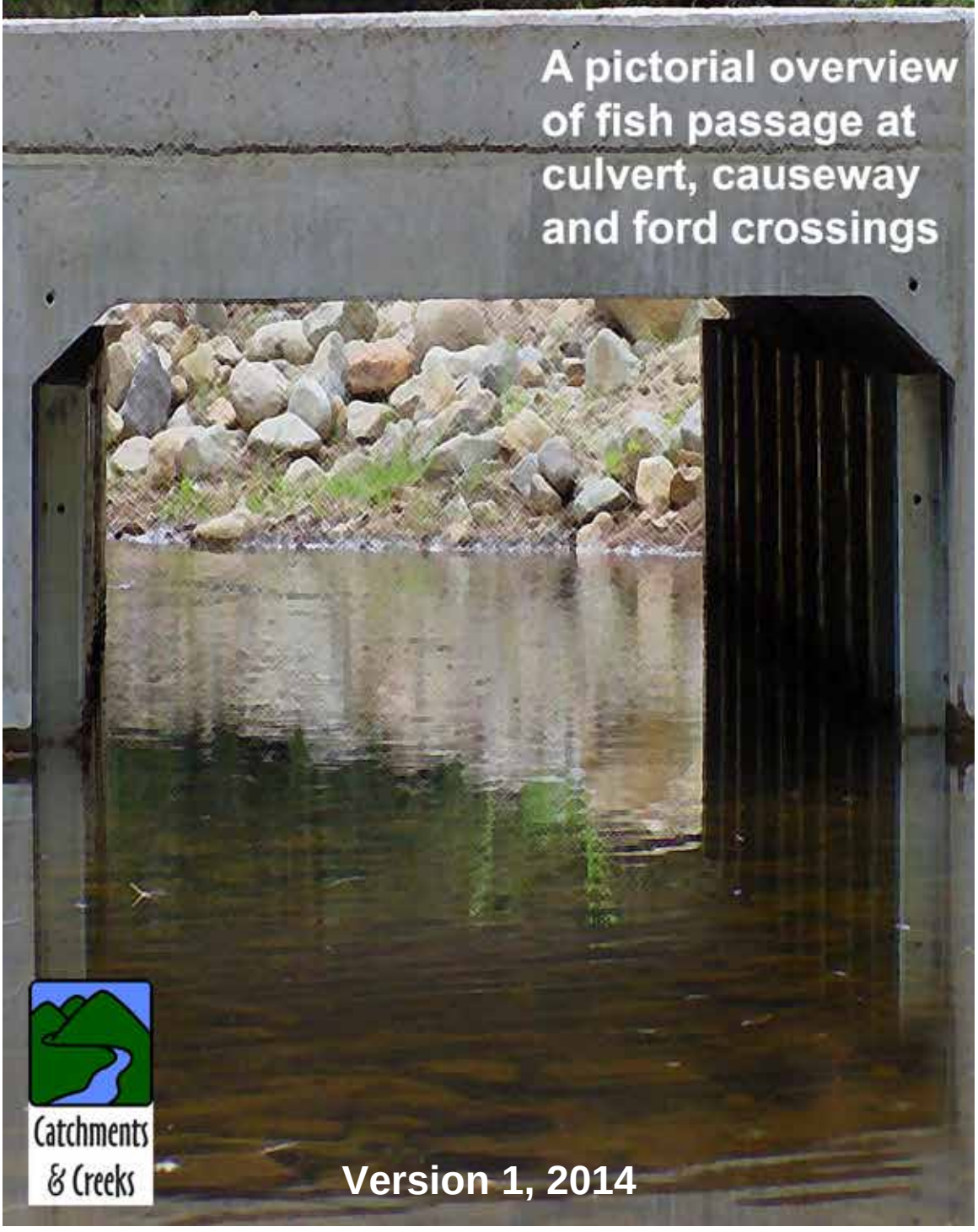
A Field Guide to Queensland's Self-Assessable Codes for Fish Passage at Waterway Crossings

A pictorial overview of fish passage at culvert, causeway and ford crossings



Catchments & Creeks

Version 1, 2014

A Field Guide to Queensland's Self-Assessable Codes for Fish Passage at Waterway Crossings

Version 1, December 2014

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Key words: fish passage, culvert design, ford design, causeway design, waterway crossings, watercourse crossings, fish passage self-assessable codes

Copies of this document may be downloaded from: www.catchmentsandcreeks.com.au

Disclaimer

Significant effort has been taken to ensure that this document is representative of the current (2014) self-assessable codes for fish passage at waterway crossings. However, the author cannot and does not claim that the document is without error, that the author's interpretation of these codes is consistent with that of Fisheries Queensland, or that Fisheries Queensland will not alter their codes from time to time rendering parts of this document obsolete.

The intent of this document is to convey the requirements of Queensland's self-assessable codes for fish passage at waterway crossings. Its is **not** the author's intension to convey his own design recommendations. As such, the author cannot provide any guarantee as to the reliability or suitability of the design requirements provided within the document or in fact by Fisheries Queensland.

The author shall have no liability or responsibility to the user or any other person or entity with respect to any liability, loss, or damage caused, or alleged to be caused, directly or indirectly, by the adoption and use of any part of the document, including, but not limited to, any interruption of service, loss of business or anticipatory profits, or consequential damages resulting from the use of this document.

Specifically, the author cannot guarantee that the design procedures presented here will:

- achieve consensus with Fisheries Queensland expectations for a given site
- achieve compliance with any statutory obligations
- achieve desirable fish passage at a specific waterway crossing.

Principal reference documents:

WWBW01 Part 3, April 2013

Code for self-assessable development – Minor waterway barrier works, WWBW01 Part 3: Culvert crossings

April 2013, Department of Agriculture, Fisheries and Forestry.

www.fisheries.qld.gov.au

WWBW01 Part 4, April 2013

Code for self-assessable development – Minor waterway barrier works, WWBW01 Part 4: Bed level crossings

April 2013, Department of Agriculture, Fisheries and Forestry.

www.fisheries.qld.gov.au

FHMOP 008, April 2013

***Waterway barrier works development approvals,* Fish Habitat Management Operational Policy FHMOP 008**

April 2013, Department of Agriculture, Fisheries and Forestry.

www.fisheries.qld.gov.au

WWBW02 Temporary works, 2013

Code for self-assessable development – Minor waterway barrier works, WWBW02 Temporary waterway barrier works

April 2013, Department of Agriculture, Fisheries and Forestry.

www.fisheries.qld.gov.au

Contents

Purpose of field guide

This is **not** a government publication and as such does not necessarily represent the opinions of the Queensland Government. The field guide has been prepared specifically to:

- improve the reader's awareness of Fisheries Queensland's self-assessable design codes
- summarise, using direct quotes wherever possible, the various self-assessable codes prepared by Fisheries Queensland for the design of fish passage at waterway crossings
- provide the reader with a guide to the potential application and interaction of four specific self-assessable codes relating to a waterway crossing design, those being: WWBW01 Part 3, WWBW01 Part 4, FHMOP 008, and WWBW02 (refer to page 3).

The photos presented within this document are intended to represent the current topic being discussed. These photos are presented for the purpose of depicting either a preferred or unsatisfactory outcome (as the case may be). In many instances the photos are representative of past practices that may not be consistent in all aspects of the current design codes.

The caption and/or associated discussion should **not** imply that the actual site was poorly engineered. The design requirements, site conditions and history of each site are not known to the author in each case, and may not be directly relevant to the current discussion. This means that there may be a valid site-specific reason why the designer chose the design or layout depicted in the photo.

About the author

Grant Witheridge is a civil engineer with both Bachelor and Masters degrees from the University of NSW (UNSW). He has over 30 years experience in the fields of hydraulics, stormwater management, creek engineering and erosion & sediment control, during which time he has worked for a variety of federal, state and local governments, and private organisations.

Grant commenced his career at the UNSW Water Research Laboratory constructing and operating physical flood models of river floodplains. He later worked for Brisbane City Council on creek engineering and stormwater management issues. He currently works through his own company Catchments & Creeks Pty Ltd.

Grant is the principal author of the revised Queensland Urban Drainage Manual (2007), Brisbane City Council's Natural Channel Design and Creek Erosion guidelines; the IECA (2008) Best Practice Erosion & Sediment Control documents, and the 2002 engineering guidelines on the Fish Passage Requirements for Waterway Crossings.

Introduction

Governments produce self-assessable design codes for the purpose of streamlining development activities and reducing unnecessary government expenditure. In some cases the codes produce conservative design outcomes that are more costly than a site-specific design; however, the convenience and expediency of the operating under a self-assessable code is usually considered worth the extra expense.

To be effective, fish passage designs must be appropriately investigated, planned and designed for the local site conditions and aquatic life. Fisheries Queensland's self-assessable design codes provide 'generic' design outcomes for a range of site conditions; however, in some cases the needs of a given site may be inconsistent with the site conditions assumed during the development of the codes. In such cases, a site-specific, 'assessable' design will be required. Designers should never knowingly apply the codes to a site where a site-specific, assessable design is known to be required in order to achieve desirable fish passage outcomes.

Fish passage along waterways is critical to the survival of Australian native fish. Selected species of both fresh and saltwater fish move along waterways at different times to access food and shelter, to avoid predators, and to complete their lifecycle.

'Fish friendly' is a term commonly used to describe a design process that promotes consideration of aquatic life issues within the design of waterway structures and waterway rehabilitation projects. To be fish friendly, a waterway crossing needs to be both appropriately designed and maintained.

Introduction

Migratory native fish

The need for fish passage

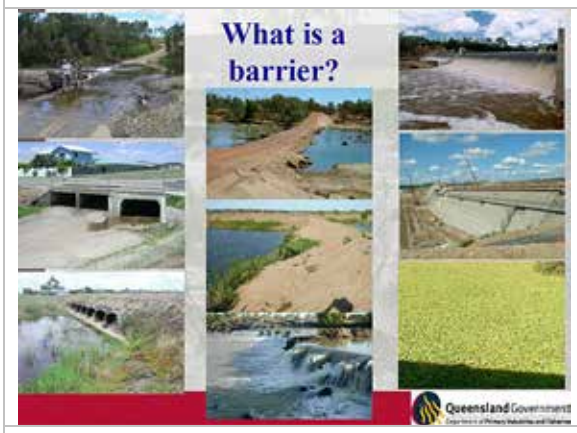
- In Queensland, many fish species require free passage along waterways for spawning migration, dispersal, feeding, or for seeking refuge during dry periods.
- Fish movement can occur seasonally and during low or flood flows.
- Floods can cause some fish to be swept downstream from their normal habitat, after which they need to move upstream to repopulate those reaches depleted of fish numbers.

Various types of waterways

What is a waterway

Waterways consist of:

- Rivers, creeks, streams, or inlets of the sea, whether fresh, brackish or saltwater.
- Lakes which provide a continuum of water flow and possess native fish.
- Permanent or ephemeral channels or depressions which allow flows to or from a main river or stream into a wetland.
- Drains constructed through the modification of natural streams.
- Canal developments.



Examples of fish passage barriers

Waterway barrier works

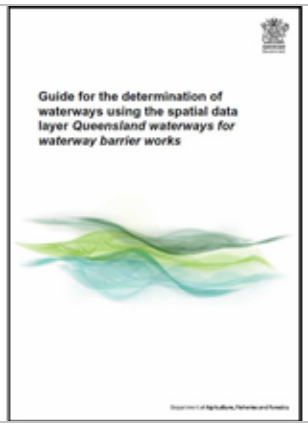
- Waterway barrier works are regulated under the *Fisheries Act 1994* and the *Sustainable Planning Act 2009* when barriers to fish movement, including partial barriers, are installed across waterways.
- Barrier works include the construction, raising or replacement of structures such as culvert crossings, bed level and low level crossings, weirs and dams, both permanent and temporary—some maintenance activities can also be considered as barrier works.

Self-assessable code WWBW01 Part 3

Self-assessable codes

- The *Sustainable Planning Act 2009* allows for self-assessment for low impact minor, temporary and some regularly rebuilt waterway barriers.
- Works that adhere to the standards and requirements of Fisheries Queensland's self-assessable codes are able to proceed without having to gain specific development approval.

