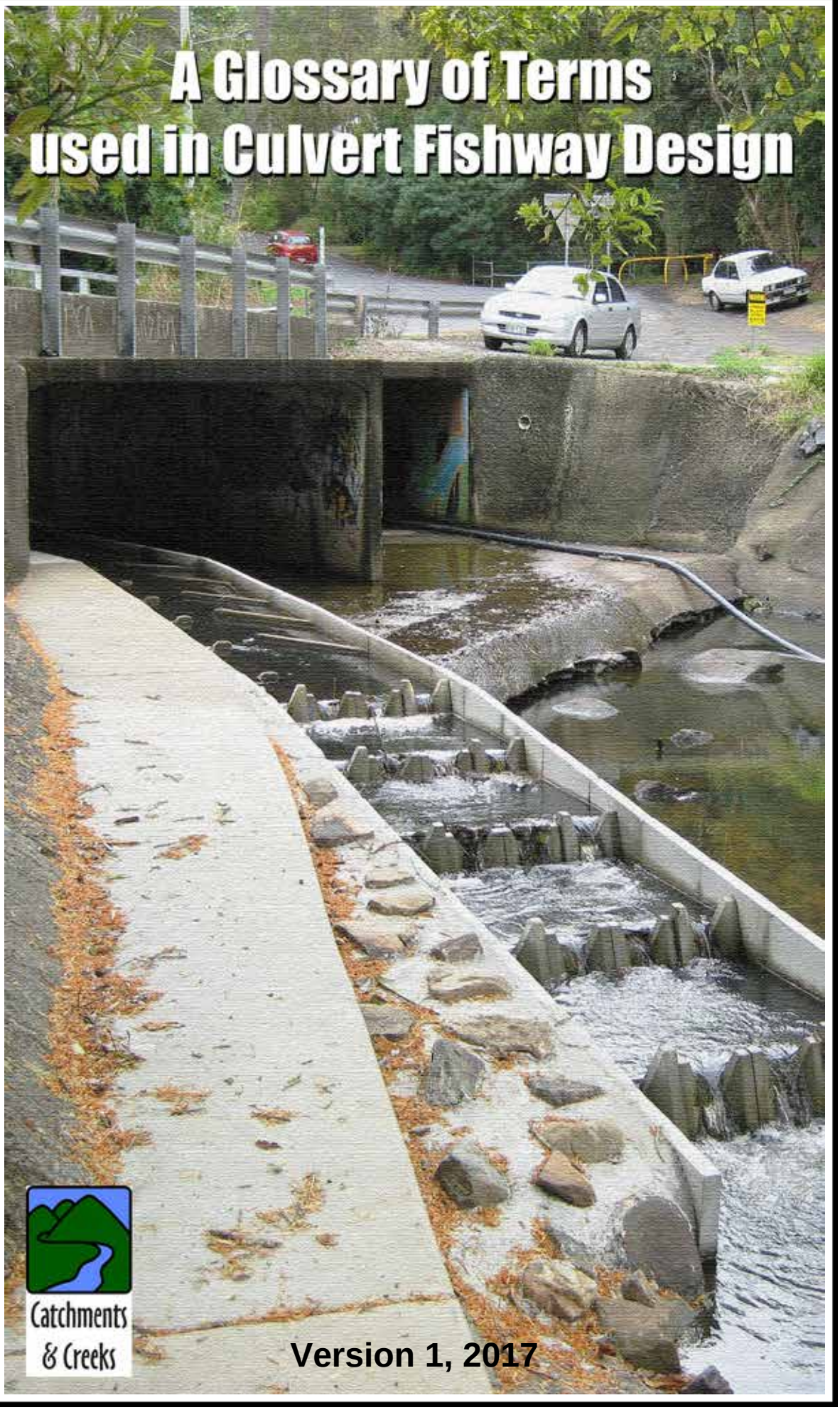
A Glossary of Terms used in Culvert Fishway Design



Catchments & Creeks

Version 1, 2017

Glossary of Terms used in Culvert Fishway Design

Version 1, September 2017

Prepared by: Grant Witheridge of Catchments & Creeks Pty Ltd, and Martin Mallen-Cooper

Published by: Catchments and Creeks Pty Ltd

Diagrams by: Grant Witheridge, Catchments and Creeks Pty Ltd

Photos by: Catchments and Creeks Pty Ltd, Martin Mallen-Cooper, Ross Kapitzke, Murray-Darling Authority, NSW Fisheries, Peter Armstrong

This document should be referenced as:

Witheridge 2017, *Glossary of Terms used in Culvert Fishway Design*. Catchments and Creeks Pty Ltd., Brisbane, Queensland

Key words: culvert design, fish passage, fishways.

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

Purpose of Glossary

This glossary of terms has been prepared for the following purposes:

- To assist waterway/road-design engineers and fisheries biologists to understand the terminology used by each of these professional groups with respect to fish passage at waterway crossings.
- To define these terms in a manner that best promotes consistency in the understanding and usage of these terms by fisheries biologist and engineering.

It is not the intension of this document to dictate to any professional body the meaning of any given term, or to insist that these two professions should adopt a single terminology. Each professional body has the right to adopt the terminology they feel best suits their own profession. The glossary is provided solely to help each of these professional bodies to recognise that some terms, such as ‘laminar flow’, have different usage within the two professions, and that some times two different terms are used to describe the same item, such as ‘rock ramp’ and ‘rock chute’.

Consequently, the definitions provided in this glossary are not necessarily consistent with the strict definitions that would normally apply when a fisheries biologist is communicating with another fisheries biologist, or an engineer is communicating with another engineer.

It is also not the intension of this glossary to alter the interpretation of terms used within government legislation and guidelines.

Where appropriate, definitions provided in Australian Standard AS1348–2002 *‘Terms Used in Road Engineering’* have been included as an alternative definition.

List of terms:

‘A’-terms: Abutment, AEP, ARI, Afflux, Aggregate, Alluvial watercourse, Amphidromous, Anadromous, Angled baffle, Angled-section, Annual exceedance probability (AEP), Apron, Arch bridge, Average flow velocity, Average recurrence interval (ARI)

‘B’-terms: Backwater, Baffle, Bankful discharge, Barrel, Barrier, Base, Base flow, Bed (stream or culvert), Bedload, Biopassage, Biota (aquatic), Block-ramp fishway, Boulder, Boundary layer, Box culvert, Bridge, Burst swimming speed, Bypass fishway

‘C’-terms: Catadromous, Catchment, Causeway, Cell (culvert), CFD, Channel-section, Chevron baffle, Chute, Circular culvert (pipe culvert), Clay, Clay-based watercourse, Cobble, Cofferdam, Corner baffle, Countersunk culvert, Critical velocity, Cross-section, Cruising swimming speed, Culvert, Cut-off wall

‘D’-terms: Design discharge (design flow), Design discharge (fish passage), Design discharge (flood), Design discharge (trafficability), Diadromous, Downstream, Drop inlet, Drop outlet, Drop structure, Drowned weir, Dry cell

‘E’-terms: Elevated apron, Embankment, Ephemeral stream

‘F’-terms: Fill, Filter fabric, Fines, Fish, Fish ladder, Fish migration, Fish passage, Fishway, Floodplain culvert, Floodway, Floor (culvert), Floor baffle, Ford, Freshes, Fry

‘G’-terms: Gabion, Grade (noun), Grade (verb), Grade control structure, Graded aggregate, Gravel, Gravel-based watercourse

‘H’-terms: Head (H), Head differential, Head loss, Headwall, Headwater, Hydraulic design method, Hydraulic jump, Hydraulics, Hydrology

‘I’-terms: Inclined sidewall baffle, Inlet control, Invert

‘J’-terms: Jetting, Jute blanket, Jute mesh

‘L’-terms: Laminar flow, Left bank, Leg (culvert), Local flow velocity, Low flow, Low-flow, Low maintenance culvert, Low maintenance fishway, L-shaped baffle

‘M’-terms: Major road, Manning's equation, Manning's roughness, Migration (channel), Migration (fish), Multi-cell culvert, Multi-purpose culvert

‘N’-terms: Natural channel design, Normal depth, No-slope culvert design, Notched baffle

‘O’-terms: Obvert, Offset baffle, Outlet control

‘P’-terms: Perennial stream, Pipe culvert, Potamodromous, Prolonged swimming speed

‘R’-terms: Ramp, Recessed culvert, Reno mattress (rock mattress), Resting zone, Ridge-rock fishway, Right bank, Rock-based watercourse, Rock-ramp, Rough turbulent flow, Roughness, Run (channel)

‘S’-terms: Sand, Sand-based watercourse, Shelter, Side baffle, Sidewall (culvert), Silt, Skylight, Smooth turbulent flow, Spoiler baffle, Stream, Stream order, Stream simulation culvert design, Stream-slope culvert design, Subcritical flow, Supercritical flow, Sustained swimming speed

‘T’-terms: Tailwater, Terrestrial fauna, Terrestrial pathway, Turbulent flow

‘U’-terms: Uniform depth, Uniform flow, Uniform velocity, Upstream

‘V’-terms: Velocity, Velocity head, Vertical-slot fishway

‘W’-terms: Water body, Watercourse, Waterfall, Waterway, Wedged sidewall baffle, Weir, Weir baffle, Wet cell, Wing wall, Wholly rough turbulent flow

A–terms

Stone pitched bridge abutment

Abutment

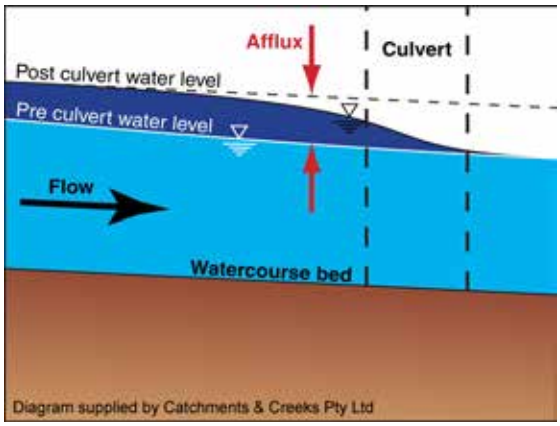
- An end support of a bridge or similar structure. [AS1348-2002]
- A point or structure on which a bridge deck abuts with the adjoining embankments.

AEP and ARI

Annual exceedance probability (AEP)	Average recurrence interval (ARI)
0.01 (1 %)	1 in 100 years
0.02 (2 %)	1 in 50 years
0.05 (5 %)	1 in 20 years
0.10 (10 %)	1 in 10 years
0.18 (18 %)	1 in 5 years
0.39 (39 %)	1 in 2 years
0.63 (63 %)	1 in 1 year

Relationship between AEP and ARI

- ‘AEP means ‘annual exceedance probability’.
- ‘ARI’ means ‘average recurrence interval’.
- AEP is the probability that a particular storm or flood event will be equalled or exceeded in any year.
- AEP is not necessarily the complement of the *return period* or the average recurrence interval.



Diagrammatic representation of afflux

Afflux

- The rise in water level on the upstream side of a constriction in a stream or channel relative to the water level on the downstream side. [AS1348-2002]
- A measure of the increase in water elevation at a given location caused by a given structure, relative to the water elevation that would have occurred at that location if the structure did not exist.

