Guidelines for the design of fish passage in culverts in Nova Scotia

November 9, 2016

The best type of stream crossing structure that allows for unobstructed fish passage is a bridge. However, it is very expensive to justify this type of installation for streams having a drainage area of less than 20 km².

Alternatively, the most economical type of stream crossing structure is a closed bottom culvert. Unfortunately, in many installations where the stream does not backwater through the culvert, fish passage is usually impeded.

Why fish passage?

- Migration is essential to the biology of many fish species.
- Complete or partial barriers to a fish's migration route along a watercourse can have serious consequences.
- Fish can fail to reproduce or they can die as a result of poorly designed passageways that delay their migration or that require them to expend higher than normal energy levels.

Fisheries Act

35. (1) No person shall carry on any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery.

Projects that have the potential to obstruct fish passage, modify flow, or projects that result in the entrainment of fish may also cause serious harm to fish. If fish passage cannot be achieved in these situations, authorization under Subsection 35(2) is required.

In addition, Sections 20 and 21 of the *Fisheries Act* require the provision of sufficient water and unimpeded passage for fish.

Therefore, there was a need for clearer guidance in the design of culverts, especially closed bottom culverts. The main goal of the guideline is to allow for proper unobstructed fish passage by providing enough water depth (backwatering) and slowing water velocities (baffling) to allow fish to successfully swim upstream.

Fisheries and Oceans Canada | Pêches et Océans Canada

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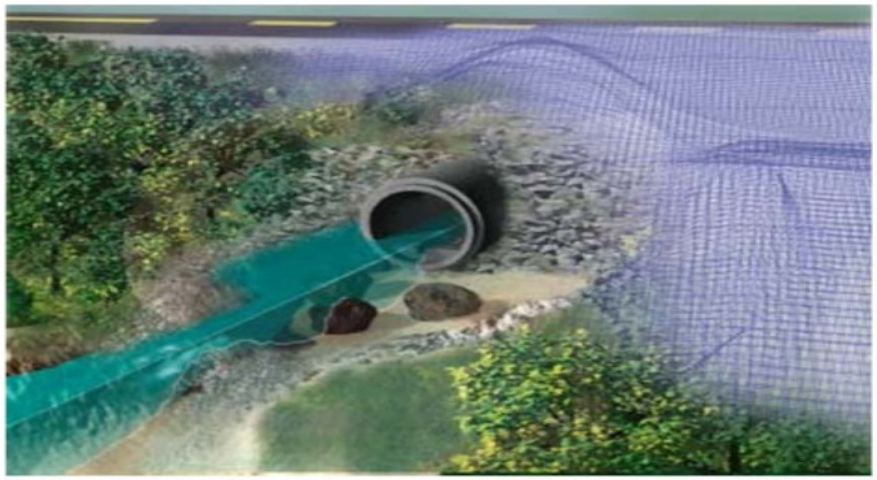
Fisheries Protection Program, Maritimes Region
February 2015



Canada

These *Guidelines* apply to:

- Open-bottom structures that alter the bed and/or banks of the watercourse
- Embedded culverts > 4 000 mm in diameter
- Non-baffled culverts (depending on the watercourse slopes, culvert diameter, and culvert length) where drainage area < 20 km^2
- Baffled culverts as fish-ways for various watercourse slopes (depending on proposed culvert diameter and length) where drainage area < 20 km^2
- The repair of existing culverts that currently do not allow for adequate fish passage, by incorporating fish passage chutes or downstream weirs

These *Guidelines* do NOT apply to:

- Watershed areas > 20 km^2
- Temporary watercourse crossings
- Watercourse slopes that are > 8% slope
- Embedded culverts < 4 000 mm in diameter
- Tidally influenced culverts
- Multiple culverts
- Engineered channels constructed for water control
- Watercourses that do not support fish that require fish passage
- Site-specific fish passage design

Does my site require fish passage?

- A qualified person needs to conduct a habitat evaluation that would include information about the fish habitat and its features, including substrate classification, water quality parameters and natural barrier identification.

