This guide provides guidance for forest licensees, technical staff, and field practitioners on techniques to rapidly assess if existing culverts on fish streams are likely to be barriers to fish passage. It aims to support the provincial-oriented guide *Field Assessment for Determining Fish Passage Status of Closed Bottom Structures*,[1] and should be used as a supplement to the field card provided in the appendix of that document.

ACKNOWLEDGEMENTS

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- *Stream simulation: Planning and design for closed-bottom structures for fish streams*
- *Streambed simulation: Fish management, water control, and culvert installation for closed-bottom stream crossings*
- *Streambed simulation: Streambed construction, infill methods, and rewatering for closed-bottom stream crossings*
- *Streambed simulation: Monitoring and maintaining a fish-friendly culvert crossing.*

REFERENCES

1. B.C. Ministry of Environment. (2011). *Field assessment for determining fish passage status of closed bottom structures* (4th ed.). Victoria, B.C.
2. Fish Passage Technical Working Group. (2014). *Fish passage strategic approach: Protocol for prioritizing sites for fish passage remediation*. Victoria, B.C.
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4. Province of British Columbia. (2017). *PSCIS user guide: Provincial stream crossing information system* (Version 2). Victoria, B.C.

PHOTO CREDIT

Cover photo shows a non-embedded culvert with an outlet drop. All photos courtesy of the Fish Passage Technical Working Group.

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Fish Passage Assessment at Culverted Sites: Rapid Field Measurements to Determine the Likelihood of a Barrier to Fish Passage

A PRACTICAL GUIDE FOR FOREST AND RESOURCE WORKERS

March 2021

This guide can be downloaded and printed from www.fpinnovations.ca

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BACKGROUND AND INTENT

This guide is intended as a reference for use during the field data collection phase of the provincial process in assessing fish passage at culverted sites.[1] It is an important part of the provincial assessment process which uses a holistic watershed approach. The field data can be used as part of the development of a fish passage restoration plan[2] or as part of regular road maintenance inspections.

The assessment measures five criteria that are hydraulic surrogates for closed-bottom structures (CBS) which are predictive of suitable conditions for fish passage. Determining if a culverted site is a barrier to fish passage is primarily based on a cumulative score of the five field data measurements. The focus is on CBS because of the large number of associated fish passage problems in comparison with open-bottom structures. Field indicators of fish passage problems at culverted sites can include lack of streambed material in the culvert, outlet drop, the culvert slope being too steep, the culvert length being too long, and an undersized culvert which constricts natural stream width.

FIELD ASSESSMENT METHODOLOGY, EQUIPMENT, AND PHOTOS

Field measurements of hydraulic surrogates are used in a scoring matrix to calculate a barrier determination value based on level of severity (low, medium, and high risk). Three surrogates are more heavily weighted than two others.[1] The chosen surrogate methodology has advantages: it requires minimal training; it is fast and efficient; it can be conducted most times of the year (not during snowy or icy conditions); and measurements can be taken at any flow level with the same results.

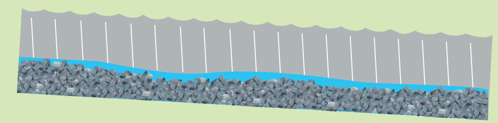
The suggested equipment list consists of the following: clinometer, 50-m fibre tape, GPS unit, digital camera, data sheets, pencils, permanent markers, flagging tape, level and rod (rod 5 m or longer for use where large fills exist), 25-m tape measure, spare batteries, laser range finder (optional), waders/boots, and personal protective equipment.

Additional data that must be collected include the location (road name, crossing name, GPS coordinates, etc.) and pictures (minimum of five – inlet, outlet, upstream, downstream, and barrel) of the site.

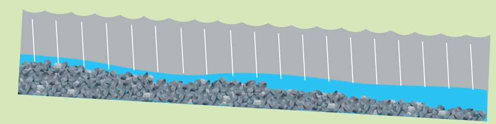
1. DEGREE OF EMBEDMENT

Measure the depth of embedment and whether the infill material is continuous throughout the culvert. The infill material is a surrogate for channel roughness, which reduces velocities and creates velocity shadows, allowing fish to burst and rest as they move upstream. A culvert that is sufficiently embedded (30 cm or 20%, whichever is greater) provides for the natural movement of streambed material (bedload) through the culvert and maintenance of proper embedment depth. A culvert that has any pipe invert showing along the length of the streambed simulation is considered not embedded; this includes partial width sections of stream simulation (Photo 2). The ranking will be either full, partial, or none.

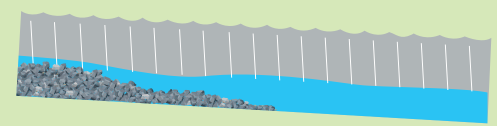
Embedded	Value
Full	0
Partial	5
None	10



Full: > 20% of height (min. 30 cm)