Rounded river aggregate

Aggregate

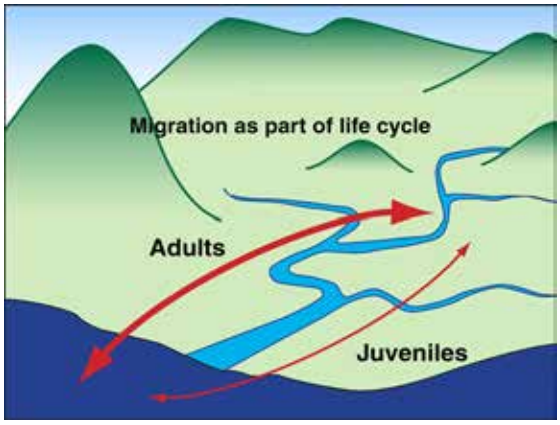
- A material composed of discrete mineral particles of specified size or size distribution, produced from sand, gravel, rock or metallurgical slag, using one or more of the following processes: selective extraction, screening, blasting, or crushing. [AS1348-2002]
- Coarse aggregate is the material retained on a 4.75 mm or 2.36 mm sieve.
- Fine aggregate is the material passing a 4.75 mm or 2.36 mm sieve.

A–terms

Gravel-based ‘alluvial’ watercourse

Alluvial watercourse

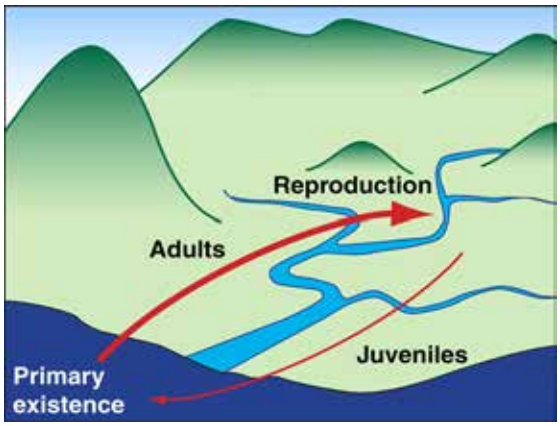
- A natural waterway channel formed primarily from flood-laid deposits of sand, silt and gravel, or a constructed channel primarily lined with alluvial material extracted from a waterway or floodplain.
- These are also known as ‘moving bed’ waterways.
- Alluvial waterways include both sand-based and gravel-based waterways.
- The term generally does not include fixed-bed, clay-based waterways that are subject to unnatural sediment loads.



Amphidromous fish movement

Amphidromous

- Fishes that migrate between marine and freshwater environments (or vice versa) at some definite stage in their life cycle, but not for the purpose of reproduction.



Anadromous fish movement

Anadromous

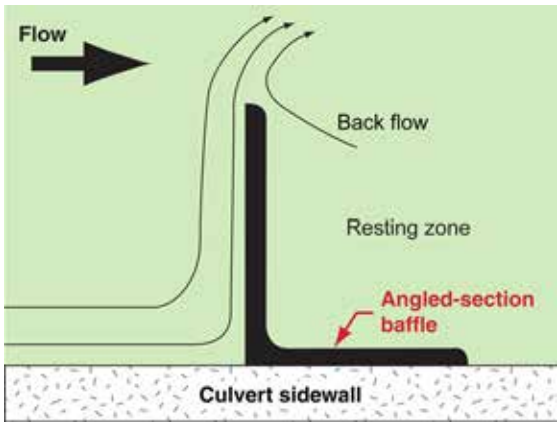
- Fishes that spend much of their life in a marine environment and which migrate to freshwater as adults to reproduce.
- The opposite is CATADROMOUS.

Angled baffles in a pipe culvert

Angled baffle

- A ‘side baffle’ or ‘weir baffle’ with an inclined crest.

A–terms



Baffle formed from an angled-section

Angled-section

- A rolled metal section that has a cross-section similar to an L-section.
- Angled sections have on occasions been used to form sidewall baffles.
- These are standard commercial sections formed from steel, stainless steel or aluminium.

Annual exceedance probability (AEP)

- The probability that a particular storm or flood event will be equalled or exceeded in any year.
- It is not necessarily the complement of the *return period* or the average recurrence interval.
- It is the term generally preferred for use when referring to infrequent flood events with a probability less than 10%.

Annual exceedance probability (AEP)	Average recurrence interval (ARI)
0.01 (1 %)	1 in 100 years
0.02 (2 %)	1 in 50 years
0.05 (5 %)	1 in 20 years
0.10 (10 %)	1 in 10 years
0.18 (18 %)	1 in 5 years
0.39 (39 %)	1 in 2 years
0.63 (63 %)	1 in 1 year

Comparison of AEPs and ARIs

Concrete apron at culver inlet

Apron

- A layer of concrete, stone, timber or other durable material placed at the entrance or outlet of a hydraulic structure (such as a culvert) in the bed of a channel or watercourse, to protect the structure against scour. [AS1348-2002]

Arch bridge

Arch bridge

- A bridge, the deck of which is supported by a curved structural member in compression which transfers the loads to the abutments or piers. [AS 1348-2002]
- An arched structure resting on supports at both extremities (footing or abutments) without intermittent supports or piers.
- These structures are often **mistakenly** termed ‘arch culverts’, but they are not culverts because the conduit is not fully enclosed by structural surfaces.

B–terms

Backwater passing through a culvert

Backwater

- That part of a stream, the water level of which is kept above normal due to some controlling influence downstream. [AS 1348-2002]
- A hydraulic condition where water levels at a given location are primarily controlled by the effects of a downstream structure (natural or artificial) or water body, rather than channel roughness.

Baffle types presented in this glossary include:

- Angled baffle
- Chevron baffle
- Corner baffle
- Floor baffle
- Inclined sidewall baffle
- L-shaped baffle
- Offset baffle
- Side baffle
- Spoiler baffle
- Wedged sidewall baffle
- Weir baffle

Baffle

- A shallow, full or partial weir (bed fixture), or narrow sidewall fixture, that introduces additional channel roughness causing a lowering of local flow velocities adjacent to the fixture for the purpose of improving opportunities for fish passage and/or to provide 'resting' zones for migrating fish.

Bankful flow

Bankful discharge

- The channel flow rate that exists when the water surface is level with the channel bank elevation above which the water would spill out of the channel and begin to enter the floodplain.
- Bankful discharge is often used as one of the critical design parameters in Natural Channel Design and sediment transport calculations.

Pipe culvert barrel

Barrel

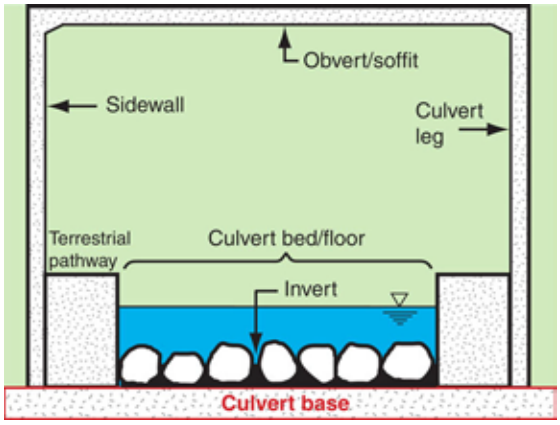
- That portion of a culvert between the end walls. [AS 1348-2002]
- An individual flow conduit of a culvert between the end walls.
- Also known as a CELL.

B–terms

Fish passage barrier (weir)

Barrier

- An obstruction (natural or artificial) to fish passage.



Culvert terminology

Base

- The solid bed or floor of a culvert.
- Typically refers to the structural base of the culvert that may be buried under sediment or natural bedding material which forms the effective 'floor' or 'bed' of the culvert.

Base flow in a rural stream

Base flow

- The stream flow rate that cannot be directly attributed to storm events.
- It includes any regular, long-term inflows, such as environmental flows, from regulated lakes or reservoirs.
- The flow rate is usually not constant, but varies with groundwater levels and long-term weather conditions.
- Also known as DRY WEATHER FLOW.

Constructed pool-riffle channel bed

Bed (stream or culvert)

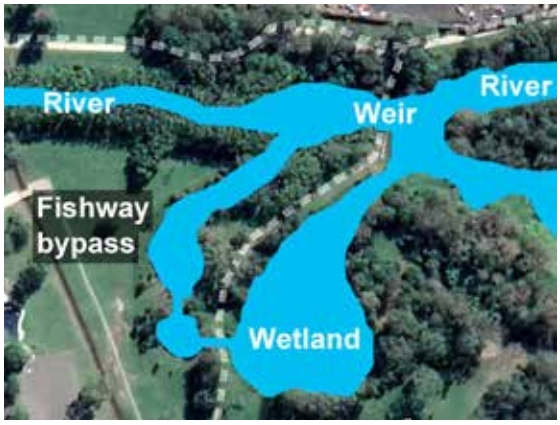
- The horizontal or near-horizontal section of a channel located between its banks, or the lower banks, if there is more than one set of banks.
- The bed of a channel may incorporate a low-flow channel, which may be narrower in width than the channel bed.
- The formal 'bed' of a culvert would unlikely include any raised sections or pathways installed for the purpose of terrestrial passage or maintenance access.

B–terms

Deposited bedload in sand-based river

Bedload

- Sediment transported by rolling, sliding or saltation (hopping) motion along a channel bed as a result of the stream flow, whether the result of normal stream flow or higher flood flows.



Bypass fishway, Bundaberg

Biopassage

- The retention or restoration of waterway and wetland connectivity and the maintenance of aquatic connectivity and aquatic conditions to facilitate the passage of all mobile aquatic species throughout their life cycle.

Turtle

Biota (aquatic)

- The total animal and plant life of a region, or sometimes a period, as seen collectively and inter-dependently.

Block-ramp fishway (Walaman)

Block-ramp fishway

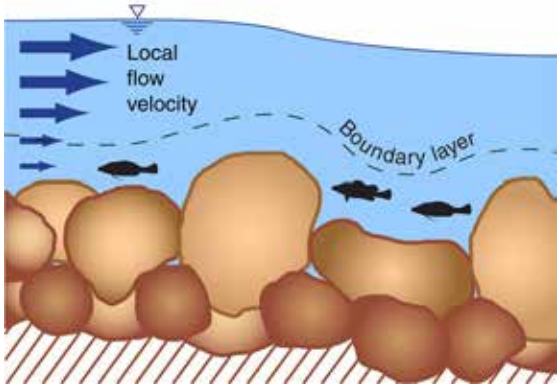
- A constructed fishway formed from pre-cast units, which simulates the operation of a ridge-rock or pool–riffle system.

B–terms

Boulders located within rural waterway

Boulder

- A rounded or sub-angular stone or piece of rock of large size, usually larger than 300 mm. [AS 1348-2002]
- Some waterway publications set the minimum size of boulders as 250 mm—that being the maximum cobble size.



Boundary layer formed over a rocky bed

Boundary layer

- A region of lower than average flow velocity that exists immediately adjacent to any fixed surface such as the bed and sidewalls of a culvert.
- In general, the rougher and more irregular the fixed surface, the thicker and the more effective the boundary layer becomes for fish passage.