  Qualified Person

  A biologist or biological technologist with adequate training and knowledge of fisheries management and fish habitat protection to be able to complete a fish habitat evaluation and obtain an electrofishing license from DFO, if required.

- If it is determined that fish could be present then the assessment should include electrofishing. The results will indicate the fish species, relative abundance and age structure (size) of fish frequenting the waters where the crossing is proposed.

Creating a profile of the watercourse

- The slope of the watercourse must be determined to ensure proper design for fish passage.

- To survey the watercourse, collect elevations both upstream and downstream of the proposed crossing location.

- The survey profile of the watercourse can be determined by taking measurements at stations on every top of riffle (high point) and every pool bottom (low point) along the watercourse thalweg and/or at stations every 5 m.

Watercourse Slope

- **Slope = ((A-B)/L)*100**
- **A** is the upstream control located at the thalweg elevation of the existing watercourse at the proposed culvert inlet
- **B** is the downstream control thalweg elevation at the first natural undisturbed riffle located at a distance of 3 times the culvert diameter plus a minimum of 3.5 m downstream of the proposed culvert outlet.
- **L** is the distance between A and B.

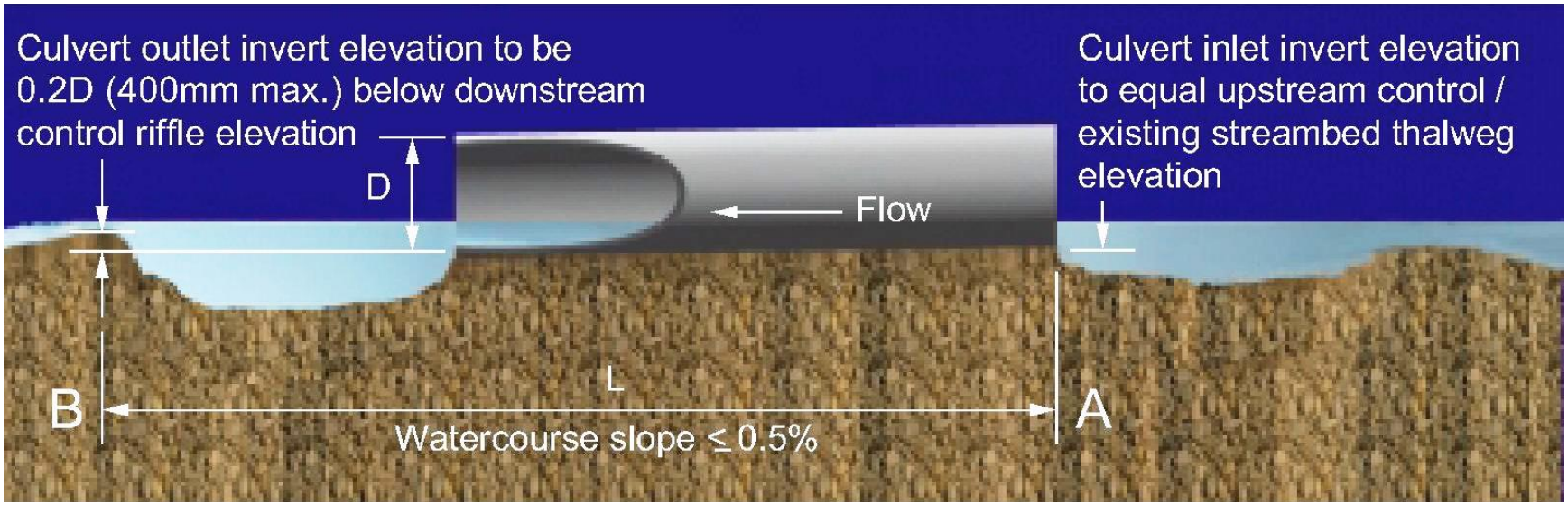
Non-Baffled Culvert

- The culvert inlet invert elevation is equal to the upstream control. The upstream control is the existing streambed thalweg elevation.

- When a proposed culvert installation has a watercourse slope of ≤0.5%, the culvert does not require baffles.

