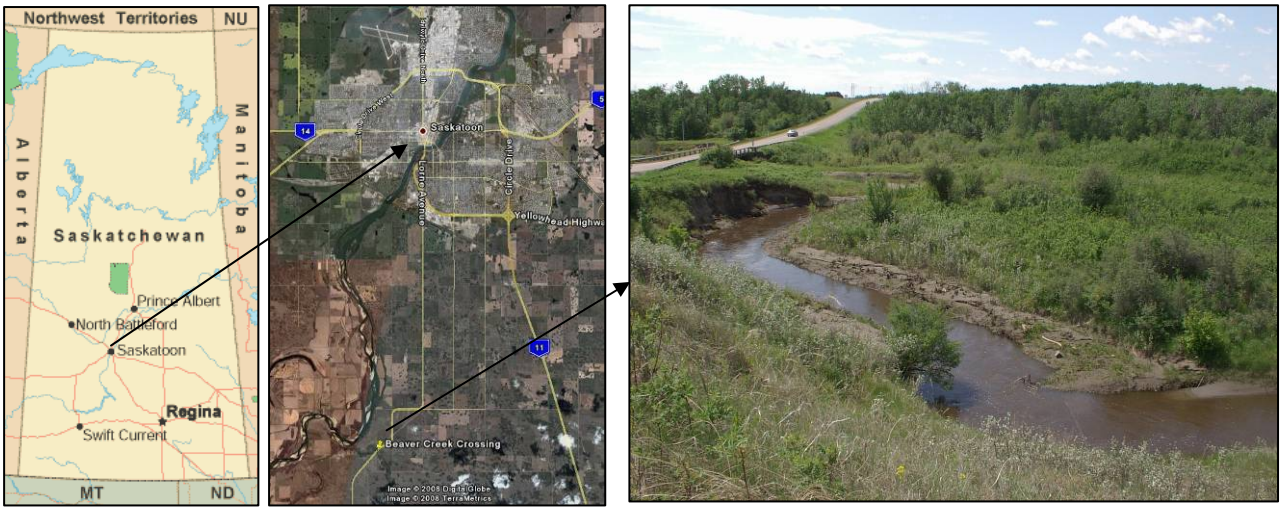

Figure 1. Location map of Beaver Creek crossing (1)

The project corridor was located within the moist mixed grassland eco-region of Saskatchewan. The Beaver Creek area contains fine silts and sands, which result in highly erodible conditions along the banks of the creek. Beaver Creek is a well-defined channel with a moderate meander pattern.

The Beaver Creek crossing is approximately 1.8 kilometers upstream of its confluence with the South Saskatchewan River. The South Saskatchewan River contains a variety of fish species. Prior to the culvert design, fish presence surveys confirmed walleye *(Stizostedion vitreum),* northern pike *(Esox lucius)*, and white suckers *(Catostomus commersoni,)* as well as small-bodied fish species were present in Beaver Creek. The physical and biological conditions of the creek indicated that the creek could be a migratory route for spawning activities. Therefore, the design velocities were limited to 0.64 and 0.39 m/s at the calculated 1 in 10 year, 3-day delay flow for the 47 m long culvert and the 66 m long culvert, respectively. The properly sized culverts ensured the continued passage of fish during spring spawning activities; therefore, no loss of productive capacity of fish would occur.

The project resulted in the loss of a portion of Beaver Creek due to the infilling and permanent rerouting of the creek through a constructed channel. Fisheries and Oceans Canada (DFO) authorized the harmful alteration, disruption or destruction (HADD) of fish habitat for the bridge-to-culvert project and required several mitigation measures during construction and compensation for the HADD.

COMPENSATING FOR THE HADD

HADD impacts are calculated from the areas of fish habitat that are harmfully altered, destroyed or disrupted. Habitat destruction at Beaver Creek included the areas that were permanently destroyed or infilled and are no longer available as habitat. These areas extend from the bottom of the creek bed to above the average high water mark (HWM). Habitat alteration included those areas along the bottom of the creek bed and below the average HWM that had been changed in some way. Habitat alteration included changes to substrate type such as the addition of rip rap or modifications to the creek bed or banks. Not all alterations are considered harmful and therefore substrate alterations were not considered in the HADD calculation. The project did not result in the disruption of fish habitat because the construction was completed in the winter under frozen conditions.