Multi-cell box culvert

Box culvert

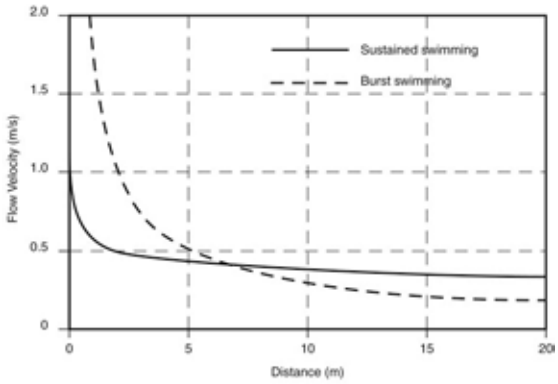
- A culvert of rectangular cross-section. [AS 1348-2002]

Bridge

Bridge

- In general terms, a bridge is any structure spanning a river, chasm, road or the like, and affording passage.
- A crossing formed by an elevated pathway that rests on the waterway, but does not fully enclose the waterway, i.e. the natural bed is retained below the crossing.
- The term ‘bridge’ also applies to arched structures spanning natural bedding material.

B–terms



Burst and sustained swimming speed

Burst swimming speed

- The peak swimming speed of fish, which can be sustained for only short periods (20 seconds), after which fish need to rest.
- Energy is primarily supplied through myotomal (body) white muscles.
- Often indicated to be around ten body lengths per second (10 BLPS), but does vary significantly for different species.

Bypass fishway, Bundaberg

Bypass fishway

- A fishway that is formed by constructing a new fish friendly channel that passes at a low-gradient around a fish barrier, such as a weir.
- The bypass channel may incorporate various individual fishway components, such as rock ramps and resting pools.

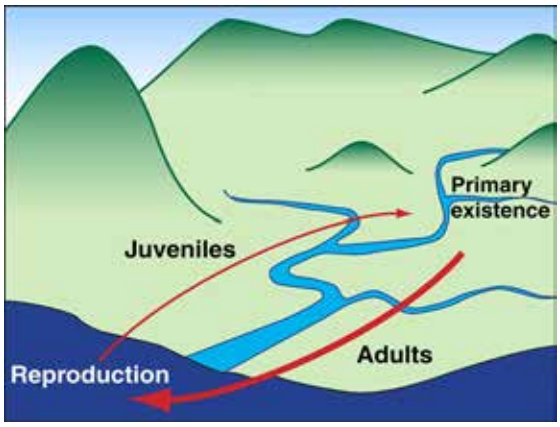
Baldwin Swamp, Bundaberg

Fish barrier (weir) on main waterway

Outflow from swamp into bypass channel

Riffle zone in bypass channel

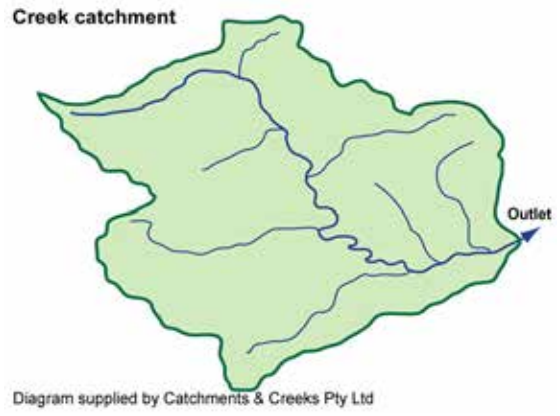
C–terms



Catadromous fish movement

Catadromous

- Fishes that spend most of their life cycle in freshwater and which migrate to the marine environment to reproduce.
- The opposite is ANADROMOUS.



Drainage catchment

Catchment

- That area of land from which stormwater runoff contributes to stream flow at the most downstream point of the catchment.
- Also known as a DRAINAGE BASIN, DRAINAGE CATCHMENT, and WATERSHED (USA).

Causeway

Causeway

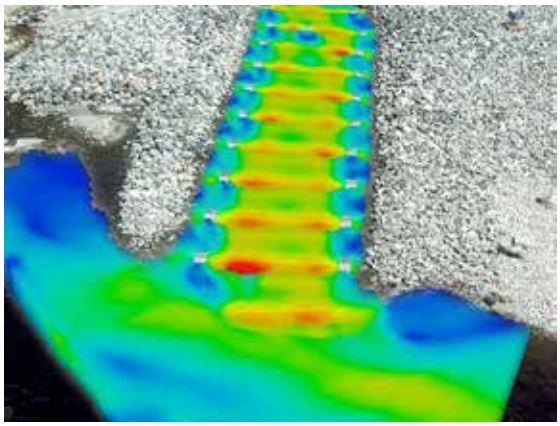
- A raised carriageway constructed across a watercourse or tidal waterway.
- The term most commonly refers to a watercourse crossing where:
  - the low-flow pipe (i.e. the culvert) has a relatively small cross-sectional area compared to that of the embankment
  - the culvert is abutted on one or both sides by a roadway embankment of significant length that is frequently overtopped by flood flows.

Single cell (barrel) of a pipe culvert

Cell (culvert)

- The individual flow conduit of a culvert between the end walls.
- Also known as a BARREL.

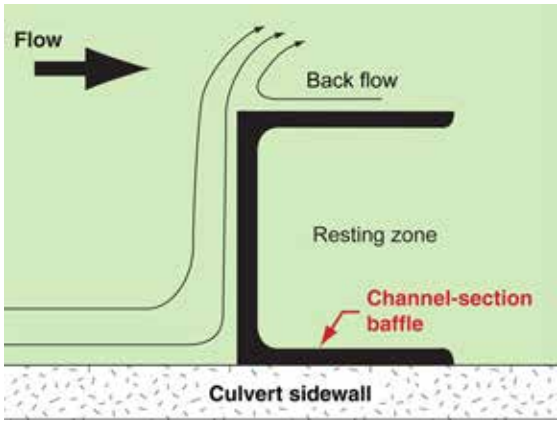
C–terms



CFD modelling of a fishway

CFD

- Means ‘Computational Fluid Dynamics’.
- A complex form of three-dimensional numerical flow modelling that attempts to model ‘local flow velocities’ rather than ‘average flow velocities’.



Baffle formed from a channel-section

Channel-section

- A rolled metal section that has a cross-section similar to an U-section.
- Channel sections have on occasions been used to form sidewall baffles within culverts, but more commonly ‘angled sections’ are used.
- These are standard commercial sections formed from steel, stainless steel and aluminium.

Chevron baffles at culvert inlet

Chevron baffle

- Regularly-spaced, low-level floor baffles formed in a V-shape (chevron) typically pointing upstream to focus turbulence and flow energy towards the centre of the channel.

Loose rock chute

Chute

- A steeply inclined section between the inlet and outlet of a flume, or other similar hydraulic structure, that conveys the flows directly from one level to a lower level.
- In most circumstances the term ‘chute’ can be directly interchanged with the term ‘ramp’.
- The term ‘chute’ is more commonly used by hydraulic engineers, while the term ‘ramp’ is more commonly used by fisheries biologists.

C–terms

Single cell pipe culvert

Circular culvert (pipe culvert)

- A single or multi-celled culvert formed from circular (pipe) sections.

Clayey soil

Clay

- This term that has two distinct meanings.

1. Soil material consisting of mineral particles smaller than 0.002 mm in equivalent diameter—this generally includes the chemically active mineral part of a soil.
2. A soil texture group containing at least 35 per cent clay and no more than 40 per cent silt—thus a ‘clayey soil’ typically contains material other than just ‘clay’.

Clay-based watercourse

Clay-based watercourse

- A watercourse where clayey soils are dominant within the stream channel.
- Channel stability is most commonly governed by the strength of the bed and bank vegetation.
- Often referred to as ‘fixed-bed’ waterways.
- In their natural condition, minor clay-based waterways often have little if any measurable sediment flow.

Cobbles on bed of gravel-based stream

Cobble and cobblestone

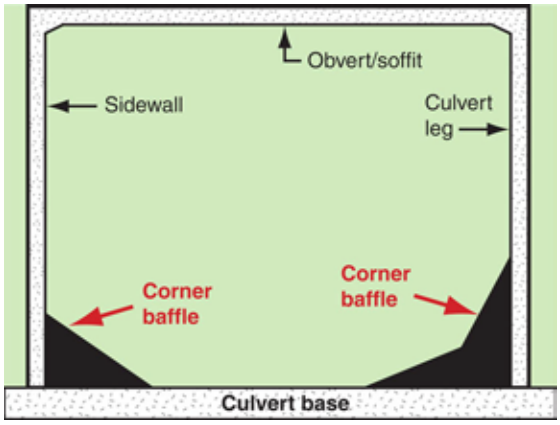
- A water-worn rounded stone usually between 60 mm and 300 mm in size. [Australian Standard, AS 1348-2002]
- Some waterway documents refer to cobbles as granular bed or bank material measuring 10 to 250 mm equivalent diameter.

C–terms

Sandbag cofferdam

Cofferdam

- A temporary enclosure formed to exclude water from an area in which construction is to take place. [Australian Standard, AS 1348-2002]
- A watertight enclosure constructed in a watercourse and then pumped dry so that bridge foundations or similar may be constructed in the enclosure.



Corner baffle

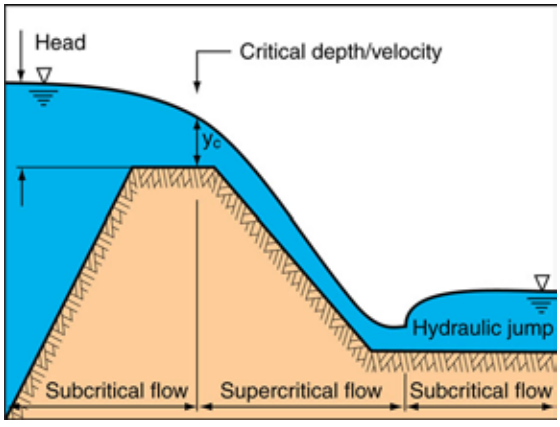
Corner baffle

- A flow control baffle located in the corner of a box culvert and used to assist fish passage.

Countersunk box culvert

Countersunk culvert

- A culvert with the structural base of the cells (or the nominated 'wet' cells) recessed into the channel bed such that a pool forms in the culvert during periods of zero flow.

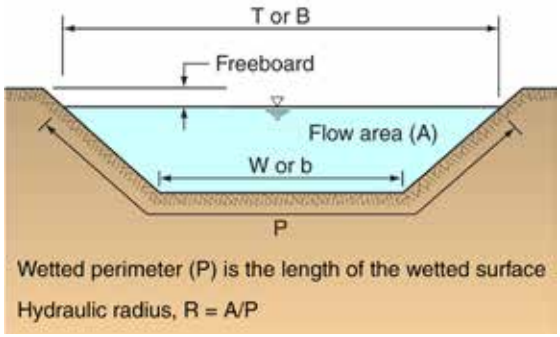


Location of critical velocity on weir

Critical velocity

- The velocity of water occurring in a channel or partially full conduit at the point of critical flow when the Froude Number $(V/(g.d)^{0.5})$ is equal to 1.0, and the specific energy (flow depth plus velocity head) is a minimum.
- It is the flow condition that exists at a single cross-section just as subcritical flow transforms into supercritical flow, but not when supercritical flow transforms back to subcritical flow.