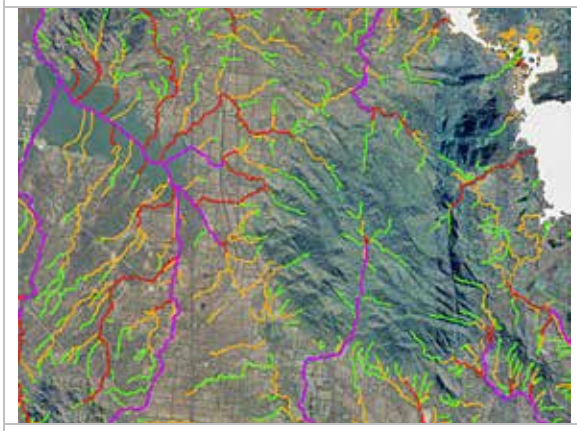
Spatial waterway mapping



Spatial data users guide, 2013

Spatial waterway mapping guide

- The Fisheries Queensland publication **'Guide for the determination of waterways using the spatial data layer *Queensland waterways for waterway barrier works*'** provides a guide to the state's spatial mapping of waterways**.**
- Published by the Department of Agriculture, Fisheries and Forestry, 2013.
- The spatial data layer *Queensland Waterways for Waterway Barrier Works* shows the furthest extent of the Fisheries Act interest in barrier works on waterways.



Example of colour-coded waterways

Colour-codes waterways

- The waterway colour identifies the risk of adverse impact of waterway barriers.
  - Green: low risk waterways
  - Amber: medium risk waterways
  - Red: high risk waterways still applicable for self-assessable works
  - Purple: highest risk waterways
  - Grey: tidal areas
- Temporary barriers within purple or grey waterways may be self-assessable.

Gully erosion

Non colour-codes waterways

- Streams that are not coloured on the data layer are not considered waterways with relevance to fish passage.
- If the work site is not located on a coloured waterway, and this has been confirmed using satellite imagery and ground-truthing, then no assessment is required and the works can proceed subject to other necessary approvals.
- However barrier works within freshwater wetlands are subject to other state and federal legislation.

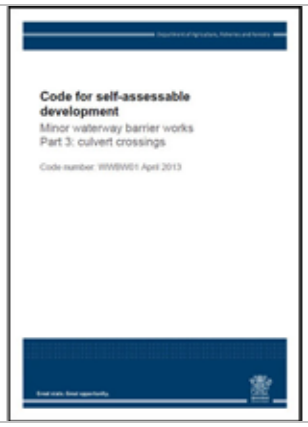
Figure 1 Anomaly in actual and mapped waterway course

Variation in 'actual' and plotted alignment

Accuracy of mapping

- The lines shown on the maps may not always represent the current location of the waterway.
- If the location of proposed works does not appear to be on a marked waterway, all care should be taken to ensure that this is indeed the case.
- A similar approach should be taken where there are isolated stream segments within the mapped network, as these may be due to a waterway traversing a wetland.

Self-assessable codes



WWBW01 Part 3, April 2013

Self-assessable codes

- The *Sustainable Planning Act 2009* (SPA) allows the use of self-assessable codes for certain low-impact or low-risk projects.
- Fisheries Queensland have developed the following self-assessable codes:
  - WWBW01 Part 1 for dams and weirs
  - WWBW01 Part 2 for floodgates
  - WWBW01 Part 3 for culverts
  - WWBW01 Part 4 bed level crossings
  - WWBW02 for temporary barrier works
  - WWBW03 for regular barrier works

Table 1: Assessment requirements for minor works

Waterway zoning colour	Risk of impact	Development Type			
		Bed-level crossing	Culvert crossing	Low impact dam/weir	Temporary works
Green	Low	Self-assessable	Self-assessable	Self-assessable	Self-assessable
Amber	Moderate	Self-assessable	Self-assessable	Development approval	Self-assessable
Red	High	Self-assessable	Self-assessable	Development approval	Self-assessable
Purple	Major	Self-assessable	Development Approval	Development approval	Self-assessable
Grey	Major	Development Approval	Development Approval	Development approval	Self-assessable

Assessment requirements of works

Application of the self-assessable codes

- Projects that comply with the requirements of a self-assessable code can be done without an approval from Fisheries Queensland.
- It must be emphasised that stipulation applies only to the approval of works through Fisheries Queensland.
- Development approval may still be required through other government departments or through the local council.

Signage at in-stream works

Notification and signage of works

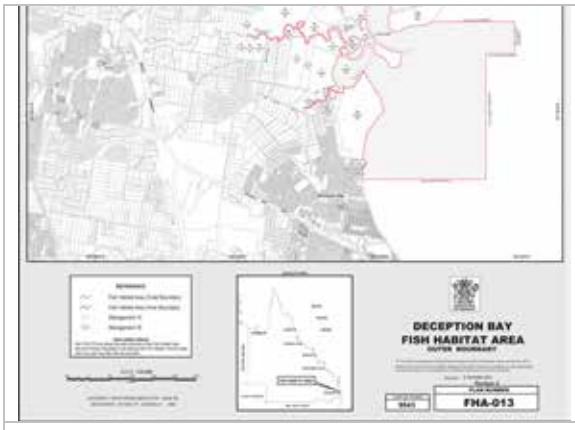
- Requirements for notification and signage still apply to works conducted under a self-assessable code—refer to the following chapter on *'Construction Issues'*.
- All works conducted under self-assessable codes require both pre-works and post-works notification.
- At all times while works are proceeding, at least one sign needs to be erected at a public road or waterway closest to the works site that enables the highest level of public visibility.

Non-approved waterway crossing

Applicability of the codes

- Replacement, modification and maintenance works undertaken under a self-assessable code must only be carried out on existing lawful structures.

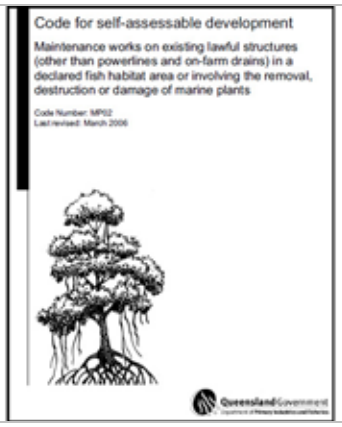
Declared Fish Habitat Areas



Fish Habitat Area map

Declared Fish Habitat Areas

- Declared Fish Habitat Areas (FHA) are a type of marine protected area which focuses on protecting natural fish habitats from alteration and degradation by strictly limiting development within and adjacent to the declared FHA, while allowing for continued community use and access.
- Maps showing the locations of all declared Fish Habitat Areas are available on Fisheries Queensland's web site.



Fisheries Queensland MP02 (2006)

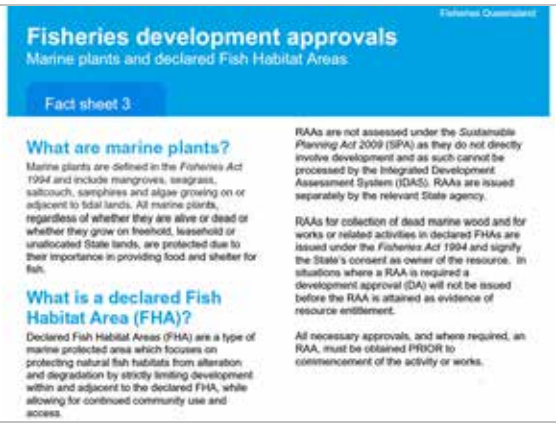
Self-assessable works in FHAs

- Works in declared Fish Habitat Areas may be self-assessable if the work is required to maintain:
  - legally built existing structures such as boat ramps, boardwalks, drains, fences, jetties, roads, safety signs, swimming enclosures and weirs.
- Also refer to self-assessable code: *Maintenance works on existing lawful structures (other than powerlines and on farm drains) in removal, destruction or damage of marine plants* (MP02).

Seagrasses and dugongs

Non self-assessable works in FHAs

- If the planning activity will disturb marine plants or interfere with a declared Fish Habitat Areas (FHA), and the activity cannot be undertaken in compliance with a self-assessable code, then an application for a fisheries development approval is required under the Sustainable Planning Act 2009 (SPA).


Fisheries development approvals
Marine plants and declared Fish Habitat Areas
Fact sheet 3
What are marine plants?
Marine plants are defined in the *Fisheries Act 1994* and include mangroves, seagrass, saltcouch, samphires and algae growing on or adjacent to tidal lands. All marine plants, regardless of whether they are alive or dead or whether they grow on freehold, leasehold or unallocated State lands, are protected due to their importance in providing food and shelter for fish.
What is a declared Fish Habitat Area (FHA)?
Declared Fish Habitat Areas (FHA) are a type of marine protected area which focuses on protecting natural fish habitats from alteration and degradation by strictly limiting development within and adjacent to the declared FHA, while allowing for continued community use and access.
RAAs are not assessed under the *Sustainable Planning Act 2009* (SPA) as they do not directly involve development and as such cannot be processed by the Integrated Development Assessment System (IDAS). RAAs are issued separately by the relevant State agency.
RAAs for collection of dead marine wood and for works or related activities in declared FHAs are issued under the *Fisheries Act 1994* and signify the State's consent as owner of the resource. In situations where a RAA is required a development approval (DA) will not be issued before the RAA is attained as evidence of resource entitlement.
All necessary approvals, and where required, an RAA, must be obtained PRIOR to commencement of the activity or works.

Fisheries Queensland Fact Sheet 3 (2010)

Resource allocation authority

- If the activity involves interference with a declared FHA, or the collection of dead marine wood from non-allocated State land, an application must be made for a resource allocation authority (RAA) under the *Fisheries Act 1994*.
- The RAA is required **PRIOR** to lodging the fisheries development approval or undertaking any works.
- An RAA is a form of evidence of 'resource entitlement', which is required for the use of public resources.

Culvert Crossings

Types of culverts

Recessed pipe culvert

Precast pipe culverts

- Pipe culverts are generally cheaper to build if a small waterway area is required.
- It can be difficult to apply added surface roughness within pipe culverts to aid fish passage, especially in small pipes.
- Fish passage generally relies on the deposition of natural bed material within the pipes.
- It can be difficult to achieve dry terrestrial passageways in single-cell pipe culverts.

Corrugated steel pipe culvert

Corrugated metal culverts

- Corrugation provide enhanced surface roughness thus reducing flow velocities adjacent to the pipe surface.
- These corrugations, however, may not produce a boundary layer of sufficient thickness to accommodate adult fish.
- Structural and corrosion problems can occur and require specific design measures.

Recessed box culvert

Precast box culverts

- Box culverts are generally cheaper to build if a large waterway area is required, or there are width restrictions, i.e. if the culvert is required to have a similar width to the connecting waterway channel.
- Large box culverts can be easier to maintain after major flood events.
- Enhanced sidewall roughness can be added to the precast units prior to their installation.
- Enhanced boundary layer development can occur in the corners of box culverts.

Box culvert with terrestrial pathways

Consideration of terrestrial passage

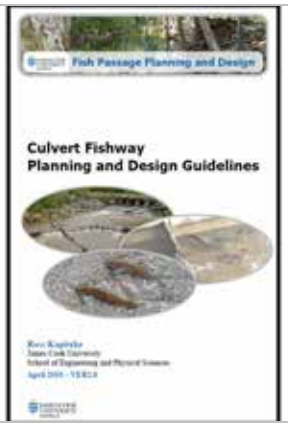
- This field guide does not provide details on how to integrate terrestrial passage features and aquatic (fish) passage features into the same culvert.
- Terrestrial passage through culverts is generally required in urban areas and on main roads where significant road kill would otherwise be expected.
- Terrestrial passage usually required the provision of a ‘dry’ pathway adjacent to both channel banks.

Purple zones

FHMOP 008, April 2013

Design guidelines

- Comprehensive design guidelines or Codes currently do not exist for culverts located within purple zones.
- Some **general discussion** is provided in the Fisheries publication; **'*Waterway barrier works development approvals,* Fish Habitat Management Operational Policy' (FHMOP 008).**
- It is likely that Fisheries Queensland will rely on the design standards set for red zones as a 'starting point', but all designs require site specific solutions.



Kapitzke, 2010

Culvert Fishway Planning and Design Guidelines. Ross Kapitzke, 2010, James Cook University, Queensland

- This publication is primarily based on the *Hydraulic Design Method* whereby flow conditions within a culvert are designed for specific fish species.
- These designs can be supported with complex three-dimensional Computational Fluid Dynamics (CFD) modelling.

Catchments & Creeks Pty Ltd, 2002

Fish Passage Requirements for Waterway Crossings. Catchments and Creeks Pty Ltd

- This publication is based on the *Stream Simulation Method*.
- This approach assumes that by mimicking the existing waterway, fish will be able to pass through the culvert, but this design philosophy is only partly true.
- Only parts of this publication would be applicable to purple zones.
- This publication is currently being reviewed.

Baffled sidewall

General (FHMOP 008, S9.1c)

- From a fish passage perspective, culverts that cater for all flows up to drown-out of the crossing are optimal.
- The provision of adequate fish passage on stream crossings requires that the culvert crossing design takes into account the hydrology of the stream and the fish species moving through the particular site.

Purple zones

Recessed, low-level, rural culvert

Culvert invert (S9.1c)

- The base of the culvert is no higher than the stream bed.
- Ideally the culvert base will be the stream bed (for open base culverts) or buried to sufficient depth to allow bed material to deposit and reform the natural bed on top of the culvert base.
- Culvert capacity and positioning are set so that low and base flows are passed, without ponding upstream.

