FPInnovations prepared this guide to provide forest and resource workers with information on culvert installations, including fish salvage and dewatering considerations for streambed simulation in closed-bottom structures for fish streams. This pamphlet is the second in a series; other important considerations presented in this series for the successful implementation of a streambed simulation culvert include planning and design, streambed material/construction, and monitoring.

FPInnovations worked in close co-operation with British Columbia's Fish Passage Technical Working Group in the development of this guide.

References

BC Ministry of Forests, Lands and Natural Resource Operations, BC Ministry of Environment, and Fisheries and Oceans Canada. (2012). *Fish-stream crossing guidebook* (rev. ed.). Victoria, BC: BC Ministry of Forests, Lands and Natural Resource Operations and Fisheries and Oceans Canada.

Cover photo courtesy of FPInnovations.
Two 7-m-long sections of a round 2.7-m-diameter culvert being positioned to be joined together with a coupler.

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Streambed Simulation: Fish Management, Water Control, and Culvert Installation for Closed-Bottom Stream Crossings

A PRACTICAL GUIDE FOR FOREST AND RESOURCE WORKERS

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INITIAL PLANNING AND REVIEW: OVERALL METHODOLOGY

- All streambed simulation construction projects must have an engineered general arrangement design prepared. The party responsible for assuring that the crossing is installed according to the design must be intimately familiar with the design and, if needed, obtain clarity from the designer. The site must be checked for adequate construction referencing, including benchmarks and reference points, prior to construction activities.
- The overall methodology shall be planned to minimize installation time and site disturbance (e.g., to soil, vegetation, and water), and promote efficiencies. Material and equipment requirements need to address both heavy equipment for excavation and installation, as well as smaller equipment for compaction, infilling, dewatering, surveying, coupling, fuelling, etc. Access and overall construction-site management need to be planned and communicated. Site safety needs to be considered and planned for all aspects of each phase of operations, including site access control such as signage.

SITE PREPARATION: FISH MANAGEMENT AND WATER CONTROL

Fish management: Fish salvage and electrofishing require personnel to have appropriate training and certification. Two common salvage methods include baited traps and electrofishing. Baited traps can be in place for 18 hours (maximum 24 hours) that includes an overnight period. Site isolation screens need to be placed across the stream width to keep fish from migrating into the work area.

Water control: The excavation needs to be dewatered for installation of the culvert and to limit erosion and sediment from the site. Common dewatering methods are the use of gravity-fed bypass/pipe, pumps and hoses, or commercial products. Gravity allows for continuous replenishment to downstream reaches if the project spans overnight. Gravity methods could also target the use of a buried conduit, allowing heavy equipment to work on top of it.

Using pumps and hoses may require a sump to collect adequate volume during low flows. Where low flows are pumped periodically, the frequency should be great enough to not allow downstream reaches to become dry (i.e., without water). Pumps also require intakes to be screened. Commercial products are available to aid in dewatering. Downstream sumps should be positioned to collect seepage water throughout the excavation, allowing sediment to be collected and contained.

CULVERT PLACEMENT AND HANDLING

Follow best management practices. Culvert handling should be planned so as to protect the integrity of the structure. A culvert should be lifted from the delivery truck and not rolled off the deck. Lifting straps can be placed around the culvert in more than one location to avoid damage and improve control. Straps provide greater control than chains; where chains are used, hooks attached to the ends can be placed under the ends of the culvert to aid with lifting. Lifting eyes attached to the culvert are useful to aid in lifting and maneuvering each culvert section.

CONSTRUCTION REFERENCING AND LAYOUT

In order to facilitate the installation of a culvert, the working points referenced on the general arrangement design must be clearly located in the field. Measuring tapes, stakes, construction levels, and string lines are simple, efficient, and effective means to facilitate the establishment of the working points, from field reference points, as well as the elevation and grade of the culvert through excavation and installation. The general arrangement design provides straight line distances from benchmarks to centreline working points at both the inlet and outlet locations. Further, straight line measurements between these inlet and outlet working points can be used to located additional working points, indicating the inlet and outlet culvert locations. Follow best installation practices for culverts.

BEDDING PREPARATION AND ELEVATIONS

The culvert installation should follow the design as well as best practices. Base preparation is critical for ensuring the long-term integrity and shape of a culvert. Where underlying soils are unsuitable or saturated, additional excavation depth may be required in order to substitute suitable material for founding the culvert. Bedding shall be prepared to provide adequate bearing and limit settlement of the structure. To obtain a good seal, set the culvert on a thin bed of fine granular material (e.g., sand) to fill corrugations and form a good seal. Establish the design culvert location and alignment using site references and working points. The design will have factored in the depth of excavation required to attain the appropriate depth of embedment. Establish the culvert's vertical location from the reference benchmark using a construction level and rod. Check, in particular, the elevations of the inlet and outlet.

Where poor foundation soils exist, substitute suitable materials and use large aggregate for ballast, as appropriate, to improve the bearing capacity of the culvert.

The location for the excavation was easily measured from established working points as indicated on the engineered design. The depth of excavation was measured with a construction level and rod.

A non-woven geotextile can be placed in the culvert backfill to mitigate water piping along the outside of the culvert. In the photo to the right, an Armstrong seal has been created. The geotextile is initially placed under the culvert and then cut, spread perpendicular to the culvert barrel, and tied at the top to form a curtain in the backfill.

Fine granular material (e.g., sand) spread along the length of the excavation allows the culvert to be well seated into the base of the excavation.

CULVERT PLACEMENT AND BACKFILL COMPACTION

Once the grade of the excavation has been established, the culvert can be located within the excavation. Where couplers are used, placing the lowest section on the ground and below the culvert can aid with the placement of the abutted section (see photo below). Where the excavated material is planned to be used as backfill, care should be taken to remove any material that could damage the culvert or not conform to compaction methods (e.g., boulders, shale, and large woody material). Compaction of the backfill is critical in order to construct a soil arch up and over the structure. If needed, supplemental fill material can be imported to the site to achieve the target compaction (typically Proctor 95).

Culverts used for streambed simulation have a design diameter big enough to provide for the natural stream width as well as additional room for habitat enhancement. These structures commonly need one or two couplers to provide the design length.

A working point showing straight-line distances between benchmarks/ reference points and the end of the structure allows for accurate locations to be easily established in the field using common equipment.

Couplers need to be secured tightly to provide a watertight seal. Gaskets can also be used with the coupler to accomplish this.

Compaction is a critical phase of the culvert installation process.

Plate compactors are common choices for the majority of the backfill envelope; jumping-jack compactors, with their smaller working area, can be maneuvered to compact under the haunches of the structure.

Erosion control can be provided by armouring the exposed soils. This is critical immediately adjacent to the water course where sediment can easily reach the aquatic environment.