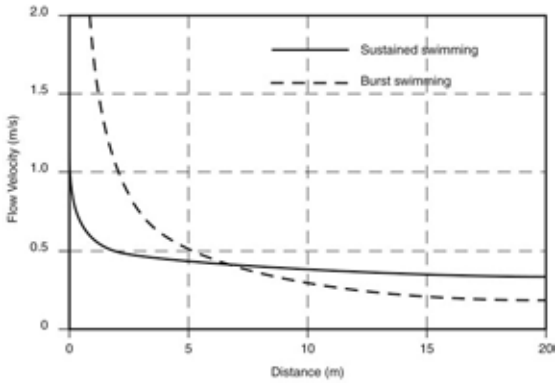
C–terms



Cross-sectional parameters

Cross-section

- A vertical section on a plan showing the profile of the conduit or channel at right-angle to the dominant direction of flow.
- Common hydraulic terms determined from the cross-section include top width (T or B), bed width (W or b), flow area (A), wetted perimeter (P) and hydraulic radius (R = A/P).



Burst and sustained swimming speed

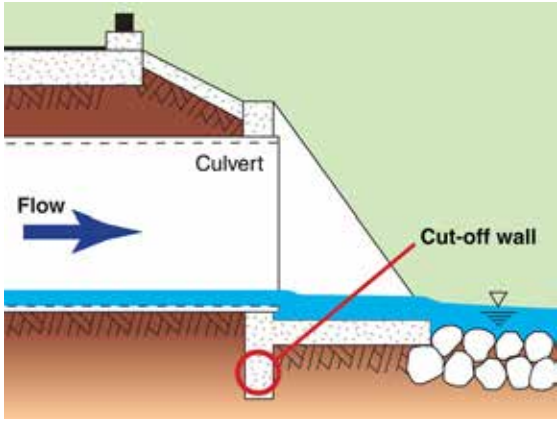
Cruising swimming speed

- The speed that fish can swim continuously with little effort or stress.
- Cruising speed is generally less than the 'sustained speed'.

Rural culvert with stock underpass

Culvert

- One or more adjacent pipes or enclosed channels for conveying a watercourse or stream below formation level. [AS 1348-2002]
- Most commonly refers to those causeways where the conduit that passes under the causeway represents a significant part of the overall causeway.
- Culverts fully enclose the waterway; however, some culverts may be recessed into the waterway bed allowing natural bedding material to exist within the cells.



Culvert cut-off wall

Cut-off wall

- A watertight wall for preventing seepage or movement of water under or past a structure, or for preventing scour from undermining a structure. [AS 1348-2002]
- An impervious barrier of material or concrete designed to intercept seepage flows through or beneath a structure, and to prevent downstream bed erosion from undermining the structure.
- Commonly used at culvert head walls and on the energy-dissipation apron of drop structures.

D–terms

Flooded road crossing

Design discharge (design flow)

- The nominated discharge (flow rate) used in the design of a hydraulic structure, or a component of the structure.
- There may be more than one design discharge used in the design of a hydraulic structure, for e.g. one discharge may be used for the design of the structure's maximum hydraulic capacity, while another is used for the design of a specific feature such as erosion control or fish passage.

Operational culvert fishway

Design discharge (fish passage)

- The design discharge used in the design of a fishway, whether or not the fishway is incorporated into another structure.

Flooded road crossing

Design discharge (flood)

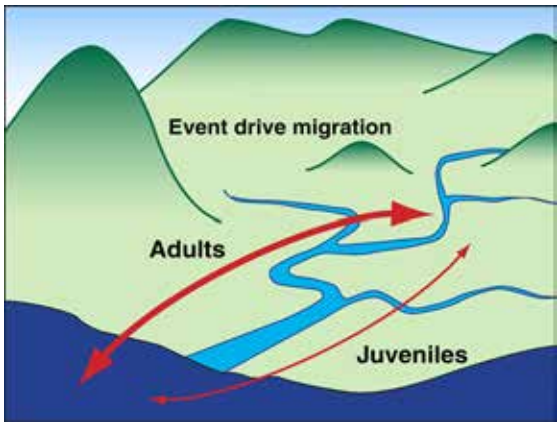
- The maximum design discharge used in the assessment of a structure's impact on local flood levels.

Limited trafficability of crossing

Design discharge (trafficability)

- The minimum design discharge during which a waterway crossing must remain trafficable.
- Trafficability is usually determined based on maximum flow depth and maximum depth*velocity product limits.
- In urban areas the trafficability limits are often based on zero water overtopping the road crossing.

D–terms



Diadromous fish movement

Diadromous

- Fishes that regularly migrate between fresh and salt water during a definite period of their life cycle.
- This includes ANADROMOUS and CATADROMOUS species.

Looking downstream

Downstream

- Any location or activity that exists within, or moves towards, the lower part of a channel or watercourse relative to a reference point within the channel or watercourse.

Culvert with a drop inlet

Drop inlet

- An inlet to a hydraulic structure comprising of a sudden or rapid lowering of the bed elevation.
- Drop inlets are commonly associated with no-slope culverts typically used on steep waterways.
- Fish passage through a culvert with a drop inlet is normally limited to those periods when the culvert is operating under 'outlet controlled' conditions (i.e a backwater exists through the culvert which drowns-out the drop inlet).

Culvert with drop outlet

Drop outlet

- An outlet of a hydraulic structure comprising a sudden or rapid lowering of the bed elevation.
- Typically associated with perched or elevated culverts.
- A fish barrier often exists during periods of low flow; however, fish passage may occur during high flows if the culvert operates under 'outlet controlled' conditions.

D–terms

Grouted boulder drop structure

Drop structure

- An open channel hydraulic structure specifically designed to allow water to fall rapidly.
- These structures usually incorporates an energy dissipation zone; however, energy dissipation may also occur within the immediate downstream channel.

Four degrees of weir drowning

Drowned weir

- A type of weir flow where the nappe is discharging underwater, and the upstream water level is affected by the downstream water level, i.e. the weir is subject to tailwater effects.
- Also known as a SUBMERGED WEIR.

A culvert containing both wet and dry cells

Dry cell

- A conduit within a multi-cell culvert that is expected to remain dry during base flow conditions.
- Dry cells are introduced into culverts to promote the under-road passage of native terrestrial fauna, which prefer a dry pathway.

Above culvert several years later

Dry cell – terrestrial fauna passage culvert

E–terms

Culvert with elevated apron

Elevated apron

- An outlet apron that is elevated above the immediate downstream channel bed.
- Elevated aprons typically represent fish barriers during periods of low flow.

Flood control embankment (levee)

Embankment

- A construction (usually of earth or stone) to raise the ground (or formation) level above the natural surface. [Australian Standard, AS1348-2002]
- Earth embankments are typically used to form the approach roads to elevated bridge crossings.

Ephemeral clay-based watercourse

Ephemeral watercourse

- A watercourse that flows during, and for short periods after, storms.
- An ephemeral watercourse may contain permanent pools.

Ephemeral sand-based watercourse

Ephemeral river (Tod River, NT)

F–terms

Placing fill adjacent to a creek

Fill

- The material placed in an embankment. [Australian Standard, AS1348-2002]
- Any material used to raise the surface of an area to a desired elevation prior to, or during, earthmoving operations.

Filter cloth

Filter fabric

- A type of geotextile that allows water to pass through, but prevents the passage of fines. [Australian Standard, AS1348-2002]
- The size of soil particles held back depends on the filter rating of the fabric.
- It is typically used as a protective lining for earth structures, batters of channels, or to separate different soil texture layers.
- It is <u>not</u> a type of erosion control blanket.

Fine aggregate (sandy material)

Fines

- Fine aggregate. [Australian Standard, AS1348-2002]
- Primarily consists of coarse silts and sands, but not fine gravel.

Pygmy perch

Fish

- An animal of a species that throughout its life cycle usually lives in water (whether freshwater or saltwater); or in or on foreshores; or in or on land under water.
- When referring to legislation, the term is likely to include: prawns, crayfish, rock lobsters, crabs and other crustaceans; and scallops, oysters, pearl oysters and other molluscs; and sponges, annelid worms, holothurians; and trochus and green snails.

F–terms

Fish ladder adjacent a weir

Fish ladder

- A constructed fishway that requires fish to 'jump' from pool to pool, or cell to cell, in order to climb the structure.

Fish migration in shallow water

Fish migration

- The progressive seasonal movement of fish and other aquatic organisms up or down a watercourse as part of their life cycle.
- It is one form of fish passage.
- It does not include the random day to day movement of fishes in search of food and habitat.

Fish passage

Fish passage

- The movement of fish and other aquatic organisms up and down a watercourse.
- Movement can be for a variety of reasons including:
  - migration
  - reproduction
  - access new habitats
  - feeding
  - avoid predators
  - shelter from floodwaters.

Baffled fishway

Fishway

- A structure designed to enable fish to move past a physical barrier (e.g. dam or weir) in a waterway.

F–terms

Floodplain culvert

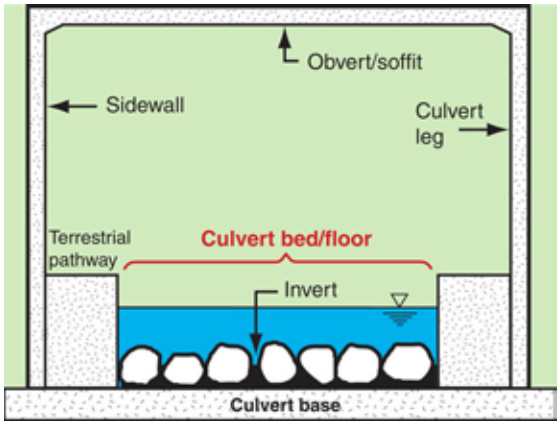
Floodplain culvert

- A culvert located in the land area adjoining rivers, streams, artificial channels, lakes, dams, bays, or oceans, that is inundated during flood events due to overbank stream flows or abnormal high tides resulting from severe storms.
- Typically these culverts are located within earth embankments adjoining a waterway bridging structure.

Floodway with creek on left

Floodway

- The channel of a stream and that portion of the floodplain that must be kept free of encroachment by development or excessive vegetation so that a defined flood (typically the 1 in 100-year flood) can pass through without causing damage to the surrounding land, or causing an unacceptable increase in flood heights.
- The floodway represents that portion of the floodplain where the appropriate management of its flood hydraulics is critical.



Culvert floor

Floor (culvert)

- The exposed surface of the bed of the culvert cell.
- That part of the culvert cell that is not considered part of the roof or sidewalls.
- Typically does not include any part of an elevated terrestrial pathway that sits on the floor of the culvert.

Offset floor baffles

Floor baffle

- A baffle fixed to the floor of a culvert or channel.

F–terms

Ford crossing of sand-based creek

Ford

- A shallow place in a stream where the bed may be crossed by traffic. [Australian Standard, AS1348-2002]
- A shallow place where a river or other body of water may be crossed by wading or otherwise passing through the water.
- A carriageway formed directly on the channel bed in a shallow section of a watercourse.

In-bank stream flow (fresh)

Freshes (fresh)

- Flows that produce a substantial rise in water height for a short period, but which do not overtop the channel bank.

Fry

Fry

- The young of fishes.