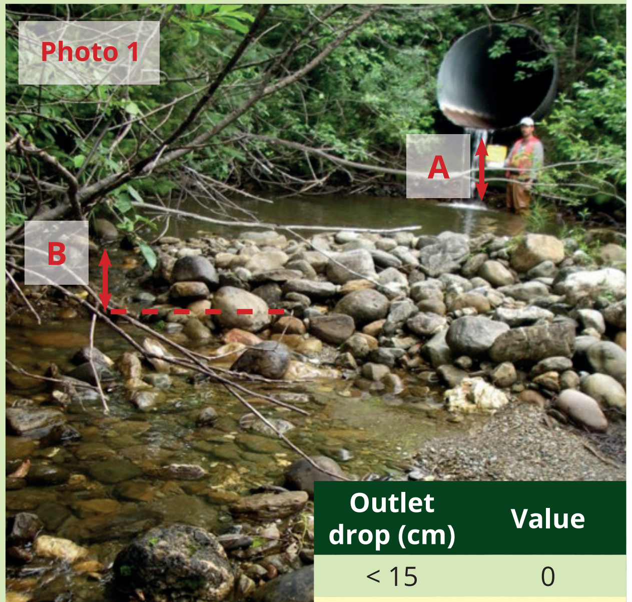
Partial: < 20% of height or < 30 cm but continuous throughout the entire pipe



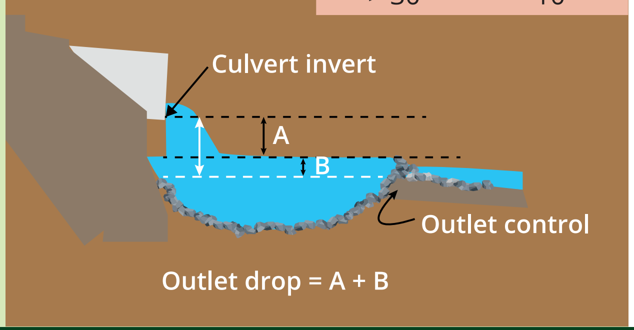
None: No material, or material is discontinuous throughout the pipe

2. OUTLET DROP

Outlet drop is the distance, measured in centimetres, from the invert (bottom) of the culvert to the top of the residual pool, which is the pool that would remain if flow from the culvert stopped and the outlet pool drained until it became level with the outlet control. This method results in measuring the maximum height of the outlet drop, but also allows the measurement to be consistent regardless of the stream flow during the field measurement. The two measurements to collect are the distance from the culvert invert (bottom) and the top of the outlet pool (current water level) (A), and from the top of the outlet pool to the lowest point along the outlet control (B); outlet drop = (A + B) (Photo 1).



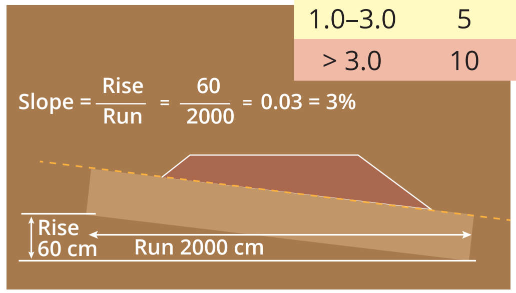
Outlet drop (cm)	Value
< 15	0
15–30	5
> 30	10



3. CULVERT SLOPE

Use a clinometer (accuracy is +/- 2%) to measure the slope of the culvert; if possible, focus along a rust or bolt line to take the measurement. The accuracy of a clinometer is adequate if the measurement is 4% or greater. If the slope measured by the clinometer is <4% (or if a clinometer cannot be used due to site conditions) then a more accurate instrument (e.g., auto level) is to be used and measurements should be recorded to the nearest 0.1%.

Slope (%)	Value
< 1.0	0
1.0–3.0	5
> 3.0	10



4. CULVERT LENGTH

Measure the culvert length to the nearest 0.01 m. If the culvert is easily accessed and flows are safe to walk/stand in, measure the length from inside the culvert. Measuring the culvert length from the road surface is difficult unless the fill is low enough that a straight-line measurement can be accomplished. Long culverts can be difficult for fish to pass through if there are no velocity shadows or if the flows are increased from the natural stream due to the culvert being narrower than the stream.

Length (m)	Value
< 15	0
15–30	3
> 30	6

5. STREAM WIDTH RATIO (SWR)

Measure the ratio of channel width to culvert width (measurements to the nearest 0.01 m). A well-designed crossing will have a culvert width greater than the channel width, resulting in an SWR less than 1. A round or elliptical culvert width can be measured horizontally at its widest location. The channel width is measured at right angles to the general orientation of the banks across the channel to the normal high-water locations on either side. The active width during normal high water may not be the same as the wetted width during measurements (Photo 3). Bank evidence of normal high water includes the boundary of rooted vegetation where there is a change in vegetation, sediment texture, or pieces of drift which tend to deposit together. Above normal high water, the soils and vegetation appear to be undisturbed by any recent stream erosion.

Where the bank is undercut, the measurement should be taken to the bank of the undercut. Three measurements should be taken of representative sections of the natural stream channel; measurements should be taken outside of the felled right-of-way and away from any stream alterations. If the channel shows a lot of variation, more measurements should be considered to improve the accuracy of the measured channel width. Measurements can be taken upstream or downstream; the average of the measurements will be the stream channel width.

The method for measuring stream channel width is described in detail in the *Fish-Stream Crossing Guidebook* (App. 2).[3]

SWR	Value
< 1.0	0
1.0–3.0	3
> 1.3	6

DETERMINING THE LIKELIHOOD OF FISH PASSAGE

The values determined for each of the 5 metrics are summed and compared against the Cumulative score table. Sites that score 20 or above will be a barrier to some or all life stages of fish. Other useful observations to record while on site include the presence of fish, aquatic habitat features, and natural barriers, which are outlined in *Field Assessment for Determining Fish Passage Status of Closed Bottom Structures*.[1]

! Fish passage data collected should be entered into the Provincial Stream Crossing Information System (PSCIS).[4]

Cumulative score	Result
0–14	passable
15–19	potential barrier
> 20	barrier