Environmental Best Practice Guidelines 5. Siting and Designing Stream Crossings

1. Background

These best practice guidelines discuss the siting and design principles that should be used to minimise environmental harm when constructing stream crossings. The principles should be considered by local councils when developing planning schemes and assessing planning permits for the construction of stream crossings.

Undertaking construction works in waterways and wetlands without expert advice can cause severe environmental harm that may be difficult and expensive to remediate. Depending on the scale of the works, advice may be needed from one or more experts, including a stream biologist, river engineer, fluvial geomorphologist or hydrologist.

2. Stream crossing types

The type of stream crossing selected will depend on the crossing's purpose and anticipated frequency of use, the site characteristics (bank height, bed stability, flow regime, depth, etc), and the budget.

If possible and appropriate, use the structure that is least likely to cause environmental harm. As a general rule of thumb, in descending order of preference, use bridges, arch culverts, open-bottom box culverts, closed-bottom box culverts, and pipe culverts.

Bridges are raised structures that carry a path or road over a waterway. They are used when frequent crossings are anticipated. Typically, bridges are used on waterways with clearly defined drainage channels, permanent and semi-permanent pools, and wetlands connected to rivers. Usually, they have little or no in-stream framework so they do not impede flows. As a result, they can be used during most floods.

Bridges are the most appropriate crossings for sites

- with actively eroding banks
- where the channel is too steep for a culvert
- with steep banks that would need considerable infilling if a culvert were used
- with threatened species, fish habitat or aquatic vegetation.

Culverts are arched, boxed or piped conduits that allow water to pass under a road or other structure. They are usually made of concrete or galvanised corrugated steel pipe. The location and size of the culvert will be determined by its flow capability requirements and the need for it to be safe during high flows. Like bridges, some large box and arch culverts do not significantly alter the form of the stream bed or the width of the channel.

Causeways are structures that raise the base of the stream bed. They allow water to go through a culvert underneath when flows are low but are inundated during floods. Typically, causeways are located on waterways with intermittent flows, poorly defined drainage channels, and semi-permanent pools that provide habitat for aquatic animals. They are suitable for wide shallow streams with gravel and soft substrate beds where it is too expensive to construct a bridge or culvert and intensive use is not anticipated.

Fords are vehicular crossings that are almost level with the river bed. Low flows pass over the structure rather than through a culvert below. They are used when infrequent use is anticipated (if more frequent use is anticipated, a permanent or temporary culvert may be needed to prevent disturbance to the channel). Fords are 'wet' crossings so they should be used only when flows are low or non-existent. Fords are suitable for intermittent waterways with little or no defined drainage channel, no lasting pools, and little or no vegetation.

Stock crossings are natural stream crossings that have had little or no modification. Stock crossings are 'wet' crossings so they should be used only when flows are low or non-existent. Stock are one of the major causes of environmental harm to waterways so stock access to waterways - and stock crossings - should be controlled and minimised.

3. Site selection

Crossings can cause severe environmental harm to waterways and are expensive to install so the number of crossings should be minimised. Existing crossings should be used if possible. If a new crossing is needed and there is a choice of sites, the site should be selected to comply with the following requirements

- the stream reach is straight, well defined and unobstructed
- a right-of-way exists
- to minimise need for training works the geology and soil conditions should be stable with minimal scouring, and minimal deposition and displacement of sediments (that is, little active erosion and meandering)
- select an area where the risk from environmental hazards such as floods and landslides is minimal
- the hydraulic effects of natural features (eg waterfalls) and artificial in-stream structures (eg weirs)
- avoid wetlands and floodplains
- avoid areas where the works could mobilise contaminated sediments
- avoid areas that have threatened species and pristine ecosystem Protected Environmental Values
- avoid areas with significant cultural heritage or geomorphological values
- select an area where disturbance to the riparian vegetation can be minimised
- select an area where public safety, use and enjoyment will not be compromised
- avoid areas of aesthetic value
- additional care will be needed if the crossing is upstream of domestic and town water supplies, aquaculture and other industrial off-takes, sensitive ecosystems, and recreational areas.

4. Bridges

Potential environmental effects

Reduces stream stability: Mobilising and removing alluvial material during construction, and scouring caused by the bridge's piers and footings can reduce the stability of the stream bed and banks.