Majories Hardyhead

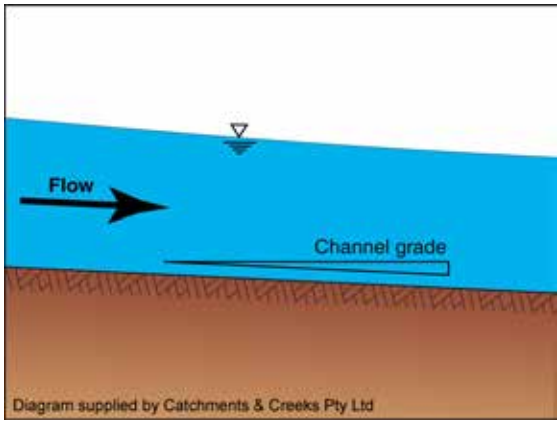
Australian Smelt

G–terms

Gabion wall under construction

Gabion

- A basket filled with rock, or similar material, usually rectangular in profile, used in the construction of retaining walls and erosion-control structures.
- Gabions that are relatively thin compared to their width and length, are commonly referred to as mattresses, rock mattresses or Reno mattresses (commercial trade name).



Channel grade

Grade [noun]

- The rate of longitudinal rise or fall of a slope with respect to the horizontal, usually expressed as a ratio or as a percentage, e.g. a 1:10 (V:H) batter has a grade of 1 in 10, 0.1 or 10%.

Uniform or poorly graded aggregate

Grade [verb]

- The action of arranging an aggregate or other material by particle size.

Grade control structure

Grade control structure

- An engineered structure that stabilises the grade (slope) of a gully or other watercourse, thereby preventing further head-cutting or lowering of the channel bed.
- Grade control structures include flumes, chutes, rock ramps, and open channel drop structures.
- Chutes and rock ramps generally have a low gradient (fish friendly), while drop structures generally have a steep gradient (i.e. not fish friendly).

G–terms

Well graded riverbed aggregate

Graded aggregate

- Aggregates having a distribution of sizes from coarse to fine, the largest size being several times larger than the smallest size. [Australian Standard, AS1348-2002]
- Aggregate that is uniform is size is termed ‘uniformly graded’ or ‘poorly graded’ aggregate.
- Aggregate that has a wide and continuous distribution of sizes from coarse to fine is termed ‘well graded’.

Gravel-lined car park

Gravel

- Various definitions exist, such as:

1. A mixture of mineral particles passing a 75 mm sieve and with a substantial portion retained on a 4.75 mm sieve. [AS1348-2002]
2. A mixture of coarse mineral particles primarily larger than 2 mm but less than 75 mm in equivalent diameter.
3. Waterway publications commonly refer to gravel as granular bed or bank material of a size 2 to 250 mm in equivalent diameter.

Gravel-based watercourse

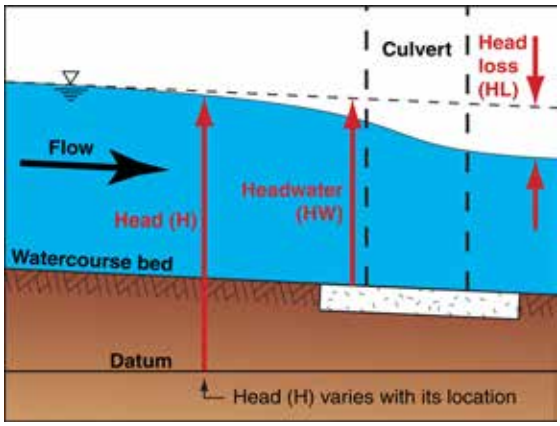
Gravel-based watercourse

- An alluvial watercourse with a channel bed primarily consisting of gravel, cobbles and boulders.
- Flood events generally cause a slow, progressive movement of the gravel and cobbles down the watercourse.
- Gravel-based waterways frequently contain pool-riffles systems along the bed.

Gravel-based watercourse

Gravel-based watercourse

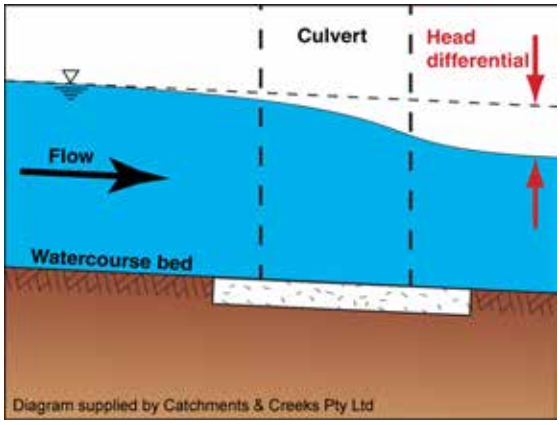
H–terms



Head, head loss & headwater

Head (H)

- The height (above a standard datum) of the surface of the column of water that can be supported by the static water pressure **at a given point**.
- The term is often confused with the term 'head loss', which is the difference in the water 'head' between two locations.
- The term 'headwater' (HW) differs from 'head' because it refers to the head well upstream of a culvert measured relative to the culvert invert at the culvert's inlet.



Head differential caused by culvert

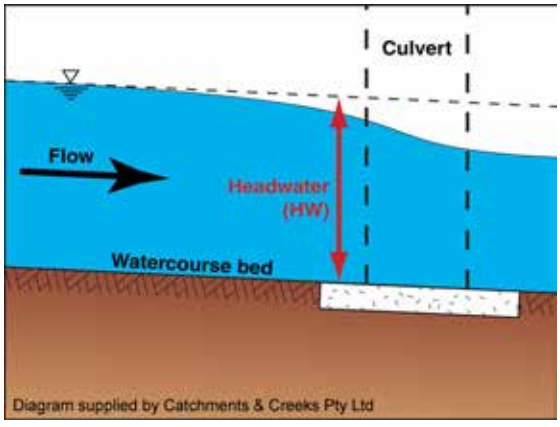
Head differential or head loss (HL)

- The difference in static water pressure head upstream and downstream of a structure or component of a structure, e.g. the operating head of a hydraulic structure.
- Also known as HEAD LOSS.

Culvert headwall without wing walls

Headwall

- A structural retaining wall at the ends of a culvert, or at the end of a drainage conduit, used primary to control seepage from behind the wall and to prevent under mining of the structure.
- Also known as an END WALL.



Culvert headwater

Headwater (HW)

- The height of water above the invert of a culvert measured at the inlet of a culvert. [Australian Standard, AS1348-2002]
- The parameter 'headwater' is relevant only to the design of 'inlet control' culverts, which are not common in current day waterway engineering.
- Also, the term 'Headwaters' refers to the small streams on the higher ground of a catchment that flow into a major watercourse.

H–terms

Offset baffle culvert fishway

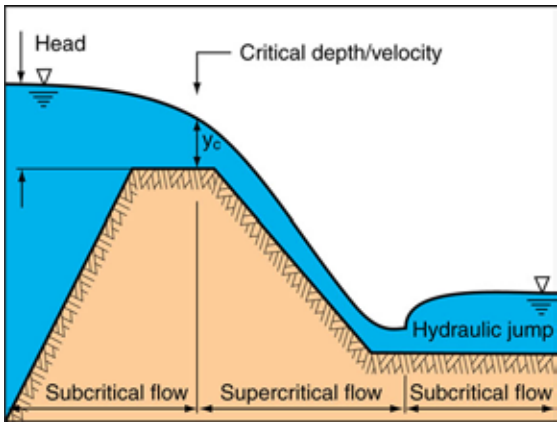
Hydraulic design method

- The methodology of designing fishways based on specified flow velocity and turbulence limits based on the swimming ability of target species.
- The 'average flow velocity', as commonly used in engineering design, is of little value in the design of these fishways; instead, the engineering design focuses on the 'local flow velocity'.
- The design procedures for this design method have been greatly enhanced by the growth of CFD modelling.

Hydraulic jump formed at culvert outlet

Hydraulic jump

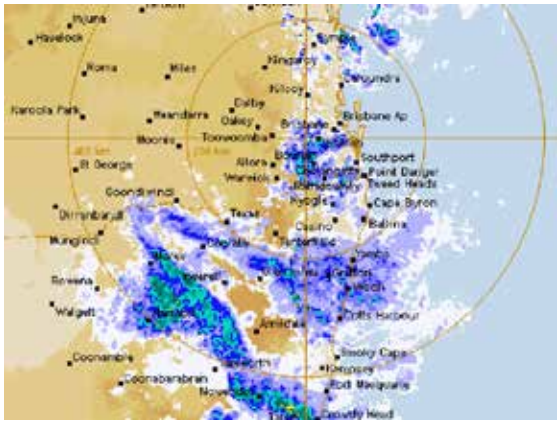
- An abrupt, turbulent rise in the water surface (in the downstream direction) resulting from the transition of supercritical flow into subcritical flow.
- The rate of rise in water surface, and the degree of turbulent within and immediately downstream of the hydraulic jump, is related to the Froude number of the approaching flow.
- Hydraulic jumps are a form of standing wave.



Hydraulics of a spillway

Hydraulics

- The study of water or other liquid flow in conduits and open channels.

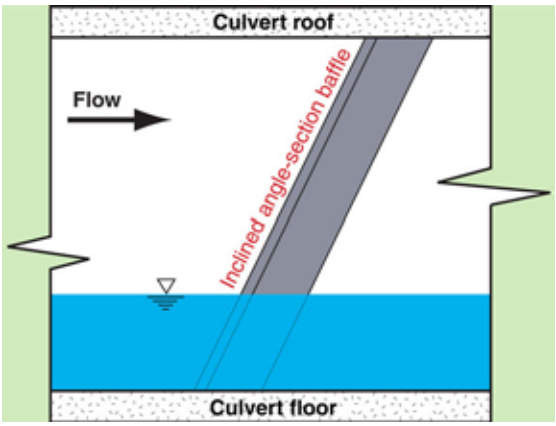


Rainfall radar map

Hydrology

- The study of water on the land or under the Earth's surface, its properties, laws, geographical distribution, and so on.

I–terms



Inclined baffle

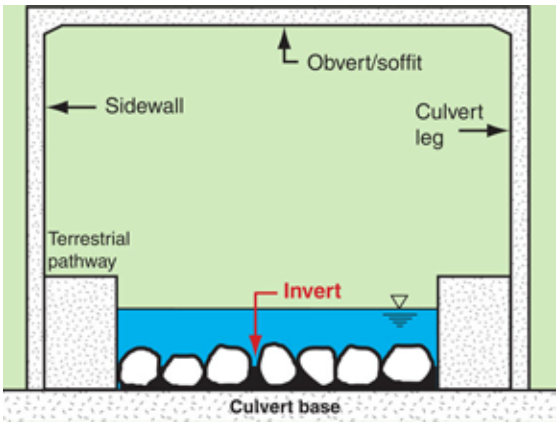
Inclined sidewall baffle

- A sidewall baffle inclined to the bed of the conduit.
- There is the unproven 'theory' that inclining sidewall baffles will reduce the potential for the baffles to capture and hold large woody debris.

Shallow-water inlet control conditions

Inlet control

- A flow condition in which the discharge through a culvert is governed by either critical flow or orifice flow conditions at the inlet of the culvert.
- In such cases, flow conditions within a culvert are dictated by the depth of headwater (relative to the culvert invert) and entrance geometry of the culvert.
- Inlet control conditions can only exist when the culvert's outlet is not drowned.