Excessive outlet turbulence

Culvert gradient, width & alignment (S9.1c)

- The slope through the culvert is equal to (no steeper than) the natural bed gradient.
- The combined width of culvert array is as close as equal to the bankful width as possible.
- Velocities and turbulence through the culverts are adequate for fish passage up to the drown-out of the crossing.
- Culvert alignment and culvert face shape minimises water turbulence.

Good light conditions within culvert

Culvert length and light levels (S9.1c)

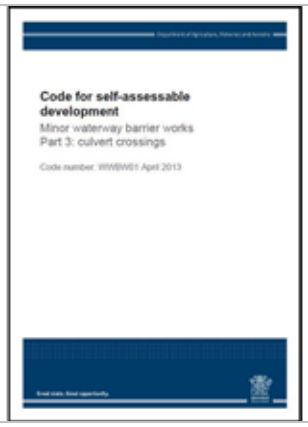
- Sufficient light passes through the culvert so that sensitive fish species (e.g. bony bream, smelt) are not discouraged by a sudden descent into darkness.
- The culvert is an acceptable length; this will vary depending on the measures taken within the culvert to facilitate fish passage (such as rest areas and the light levels through the culvert).

Debris caught on debris deflector walls

Culvert height and maintenance (S9.1c)

- The road height above the culvert is as low as structurally possible (while still providing the essential design attributes, e.g. flood immunity of crossing).
- Design and maintenance measures deal with debris and sedimentation issues in such a manner as to minimise adverse impacts on fish passage.

Red zones (common design features)



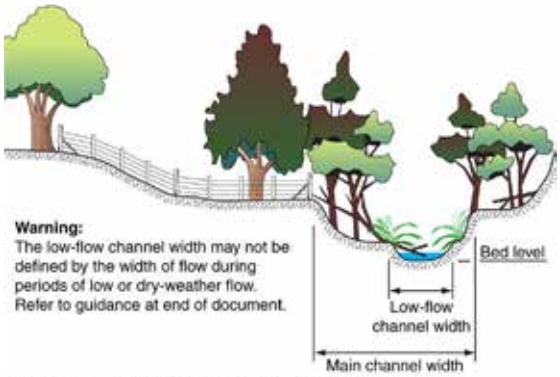
WWBW01 Part 3, April 2013

Reference document

- The self-assessable design code applicable to culverts in red, amber and green zones is WWBW01.

Duration of works (S5.2.1)

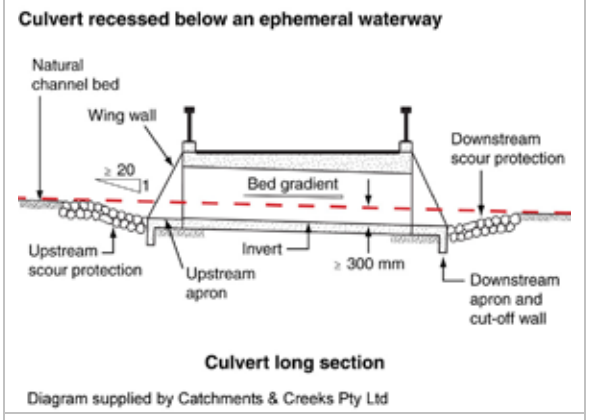
- Works must commence and finish within a maximum time of 180 calendar days and instream sediment and instream silt control measures associated with the works must be removed within this period.



Low-flow width (WWBW01/3 Fig-2)

Minimum width (S5.2.2)

- The width of the culvert cell aperture or total width of the combined culvert aperture width (culvert array) must span a minimum of 100% of the low flow channel width.
- Refer also to design options 1, 2 & 3 on following pages for additional culvert width requirements.
- Note; each of the design options (1, 2 & 3) have themselves various design alternatives (1 & 2).



Aprons & scour control (WWBW01/3 Fig-6)

Culvert gradient (S5.2.2)

- The culvert must be installed at no steeper gradient than the waterway bed gradient.

Sidewall baffles (looking upstream)

Outer sidewall roughness (S5.2.2)

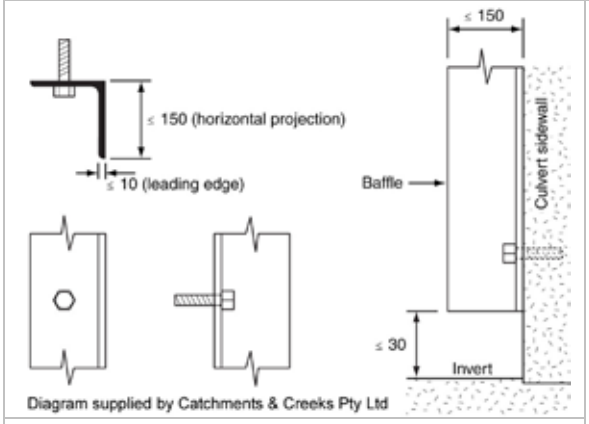
- The outermost sidewalls of the culvert must incorporate roughening elements.
- For a single cell culvert crossing, roughening elements must be on both sidewalls.
- These roughness elements must be installed to a minimum of 95% of the full height of the vertical extent of the culvert sidewalls with a gap of no greater than 30 mm at the bottom.

Red zones (common design features)

Baffles on upstream wing wall

Wing wall roughness units (S5.2.2)

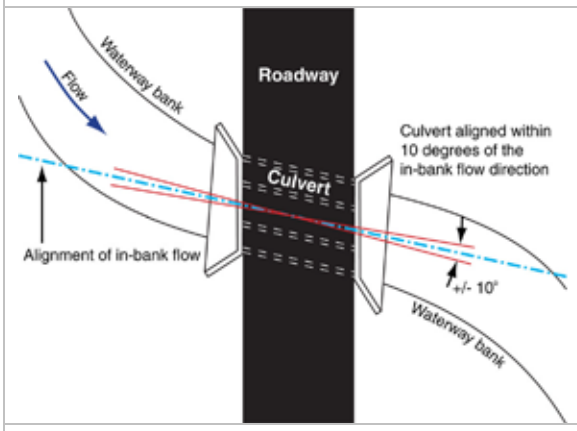
- Roughening elements must be installed on the upstream wing walls on both banks to the height of the upstream obvert or the full height of the wing wall.
- The 'intent' of the roughening elements is to achieve a contiguous lower velocity zone (no greater than 0.3 m/sec) for at least 100 mm width adjacent to the sidewall, over a wide range of flows, through the full length of the culvert extending past the wing walls to the natural bank roughness.



Sidewall baffles (WWBW01/3 Fig-4)

Size of roughness units (S5.2.2)

- Baffles must:
  - protrude (horizontally) a maximum of 150 mm into the flow
  - maximum 10 mm thick (leading edge)
  - spaced at 2 x width (horizontal protrusion) of baffle (max 300 mm) within 1.2 m (upstream and downstream) of the culvert inlet/outlet
  - spaced at 4 x width (horizontal protrusion) of baffle (max 600 mm) through the rest of the structure.



Culvert alignment to flow direction

Alignment of culvert (S5.2.2)

- New culvert cells must be aligned parallel (within 10°) with the direction of [in-bank] water flow to minimise turbulence.

Option 3 culvert with rock chutes

WWBW01 Part 3, section 5.2.3

- Culvert crossing configurations must also meet one of the following options:
  - Option 1: Flat bed culverts
  - Option 2: Culverts with nominated 'wet' and 'dry' cells.
  - Option 3: Low height culverts
- Details of these three options are provided in the following pages.
- Options 1 & 2 have two (2) alternative culvert layouts.
- Option 3 has three alternative layouts.

Red zones (common design features for options 1, 2 & 3)

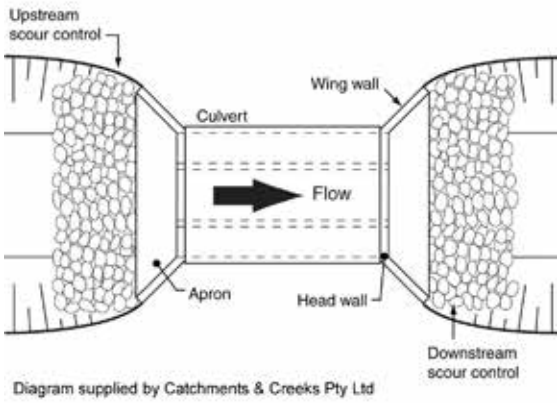


Diagram supplied by Catchments & Creeks Pty Ltd

Scour protection (WWBW01/3 Fig-5)

Culvert aprons (S5.2.4)

- Aprons must abut culvert inverts (including buried culverts) at the same level (this is to ensure that there is no drop in elevation at the join).
- Where aprons are at bed level they must be must be roughened throughout to approximately simulate natural bed conditions.
- Aprons must be installed at no steeper gradient than the waterway bed gradient.

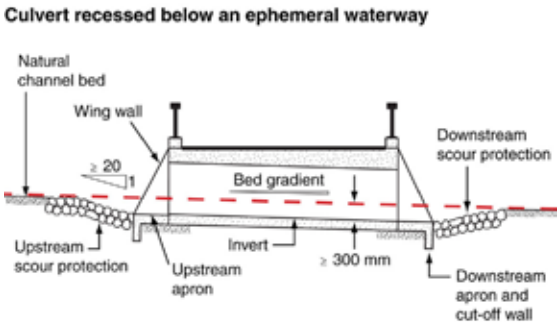


Diagram supplied by Catchments & Creeks Pty Ltd

Aprons & scour control (WWBW01/3 Fig-6)

Scour protection (S5.2.4)

- Scour protection must abut the apron (including buried aprons) at the same level (this is to ensure that there is no drop in elevation at the join).
- The stream bed must abut the scour protection or the apron at the same level (this is to ensure that there is no drop in elevation at the join).
- If the culvert is set below bed level then the surface of the apron (and/or scour protection) must also be below bed level.

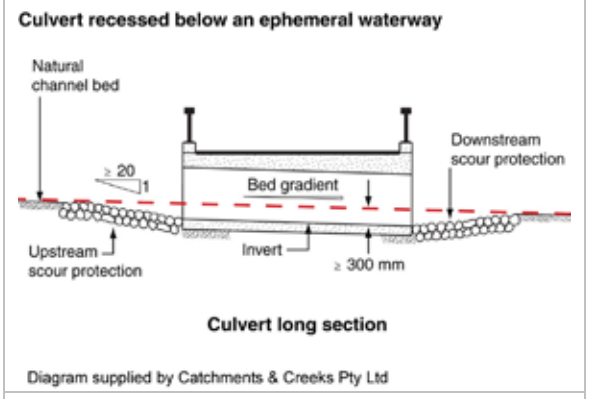


Diagram supplied by Catchments & Creeks Pty Ltd

Culvert without concrete apron pads

Culvert without aprons (S5.2.4)

- If the culvert does not have aprons, then the scour protection must abut culvert inverts (including buried culverts) at the same level (this is to ensure that there is no drop in elevation at the join).

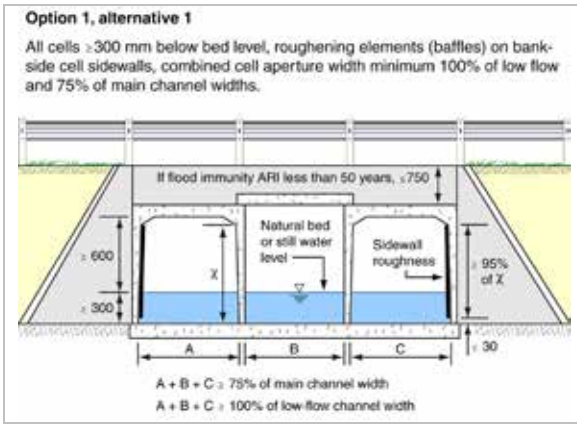
Low-flow formed into scour protection

Stream bed scour protection (S5.2.5)

Stream bed scour protection must:

- Be installed at a gradient no steeper than 1 in 20 (for downstream scour protection) or the natural channel gradient, whichever is steeper.
- Incorporate a low-flow channel within the scour protection.
- Use clean rocks at least 100 mm diameter with minimal fine material.
- Ensure the rock armouring is not over compacted but left proud and uneven.