Degrades water quality: Mobilising sediments during construction, and scouring caused by the bridge's piers and footings may increase the sediment load and turbidity of the waterway. Runoff from the bridge's decking and approach roads may also degrade water quality.

Destroys bank vegetation: The stream banks under bridges are usually permanently dry and shaded because light and moisture are blocked by the bridge. The resulting death of the vegetation cover can lead to instability of the banks, less filtering of overland flow, and a loss of food and shelter for animals.

Restricts movement of animals: The bridge footings and bank armouring may stop animals moving along the banks. This may force animals to use the nearby roads, which increases their chances of being killed on the road, particularly on busy roads.

Environmental design requirements

Before constructing a bridge a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below.

- Contractors and plant operators undertaking construction works in streams should adopt the principles outlined in *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands* to minimise the risk of causing environmental harm.
- The bridge should be designed and constructed to accommodate all flow conditions. Expert advice will be needed on a range of geographical, hydrological, hydraulic and geo-technical issues. If the bridge is to be used by the public and heavy vehicles, detailed design drawings should be submitted. The drawings should be certified by a qualified engineer and satisfy all the relevant Australian Standards.
- The bridge should be perpendicular to the waterway.
- The waterway's natural hydraulic regime should be preserved as much as possible. The piers and footings should be placed beyond the channel and above the high water mark to avoid constricting the channel and reducing the flow area.
- If the piers and footings must be placed in the channel, they should be parallel to the flow so the flow is not directed onto the banks. The minimum number of optimally shaped pylons should be used to minimise eddying and scouring of the waterway. Erosion protection should be included if scouring is likely to occur.

The number of piers and footings should be kept to a minimum in stream channels

- Rock beaching is usually used on the batters to protect against scouring of the abutment because it is unlikely the area will revegetate due to a lack of light and moisture under the bridge. Generally, the beaching should extend three metres upstream and downstream of the bridge. The batters should be excavated to the depth of the beaching to maintain the channel area. The batter slope should be 1:1-1:2 (vertical:height). Generally, the beaching should extend at least 600 mm below the toe of the banks to prevent undermining. Rock beaching may not be needed if the banks are stable.
- Using grated decking on a multi-lane bridge, so light and moisture can penetrate, may be considered if the risk of pollution from road spills is minimal.
- If possible, enough space should be provided under the bridge for animals to walk along the banks.
- Steep approaches to the bridge should be avoided.
- Cross-fall drains should be used to drain water from the access road into a sediment trap or the roadside vegetation. The drains should be at least 20 metres away from the crossing.

5. Culverts

Potential environmental effects

Degrades stream bed and associated habitats: If a culvert replaces a section of the stream, the stream bed and its associated aquatic and riparian habitats will be lost.

Initiates erosion of channel: If a culvert is installed too high - so the downstream end lies above the stream bed (perched culvert) - a waterfall will result. This can lead to bed scouring, bank erosion, and undercutting and structural damage of the culvert. If the culvert slope is too great, the increased water velocity can cause erosion downstream.

Initiates erosion around culvert: Confining the stream flow to a culvert may alter the flow regime and trigger erosion, deposition at the inlet, and scouring at the outlet.

Causes flooding: Blockage of culverts by waterborne debris can cause flooding during high flows. Bridges are better able to accommodate high flows.

Restricts fish movement: Tasmanian freshwater fish migrate downstream to estuaries to spawn and the juveniles migrate upstream. Fish have always had to overcome natural barriers, such as waterfalls and log-jams, when migrating. However, the expansion of forestry and urbanisation has greatly increased the number of barriers they face. A complete barrier can lead to extinction of migratory species upstream and possibly downstream. Tasmanian native freshwater fish cannot jump so a perched culvert with a drop of more than 10 centimetres will usually be a barrier to migration upstream. A survey of culverts in southern Tasmanian forestry catchments found that 50 percent of those surveyed did not allow fish to enter because of perching. A survey of culverts on Tasmanian roads would probably produce similar results.

Perched culverts are a barrier to fish passage

Culvert inlets constrict stream flow, which increases the flow velocity at the inlet. The increased velocity may make it difficult for fish to swim upstream out of the culvert.