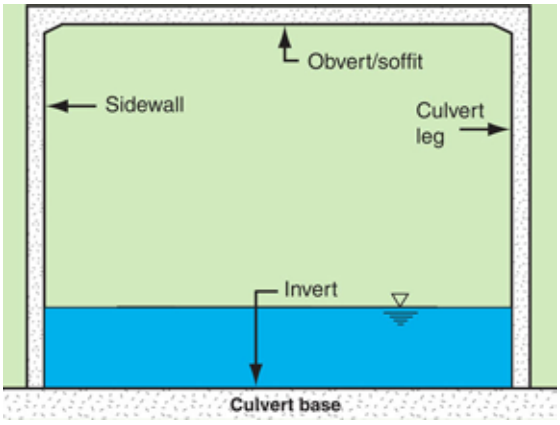


Invert of box culvert with 'natural' bed

Invert

- The lowest portion of the internal surface of a culvert or channel at a given location or cross-section.

Rocky 'invert' of a fish-friendly culvert



Invert of box culvert without rocky bed

J–terms

Outlet jetting from culvert

Jetting (outlet jetting)

- The concentrated discharge of water into a wider water body resulting in a concentrated stream of water (the 'jet') that either floats on the surface (a floating jet) or is submerged under the water surface (a submerged jet).
- The erosive effects of an outlet jet typically extend a distance of over ten times the diameter/thickness of the jet (which ever is the smaller dimension).

Jute blanket

Jute blanket

- A temporary erosion control blanket formed from 'jute', a strong vegetable fibre.
- In the past, jute blankets have commonly been used as a temporary erosion control measure during the revegetation of stream.
- The current preference is to use 'jute mesh' in waterway rehabilitation instead of jute blankets.

Jute mesh

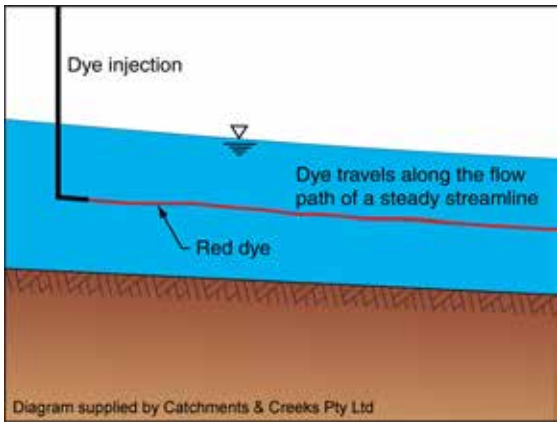
Jute mesh

- A coarsely woven material of jute yarn, which can be used to control soil erosion in waterways and on steep slopes. [Australian Standard, AS1348-2002]
- Jute mesh is often preferred in waterway rehabilitation because it is less likely to be stripped from the banks by elevated stream flows.

Pinning of jute mesh

Planting in a jute mesh

L–terms



Laminar flow conditions

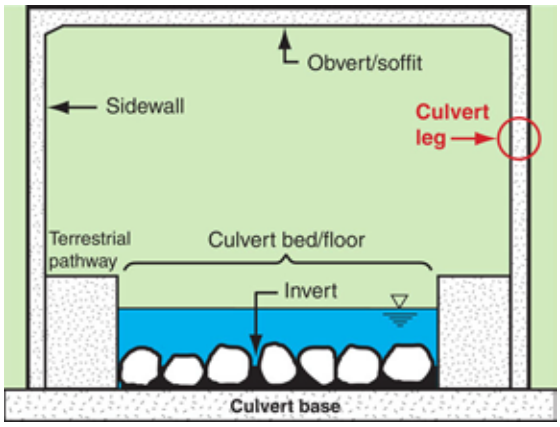
Laminar flow

- A flow condition characterised by fluid particles moving along smooth paths in laminas (layers), with one layer gliding smoothly over an adjacent layer.
- The viscous properties of the fluid suppress any random (turbulent) motion of the fluid particles thus preventing mixing between adjacent layers.
- Fisheries officers and some engineers often use this term to refer to any flow that demonstrates a condition of low turbulence.

Left and right banks

Left bank

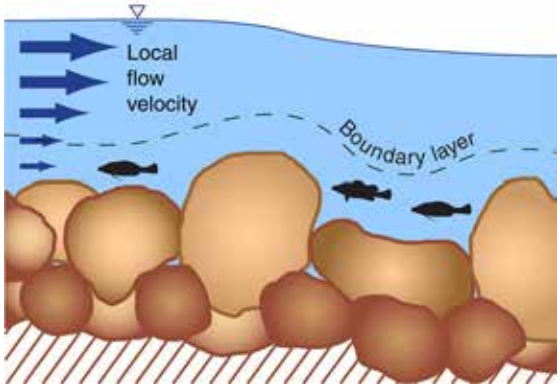
- Engineering convention suggests that the left bank or left channel wall is that surface observed on the left-hand side when looking downstream (i.e. in the direction of flow).
- Fisheries officers, however, often describe waterway features in relation to a view looking upstream (i.e. the direction most commonly associated with migrating fish).
- Consequently, the terms ‘left’ and ‘right’ need to be clearly defined within fish passage publications.



Vertical leg of a box culvert

Leg (culvert)

- The vertical member of a box culvert unit.



Arrows showing local velocity at depth

Local flow velocity

- The actual flow velocity at a specific location or point along a streamline.
- ‘Depth average velocity’ is the average of the local flow velocities along a vertical plain.
- ‘Average velocity’ is the average of the local flow velocities across the full depth and width of a cross-section.
- Hydraulic engineers most commonly analyse and reference the ‘average flow velocity’, which is generally not an critical factor in fish passage engineering.

L–terms

Meandering low-flow channel

Low flow (noun) and low-flow (adjective)

- [Noun] The underlying flow rate that cannot be directly attributed to storm events.
- It includes any regular, long-term inflows, such as environmental flows from regulated lakes or reservoirs.
- [Adjective] A term used to define the function of a noun as being related to the movement of low flows, such as a 'low-flow channel'.

Culvert subject to heavy sedimentation

Low-maintenance culvert

- A culvert that either:
  - requires very little maintenance to maintain its design functions, or
  - is easy and inexpensive to maintain after flood events.
- Aspects of a low-maintenance culvert include cost of maintenance, difficulty of maintenance, frequency of maintenance, the provision of safe access and working environment, and the ability to fully recover the design features of the culvert.

Low-maintenance rock ramp fishway

Low-maintenance fishway

- A fishway that either:
  - requires very little maintenance to maintain its design functions, or
  - is easy and inexpensive to maintain after flood events.
- Aspects of a low-maintenance fishway include cost of maintenance, difficulty of maintenance, frequency of maintenance, the provision of safe access and working environment, and the ability to fully recover the design features of the fishway.

L-shaped corner baffles

L-shaped baffle

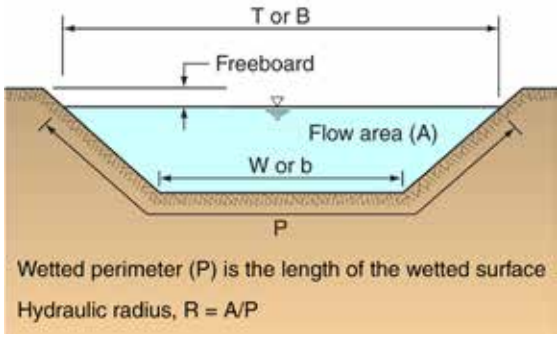
- A side-baffle formed in a L-shape.

M–terms

Major road bridge

Major road

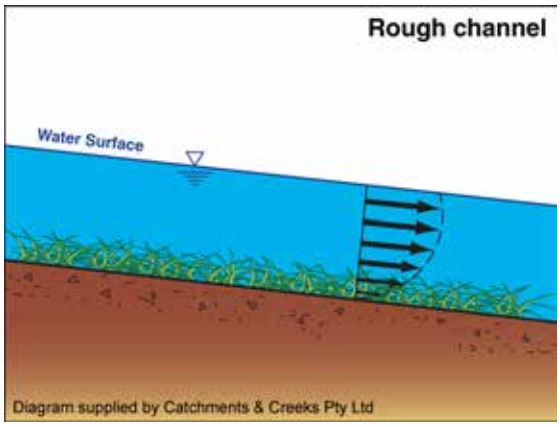
- A road to which is assigned a permanent priority for traffic movement over that of other roads. [Australian Standard, AS1348-2002]
- A road whose primary function is to serve through traffic, includes collector roads, sub-arterial and arterial roads.
- These roads are most commonly the responsibility of the state's Road and Traffic Authority (RTA) or Department of Main Roads (DMR) as the case may be.



Channel cross-section

Manning's equation/formula

- A formula used to predict the 'average' flow velocity in an open channel.
- **$V = (1/n).R^{2/3}.S^{1/2}$** (Metric SI units)
  - V = mean velocity of flow [m/s]
  - R = hydraulic radius [m]
  - S = channel slope [m/m]
  - n = Manning's roughness coefficient of the channel/conduit [dimensionless]
- Note; the coefficient '1' is assumed to have the units of [$m^{1/3}/s$], thus allowing Manning's n to remain dimensionless.



Channel hydraulics

Manning's roughness

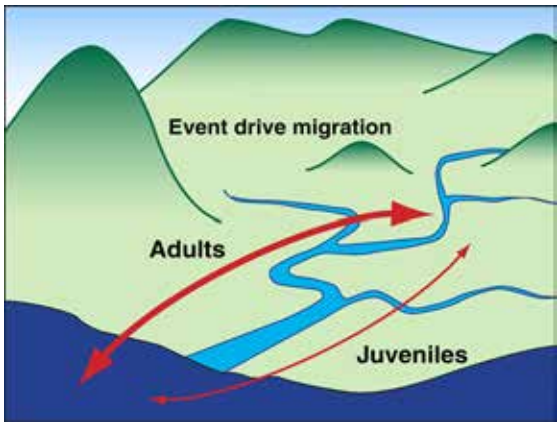
- The numerical representation of the hydraulic roughness (n) of a conduit, flow path or channel as used in the Manning's formula.
- In the hydraulic analysis of waterways, the nominated roughness coefficient (n) must account for the surface roughness, as well as the effects of channel irregularities and channel meander.
- The terms is considered 'dimensionless', thus allowing the same term to be used in metric and imperial equations.

Landforms caused by channel migration

Migration (channel)

- The lateral movement of the whole channel, including both banks.
- Channel migration typically results in the formation of channel meanders.
- Long-term channel migration typically results in the formation of off-stream pools and oxbows.

M–terms



Diadromous fish movement

Migration (fish)

- The specific directional movement of fishes (upstream or downstream) in response to a life cycle need, including, but not limited to, reproduction.

Multi-cell box culvert

Multi-cell culvert

- A causeway or culvert that contains more than one conduit.

Multi-purpose culvert

Multi-purpose culvert

- A culvert that is designed in a manner that allows it to perform several functions, such as:
  - conveyance of stream flows
  - natural migration of bed sediments
  - human passage in the form of pedestrian and bikeway tunnels
  - fish passage
  - terrestrial passage.