Red zones (Option 1, S5.2.3)



Alternative 1 (WWBW01/3 App-2/1)

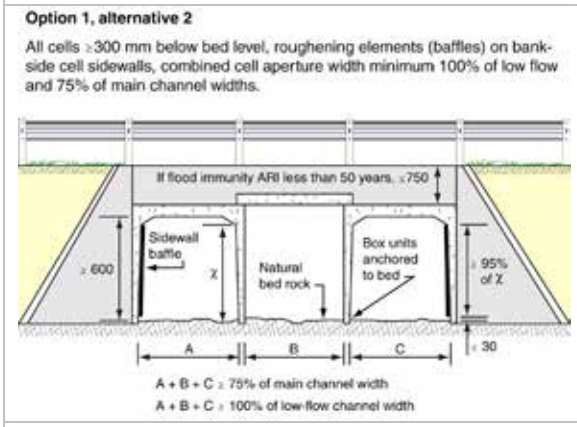
Culvert width

- The width of the culvert cell aperture or total width of the combined culvert aperture width (culvert array) must span a minimum of 75% of the main channel width.
- This requirement is the same as Option 2.

Recessed box culvert

Culvert invert

- All culverts in the crossing are set at a minimum of 300 mm below bed level.
- An exception applies to open bed culverts installed on bedrock where the natural bed surface is maintained through the culvert.
- This requirement is the same as Option 3, but not Option 2.



Alternative 2 (WWBW01/3 App-2/2)

Culvert obvert

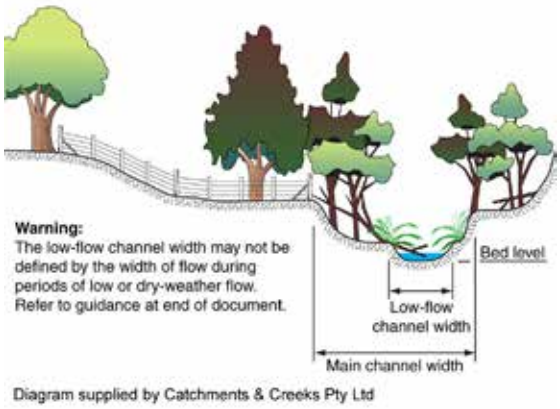
- The obvert (internal roof) of the culvert must be a minimum of 600 mm above the 'commence to flow' water level (or bed level on dry waterways).
- This requirement is the same as Option 2.

Excessive deck thickness

Deck thickness

- If the culvert crossing is designed with a flood immunity ARI less than 50 years (2% flood) the depth of cover over the culvert (including the pavement) is no greater than 750 mm.
- This requirement is the same as Option 2.
- The extensive deck thickness shown left was required to house existing services, thus making the design inconsistent with the self-assessable codes.

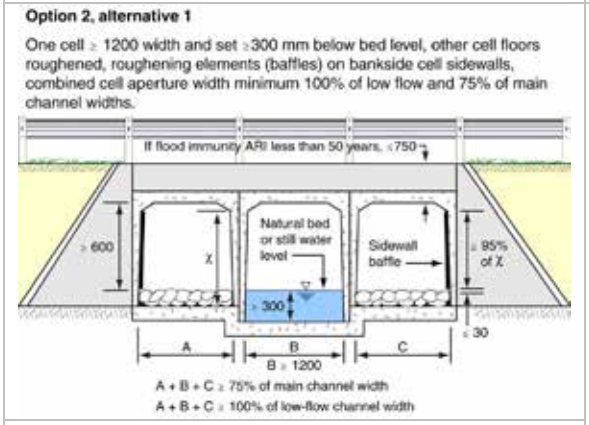
Red zones (Option 2, S5.2.3)



Low-flow width (WWBW01/3 Fig-2)

Culvert width

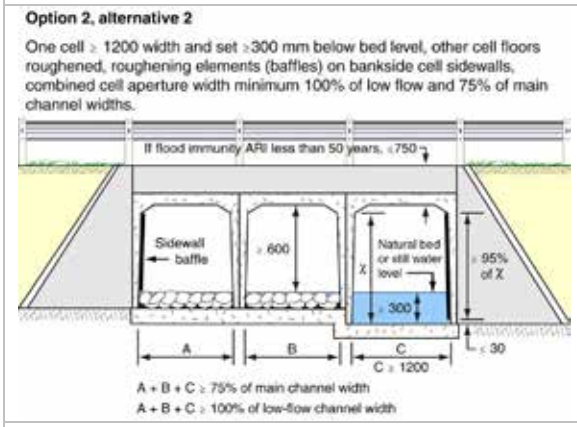
- The width of the culvert cell aperture or total width of the combined culvert aperture width (culvert array) must span a minimum of 75% of the main channel width.
- This requirement is the same as Option 1.



Alternative 1 (WWBW01/3 App-2/3)

Culvert obvert and deck thickness

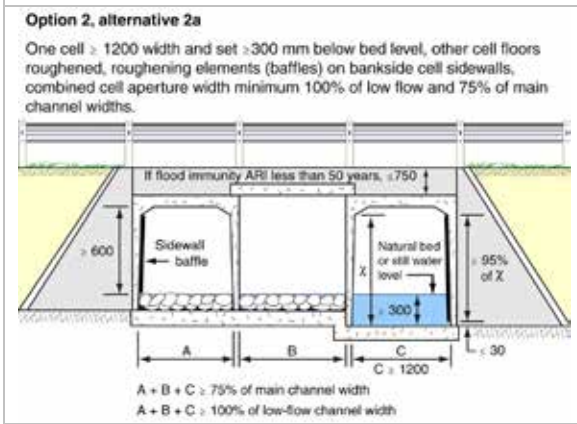
- The obvert (internal roof) of the culvert must be a minimum of 600 mm above the commence to flow water level or bed level on dry waterways (*same as Option 1*).
- If the culvert crossing is designed with a flood immunity ARI less than 50 years (2% flood) the depth of cover over the culvert (including the pavement) is no greater than 750 mm (*same as Option 1*).
- **Note;** the image shown left does not demonstrate appropriate bed roughness or invert levels.



Alternative 2 (WWBW01/3 App-2/4)

Recessed 'wet' cell (unique to Option 2)

- At least one culvert in the crossing is set at a minimum of 300 mm below bed level, unless installed on bedrock where the natural bed surface is maintained, with minimum dimensions of:
  - 1200 mm width for box units
  - 1500 mm diameter for pipes
  - obvert of recessed cell is no less than maximum cell obvert (see note below)
  - the 'wet' cell is aligned with the low-flow channel of the watercourse.



Alternative 2 utilising a bridging slab

Other cells

- All other culvert cells in the crossing are:
  - at bed level (or below bed level)
  - roughened throughout the culvert floor to approximately simulate natural bed conditions.
- Note: an exception to the above ruling regarding the obvert of the 'wet' cell exists where slab links (bridging slabs) are incorporated and the obvert of the slab link barrel is no higher than the top of the adjacent box culvert.

Red zones (Option 3, S5.2.3)

Option 3, alternative 1

All cells ≥300 mm below bed level, one cell ≥1200 mm internal width, roughening elements (baffles) on bankside cell sidewalls, rock chutes adjacent each bank, combined cell aperture width minimum 3600 mm or 100% of main channel width.

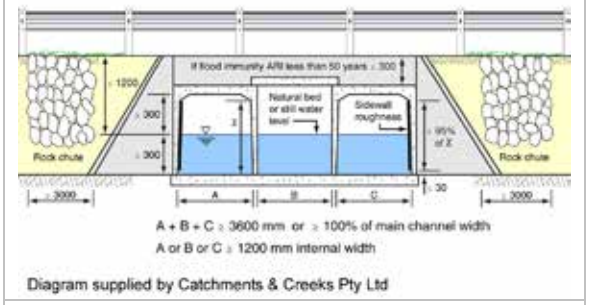


Diagram supplied by Catchments & Creeks Pty Ltd

Alternative 1 (WWBW01/3 App-2/5)

Culvert deck

- The maximum deck (pavement) height of the crossing is 1200 mm at the lowest point of the natural stream bed.
- The obvert (internal roof) of the culvert cells must be a minimum of 300 mm above the commence to flow water level (or bed level on dry waterways).
- **Note 1:** all diagrams show the culvert as viewed from the outlet looking upstream.

Option 3, alternative 2

Culvert located adjacent to one stream bank, all cells ≥300 mm below bed level, one cell ≥1200 mm internal width, roughening elements (baffles) on outer sidewalls, combined cell aperture width 3600 mm minimum or 100% of main channel width, rock chutes adjacent to culvert and opposite bank.

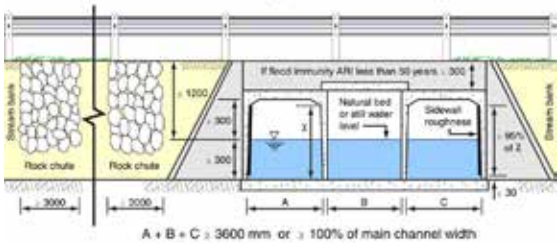


Diagram supplied by Catchments & Creeks Pty Ltd

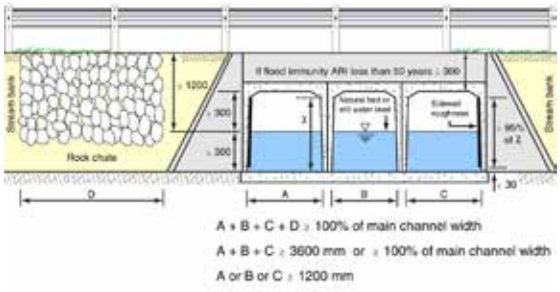
Alternative 2 (WWBW01/3 App-2/6)

Culvert width

- The crossing incorporates a minimum combined culvert aperture width of 3.6 m or 100% of the main channel width.
- The crossing incorporates at least one culvert with a minimum width of 1200 mm for a box culvert; or 2 x 900 mm diameter pipe culverts.
- **Note 2:** convention is for the left and right banks to be defined as viewed looking downstream.
- **Note 3:** culvert should align with the low-flow channel.

Option 3, alternative 3-alt

All cells ≥300 mm below bed level, one cell ≥1200 mm internal width, roughening elements (baffles) on outer sidewalls (adjacent stream bank), combined cell aperture width plus rock chute width ≥100% of the main channel width.



Alternative 3, but without a bridging slab

Culvert invert and obvert

- All culverts are installed [at least] 300 mm below bed level unless installed on bedrock where the natural bed surface is maintained (*same as Option 1*).
- The obvert (internal roof) of the culvert cell(s) must be a minimum of 300 mm above the commence to flow water level (or bed level on dry waterways).
- **Note 4:** the purpose of the rock chutes is to encourage fish passage over the road embankment as floodwater just begin to overtop the road.

Box culvert with adjacent rock chutes

Rock ramps

- Adjacent to each bank (or bank-side culverts if the culverts are located adjacent to the bank) construct a rock chute at a slope no greater than 1 in 20 (5% grade).
- The width of each rock chute is a minimum of 3 m, or the combined culvert cell aperture and rock chute width spans 100% of the main channel width.
- As a minimum the toe of the rock chute is to extend down to a level that is half-way between bed level and the level of the obvert of the culverts.

Amber zones (S5.3)

Amber zone, single cell culvert

Single cell ≥ 300 mm below bed level, cell aperture width ≥ 2400 mm or 100% of main channel width.

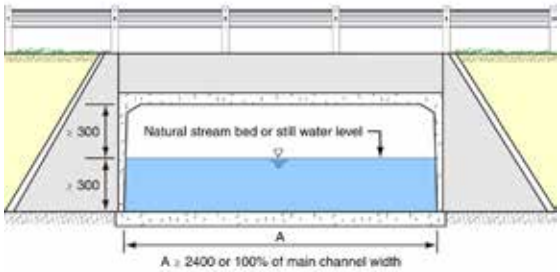


Diagram supplied by Catchments & Creeks Pty Ltd

Single cell culvert (WWBW01/3 App-2/8)

Amber zone, multiple cell culvert

All cells ≥ 300 mm below bed level, combined cell aperture width ≥ 2400 mm or 100% of main channel width.

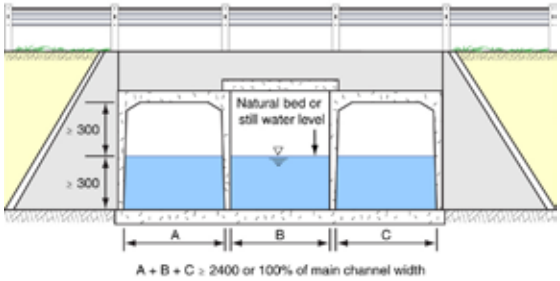


Diagram supplied by Catchments & Creeks Pty Ltd

Multi-cell culvert (WWBW01/3 App-2/9)

Amber zone, multiple cell culvert with simulated natural bed conditions

All cell beds simulate natural stream bed conditions and a combined cell aperture width ≥ 2400 mm or 100% of main channel width.