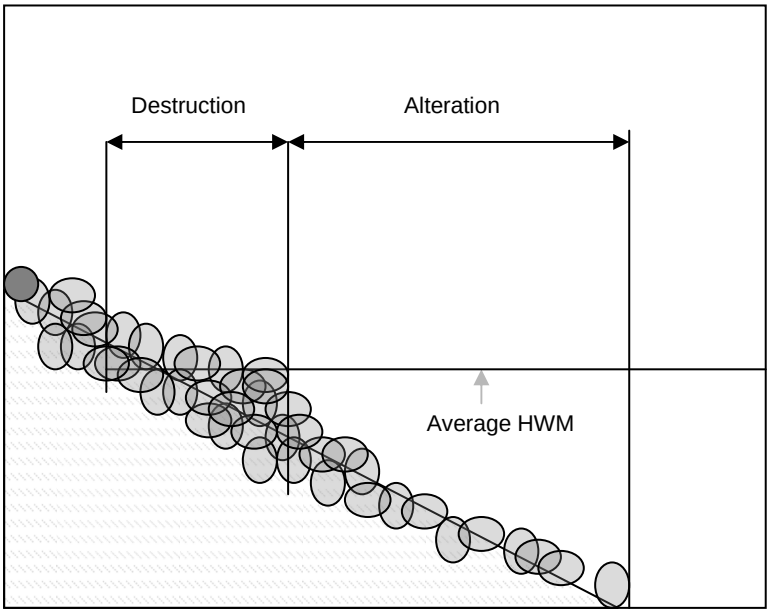

Figure 2. Destruction and Alteration of Fish Habitat Diagram

Compensation for Fish Habitat

The culvert installation project started in mid-January 2007. The DFO Authorization stipulated in-water work was prohibited from April 1 to May 31 of any year due to spring spawning activities in the creek. The timing constraint allowed for the installation of the culverts, removal of the old bridge, and construction of the new channel by March 31, 2007.

Compensation for the destroyed fish habitat included construction of a new channel with similar dimensions as of the original channel. The width of the new channel was 11.0 meters at a 1.497 m depth of water, or average HWM. The width multiplied by the 87.09 m long new channel resulted in the creation of 957.99 m^2 of fish habitat. Substrate in the existing channel consisted of silt and sands. In order to stabilize the bottom of the new channel, rip rap was placed along bottom of the channel up to the average high water. A segment of the original channel was preserved as a back flood area for future spawning activities; however, this area was not

considered in the compensation calculation. The amount of habitat created compared to the amount destroyed resulted in a net gain of fish habitat. DFO's Compliance with the conditions of the Authorization and adherence to the design details resulted in a gain of approximately 64 m^2 of fish habitat on Beaver Creek (2).

Once the new channel was constructed, the coffer dams were removed, and the new channel was connected to the original reaches of Beaver Creek upstream and downstream. The new channel accommodated the spring runoff. Erosion control products were installed upslope to prevent sedimentation from entering the creek; however, the remaining components of the compensation project did not begin until late-September.

Compensation for Riparian Habitat

The compensation section of the Authorization also included riparian habitat improvements along the banks of Beaver Creek. Though riparian habitat is above the average high water mark of any creek and typically not considered fish habitat, the Authorization clearly stated those improvements were part of the compensation works at Beaver Creek. As such, site stabilization with bioengineered methods was a condition of the HADD Authorization. Soil bioengineering includes using live plant materials to perform an engineering function (3). The bioengineered features included willow staking along the rip rap, brush mattressing and brush layering along the banks of the creek, and potted plantings on the erosion control blankets. See Figure 2 below.