When culvert gradients are more than 2 percent (1:50), the resultant high water velocities can make it difficult for native fish to swim through. The problem is more severe during high flows and in culverts with smooth walls, particularly if there are no resting places (eg behind baffles) in the culvert. A survey of culverts in southern Tasmanian forestry catchments found that 70 percent of those surveyed impeded the movement of fish because the culvert slope was greater than 2 percent (1:50). High water velocities can also impede the movement of other aquatic species, such as platypuses and water rats.

If several small pipes are used rather than one large barrel, the culverts may be too small for fish to swim through. The fish may also be reluctant to enter the culverts because they are too dark. Anecdotal information suggests that some platypuses and giant freshwater lobsters (Astacopsis gouldi) are killed on roads when avoiding such culverts.

Fish cannot swim large distances without resting. A lack of pools and rest areas immediately upstream and downstream of the culvert may make the culvert impassable if the distance they have to swim without a rest is too far.

Debris and sediment may block small diameter culverts particularly if trash screens or stock barriers have been installed. While total blockages are unlikely, the accumulated debris may stop migratory species passing through by creating a physical barrier or increasing flow velocity.

Reduces recreational use: Culverts may reduce recreational use of the river, particularly for fishing and canoeing.

Environmental design requirements

Before constructing a culvert/s a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below.

Round culverts are the most commonly used and worst designed culverts in terms of environmental outcomes. However, all culverts can cause significant environmental harm.

The flow characteristics and road alignment may restrict the design of culverts. Nevertheless, they should be designed and installed according to the following requirements.

- Contractors and plant operators installing culverts should adopt the principles outlined in *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands* to minimise the risk of causing environmental harm.
- The culvert's capacity should be able to accommodate peak flow volumes.

Open-bottom culverts with the natural streambed running through them are the preferred culvert structures

- Open-bottom culverts should not create a break in the bed substrate, and should be large enough not to constrict flows or trap debris during normal flow conditions.

If an open-bottom culvert is not possible, the following requirements apply

- One large culvert spanning the width of the waterway is preferable to two or more small culverts because it is usually more efficient hydraulically.
- If multiple culverts are needed to span the stream bed, one or more should be slightly lower than the others to concentrate low flows and allow fish to swim through.
- The culvert should be perpendicular to the flow to minimise the length needed (less than 4 metres) and allow fish to swim through.
- The culvert gradient should be similar to that of the stream, which should be gently sloping. If fish may be passing through, avoid using culverts on a waterway that has a gradient of more than 2 percent (1:50). The gradient immediately downstream of the culvert should be less than 5 percent (1:20) so fish can approach the culvert outlet.
- The culvert should not create any significant discontinuities in the water profile. Its size and placement should not cause ponding upstream, unless ponding is typical of the river reach. Perched culverts should be less than 10 centimetres above the receiving waters.
- If fish may be moving through the culvert, the culvert invert should be buried so a minimum of 20 percent of the diameter (round culvert) or 20 percent of the height (box culvert) lies below the channel bed. Generally, the invert should be placed so the water in the culvert is at least 200-500 millimetres deep during low flows.
- If the culvert gradient is 0.5-3.5 percent (1:200-1:30) the culvert diameter should be at least 1.25 times the width of the channel and the downstream invert should be embedded at least 20 percent below the stream bed. Natural substrate should be placed in the culvert if possible. This guideline applies only if the product of channel slope and culvert length is less than 20 percent of the culvert diameter.
- If possible, the culvert should be designed so its hydraulics are similar to that of the stream and the weakest fish species can swim through. The water depth should allow the largest fish species to remain submerged.
- The culvert should have at least 600 millimetres of space above the typical base flows so it is light enough inside that fish are not discouraged from entering and swimming through.
- Water velocities in the culvert should be similar to those at the site before the culvert was constructed. There should also be no differences in the flow rates upstream, in and downstream of the culvert.
- Baffles or large angular rocks typical of the area can be cemented along the base of longer concrete culverts to reduce flow velocities and allow fish and invertebrates to pass through. Lining the base of the culvert with a rough concrete finish and/or natural substrate will increase turbulence and make it easier for fish to swim through. Velocities of less than 0.3 metres/second will allow most native fish to swim through a 5 metre culvert. Placing small rocks along the base may also help other species, such as platypuses and water rats, pass through the culvert.
- Water velocities may be decreased and water depths increased by using appropriately designed tail-water control devices. These devices can be incorporated into the outlet-basin design.
- Fish resting pools constructed upstream and downstream of the culvert should be at least two metres long along the direction of flow, be deep enough for fish to remain submerged, and contain rocks and vegetation to provide cover. Aquatic and riparian plants can provide shading.