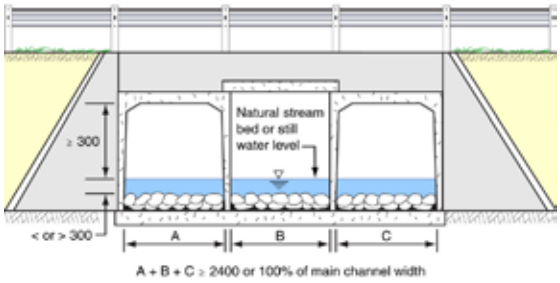
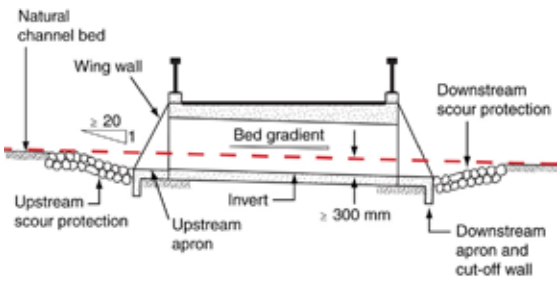


Diagram supplied by Catchments & Creeks Pty Ltd

Multi-cell culvert & natural bed conditions

Culvert recessed below an ephemeral waterway



Culvert long section

Diagram supplied by Catchments & Creeks Pty Ltd

Aprons & scour control (WWBW01/3 Fig-6)

Duration of works (S5.3.1)

- Works must commence and finish within a maximum time of 360 calendar days and instream sediment and instream silt control measures associated with the works must be removed within this period.

Culvert width, obvert and gradient

- The crossing must have a minimum (combined) culvert aperture width of 2.4 m or span 100% of the main channel width.
- The obvert (internal roof) of the culvert cell(s) must be a minimum of 300 mm above the commence to flow water level (or bed level on dry waterways).
- The culvert must be installed at no steeper gradient than the waterway bed gradient.

Culvert invert and bed conditions

- All new or replacement culvert cells must be installed at or below bed level.
- Where the cell is installed at less than 300 mm below bed level, the culvert floor must be roughened throughout to approximately simulate natural bed conditions, unless installed on bedrock where the natural bed surface is maintained.
- Where the cell is installed 300 mm or more below bed level, no roughening is required on the culvert floor.

Aprons and scour protection

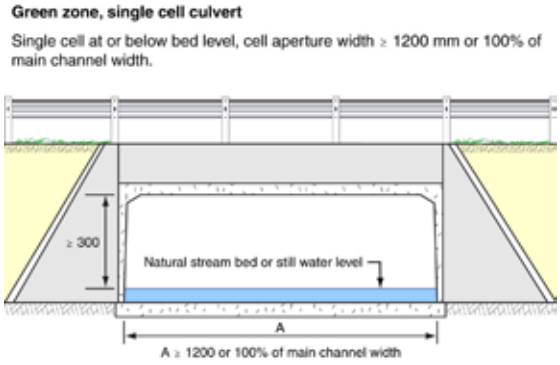
- Apron and stream bed scour protection must be as per red zone (sections 5.2.4. and 5.4.5).

Green zones (S5.4)

Construction of a recessed culvert

Duration of works (S5.4.1)

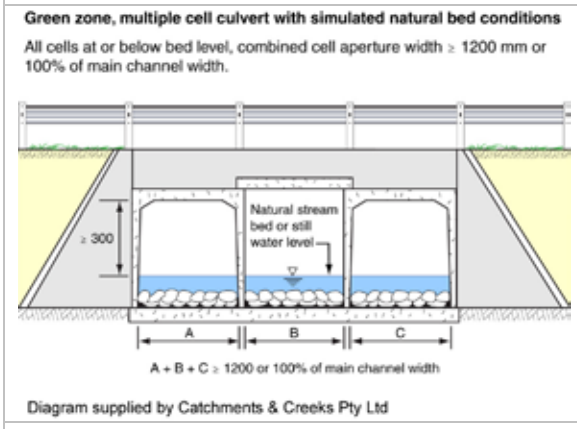
- Works must commence and finish within a maximum time of 360 calendar days and instream sediment and instream silt control measures associated with the works must be removed within this period.
- This condition is as per amber zones.



Culvert options (WWBW01/3 App-2/10)

Culvert width, obvert and gradient

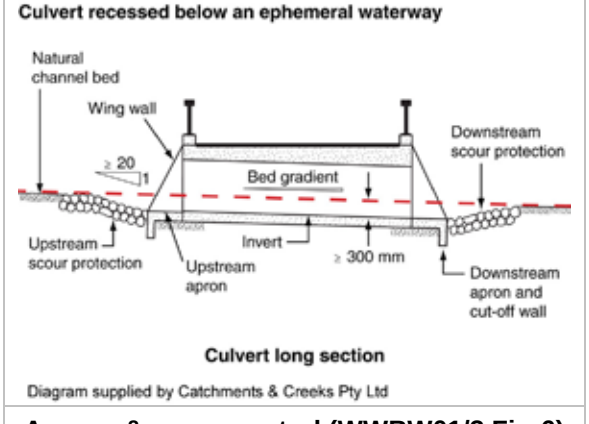
- In all crossings the minimum (combined) culvert aperture width must be 1.2 m or span 100% of the main channel width.
- The obvert (internal roof) of the culvert cell(s) must be a minimum of 300 mm above the commence to flow water level (or bed level on dry waterways).
- The culvert must be installed at no steeper gradient than the waterway bed gradient.



Multi-cell culvert & natural bed conditions

Culvert invert and bed conditions

- All new or replacement culvert cells must be installed at or below bed level.
- Where culvert bed is installed at the channel bed level, it is desirable but not mandatory that it is roughened throughout to approximately simulate natural bed conditions.



Aprons & scour control (WWBW01/3 Fig-6)

Aprons and scour protection

- Apron and stream bed scour protection must be as per red zones (sections 5.2.4. and 5.4.5).
- Where aprons are at bed level, it is desirable but not mandatory that they are roughened throughout to approximately simulate natural bed conditions.

Bed-level Ford and Causeway Crossings

Bed level (ford) crossings

WWBW01 Part 4, April 2013

Self-assessable design code

- A 'ford' is a crossing formed on the natural stream bed.
- Ford crossings are only suitable within sand, gravel or rock-based waterways.
- Ford crossings in clay-based waterways required rock stabilisation of the bed.
- ***Code for self-assessable development – Minor waterway barrier works, WWBW01 Part 4: Bed level crossings***, April 2013, Department of Agriculture, Fisheries and Forestry.

Sand-based ford crossing

Sand-based waterways

- Deep, loose sand dominates the make-up of the stream bed.
- These are 'alluvial' waterways that experience significant sediment (sand) flow during both minor and major stream flows.
- The bed material can be highly mobile during floods, and the bed form can change with each flood.
- The channel bed is usually near-flat, possibly with a low-flow channel.

Gravel-based ford crossing

Gravel-based waterways

- Bed material is made-up of well-rounded gravels and boulders.
- These are 'alluvial' waterways usually containing pools and riffles that completely reform during severe flooding.
- The bed material can be highly mobile during severe floods, but generally stable during minor floods.
- The channel bed is typically flat and crossing are normally located at riffles where low flows spill across the full bed width.

Rock-based ford crossing

Rock-based waterways

- Bed material is made-up of exposed rock outcrops separated by sections of clay, sand or gravel-based channels.
- These are fixed-bed 'spilling' waterways usually containing riffles and waterfalls followed by deep pools.
- The waterway bed is normally very stable; however, significant sediment flows can still occur during floods.
- The bed profile can be highly variable.

Causeway crossings

Low level causeway crossing

Causeways

- A ‘causeway’ is a crossing elevated above the natural stream bed.
- Causeways with low-flow pipes are considered undesirable fish barriers.

WWBW01 Part 4, April 2013

Causeways without low-flow pipe

- Preferred designs follow WWBW01/4.
- ***Code for self-assessable development – Minor waterway barrier works, WWBW01 Part 4: Bed level crossings***, April 2013, Department of Agriculture, Fisheries and Forestry.

WWBW01 Part 3, April 2013

Low-set culvert crossings

- If a low-flow culvert is required in the crossing to maintain the road surface dry, then the culvert design should follow the requirements of WWBW01/3.
- ***Code for self-assessable development – Minor waterway barrier works, WWBW01 Part 3: Culvert crossings***, April 2013, Department of Agriculture, Fisheries and Forestry.

Bed level crossings (common design features)

Ford crossing under construction

Construction issues

- Sites are to be open for inspection by Fisheries Queensland staff—refer to further discussion in the next chapter.
- Abandoned structures to be fully removed within four weeks (S5.1.2).
- Site susceptible to acid sulfate soils need to be tested for their existence (S5.1.4).
- Disturbance to bed and bank to be minimised (S5.1.5–5.1.8).
- Work must not commence during times of elevated flows (S5.1.9–5.1.11).

Temporary bridge crossing

Temporary crossings (S5.1.13)

- If temporary structures, such as bunds or sidetracks are required for construction, refer to the Fisheries Queensland code for self-assessable development WWBW02 Temporary waterway barrier works.
- Refer to expanded discussion in the following chapter *'Temporary Structures'.*

Pre-works advice sheet (WWBW01/4 Ch-8)

Notification to Fisheries (S5.1.17–5.1.25)

- All works conducted under both self-assessable codes and development approvals require both pre-works and post-works notification.
- Separate notification is required for associated works at the same site under other Fisheries Queensland self-assessable codes.
- Pre-works advice sheets must be completed submitted at least 5 but no more than 20 business days before work commence.

Signage at in-stream works

Signage (S5.1.26–5.1.30)

- At all times while works are proceeding, at least one sign is to be erected at a public road or waterway closest to the works site that enables the highest level of public visibility.
- Each sign must have minimum dimensions of 500 mm by 500 mm.
- These signs are to be removed within 48 hours of completion of works.

Bed level crossings (common design features)

Replacement of existing crossing

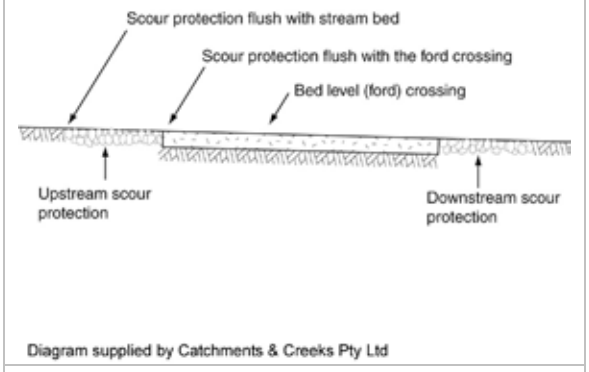
Replacement of existing crossing (S5.1.31)

- Replacement of an existing crossing must be treated as the construction of a new crossing, thus carried out in accordance with the relevant sections 5.2, 5.3 or 5.4 of WWBW01 Part 4.

Ford crossing of gravel-based creek

Crossing dimensions (S5.1.32)

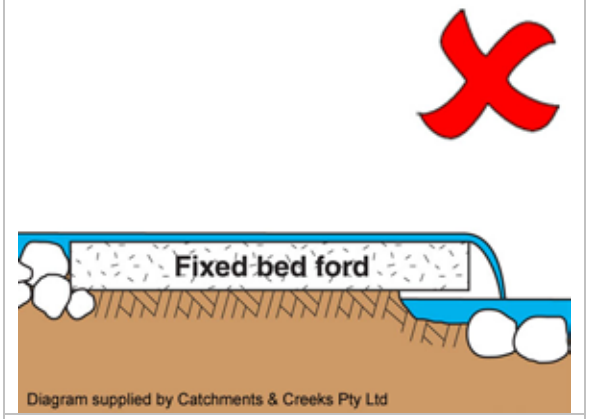
- The bed level crossing must be no greater than 15 m wide (along stream) not including stream bed scour protection.
- New bed level crossings must be aligned perpendicular (within 10°) to water flow.
- Use clean rocks that are an equivalent or larger size than the natural bed material and at least 50 mm, with minimal fines.
- The surface is to be left rough and not to be over compacted (e.g. track-rolled finish or rougher).



Scour protection (WWBW01/3 Fig-2)

Stream bed scour protection (S5.1.33)

- Scour protection must abut the surface edge of the crossing at the same level.
- The stream bed must abut the scour protection at the same level (no drop).
- Installed at a gradient no steeper than 1 in 20 or the natural channel gradient, whichever is steeper.
- Scour protection must incorporate a low-flow channel.
- Use clean rocks (minimal fine material), at least 100 mm, left proud and uneven.



Creation of a fish barrier at ford crossing

Post-construction maintenance

- All crossings constructed or replaced under code WWBW01/4 must be inspected at least annually and reinstated to original design specifications if required, in order to maintain fish passage.
- For the life of the crossing, relative elevation levels of the crossing invert and stream bed scour protection and the stream bed must be retained so that there are no drops in elevation at their respective joins.

