# Lessons Learnt 004

## Installation of a fish pass and baffles to promote trout passage through long perched culverts

November 2019 V2

*This case study forms part of a series that provides key information and guidance about how to potentially improve a fish passage barrier in a New Zealand waterway.*

*While providing fish passage is advantageous to most fish, removing or remediating a barrier can also affect fish populations by introducing invasive species to new areas.*

Culvert

STRUCTURE TYPE

1/5

IMPROVEMENT RATING*

### What was the problem?

Six 120 m long, 2.6 m diameter barrel culverts (2% gradient; 2 cm average water depth) (Figure 1) pass the flow of Forks Stream under the Tekapo Hydro Canal, 1 km downstream from Lake Tekapo in the MacKenzie Basin. At this location this stream is subject to flows of between 1 and 50 $m^3s^{-1}$.

The outlets of these culverts are perched 2 m above the apron and are a barrier to adult trout. The perch is a result of the original design of the structure as fish passage was not taken into consideration. After passing under the canal, Forks Stream joins the Tekapo River about 100 m downstream of the culverts.

Prior to canal / culvert construction in 1972, Forks Stream sustained a recreational trout fishery based on annual spawning runs of up to 400 rainbow trout (*Oncorhynchus mykiss*) and 50 brown trout (*Salmo trutta*) from the Tekapo River.

Restoration of access to the 20km of upstream habitat was considered a priority as this was once an important sports fishery area.

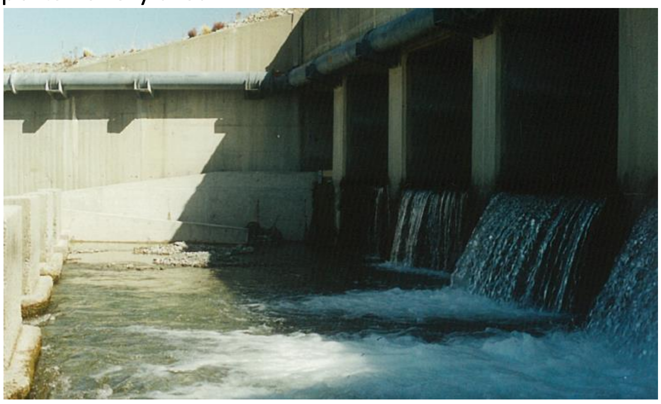

**Figure 1 Perched outlets of the six 120 m culverts running under the Tekapo Canal (1992. Photo: Mark Webb).**

* Improvement rating: 1/5 - Some improvement in passage over part of the barrier for some species/lifestages

### What was the solution?

**Figure 2. Pool/weir fish pass installed on the outlet of the Tekapo Canal. (April 1992; Source: Mark Webb)**

In 1992, Electricorp Pty Ltd funded Fish and Game to install nine removable tanalised timber jump pool / weir fish passes (200 mm height; 900 mm width) in a 'U' formation in the last culvert barrel on the true right, to overcome perching (Figure 2).

The fish pass was designed for the median flows recorded in this culvert (about 20 l / s) and were considered adequate to provide upstream passage for adult trout. Monitoring showed the fish passes alone did not provide passage through the culvert length into the upper catchment.

In response, in 1995 we trialled installing baffles to enhance trout passage through the culverts. A key element of in-culvert fish passage was that any structure must be self cleaning. A simple herring bone baffle design using sandbags was trialled but was unsuccessful. A lack of resting pools to provide respite from continuously high water velocities was identified as a fault.

A further design was trialled using a 10.9 m prototype section of baffling within the culverts to accommodate the 2% culvert base gradient, plus an additional grade, to allow for provision of resting pools between baffled sections. The prototype consisted of four baffles on a 5% gradient and a pool (0.5 m depth x 4.2 m) at the upstream end (Figure 3). This represented one baffle unit plus pool that could be repeated throughout if sucessful.

**Figure 3. Baffles on a 5% gradient base overlying the culvert with a 2% gradient base. (Source: M Webb)**

## Monitoring results

Short term monitoring of the pool / weir fish pass was undertaken using upstream migrating adult rainbow trout released into the forebay below the culverts (foreground Figure 1).

Trout negotiated the fish pass below the culvert to the last jump. However, trout could not negotiate more than 3 m inside the culvert barrel due to high water velocities.

Monitoring of released trout in the section of prototype baffles within the culvert found that during a 36-hour period, 13 large trout (480 to 600 mm) only negotiated to the pool above the second baffle (approx. 5 m upstream). Pool depth was designed to be 0.5 m in flows of 90 l/s to 130 l/s, however in practice this became 0.65 m.

## Did it work?

Partially. The pool / weir fish pass installed at the culvert outlet enabled trout to get past the 2 m vertical perch, however, attempts to get trout through the culvert failed. The length and gradient of the culvert was found to prevent trout passage. In addition, the fish pass structure could not pass flood debris and the concrete walls became damaged beyond repair.

The 2% gradient of the culvert barrel required that the in-culvert baffle fish pass had an overall gradient of 5% in order to provide resting pools of 0.5 m depth between baffled units. This gradient exceeded the 3% gradient trialled by the designers of the fish pass. The extra gradient produced higher velocities and probably reduced the slower flow features produced by the lower gradient that are required for successful passage.

The marine ply prototype baffles trialled showed water pooled and flowed around baffles at flows of 90 l/s to 130 l/s so showed promise. But monitoring showed passage was not successful with baffling.

## Lessons learnt

1. The pool / weir fish pass enabled passage for adult trout over the vertical perch, however, could not withstand damage from flood debris.
2. Herring bone baffle design within the culvert was not effective at providing passage for trout, even with resting pools. The design could be altered to provide less depth and velocity that may allow better passage.
3. Given the flood damage to the concrete base of the fish pass at the bottom of the culvert it is unlikely any structure within the culvert barrel would remain intact permanently at this location.
4. It is important to consider all limitations on passage within and surrounding the structure when trying to remediate a barrier and provide passage. In this situation, perching, the length of the culvert and flow were all limitations needing management.
5. Outcome monitoring is crucial as it was found that the culverts still presented a barrier even after the fish pass successfully enabled access into the culvert.

## For further information

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*This is a revised/updated version, original was published in September 2015.*