

New Culvert Installation

Fish Passage Action Team – Advisory Note 11072501

Title: Best Practice Guidance for New Culvert Installation Providing Fish Passage

Overview

Some regulations for providing fish passage through culverts require the culvert to be embedded and retain bed material throughout the structure. While embedded culverts can provide aesthetic and ecological benefits, their design and installation can present challenges—particularly in long, steep, or narrow culverts. Effective design is essential to ensure long-term fish passage, structural performance, and reduced maintenance requirements. This advisory note is for culvert installation that supports fish passage, while minimizing the risk of debris accumulation and structural failure where complete culvert embedment is challenging.

Design Principles

Embedded Outlet & Backwatering:

Ideally, at least the culvert outlet is embedded below the downstream bed level to make sure it is not overhanging or undercut. Culvert embedment can be supported using backwatering techniques and nature-like rock ramps (refer to the NZ Fish Passage Guidelines 2024 for design guidance).

Flexible Baffle Integration:

The embedded outlet can transition smoothly into a series of flexible baffles within the culvert pipe. These create variable fish-friendly hydraulic conditions throughout the culvert's length, such as:

- Resting pools
- Low-velocity zones
- Nature-like complex flows
- Baffles may retain natural bed material or act as surrogate bed material, improving hydraulic complexity in otherwise smooth culverts and thereby improving fish passage.

Site-Specific Considerations:

- The need for a concrete outlet apron and the depth of culvert embedment should be determined based on local site conditions (e.g. gradient, substrate type, expected flow, erosion potential).
- Baffle length should be proportional to culvert diameter or width, with consideration for anticipated flow volumes.
- Baffle spacing should be guided by culvert gradient and flow conditions. Closer spacing is generally required for steeper slopes or higher flows.

Conclusion: By embedding the outlet and incorporating flexible baffles, the system promotes fish movement, mimics natural stream processes, and improves resilience against blockages, and excessive maintenance costs.

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Examples

Poor design. National Highway. Upstream end. Length 80M. Gradient 1%. 50% blockage at upstream end. 100% blockage at downstream end. Flow now subsurface.

Note: Deposition zones immediately downstream of culvert outlets should have access for machinery to undertake maintenance e.g. removing bed material to prevent the culvert becoming blocked.



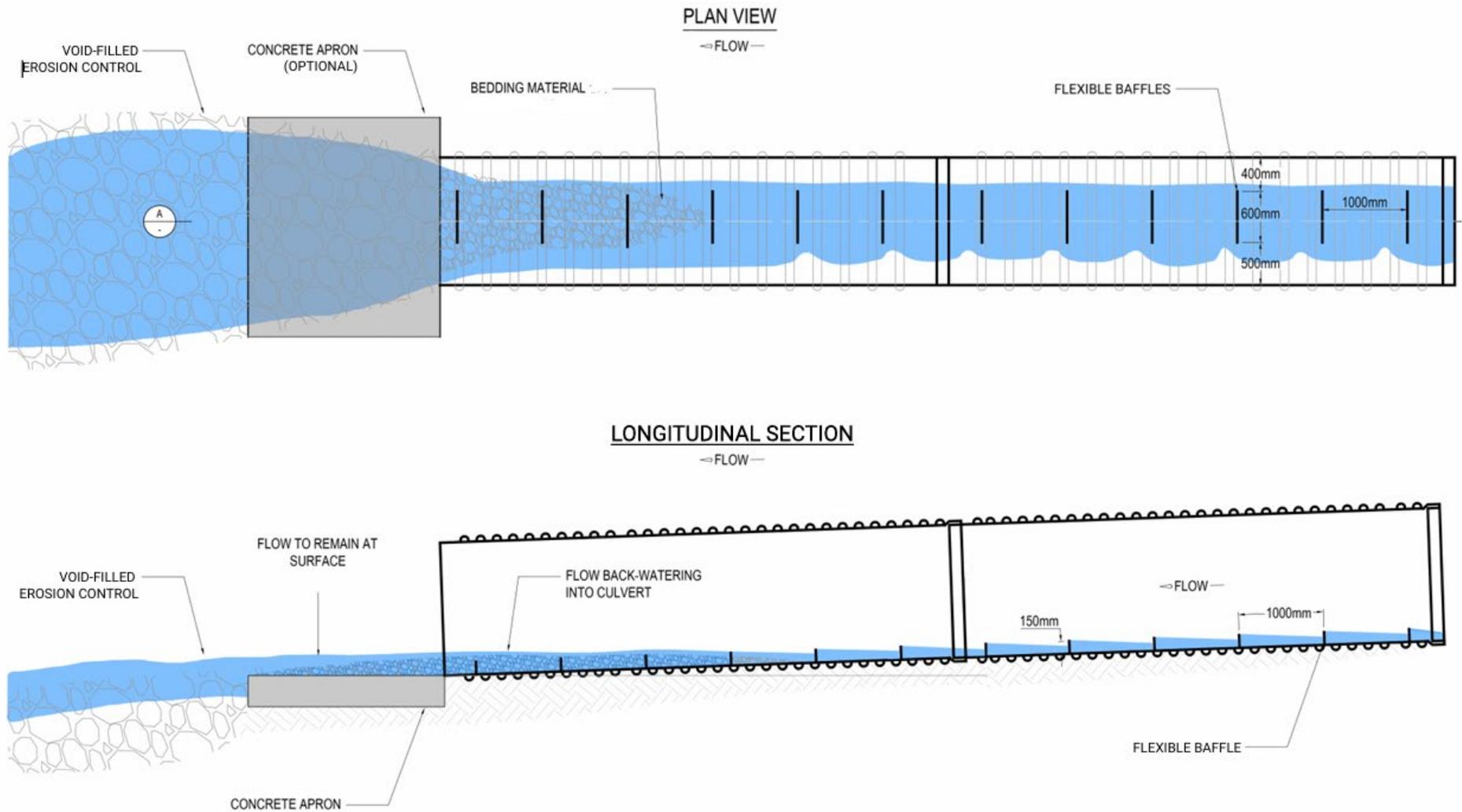
Poor design. The outlet is perched, preventing fish from entering the culvert. The culvert has a smooth bore with high velocities lacking complexity.