Purple and red zones

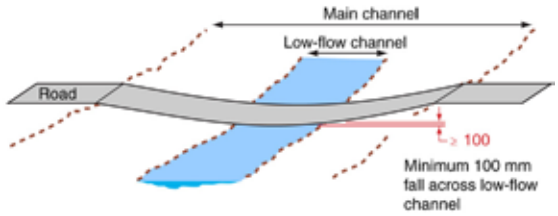
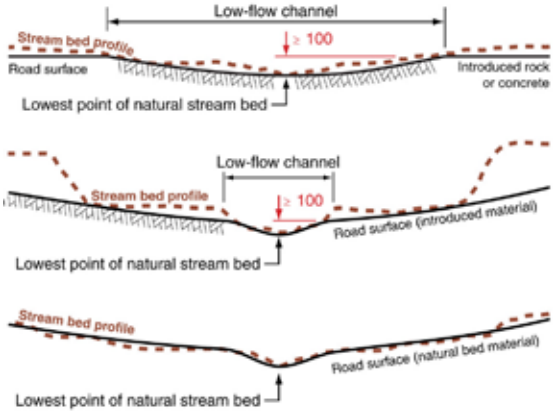


Diagram supplied by Catchments & Creeks Pty Ltd

Design option 1 (WWBW01/4 Fig-3)



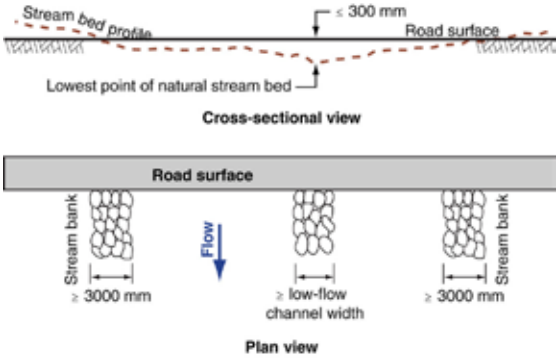
Design option 1 (WWBW01/4 Fig-4)

Duration of works (S5.2.1)

- Works must commence and finish within a maximum time of 180 calendar days and instream sediment and silt control measures associated with the works must be removed within this period.

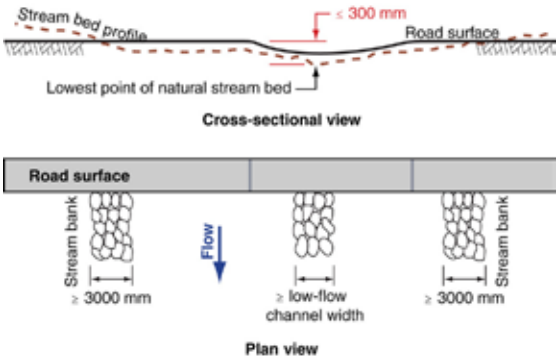
Option 1 (Ford crossing, S5.2.2)

- The lowest point of the bed level crossing must be installed at the level of the lowest point of the natural stream bed (pre-construction), within the footprint of the proposed crossing.
- There must be a height difference of at least 100 mm from the lowest point of the crossing to the edges of the low flow section of the crossing.
- If the crossing is constructed from concrete or introduced rock then the level of the remainder of the crossing must be no higher than the lowest point of the natural stream bed outside of the low flow channel.
- If the crossing is constructed from the natural bed material the level of the remainder of the crossing must be no higher than the highest point of the natural stream bed outside the low flow channel.



Purple and red option 2 (no low-flow section incorporated into road)

Design option 2 (WWBW01/4 Fig-5)



Purple and red option 2 (with low-flow section incorporated into road)

Design option 2 (WWBW01/4 Fig-6)

Option 2 (Causeway, S5.2.2)

- The deck height (pavement surface) of the bed level crossing can be built up to a maximum of 300 mm above the lowest point of the natural stream bed (pre-construction), within the footprint of the proposed crossing.
- Adjacent to each bank, construct a rock chute at a slope no greater than 1 in 30 slope (3.3% grade).
- Adjacent to the low flow section of the crossing or aligned with the low flow channel of the waterway, construct a rock chute at a slope no greater than 1 in 30 slope (3.3% grade).
- The width of each bank-side rock chute is a minimum of 3 m or 100% of the main channel width.
- The width of the low flow rock chute is a minimum of 100% of the low flow channel width.
- Where concrete is the construction material for the crossing, then the surface of the crossing must be roughened for the width of each rock chute, e.g. using a rough broom finish, exposed aggregate etc.

Amber zones

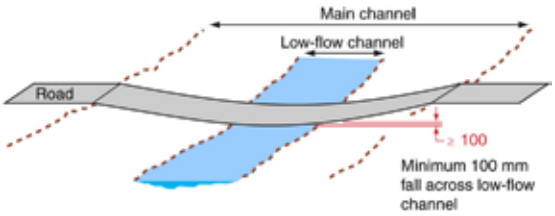
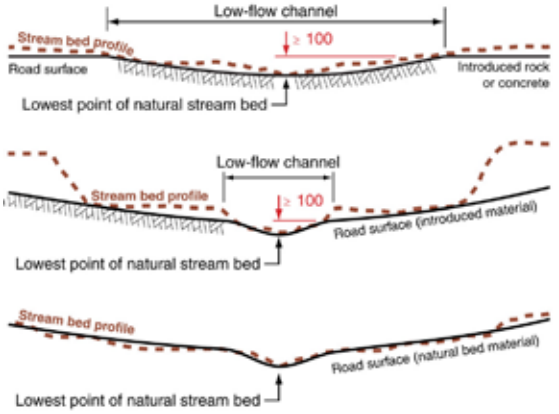


Diagram supplied by Catchments & Creeks Pty Ltd

Design option 1 (WWBW01/4 Fig-3)



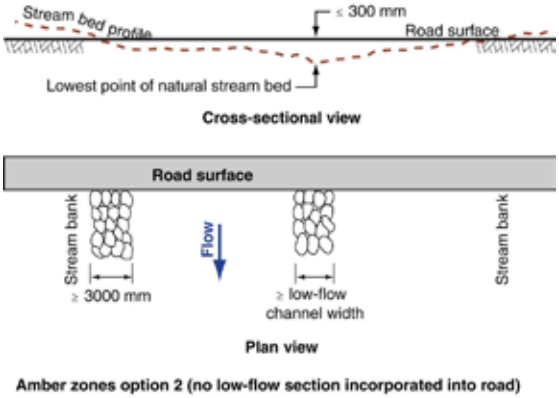
Design option 1 (WWBW01/4 Fig-4)

Duration of works (S5.3.1)

- Works must commence and finish within a maximum time of 360 calendar days and instream sediment and silt control measures associated with the works must be removed within this period.

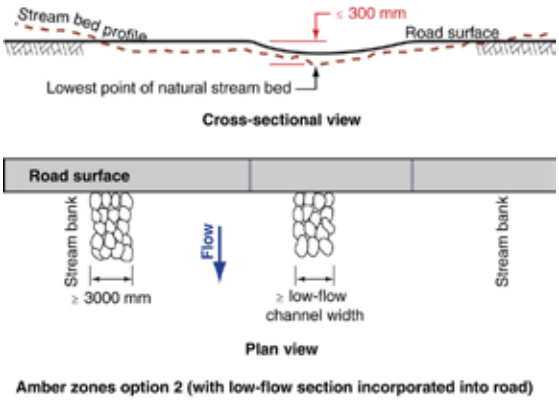
Option 1 (Ford crossing, S5.3.2)

- The lowest point of the bed level crossing must be installed at the level of the lowest point of the natural stream bed (pre-construction), within the footprint of the proposed crossing.
- There must be a height difference of at least 100 mm from the lowest point of the crossing to the edges of the low flow section of the crossing.
- If the crossing is constructed from concrete or introduced rock then the level of the remainder of the crossing must be no higher than the lowest point of the natural stream bed outside of the low flow channel.
- If the crossing is constructed from the natural bed material the level of the remainder of the crossing must be no higher than the highest point of the natural stream bed outside the low flow channel.



Amber zones option 2 (no low-flow section incorporated into road)

Design option 2 (WWBW01/4 Fig-7)



Amber zones option 2 (with low-flow section incorporated into road)

Design option 2 (WWBW01/4 Fig-8)

Option 2 (Causeway, S5.3.2)

- The deck height (pavement surface) of the bed level crossing can be up to a maximum of 300 mm above the level of the lowest point of the natural stream bed (pre-construction), within the footprint of the proposed crossing.
- Adjacent to one bank, construct a rock chute from the downstream bed level to the road surface level, at a slope no greater than 1 in 30 slope (3.3% grade).
- Adjacent to the low flow section of the crossing or aligned with the low flow channel of the waterway, construct a rock chute at a slope no greater than 1 in 30 slope (3.3% grade).
- The width of the bank-side rock chute is a minimum of 3 m or 100% of the main channel width.
- The width of the low flow rock chute is a minimum of 100% of the low flow channel width.
- Where concrete is the construction material for the crossing then the surface of the crossing must be roughened for the width of the rock chute, e.g. using a rough broom finish, exposed aggregate etc.

Green zones

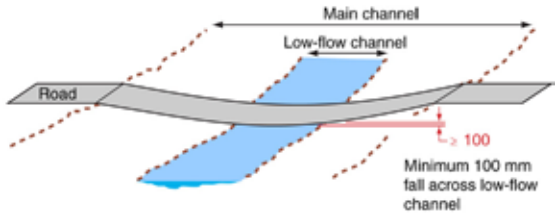
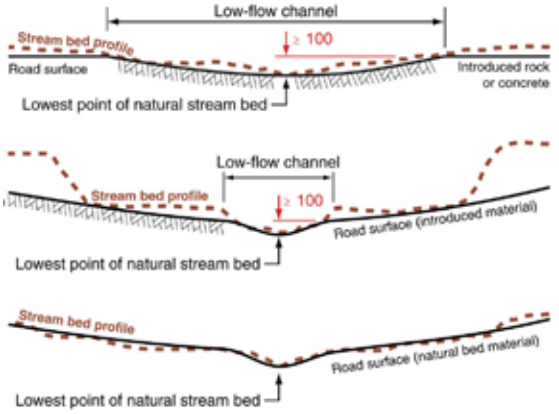


Diagram supplied by Catchments & Creeks Pty Ltd

Design option 1 (WWBW01/4 Fig-3)



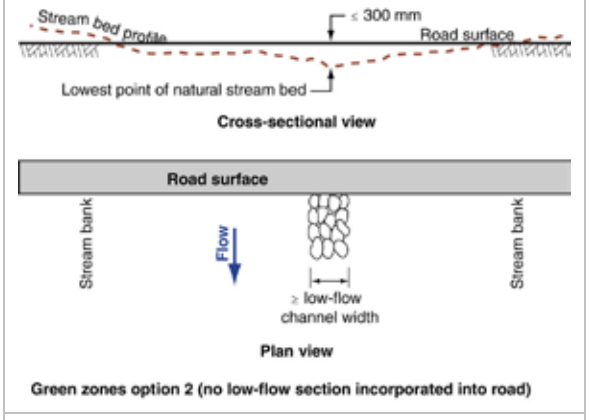
Design option 1 (WWBW01/4 Fig-4)

Duration of works (S5.4.1)

- Works must commence and finish within a maximum time of 360 calendar days and instream sediment and silt control measures associated with the works must be removed within this period.

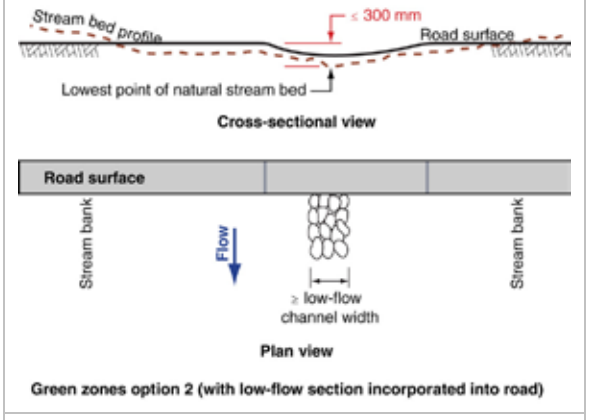
Option 1 (Ford crossing, S5.4.2)

- The lowest point of the bed level crossing must be installed at the level of the lowest point of the natural stream bed (pre-construction), within the footprint of the proposed crossing.
- There must be a height difference of at least 100 mm from the lowest point of the crossing to the edges of the low flow section of the crossing.
- If the crossing is constructed from concrete or introduced rock then the level of the remainder of the crossing must be no higher than the lowest point of the natural stream bed outside of the low flow channel.
- If the crossing is constructed from the natural bed material the level of the remainder of the crossing must be no higher than the highest point of the natural stream bed outside the low flow channel.