Above culvert several years later

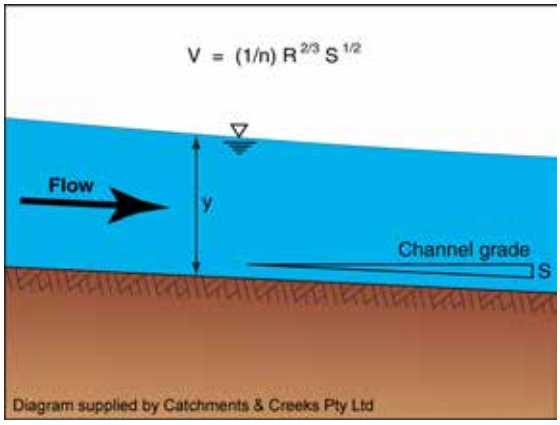
Pedestrian underpass and bikeway

N–terms

Drainage channel under construction

Natural Channel Design (NCD)

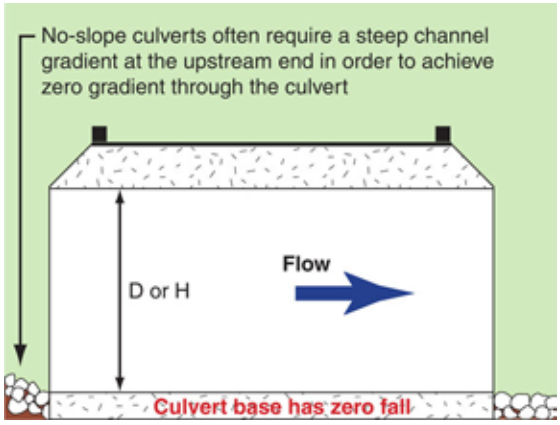
- A channel design concept based on the planning, design, construction and maintenance of a drainage channel that is compatible with current and future hydrologic, ecological and social requirements for the catchment.
- The concept is primarily used in the construction of drainage channels (whether or not a watercourse previously existed at that location) and in the reconstruction of modified 'natural' waterways.



Normal depth

Normal depth

- The depth (y or d) at which uniform flow occurs at a given discharge in a channel of given cross-section, slope and roughness.



No-slope culvert long-section

No-slope culvert design

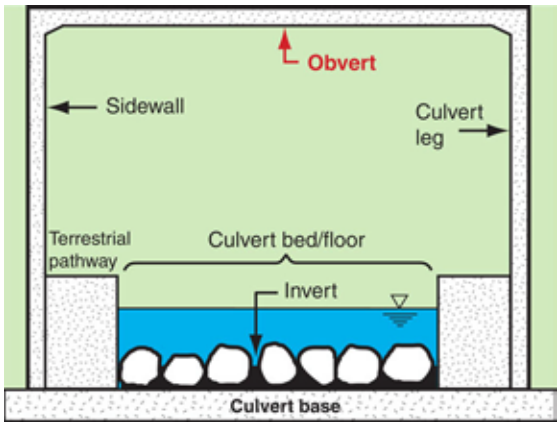
- A culvert design philosophy that involves the placement of culverts along a waterway such that base of the culvert has zero gradient (i.e. zero fall in the bed invert along the culvert's length).
- Sediment or natural bed gravel may be allowed to deposit along the base of the culvert to form a more fish-friendly channel bed.

Notched shallow weir baffles

Notched baffle

- A weir-baffle that contains a 'notch' in the weir crest from which water discharges at a greater depth compared to the rest of the weir.
- During periods of low flow, overtopping flows may be restricted to just the width of the notch.

O–terms



Culvert obvert

Obvert

- The highest portion of the internal surface of a culvert or arch at a given cross-section.
- Also known as the SOFFIT.

Offset baffle (Walaman)

Offset baffle

- A set of weir-baffles offset in their longitudinal placement, often at different angles to the sidewalls.

Culvert operation under outlet control

Outlet control

- A hydraulic condition in which factors downstream of a culvert's entrance govern the discharge characteristics of the culvert.
- It is the flow condition that will most likely exist in low gradient waterways.
- Current design practices prefer the adoption of outlet control culverts due to their enhanced fish passage capabilities relative to 'inlet control' culverts.
- See also INLET CONTROL.

Culvert operation under outlet control

Culvert operation under outlet control

P–terms

Perennial watercourse

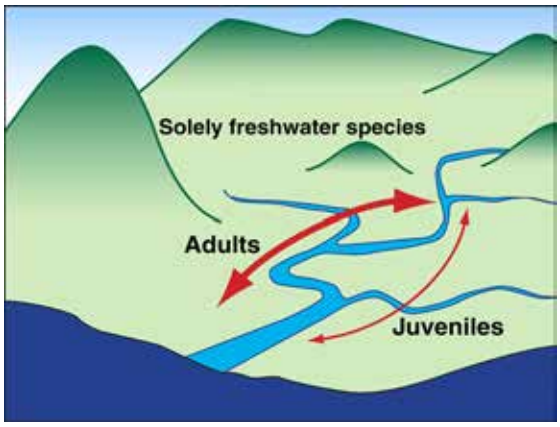
Perennial stream

- A watercourse with a continuous flow regime.

Pipe culvert

Pipe culvert

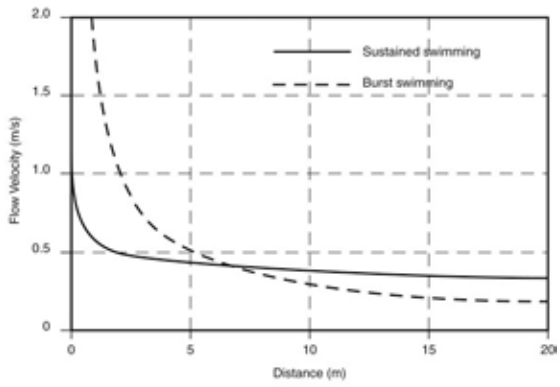
- A culvert containing circular (pipe) conduits.



Potamodromous fish movement

Potamodromous

- Fishes that make true migrations wholly in freshwater.



Burst and sustained swimming speed

Prolonged swimming speed

- The swimming speed that fishes can maintain for 20 seconds to 200 minutes, and ends in fatigue.
- This swimming speed spans the speeds between ‘sustained’ and ‘burst’.
- Energy is supplied to slow (red) and/or fast oxidative glycolytic (pink) and/or fast glycolytic (white) fibres.
- White muscle fibres have a high power output, but a low energy reserve.

R–terms

Rock ramp

Ramp

- A mildly steep grade control structure or fishway that conveys water at a gradient steeper than the adjoining reaches of the watercourse.
- In most circumstances the term ‘ramp’ can be interchanged with the term ‘chute’.
- The term ‘ramp’ is more commonly used by fisheries biologists, while the term ‘chute’ is more commonly used by hydraulic engineers.

Recessed box culvert

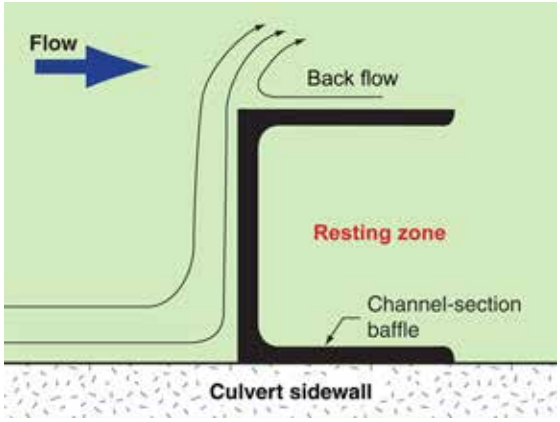
Recessed culvert

- A culvert with the base of all or some of the cells recessed below the normal elevation of the channel bed.
- If only some of the cells are recessed, then those that are recessed are also termed, ‘wet cells’.

Channel lined in rock mattresses

Reno mattress (rock mattress)

- A commercial brand of a ‘rock mattress’.
- A rock mattress being a low profile flexible rock-filled basket with a length and width significantly greater than its depth, thus forming a ‘mattress’ like structure.
- Ordinarily used for scour protection in areas of high flow velocity and/or turbulence.



Resting zone behind sidewall baffle

Resting zone

- A low velocity, low turbulent region of a water body that allows fishes to rest at ‘cruising speed’ prior to periods of bust speed or sustained swimming speed.

R–terms

Ridge-block fishway

Ridge-block fishway

- A fishway formed from per-cast units that simulates a ridge-rock fishway or riffle system.

Ridge-rock fishway

Ridge-rock fishway

- A stepped channel bed that promotes low flows to spill between the adjacent surfaces rocks that are placed in a line across the channel bed.
- Typically the spill height is limited to a maximum of 100 mm.

Left and right banks

Right bank

- Engineering convention suggests that the right bank or right channel wall is that surface observed on the right-hand side when looking downstream (i.e. in the direction of flow).
- Fisheries officers, however, often describe waterway features in relation to a view looking upstream (i.e. the direction most commonly associated with migrating fish).
- Consequently, the terms ‘left’ and ‘right’ need to be clearly defined within fish passage publications.

Rock-based watercourse

Rock-based watercourse

- A watercourse with significant areas of exposed rock forming riffles and waterfalls.
- These rock outcrops are often separated by sections of clay, sand or gravel-based channels.
- Deep energy-dissipation pools typically exist immediately downstream of the riffles and waterfalls.
- These are fixed-bed ‘spilling’ waterways.

R–terms

Rock ramp fishway

Rock ramp fishway

- A fishway ramp or chute formed from grouted or loosely placed rocks.
- Typically, the gradient of rock ramp fishways is limited to a maximum of 1 in 20.

Rough turbulent flow conditions

Rough turbulent flow

- A flow condition that incorporates strong turbulence and eddies that extent from the bed to the water surface.
- This is a fully-mixed flow condition that has no discernible layers or stratification.
- Known also as TURBULENT FLOW or WHOLLY ROUGH TURBULENT FLOW.
- Also see 'smooth turbulent flow' where flow turbulence and eddies are limited to regions or layers, but full depth mixing still occurs.

Significant bed and bank roughness

Roughness

- A property of the channel surface or channel form that directly affects the flow properties of a conduit, channel or overland flow path.
- It is the overall hydraulic roughness of a channel, including surface roughness, channel irregularity, channel meander, variations in the channel cross-sectional, channel vegetation and channel obstructions.

Channel 'run'

Run (channel)

- A section of channel that is neither a 'pool' or 'riffle'.
- It is a section of a waterway that has a near-continuous downstream gradient that usually allows the reach to fully drain if flows stop (this depends on the low-flow backwater conditions of the channel).

S–terms

Exposed, sandy creek bank

Sand

- [1] Natural mineral particles that will pass through a defined sieve (normally 4.75 mm or 2.36 mm) and that are free of appreciable quantities of clay and silt. [Australian Standard, AS1348-2002]
- [2] A soil consisting primarily of particles between 0.02 and 2.0 mm in equivalent diameter.
- Fine sand is defined as particles between 0.02 and 0.2 mm, and coarse sand as those between 0.2 and 2.0 mm.

Sand-based watercourse

Sand-based watercourse

- A watercourse that has a channel bed primarily consisting of deep, loose sand.
- These are ‘alluvial’ waterways that experience significant bedload movement during both minor and major stream flows.
- The depth of the sand typically exceeds the depth of the root systems of some of the bed and lower bank vegetation.
- If the depth of the loose sand is shallow, then this is likely to be a ‘clay-based watercourse’ with some bed sediment.