Good design. CGI - Culvert backwatered allowing fish passage into and on through the culvert. Extra rocks confine low flows. Vegetation will contribute to shading.



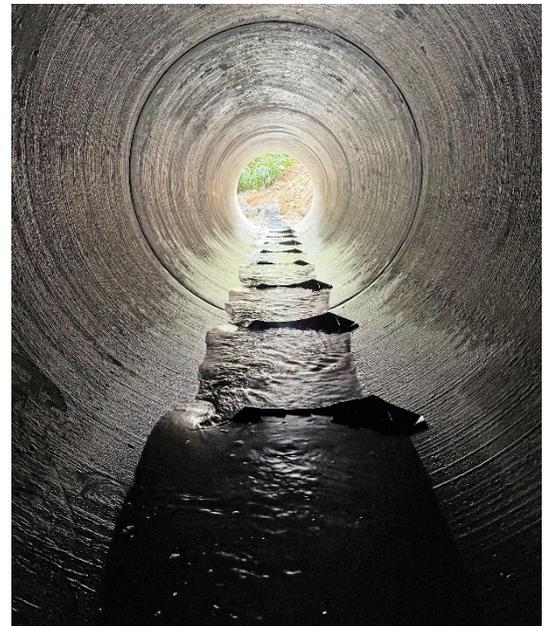
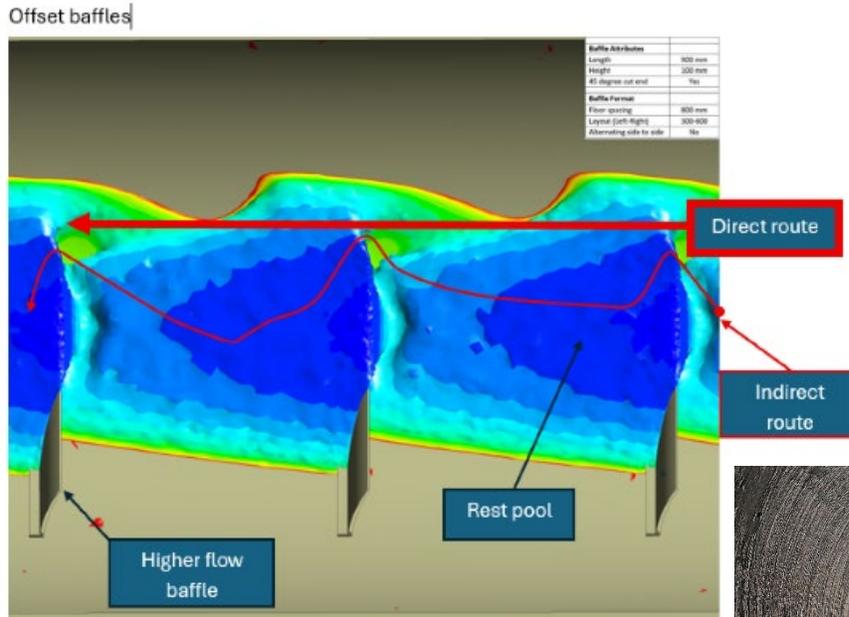
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The above culvert configuration is an example that provides a sustainable solution that balances infrastructure needs with ecological function.

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Understanding how baffles help with fish passage



CFD modelling shows typical flow interaction with offset baffles along with passage options for fish during base and low flows.

Fish passage options will increase during higher flows.

Glossary of terms

Complex flow – a range of depths, flow directions and velocities down through the water column

Rest pool – a Low Velocity Zone (LVZ) of sufficient length and depth to accommodate fish navigating upstream. Somewhere to rest and potentially to feed to restore energy.

Offset baffles – baffles positioned off to one side

Deposition Zone - an area immediately downstream of a structure where bed material is typically deposited due to a reduction in water velocity.

Backwatering - restriction of flow causing water to back upstream reducing velocity and increasing depth.

For further guidance, contact the Fish Passage Action Team.