- Inlet and outlet flow velocities of less than 0.9 metres/second will not transport silt.
- A rip-rap apron should be placed up to six culvert diameters beyond the end of the pipe to prevent erosion downstream of the culvert outlet, particularly if the slope of the stream bed is greater than 2 percent (1:50). The apron should have a V-shaped cross-section so fish can swim through when water levels are low.
- The capacity of the culvert should be large enough to accommodate some deposition of gravel in the culvert.
- The culvert should be large enough to accommodate the anticipated debris and sediment load. The greater the anticipated load the greater the cross-sectional area needed for the culvert. Regular maintenance will be needed to remove debris and sediment and check for erosion.
- The culvert should not reduce the cross-sectional area of the channel and infilling of the channel should be avoided.
- Fill placed below the high water mark must be free of fines, sediment, soil, pollutants, contaminants, toxic materials and other waste materials.
- Steep approaches to the crossing should be avoided.
- Cross-fall drains should be used to drain water from the approach road into a sediment trap or the roadside vegetation. The drains should be at least 20 metres away from the crossing.

6. Causeways

Potential environmental effects

Initiates erosion: Poorly sited causeways can lead to erosion of the stream bed and banks. Scour holes may develop downstream of the causeway, and may undermine and outflank the structure. Restricted sediment transport and increased flow velocities may increase bed erosion.

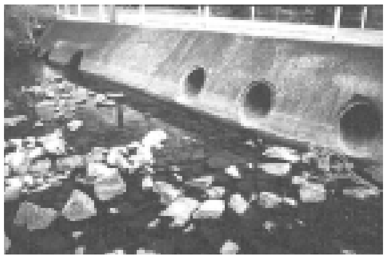
Deposits sediment into river: Poorly designed causeway approaches can erode and deposit large amounts of sediment into the waterway.

Causes flooding: Causeways can cause more frequent local flooding if they restrict flows.

Restricts fish movement: In steep gradient streams, a drop may be created on the downstream side of the causeway. This may make it difficult for fish and other aquatic animals to cross. Many freshwater species, particularly fish, need to swim freely in rivers to survive. Fish blocked by structures are more likely to be taken by birds.

Environmental design requirements

Before constructing a causeway a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below.



Multi level culverts may allow fish to pass through causeways during low flows

- Contractors and plant operators constructing causeways should adopt the principles outlined in *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands* to minimise the risk of causing environmental harm.
- If a culvert is used it should comply with the environmental design requirements for culverts (see 'Section 5. Culverts').
- The causeway should be sited on a straight stretch of the waterway that has a minimal gradient.
- The causeway should be perpendicular to the waterway.
- The river's normal hydraulic regime should be preserved as much as possible.
- The site should have a stable substrate and scour resistant material immediately downstream.
- The causeway should not be sited near a riffle or pool if possible because of the likelihood of causing erosion and degrading aquatic habitat.
- Both ends of the causeway should be 'keyed in' to the bank for 3-5 metres.
- The surface of the causeway should be constructed of erosion-proof material, such as interlocking angular rock or concrete.
- Deep box cuts should be avoided on the approaches to the causeway.
- Cross-fall drains should be used to drain water from the approach road into a sediment trap or the roadside vegetation. The drains should be at least 20 metres away from the crossing.

7. Fords

Potential environmental effects

Initiates erosion: Poorly designed and sited fords may trigger stream bed and bank erosion. Scour holes may develop below the ford if the invert is higher than the stream bed. This may eventually undermine and outflank the ford. Poorly designed approaches to fords may erode and deposit large amounts of sediment into the waterway.

Destabilises channel: Frequent use of unhardened fords may destabilise the channel and cause bed and bank erosion and siltation.

Restricts sediment transport: Fords may block sediment moving downstream by acting as a weir. Restricted sediment transport and increased flow velocities may increase bed erosion downstream of the ford.

Causes flooding: Fords may increase the frequency of local flooding by restricting flows.