Green zones option 2 (no low-flow section incorporated into road)

Design option 2 (WWBW01/4 Fig-9)



Green zones option 2 (with low-flow section incorporated into road)

Design option 2 (WWBW01/4 Fig-10)

Option 2 (Causeway, S5.4.2)

- The deck height (pavement surface) of the bed level crossing can be up to a maximum of 300 mm above the level of the lowest point of the natural stream bed (pre-construction), within the footprint of the proposed crossing.
- Adjacent to the low flow section of the crossing or aligned with the low flow channel of the waterway, construct a rock chute at a slope no greater than 1 in 30 slope (3.3% grade).
- The width of the low flow rock chute is a minimum of 100% of the low flow channel width.
- Where concrete is the construction material for the crossing then the surface of the crossing must be roughened for the width of the rock chute, eg using a rough broom finish, exposed aggregate etc.

Construction Issues

Construction issues

Site inspection

Access by Fisheries Queensland

- Sites are to be open for inspection by Fisheries Queensland staff during business hours:
  - after Fisheries Queensland has received the pre-works advice sheet
  - during works
  - up to 10 business days after Fisheries Queensland has received the post-works advice sheet.

Construction during the dry season

Timing of works

- Work must not commence during times of elevated flows.
- Excavation work in un-bunded tidal areas is to be scheduled to occur within two hours either side of low tide.
- In tidal areas, flow at the site must not be impeded beyond 21 days.

Pre-works advice sheet (WWBW01/3 Ch-8)

Notification to Fisheries Queensland

- All works conducted under both self-assessable codes and development approvals require both pre-works and post-works notification.
- Separate notification is required for associated works at the same site under other Fisheries Queensland self-assessable codes.
- Pre-works advice sheets must be completed submitted at least 5 but no more than 20 business days before work commence.

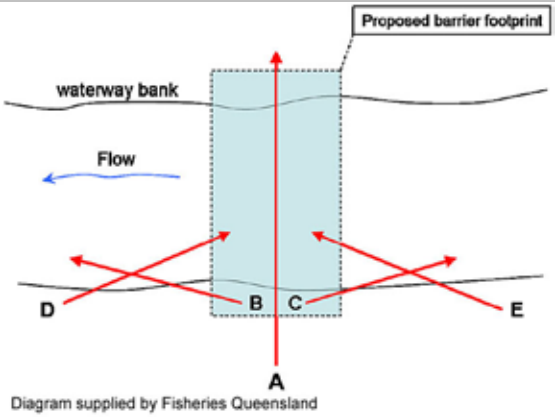


Diagram supplied by Fisheries Queensland

Orientation of site photos

Site photographs

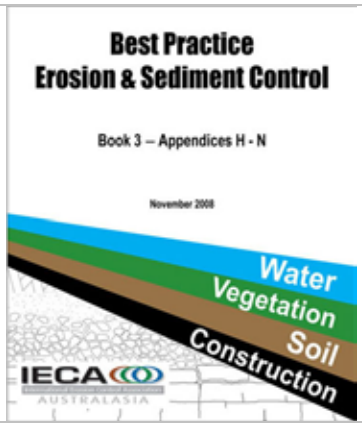
- A map of the location of the works and site photographs are to be included with the pre-works and post-works advice sheets.

Construction issues

Signage at in-stream works

Signage

- At all times while works are proceeding, at least one sign is to be erected at a public road or waterway closest to the works site that enables the highest level of public visibility.
- Each sign must have minimum dimensions of 500 mm by 500 mm.
- These signs are to be removed within 48 hours of completion of works.



IECA, Book 3 (2008)

Erosion and sediment control

- Impacts on water quality are to be minimised by undertaking works to the standards set out in the Best Practice Erosion and Sediment Control guidelines (IECA, 2008).
- Key reference material may be found in Book 3, Appendix I *Instream works*, of the IECA guidelines.

Acidic water pooled near work site

Acid sulfate soils

- Acid sulfate soils (ASS) and potential acid sulfate soils (PASS) occur naturally over extensive low-lying coastal areas, predominantly below 5 m AHD.
- If the risk of acid sulfate soils exists, then:
- appropriate soil testing must occur prior to the start of construction
- soil disturbances must comply with a relevant state guidelines
- all material used in the construction of elevated surfaces must be ASS free and PASS free.

Temporary road bypass

Temporary works

- If temporary structures such as bunds or sidetracks are required for construction, refer to the Fisheries Queensland code for self-assessable development WWBW02 Temporary waterway barrier works.

Construction issues

Culvert construction

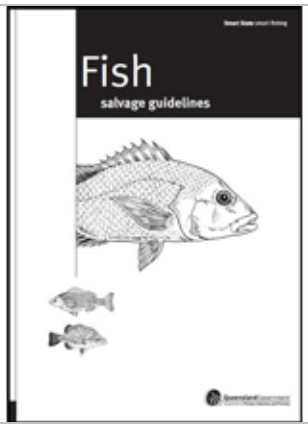
Minimise disturbance

- During construction, disturbance to the instream bed and bank sediment of the waterway beyond the barrier footprint must be minimised as much as practical.

Retention of tree root system

Vegetation clearing

- If it is necessary to remove vegetation (marine, aquatic or riparian) for the development, the vegetation is to be cut no lower than ground level and the roots are to be left in the ground to aid in stabilisation.
- If deep excavation is required during construction the roots may only be removed within the construction footprint area under this code.



Fish Salvage Guidelines (2004)

Entrapment of wildlife

- Provisions must be made to minimise the risk of fish kills arising from the works e.g. through entrapment of fish upstream or between works.
- Fisheries Queensland Fish Salvage Guidelines are to be implemented in the event of fish becoming trapped by construction works.

Fish kill

Reporting of fish kills

- Fish kills must be reported to the Department of Environment and Heritage Protection (EHP) on 1300 130 372.

Construction issues

Site inspection

Supervision of fishway construction

- Any loose-form component of a fishway (e.g. rock ramps, rock/aggregate bed roughness) requires the on-site presence of a fishway expert to ensure correct placement of the material.
- It is unreasonable to assume that the engineered plans contain sufficient detail to allow the structures to be fabricated without expert supervision.

Incomplete removal of old bridge

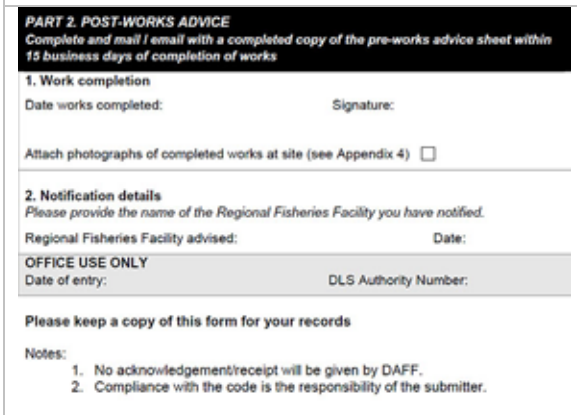
Removal of old structure

- Where the works result in an obsolete crossings then the old crossing and its associated components are to be completely removed from the waterway within four weeks of the completion of the new crossing.

Site rehabilitation works

Site rehabilitation

- All disturbed surfaces are to be rehabilitated.
- The bed and banks are to be reinstated to natural stream profiles and stability within five business days of completion of works.
- The waterway bed is retained with natural substrate or reconstructed with substrate comparable to the natural substrate size and consistency.
- Bed and bank vegetation community is rapidly re-established with native species.



PART 2. POST-WORKS ADVICE
Complete and mail / email with a completed copy of the pre-works advice sheet within 15 business days of completion of works

1. Work completion

Date works completed: Signature:

Attach photographs of completed works at site (see Appendix 4) ☐

2. Notification details

Please provide the name of the Regional Fisheries Facility you have notified.

Regional Fisheries Facility advised: Date:

OFFICE USE ONLY
Date of entry: DLS Authority Number:

Please keep a copy of this form for your records

Notes:
1. No acknowledgement/receipt will be given by DAFF.
2. Compliance with the code is the responsibility of the submitter.

Post works notification form

Final notification

- Within 15 business days of the completion of works, a post-works advice sheet is to be completed in full and submitted to the manager (Planning and Assessment) of the relevant Regional Fisheries Centre.
- This requirement also applies to emergency maintenance works.
- For entities undertaking a program of works (including emergency maintenance works), a single post-works notification can be made for the waterway barriers.

Temporary Works

Temporary works

WWBW02 Temporary works, 2013

Code for self-assessable development – Minor waterway barrier works, WWBW02 Temporary waterway barrier works**,** April 2013, Department of Agriculture, Fisheries and Forestry.

www.fisheries.qld.gov.au

Site inspection

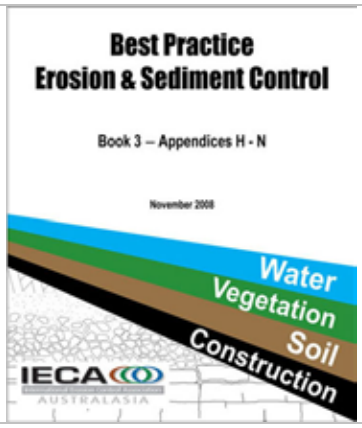
Access by Fisheries Queensland

- Sites are to be open for inspection by Fisheries Queensland staff during business hours:
  - after Fisheries Queensland has received the pre-works advice sheet
  - during works
  - up to 10 business days after Fisheries Queensland has received the post-works advice sheet.

Acid sulfate soils

Acid sulfate soil (S5.1.3)

- In areas of acid sulfate soils (ASS) or potential acid sulfate soils (PASS):
  - all material used in the works must be ASS free and PASS free
  - all work affected by ASS or PASS is to be managed in accordance with *Queensland Acid Sulfate Soil Technical Manual Soil Management Guidelines*.



IECA, Book 3 (2008)

Construction practices

- The dimensions of the temporary barrier are limited to the minimum practicable for the site and purpose (S5.1.2).
- Restrictions on site disturbance are defined in section 5.1.4 to 5.1.6 and discussed further in the previous chapter.
- Erosion and sediment control standard (S5.1.7), timing of works (S5.1.8), signage (S5.1.24/28) and responses to fish kills (S5.1.9/10) are discussed in the previous chapter, *Construction Issues*.

Temporary works

Temporary road bypass

Removal of a temporary structure

- If there is more than one temporary waterway barrier in the location, the most downstream waterway barrier must be removed first.
- All waterway barrier material must be removed from within the waterway and be disposed of at least 50 m away from the waterway.

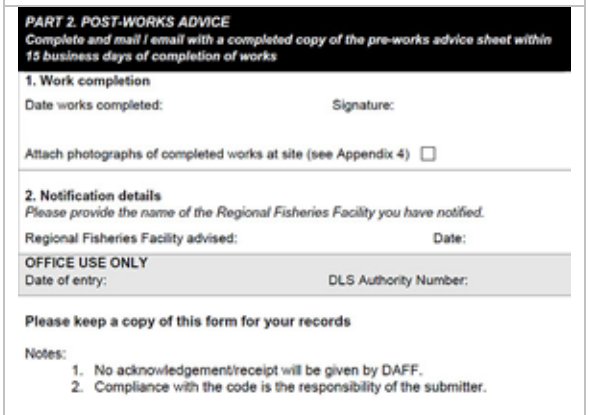
Creek bank revegetation

Site restoration

Disturbed areas should be restored and/or rehabilitated, so that as a minimum:

- The profiles of the bed and banks are re-instated to natural stream profiles and stability within five (5) business days.
- The waterway bed is retained with natural substrate or reconstructed with substrate comparable to the natural substrate size and consistency.
- Bed and bank vegetation community is rapidly re-established with native species.

Pre-works advice sheet (WWBW01/3 Ch-8)



PART 2. POST-WORKS ADVICE
Complete and mail / email with a completed copy of the pre-works advice sheet within 15 business days of completion of works

1. Work completion

Date works completed: Signature:

Attach photographs of completed works at site (see Appendix 4) ☐

2. Notification details

Please provide the name of the Regional Fisheries Facility you have notified.

Regional Fisheries Facility advised: Date:

OFFICE USE ONLY
Date of entry: DLS Authority Number:

Please keep a copy of this form for your records

Notes:
1. No acknowledgement/receipt will be given by DAFF.
2. Compliance with the code is the responsibility of the submitter.

Post works notification form

Notification to Fisheries Queensland

- All works in this code require both pre-works and post-works notification.
- The pre-works and post-works advice sheets must be completed in full.
- Location map and site photographs are to be included with the pre-works and post-works advice sheets.
- Separate notification is required for associated works at the same site under other Fisheries Queensland self-assessable codes.
- At least five but no more than 20 business days before work commences, the pre-works advice sheet must be completed in full and submitted to the manager (Planning and Assessment) of the relevant Regional Fisheries Centre.
- Entities undertaking emergency works must notify Fisheries Queensland as soon as practicable after commencing works.
- Within 15 business days of the completion of works (including emergency works), the post-works advice sheet is to be completed in full and submitted to the manager (Planning and Assessment) of the relevant Regional Fisheries Centre.

