Crossings
3.4 Single Culvert River Crossings

Single culvert crossings are the most common structure used to cross small to medium sized rivers.

Culverts are relatively easy to install and low cost compared to other crossing structures. Designed, constructed and maintained correctly they will endure, but careful planning and installation is required to prevent failure and ensure fish passage.

Culvert pipes can be smooth or corrugated and can be made from a wide range of materials – plastic, concrete, galvanised steel or aluminium.

Culvert installation.

This guide is provided as a reference document and does not constitute a statutory obligation under the Resource Management Act 1991 or the National Environmental Standards for Plantation Forestry.

Please refer to the 'how to use' section of the introduction at http://docs.nzfoa.org.nz/forest-practice-guides/ for advice on how to use this guide.

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A Where and when to use
1. To cross small to medium sized rivers.
2. Where there is a low gravel movement that could infill the culvert.
3. Where there are greater than low volumes of traffic (e.g. greater than 20 axle movements per day).

B Where not to use
1. A resource consent would be needed where the culvert is:
   a. within 500 m of a dwelling that is within 15 m of a river bed greater than 3 m wide, or
   b. downstream of a dwelling with a ground floor level that is less than 1 m above the highest part of the culvert crossing.

C Design
1. Consider geology, soil type, topography, rainfall, storm events, and traffic usage in the design.
2. Consider whether there are other downstream values in the catchment that could be affected by a culvert crossing (e.g. infrastructure and dwellings).
3. To reduce scour of the approaches, locate the crossing on a straight section of river, if possible.
4. Try to avoid locations that alter the natural course and gradient of the river or create erosion of the banks and bed of the river.
5. Design to not cause flooding or ponding to any other property or impact on other existing structures.
6. Design the culvert to convey a one in 20 year flood flow event (5% AEP) without heading up. Calculate the flood design and use engineering formulae to determine the required culvert size (refer to Schedule 2 of the NES-PF for flood design flow calculators and/or https://stream-explorer.niwa.co.nz). In higher risk situations, consult with a forest engineer, hydrologist or other specialist to help with design and construction if necessary. Given the costs and risks involved for large culverts, or culverts higher than 3.5 m (measured up from the bed of the river at the inlet – including the pipe and fill), it is recommended that flood design calculations are peer reviewed.
   a. Reinforced concrete pipes have very good hydraulic characteristics, as they are smooth, and have a high load bearing capacity – but they may create a barrier to fish passage.
   b. Use existing structures, where present, as a tool to gauge the culvert pipe size against that derived from the flow calculations.
   c. Ensure the contributing catchment area and average annual flow are considered.
7. Consider designing armoured spillways where culverts may be at risk of overtopping.
8. Design for upstream and downstream passage of fish.
9. The minimum diameter for a single culvert river crossing is 450 mm.
10. Ensure sufficient culvert length. If the culvert is too short the batter slopes are over-steepened. This can lead to the fill slope slumping and the discharge of sediment into the river.
Crossings

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**Construction**

1. Ensure any installation specifications and procedures are followed.
2. Construct in suitable weather and with low river flow.
3. Check for any fish spawning timing constraints under the NES-PF.
4. Limit earthwork disturbance to the immediate work site, which will include an area upstream and downstream of the crossing site.
5. Minimise the need for machinery to operate in flowing water.
6. Divert the river around the culvert trench temporarily to make sure the culvert foundation is properly prepared, to reduce the risk of contaminants entering water and minimise discharge of sediment.
7. Construct the culvert trench or bed at the correct depth and grade so that when constructed both the inlet and outlet are 20% below river bed level. This will allow for fish passage.
8. Bed the culvert in so that it lies flat and is supported on the firm base of the trench.
9. Take care not to damage the culvert during installation. Some culvert materials are more prone to damage than others.
10. Backfill, using clean fill with no organic matter, and compact around the pipe to eliminate water bypassing the culvert, and resulting in it scouring out.
11. Compact the fill in layers to strengthen and stabilise the fill.
12. Wet or curing concrete must not be in contact with flowing water. Cement is a contaminant and is toxic to invertebrates and fish. When pouring concrete, the water channel will need to be temporarily diverted.
13. If necessary, protect the inlet headwall and outlet. Armour if necessary. Use rip rap, reno mattress, durable logs, gabions, wing walls or energy dissipating structures.
14. Do not use tyres, untreated wood or logs to construct the headwalls of the structure.
15. Where practicable, divert road surface water away from culvert fill.
16. Use stormwater and sediment control measures to limit sediment entry into the river (e.g. berms, cut-outs, water table drains, flumes and sediment traps).
17. Check regularly during and on completion of construction. If the work does not meet the design plan and standards then initiate corrective actions.

**Maintenance**

1. Prepare a routine maintenance plan including heavy rainfall response measures.
2. Check culverts after a heavy rain or a flood event. They may require regular maintenance especially to the headwall, batters and outlet, and maintenance of fish passage.
3. Culvert pipe inverts (the base of the pipe) and headwall and/or outlets wear out over time. They erode through debris and bed load abrasion or from water chemistry, especially corrugated steel. Re-strengthen steel and concrete bottoms. This often requires specialist engineering assistance.
4. Consider fish passage retrofits if necessary for fish passage.
Other methods

1. Box culverts can accommodate significantly larger flows than cylindrical corrugated pipe alternatives. Another advantage is the minimal excavation and backfilling required. Box culverts can also be designed to carry heavy wheel loadings with little or no fill material placed over the culvert to distribute the load.

Technical specification guidelines

1. Construct a spillway/secondary flow path if required:
   a. Establish the low point at one end of the crossing.
   b. Build an armoured flow path using rock or engineered structures such as reno mattress.
   c. Construct a spillway on undisturbed ground adjacent to the structure to accommodate exceptional flood flow events.

2. For fish passage re-instatement, spat rope or fish ladder options can be used:
   a. Use spat ropes for native fish passage in culverts less than 1 m internal diameter.
   b. Use at least two spat ropes.
   c. Anchor ropes to shackles attached to waratah sections upstream of the culvert.
   d. Drive anchors below river bed level or on the river banks.
   e. Seek specialist assistance and view online resources.

National Environmental Standards for Plantation Forestry

Particular relevant provisions for crossings are Regulations 38 – 49.

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Examples

A well sited culvert, with stable stream banks and fish passage.

Poorly constructed culvert – with untreated logs, a substandard headwall and sediment discharges from the culvert fill. The pipe is too short for road carriageway.
Perched culverts do not allow for fish passage.

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Other Practice Guides in this series

- 3.1 Battery Culvert River Crossings
- 3.2 Drift Deck River Crossings
- 3.3 Ford Crossings
- 3.4 Single Culvert River Crossings
- 3.5 Single Span Bridge River Crossings
- 3.6 Temporary Crossings