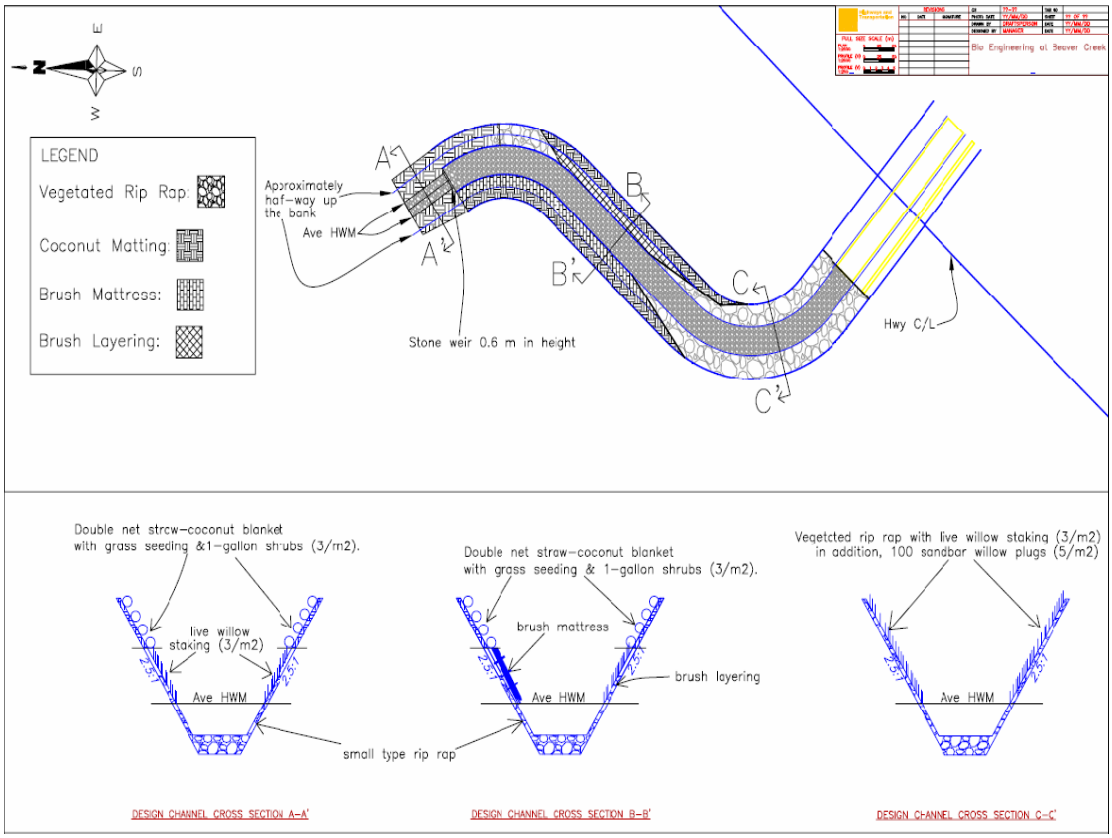

Figure 3. Bioengineering Design Drawing

MHI partnered with the adjacent landowner, the Meewasin Valley Authority (MVA) Conservation Centre, and developed a bioengineering design aimed to rehabilitate and stabilize the banks of the new channel. MVA property is located along Beaver Creek situated between Highway No. 219 and the South Saskatchewan River. MVA's interest in the project stemmed not only from their proximity to the project, but also due to the conservation efforts of the organization. The MVA is an organization dedicated to conserving the natural and cultural heritage resources of the South Saskatchewan River valley (3).

The bioengineered techniques along the banks of Beaver Creek utilized local willow species. Willow species included sandbar, yellow, and dogwood willows. The MVA staff harvested approximately 7,600 willow stakes and stems from nearby Crown land. The willows were harvested in the fall when the species were dormant then stored inside the large culvert for several weeks where cool and moist conditions existed.

Willow staking is effective in areas with silty soils that tend to move down the slope in spring (4). Willow stakes were placed in the riprap area nearest the culvert outlet. MVA supplied 2,100 stakes that were a minimum of 45.0 cm in length with a minimum diameter of 1.9 cm. The stakes were spaced at density of $3/m^2$ and planted deep enough so that only 20 per cent of the stake was exposed above ground. The willow staking, or vegetated riprap as it is sometimes referred to, accounted for approximately 700 m^2 of the bioengineering project. Brush mattresses were used to slow the flow of water across the surface of the bank. An additional 2,700 willow stems were used to create brush mattresses; the willow stems ranged from 2.5 – 3.0 m in length. The willows were placed against the inside slope of the bank at rate of 45 stems per lineal meter. The willows formed a 60 m long row that was held in place by 300 wooden stakes and rope. The stakes and rope effectively held the willows down to form the mattress. This technique was selected because higher flows are anticipated along the bend in the channel. An additional 2,800 willows were installed vertically into the bank to form brush layers. Three brush layers were constructed using 1.5 m long willow poles at a rate of 20 stems per lineal meter totaling 140 lineal meters. A trench was excavated prior to the planting and once the planting was completed, the trench was backfilled. All disturbed areas were seeded with a native seed mix. Any remaining exposed areas were covered with straw-coconut erosion control blankets. The intent of the erosion control products was to prevent erosion activity upslope. In addition to the matting, potted shrubs were planted in the spring of 2008 to increase vegetation upslope. The potted shrubs were planted at density of $3/m^2$ over a 600 m^2 area and consisted of sandbar willow, wolf willow, red-osier dogwood, snowberry and native roses. The bioengineering installation was completed while the willows and other species remained in their dormant stage. Fertilizer and water was added to the plants during installation to ensure success.

This type of project was a first for MHI and was a challenge to those involved. Proper research, adequate lead time, and a commitment from the project team ensured the compensation works were successfully completed.

CONCLUSIONS

The activities associated with the compensation work were completed as a condition of compliance with the Authorization issued by DFO for the bridge-to-culvert project. Frequent communication with DFO biologists along with the submission of photographs for each phase of construction plus a summary report ensured the goals of the habitat compensation were achieved. Compensation requirements for both riparian habitat and fish habitat proved to be an effective approach. Compensating for the loss of the existing channel and the habitat it provided required that the new channel be stable in order to function properly; the new channel required adequate vegetation to stabilize the highly erodible slopes, to maintain biodiversity in the area, and to prevent the invasion of noxious species. Healthy, properly functioning riparian areas also help to capture sediment before it can enter a watercourse. The anticipated result is that the vegetated areas upslope will increase the value of the fish habitat within Beaver Creek.

Post-construction monitoring includes the submission of a report annually for a three-year period ending in 2010. The monitoring activities will assess bank stability, vegetation and habitat conditions as well as culvert performance. All compensation efforts, including the bioengineered features, must be functioning as intended or remedial works will be required. All monitoring efforts and any required remedial work will be done at the satisfaction of DFO; therefore, the Ministry’s commitments may extend well beyond 2010.

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