Specific requirements for coloured zones

Coastal dredging

Temporary sheet piling in tidal waters

Grey (tidal) zones

- Works must commence and finish within a maximum time of 180 calendar days and instream sediment and silt control measures associated with the works must be removed within this period (S5.2.1).
- Excavation work in un-bunded tidal areas is to be scheduled to occur within two hours either side of low tide.
- The area between two barriers, or upstream of a single barrier must be kept free of water to prevent stress and possible mortality of marine plants.
- The method of draining the water must not have detrimental impacts on the wellbeing of fish.
- Flow at the site must not be impeded beyond 21 days.

Maintenance to sewer pipe

Purple and red zones (S5.3.1)

- Works must commence and finish within a maximum time of 180 calendar days and instream sediment and silt control measures associated with the works must be removed within this period.

Temporary creek crossing

Amber and green zones (S5.4.1)

- Works must commence and finish within a maximum time of 360 calendar days and instream sediment and silt control measures associated with the works must be removed within this period.

Maintenance Requirements

Maintenance requirements

Debris blockage of culvert

Impact of debris blockages on fish passage

- Debris blockages at watercourse crossings can physically block fish passage as well as causing increased flow turbulence.

Post-flood culvert inspection

Inspection and maintenance program

- All crossings constructed or replaced under the self-assessable codes must be kept clear of blockages through a regular inspection program in order to maintain appropriate fish passage past the structure (Part 3, S5.1.33).
- Entities undertaking emergency maintenance works shall notify as soon as practicable after commencing the works (Part 3, S5.1.23 & Part 4, S5.1.23).

Outlet scour downstream of culvert

Impact of outlet erosion on fish passage

- Outlet erosion from culverts can cause the formation of scour holes in the waterway that can undermine the culvert's apron resulting in the formation of a fish passage barrier.
- For the life of a culvert crossing, relative levels of the culvert invert, apron and scour protection and the stream bed must be kept so that there are no drops in elevation at their respective joins (Part 3, S5.1.34).

Head-cut erosion moving up to a culvert

Impact of head-cut erosion on fish passage

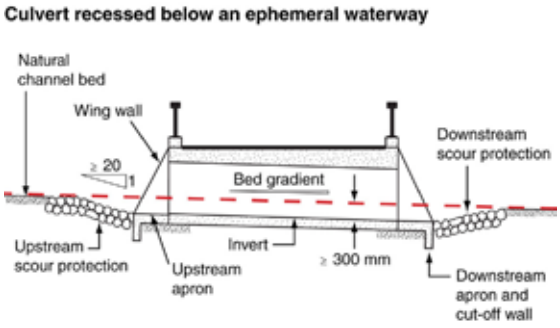
- A discontinuity (fall) in bed levels can form at the culvert outlet as a result of natural or induced erosion within the downstream channel.
- Head-cut erosion is the existence of a mobile channel bed discontinuity (waterfall) that migrates up a watercourse.
- Such erosion is usually initiated by a downstream disturbance, but can be the indirect result of the culvert concentrating up-slope runoff into the watercourse.

Maintenance requirements

Drainage channel maintenance

Duration of maintenance works (S5.6.1)

- Maintenance works must commence and finish, and instream sediment and silt control measures associated with the works must be removed within the following periods:
  - in grey (tidal), purple and red zones, 180 calendar days
  - in amber and green zones, 360 calendar days.



Aprons & scour control (WWBW01/3 Fig-6)

Apron and stream bed protection (S5.6.2/3)

- Apron and stream bed scour protection replacement works must be as per new works for red zones (Part 3 S5.2.4. & S5.4.5, or Part 4 S5.1.33 as appropriate).
- Where aprons in green zones are at bed level, it is desirable but not mandatory that they are roughened throughout to approximately simulate natural bed conditions.

Headwall construction

End wall, headwall and wing wall replacement (S5.6.4)

- Replacement of end walls, headwalls and wing walls must:
  - not raise the base of the culvert
  - not reduce the culvert cell cross-sectional area.

Flood damage to rail culverts

Emergency maintenance works (S5.6.5/6)

- For emergency culvert maintenance:
  - the culvert cell or cells may be replaced back to original design specifications
  - or replaced with cells of greater height and width dimensions, but not less than the original cell width and height.
- The culvert must be rebuilt/upgraded as per the current self-assessable code or under a development approval within two (2) years of the commencement of the emergency maintenance works to incorporate provisions for fish passage.

Maintenance requirements

Culvert in need of maintenance

Concrete inverts in steel culverts (S5.6.7/9)

- There are to be no drops in elevation at the finished works as per section 5.1.34.
- Concrete inverts must:
  - be a maximum of 100 mm thick
  - the surface must be roughened
  - baffles (if used) as per section 5.2.2.
- Retro-fitting invert works within purple and grey zones are limited to structures that were built under a fisheries development approval or the current or previous self assessable code WWBW01.

Culvert in need of maintenance

Re-sleeving existing culverts (S5.6.10)

- The base of the culvert cell may be raised by a total maximum of 100 mm above the original culvert base design level.
- Ensure there are no drops in elevation between the new culvert base level and any joins to associated aprons, stream bed scour protection or the stream bed.
- In red and amber zones, culvert invert (floor) and sidewalls are roughened e.g. by spray-crete, baffles, vertical grooves.
- Baffles (if used) as per section 5.2.2.

Failed concrete pipe lining

Re-sleeving in purple/grey zones (S5.6.11)

- Re-sleeving works on purple and grey zones are limited to structures that were built under a fisheries development approval or the current or previous self-assessable code WWBW01.

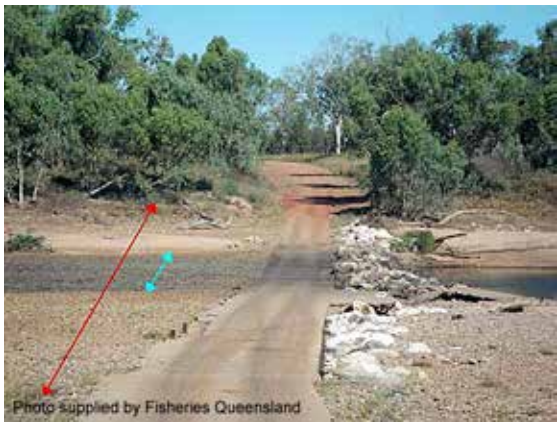
Lengthening of an existing culvert

Lengthening of existing culverts (S5.5.2)

- Increasing the length of a culvert cell (upstream-downstream) is considered waterway barrier works.
- Culvert cell lengthening must:
  - not raise the base of the culvert cell
  - not reduce the culvert cell cross-sectional area from that of the existing culvert configuration.

Identification of ‘Channel Width’ and Width of ‘Low-flow Channel’

Defining the main channel and low-flow channel



Purple: Leichardt River (Coolullah Station)

Purple zone: Bottle Creek (Rosedale)

Purple zone: Elizabeth Creek (Burketown)

Purple zone: Gilliat River (Julia Creek)

Main channel

- The main channel of a given waterway is the active component of the flow channel.
- The extent of the main channel is also referred to as bankful level.
- The majority of creeks and rivers display geomorphologic features indicative of the main (active) channel.
- The channel may contain more than one active channel, especially in low gradient waterways with sand and gravel sediments.

Defining the main channel

- The furthest extent of the main channel can be characterised by a distinct change in the appearance of the bank at a certain level, including:
  - undercutting
  - changes in vegetation density
  - sudden changes in bank slope
  - boundary levels for water marks
  - mosses or lichens
  - changes in sediment particle size
  - the height of a point bar on the inside of a meander bend.

Main channel width

- The determination of the main channel should be made in an area of the waterway that is relatively stable and not severely altered by localised scouring and erosion.
- Where the main channel width is variable at a given site, an average width for the site may be used for determining dimensions of the waterway.
- Overseas studies have found that the bankful discharge occurs at an average recurrence interval between 1 and 2 yrs.

Example photos

- These photos are examples of waterways throughout Queensland and show the main and low flow channels.
- In some waterways the low flow and main channels may be difficult to differentiate such as the waterhole sections of wallum and low slope western waterways.

Defining the main channel and low-flow channel

Purple zone: Splitters Creek (Bundaberg)

Purple zone: Thomson River (Stonehenge)

Red zone: Un-named tributary (Rosedale)

Red zone: Splitters Creek (Bundaberg)

Amber: Un-named tributary (Baffle Ck)

Amber; Un-named tributary (Condamine)

Green: Butha Creek (Great Sandy Straits)

Green zone: Deepwater National Park

Glossary of terms

Acid Sulfate Soils (ASS)	Acid sulfate soils are soils that contain iron sulfides. When exposed to air these sulfides oxidise to produce sulfuric acid, which has negative consequences for animals, plants and humans. Acid sulfate soils are mainly found on coastal lowland areas below five metres Australian Height Datum (AHD).
AEP	Annual exceedance probability. This describes the likelihood of a flood of any given size or larger. AEP is expressed as a percentage for a given flood discharge, e.g. an AEP of 5% means a 1 in 20 chance of that discharge occurring in any one year.
Aperture	The internal (open) width of the culvert cell(s)
Array	Collective term for culvert cells, where more than one culvert is used in a crossing to span the waterway.
Bank-side	The side of a culvert cell adjacent to the waterway bank.
Barrier	For the purposes of this code a waterway barrier is a crossing that incorporates a culvert and is located on a marked waterway. A waterway barrier limits fish access and movement along a waterway. Culvert crossings can act as barriers through increased water velocity and turbulence, shallow water depth, lack of resting and hiding areas, steps and drops in elevation across the gradient, constriction of channel, low lighting and debris blockage etc.
Bed level	Bed level is considered to be the lowest point of the natural stream bed (pre-construction), within the footprint of the proposed crossing.
Causeway	A raised carriageway constructed across a watercourse or tidal waterway.
Culvert cell	Culvert cell is a support structure for a crossing over a waterway. Common culvert cell types include bottomless, box and pipe.
Culvert crossing	A crossing over a waterway that incorporates culvert cells.
Deck height	The height of the road/pavement surface above the stream bed at the point where a measurement is taken.
Depth of cover	The height of fill from the obvert of the culvert cell to the surface of the road/pavement.
Emergency maintenance works	The necessary works undertaken on a culvert crossing to re-open a road that is no longer safely functional due to the sudden unforeseen failure or destruction of the crossing as a direct result of flooding, fire or earthquake accidental vehicle impact. The definition of emergency maintenance works does not include: failure due to wear and tear; increased traffic; obsolescence; inadequate design or materials; or construction practices.
Elevated flows	Flows other than no flow, base flow or low flow conditions.
Footprint of works	The works footprint includes the base of the culvert crossing structure, apron works, scour protection works, headwall and wingwalls and abutments. It does not include approach roads and access tracks.
Ford	A carriageway formed directly on the channel bed in a shallow section of a watercourse.
Freshwater	Waters that are upstream of tidal influence.
Invert	The bottom floor of the culvert cell
Leading edge	The edge of the roughening element that is perpendicular to the flow.

Low flow	For perennial waterways, low flows are base flow volumes or levels. For ephemeral waterways, low flows at commence to flow levels up to the level or volume of a one in one year flow event.
Main channel	The active component of the flow channel characterised by a distinct change in appearance or structure at the upper limit of the channel such as undercutting, changes in vegetation density, sudden changes in bank slope, boundary levels for water marks, mosses or lichens, changes in sediment particle size. Approximate Q values of Q1 – Q2 or AEP equivalent. Where the main channel width is variable, use an average width for the site.
Marine plants	As defined under the Fisheries Act 1994, section 8. Includes but is not limited to mangroves, seagrass, saltcouch, algae and samphire (succulent) vegetation and adjacent plants such as Melaleuca and Casuarina.
Obvert	The interior top of the culvert cell.
Permanent waterway barrier works	For the purposes of this code, permanent waterway barrier works are waterway barrier works that are (or will be) in place for a period longer than twelve months.
Rock chute	A rock chute is a section of stream bed or channel that has been armoured with rock, generally for erosion protection. In this context the rock chute is constructed within a waterway, adjacent to a bank, culvert or low flow section of a crossing in order to provide a level of fish passage at the crossing prior to drown-out.
Scour protection	Stream bed structures upstream and downstream of culvert crossings installed to prevent or repair destabilisation and/or removal of substrate by the action of water flows on the waterway bed, adjacent to the hard structures of the works.
Tidal	Tidal waters are waters that are tidal or subjected to tidal influence.
Waterway bed gradient	The waterway bed gradient is the slope, rise or fall of the waterway. This is usually dependent on the location along the waterway.