Restricts movement of fish and aquatic animals: Fixed structures, such as concrete fords, cannot adjust their form as the height of the stream bed changes. If the stream bed deepens in a steep gradient stream, a vertical drop and waterfall may develop on the downstream side of the ford. This may prevent or make it difficult for fish and other aquatic animals to travel upstream across the ford.

If the ford is made of smooth concrete, the increased water velocities may make it difficult for fish and other aquatic animals to cross.

Flows are often spread across the width of fords during low flows. As a result, the water may be too shallow to allow fish and other aquatic animals to cross.

Environmental design requirements

Before constructing a ford a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below.

- A ford is appropriate only if infrequent use is anticipated.
- Contractors and plant operators constructing fords should adopt the principles outlined in *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands* to minimise the risk of causing environmental harm.
- The ford should be constructed and used during the driest times of the year.
- The site of the ford should have a stable, non-erodible rock or bedrock base to minimise siltation from traffic. Sandy, vegetated and silty sites are not appropriate.
- The ford should be perpendicular to the waterway.
- If rocks are used to construct the ford, they should be almost level with the stream bed and they should not affect flows significantly. Only clean material from another site should be used. Excavating rock from the stream is rarely acceptable.
- The surface of the ford should be constructed of an erosion-proof material, such as interlocking angular rock or concrete.
- Concrete fords should have a 'V'-shaped or rounded notch on the thalweg of the stream (lowest point of main channel) so fish can swim across the ford during times of low flow. The 'V' or notch should be least 5 centimetres deep and 30 centimetres wide.

Fords should be perpendicular to the waterway on non-erodible substrate

- Avoid deep box cuts on the approaches to the ford. The height of the banks adjacent to the ford should be less than 2 metres.
- Non-erodible material should be used on both banks to stabilise the approaches to the ford.
- The amount of vegetation removed adjacent to the ford should be minimised.

- Cross-fall drains should be used to drain water from the approach road into a sediment trap or the roadside vegetation. The drains should be at least 20 metres away from the crossing.
- Grease, oil and other fluids should be cleaned off all vehicles before entering the ford.
- A fence may be needed to stop stock entering the stream from the ford.

8. Stock crossings

Potential environmental effects

Degrades stream bed and banks: Stock in waterways degrade stream beds and banks by destroying the vegetation cover, eroding the bed and banks, compacting the soil and introducing weeds.

Degrades water quality: Stock in waterways degrade water quality by stirring up sediment. They also increase the number of bacteria and viruses in the water when they defecate into waterways. If access is uncontrolled, injured and dead stock can contaminate the stream and threaten public health.

Uncontrolled stock access can destabilise the stream bed and banks and degrade water quality

Environmental design requirements

Before constructing a stock crossing a works plan should be prepared. The plan should outline the works to be undertaken and the measures that will be used to minimise the risk of causing environmental harm. The measures outlined should include those described below.

- Contractors and plant operators constructing stock crossings should adopt the principles outlined in *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands* to minimise the risk of causing environmental harm.
- Stock crossings should not be used as watering points.
- If a naturally hardened substrate is not available, modification of the stream should be limited to hardening the stream bed.
- The approaches should be constructed of gravel or stone.
- Smooth approach ramps and walkways allow manure to be removed with a scraper.
- Electric fences should be placed on both sides of the walkway to stop stock moving along the stream bed and banks. Alternatively, plain-wire fences may be used because they are easily repaired and replaced after floods. Mesh-type fences (eg ringlock) should not be used because they catch debris and restrict flood flows.

If a temporary watering point is needed

- Allow stock to drink only at properly constructed and controlled access points. The watering point should be located on the downstream side of an inside bend that is not prone to erosion.
- Fencing off the riparian zone allows the timing, intensity and duration of stock access to the waterway to be controlled. Fences around the watering point should extend into the water.
- Providing water in troughs and dams away from the stream is better than creating a temporary watering point along the bank.

9. Ongoing maintenance

All stream crossings should be maintained regularly to minimise the risk of causing erosion and flooding, and obstructing the passage of fish and other animals. Regular inspections and maintenance should be carried out on new crossings, after periods of high flow, and before fish and other animals begin migrating. The inspection and maintenance should

- clear debris from the crossing's surface, entrance and exit
- remove excess silt from the entrance and exit of the culvert/s if more than a third of the entrance is blocked.
- make sure erosion is not being exacerbated.

