Forest Practice Guide

Non-Regulatory

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.

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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Crossings
3.4 Single Culvert River Crossings

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
3.4 Single Culvert River Crossings

D 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.

E 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.

Crossings
3.4 Single Culvert River Crossings

F Other methods

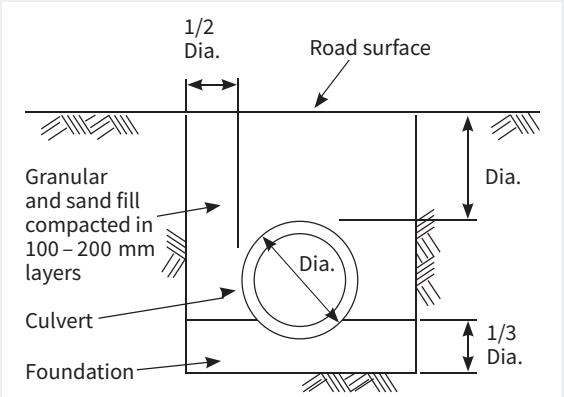
1. Box *culverts* can accommodate significantly larger flows than cylindrical corrugated pipe alternatives. Another advantage is the minimal excavation and backfilling required. Box *culverts* can also be designed to carry heavy wheel loadings with little or no *fill* material placed over the *culvert*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

Box culvert

Refer also to the Department of Conservation **Fish Passage Guidelines:** https://www.doc.govt.nz/nature/habitats/freshwater/fish-passage-management/nz-fish-passage-guidelines/

G Technical specification guidelines

Culvert installation practices/recommendations[1]



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.

1 From the Forest Roading Manual page 115. http://www.nzfoa.org.nz/resources/file-libraries-resources/transport-and-roading/484-nz-forest-road-engineering-manual-2012/file

Crossings
3.4 Single Culvert River Crossings

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.

Crossings
3.4 Single Culvert River Crossings

Perched *culverts* do not allow for fish passage.

Contact

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