- The culvert outlet invert elevation is to be set at 0.2 times the culvert diameter/height to a maximum of 400 mm below the downstream control elevation thalweg or the first natural undisturbed riffle located at a distance of 3 times the culvert diameter/width plus a minimum of 3.5 m downstream of the culvert outlet to stabilize the downstream end of the pool.

Non-Baffled Culvert

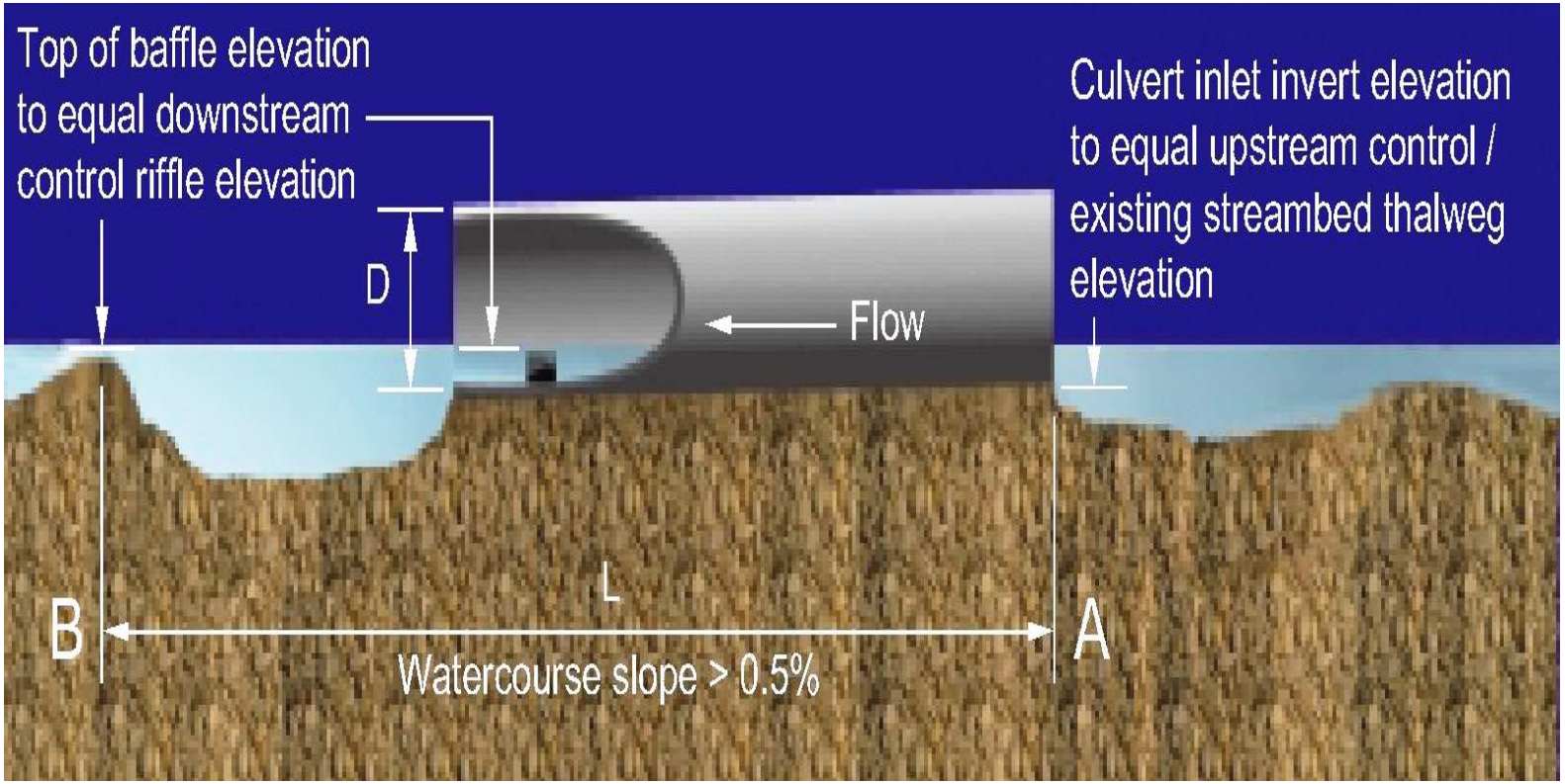


Baffled Culverts

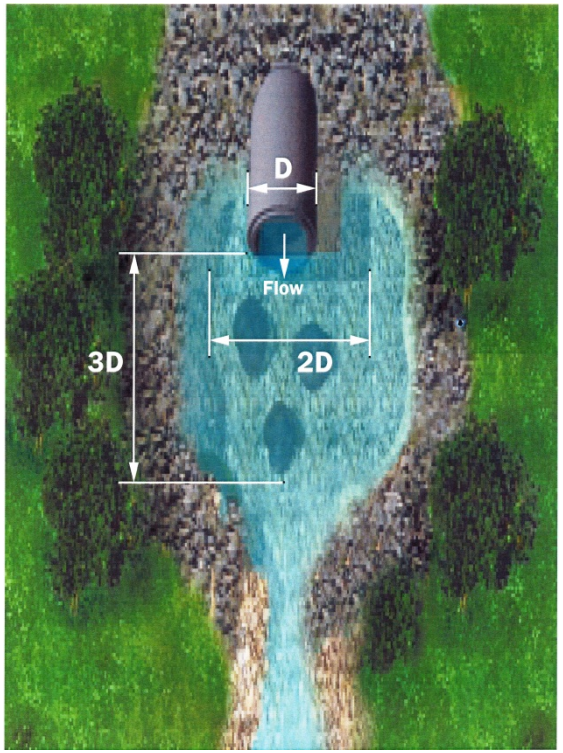
- Carefully determine the culvert outlet invert elevation to ensure that the baffle top elevation at the lowest baffle is equal to the downstream control riffle/step elevation. This downstream control is the thalweg elevation of the streambed at the first natural undisturbed riffle/step located at a distance of 3 times the culvert diameter plus a minimum of 3.5 m downstream of the culvert.

- Determine the location of the lowest baffle at the same time you determine the outlet invert elevation because there is a correlation between the two placements. The lowest baffle should be at most 1.25 m from the downstream end of the culvert.