10. Removing crossings

Stream crossings impede the movement of migratory fish and other animals. If a crossing is no longer being used, consider removing it and rehabilitating the site. Seek advice from the Inland Fisheries Service before removing any crossings.

11. References

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These guidelines should be used in conjunction with the appropriate technical advice and literature.

Checklist

This checklist summarises the environmental design requirements outlined in E*nvironmental Best Practice Guidelines 5. Siting and Designing Stream Crossings*. The plan of works prepared should describe the proposed works and show that the measures listed below will be used to minimise the risk of causing environmental harm during and after the works.

- ❑ Works plan prepared

Stream crossing types (Section 2)

- ❑ Crossing type appropriate

Site selection (Section 3)

- ❑ Stream straight and well defined
- ❑ Right-of-way exists
- ❑ Geology and soil conditions appropriate
- ❑ No major environmental hazards
- ❑ Flow not affected by in-stream natural features or other structures
- ❑ Not wetland or floodplain
- ❑ Contaminated sediments not likely to be mobilised
- ❑ Threatened flora and fauna protected
- ❑ No pristine ecosystem Protected Environmental Values
- ❑ Sensitive ecosystems protected
- ❑ Cultural heritage and geomorphological values protected
- ❑ Vegetation disturbance minimised
- ❑ Public safety and use not compromised
- ❑ Minimal aesthetic effects
- ❑ Downstream town and domestic water supplies protected
- ❑ Sensitive downstream industrial off-takes protected

Bridges (Section 4)

- ❑ Works conform to *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*
- ❑ Engineering advice sought
- ❑ Design drawings comply with Australian Standards
- ❑ Perpendicular to waterway
- ❑ Piers and footings designed and sited appropriately
- ❑ Appropriate rock beaching used
- ❑ Grated decking considered
- ❑ Terrestrial access along stream banks provided
- ❑ Approaches well designed
- ❑ Sediment control measures used

Culverts (Section 5)

- ❑ Works conform to *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*
- ❑ Expert advice sought
- ❑ Retains natural stream bed
- ❑ Peak flow capacity adequate
- ❑ Low flows concentrated
- ❑ Perpendicular to flow
- ❑ Length does not restrict movement of aquatic animals
- ❑ Gradient approximates stream gradient
- ❑ No ponding upstream
- ❑ Drop less than 10 cm in perched culverts
- ❑ Pipe culvert embedded in stream bed
- ❑ Culvert size allows light entry
- ❑ Natural flow velocities retained
- ❑ Internal surface modified to reduce water velocities
- ❑ Tail-water control devices considered
- ❑ Shaded fish resting pools upstream and downstream of culvert
- ❑ Erosion control at outlet if necessary
- ❑ Anticipated sediment and debris load accommodated
- ❑ Fill material effects minimal
- ❑ Approaches well designed
- ❑ Sediment control measures used

Causeways (Section 6)

- ❑ Works conform to *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*
- ❑ Expert advice sought
- ❑ Complies with culvert environmental design requirements
- ❑ Site appropriate
- ❑ Perpendicular to flow
- ❑ Stream substrate stable
- ❑ Not sited near riffle or pool
- ❑ Causeway 'keyed in' to banks
- ❑ Roughened erosion-proof surface used
- ❑ Approaches well designed
- ❑ Sediment control measures used

Fords (Section 7)

- ❑ Frequency of use appropriate
- ❑ Expert advice sought (depending on scale of works)
- ❑ Works conform to *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*
- ❑ Site appropriate
- ❑ Minimal effects on flows
- ❑ Substrate stable
- ❑ Approaches well designed and stable
- ❑ Roughened erosion-proof surface used
- ❑ Fish able to cross during low flows
- ❑ Fenced off to control stock access
- ❑ Sediment control measures used

Stock crossings (Section 8)

- ❑ Expert advice sought (depending on scale of works)
- ❑ Works conform to *Environmental Best Practice Guidelines 2. Construction Practices in Waterways and Wetlands*
- ❑ Site and substrate appropriate
- ❑ Walkway at or near stream bed level
- ❑ Minimal effects on flow
- ❑ Fenced off to control stock access
- ❑ Off-stream watering points considered
- ❑ Access points hardened
- ❑ Sediment control measures used

Ongoing maintenance (Section 9)

- ❑ Maintenance program prepared