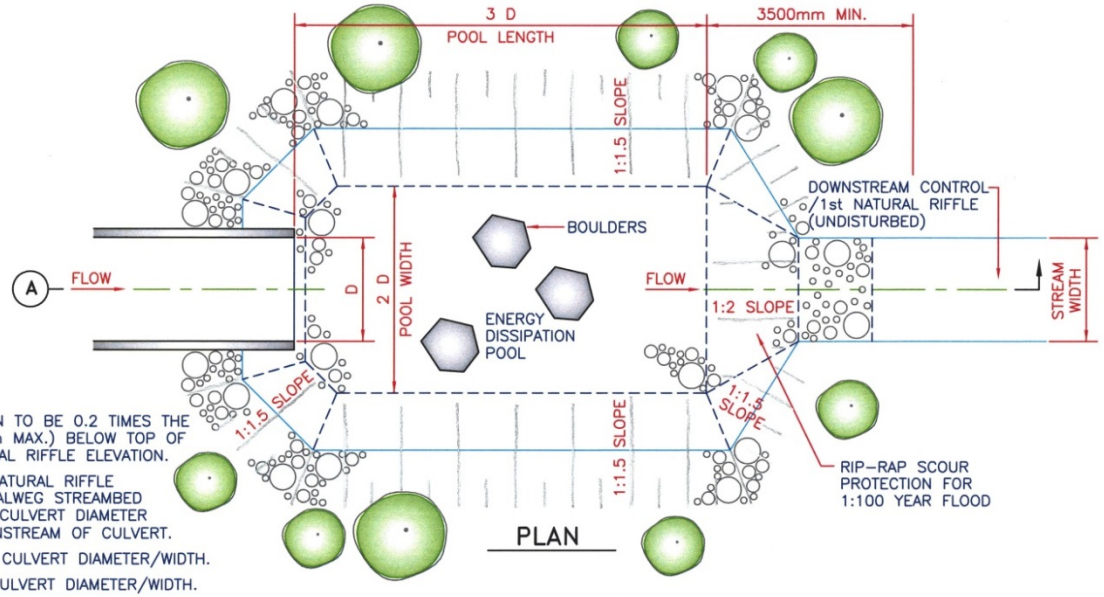
Baffled Culvert



EDP



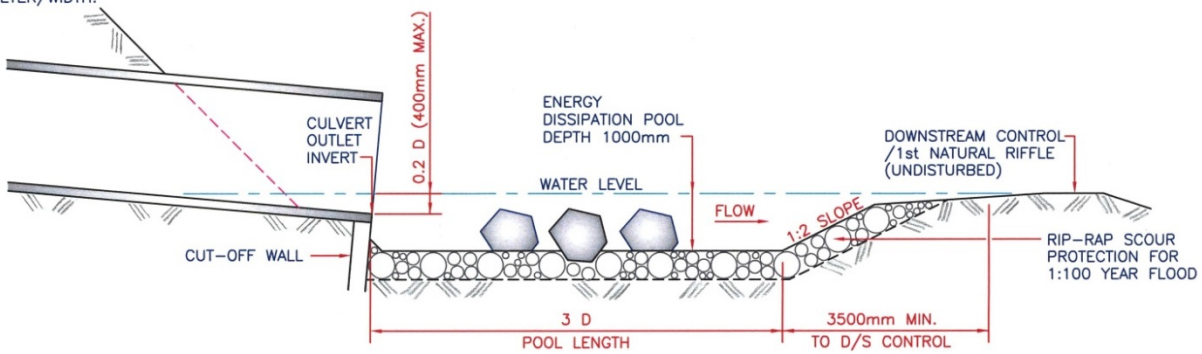
- Do not use any filter fabric in the construction of the pool.
- The depth of the pool must be a minimum of 1 m.
- The width at the bottom of the dissipation pool is 2 times the culvert diameter (D).
- The length at the bottom of the dissipation pool is 3 times D.
- At the downstream end of the dissipation pool (at 3D), the slope up to the existing elevation of the natural stream is to be constructed at no more than 1:2. This area of the pool is to have riprap scour protection to withstand a 1:100 year flood event.



PLAN

NOTES

1. CULVERT OUTLET INVERT ELEVATION TO BE 0.2 TIMES THE CULVERT DIAMETER/WIDTH (400mm MAX.) BELOW TOP OF DOWNSTREAM CONTROL/1st NATURAL RIFFLE ELEVATION.
2. THE DOWNSTREAM CONTROL/1st NATURAL RIFFLE IS THE EXISTING UNDISTURBED THALWEG STREAMBED ELEVATION LOCATED 3 TIMES THE CULVERT DIAMETER /WIDTH PLUS 3500mm MIN. DOWNSTREAM OF CULVERT.
3. POOL LENGTH TO EQUAL 3 TIMES CULVERT DIAMETER/WIDTH.
4. POOL WIDTH TO EQUAL 2 TIMES CULVERT DIAMETER/WIDTH.
5. D EQUALS CULVERT DIAMETER/WIDTH.
6. SLOPE EXPRESSED AS VERTICAL:HORIZONTAL.



SECTION A

Retrofitting - Chute

When a fish passage chute can be installed?
You may install a chute at the outlet invert end of the existing culvert as a **temporary solution** until it is time to replace the culvert if all of the following criteria are met:

The height of the vertical barrier from the culvert's outlet invert elevation down to the downstream control elevation is less than 250 mm

The culvert length is less than 25 m

The culvert slope is less than 1%

The current culvert has been in place for at least 5 years and is structurally sound.

Important Information

www.dfo-mpo.gc.ca/library/353873.pdf (*Guidelines for the design of fish passage for culverts in Nova Scotia, 2015.)*

www.dfo-mpo.gc.ca/pnw-ppe/contact-eng.html **(Contact information for DFO-FPP Office in Dartmouth, Nova Scotia)**

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http://www.letstalkfishhabitat.ca/?utm_source=stakeholder-e&utm_campaign=talk-fish&utm_medium=eml
(Online public consultation for the changes to the *Fisheries Act*)