Shelter provided by edge plants

Shelter

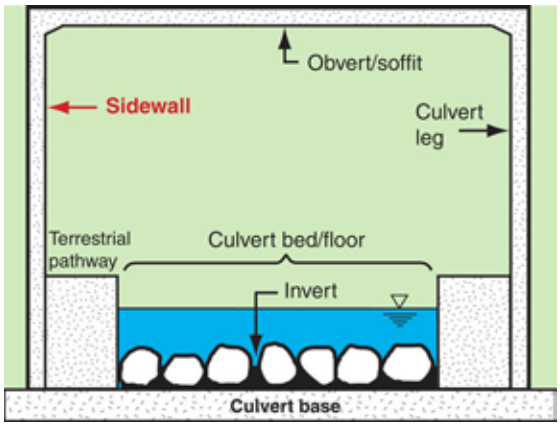
- That part of a water body that allows aquatic life to hide from predators and shelter from adverse flow and weather conditions, such as the midday sun and high-velocity flood flows.
- Shelter may consist of cavities between loose bed rock; areas of low-velocity water behind and around reed beds, rocks and snags; shade under waters edge plants; and backwater areas.

Side baffles

Side baffle

- A baffle attached to the culvert sidewall.

S–terms



Culvert sidewall

Sidewall (culvert)

- The exposed vertical surface of the culvert leg (box culverts) or the mid-elevation region of the inner surface of a circular (pipe) culvert.

Deposited silt

Silt

- [1] Alluvial material intermediate in particle size between sand and clay. It is usually non-plastic. [Australian Standard, AS1348-2002]
- [2] A soil primarily consisting of particles between 0.002 and 0.02 mm in equivalent diameter.

Central skylight in a box culvert

Skylight (fishway)

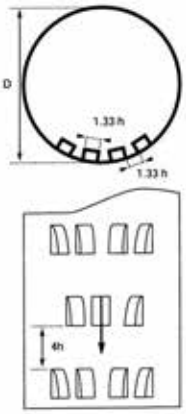
- A device used to increase the protrusion of natural light through the roof of a culvert or bridge deck to aid fish and/or terrestrial passage during periods of daylight.

Smooth turbulent flow conditions

Smooth turbulent flow

- A flow condition where flow turbulence and eddies are limited to regions or layers, but full depth mixing still occurs.
- Smooth turbulent flow conditions normally exist only in low-gradient channels that have a uniform cross-section, and few surface irregularities.
- The alternative is ‘wholly rough turbulent flow’ where flow turbulence and eddies extent from the bed to the water surface.
- Sometimes **incorrectly** referred to as ‘laminar’ flow.

S–terms



Spoiler baffle

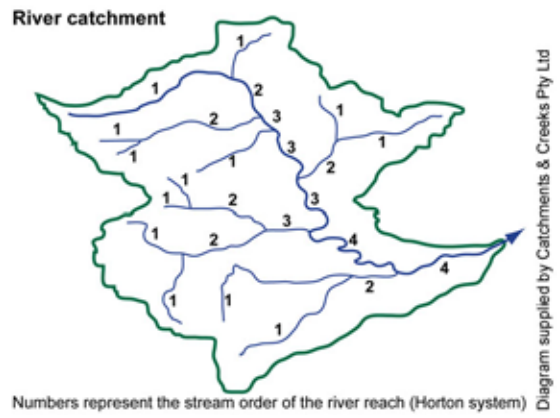
Spoiler baffle

- A fishway formed from streamline, near-rectangular, pre-cast or cast in-situ, baffles attached to the bed of a channel or culvert.

Small rural stream

Stream

- A small watercourse, such as a creek or brook, with a sustained base flow that may or may not be permanent.
- Creeks that are sourced from springs or seasonal snowmelts are often referred to as streams.
- When used in relation to: streambed, stream bank and stream flow; the term may refer to any type of watercourse, whether or not there is a sustained base flow.



Example of stream order

Stream order

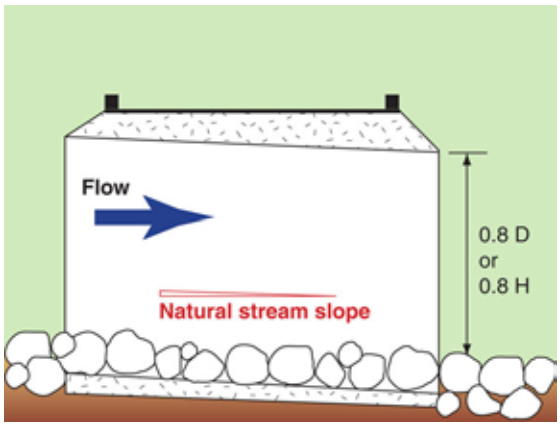
- Stream order is a system for ranking the individual reaches of a waterway.
- There are a number of ranking systems.
- In the Horton system a first-order stream has no contributing branches based on a specified mapping scale—the choice of map scale is critical.
- A second-order stream has at least two contributing first-order branches.
- A third-order stream has at least two contributing second-order branches, etc.

Example of stream simulation

Stream simulation culvert design

- A fish-friendly culvert design philosophy based on the reproduction of locally relevant ‘natural’ channel conditions within a culvert.

S–terms



Stream-slope culvert long-section

Stream-slope culvert design

- A culvert design philosophy that involves the placement of culverts along a waterway such that base of the culvert has the same gradient as the waterway.
- Sediment or gravels may be allowed to deposit along the base of the culvert to form a more natural channel floor.
- The photos provided below for 'Subcritical' and 'Supercritical' flow conditions show an example of the undesirable flow conditions that can develop in stream-slope culverts.

Subcritical flow (downstream of HJ)

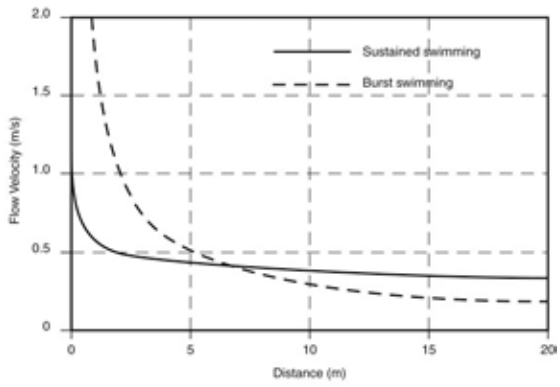
Subcritical flow

- A free-surface flow condition which has a Froude number less than one (1), a depth greater than the critical depth, and a velocity less than the critical velocity.
- During subcritical flow, the flow conditions at any given cross-section are primarily controlled by the flow conditions immediately downstream of that location.
- *Note: 'HJ' in the caption (left) means hydraulic jump.*

Supercritical flow (upstream of HJ)

Supercritical flow

- A free-surface flow condition which has a Froude number greater than one (1), a depth less than the critical depth, and a velocity greater than the critical velocity.
- During supercritical flow, the flow conditions at a given cross-section are primarily controlled by the flow conditions immediately upstream of that location.
- *Note: 'HJ' in the caption (left) means hydraulic jump.*



Burst and sustained swimming speed

Sustained swimming speed

- The swimming speed that fish can maintain for long periods (> 200 minutes) without muscular fatigue.
- Energy is supplied to slow oxidative (red) muscle fibres, which do not fatigue, but do not have a high power output.
- Often indicated to be around three body lengths per second (3 BLPS) but does vary significantly for different species.

T–terms

Tailwater conditions d/s of a culvert

Tailwater

- The hydraulic conditions immediately downstream of a given hydraulic structure, flow path, or a given reach of a flow path.
- Appropriate tailwater conditions are critical in the design of 'outlet control' culverts.
- *(Note; 'd/s' in the caption, left, means 'downstream)*

Eastern Water Dragon

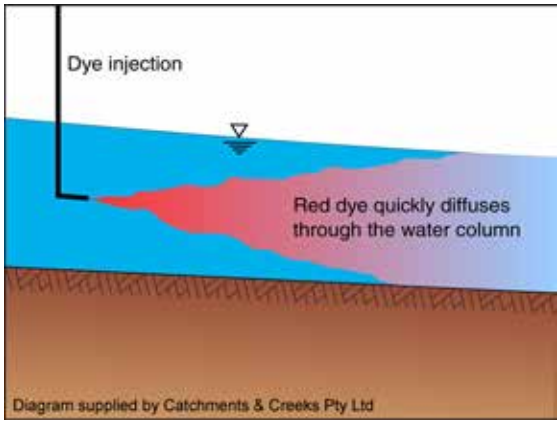
Terrestrial fauna

- Fauna that move across the surface of dry land as distinguished from the water.

Terrestrial pathways (including lizard run)

Terrestrial pathway

- A movement pathway specifically installed for the benefit of terrestrial fauna passage.
- Terrestrial pathways are most commonly 'dry' during periods of low flow.
- A 'lizard run' is an elevated terrestrial pathway specifically formed for fauna that would not normally move along open (exposed) low-level pathways.

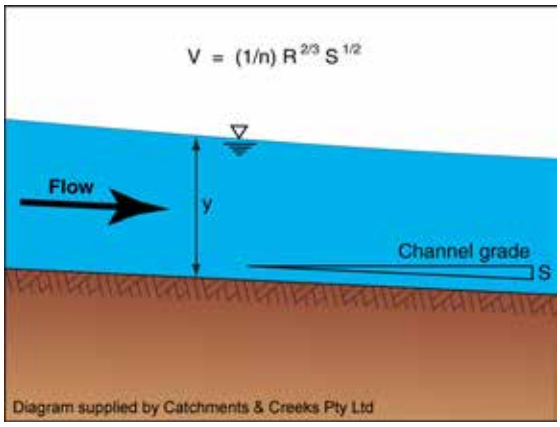


Turbulent flow conditions

Turbulent flow

- A flow condition characterised by fluid particles moving along irregular flow paths.
- The viscous properties of the fluid are insufficient to suppress any turbulent motion of individual fluid particles, thus causing an exchange of momentum and mixing between adjacent layers.
- See also SMOOTH TURBULENT FLOW and WHOLLY ROUGH TURBULENT FLOW.

U–terms



Uniform depth

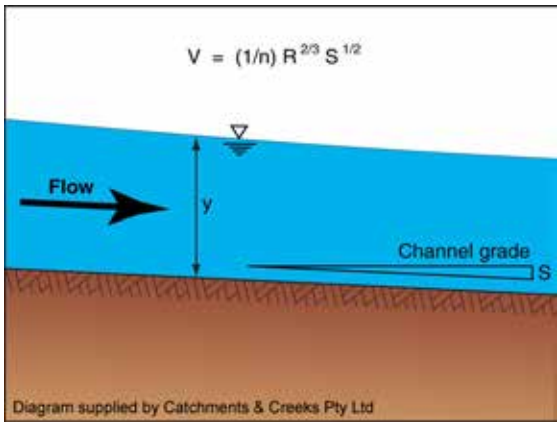
Uniform depth

- The depth (y or d) at which uniform flow occurs at a given discharge in a channel of given cross-section, slope and roughness.
- Also known as NORMAL DEPTH.

Uniform flow conditions

Uniform flow

- A flow condition in which hydraulic conditions, such as depth and velocity, are the same at all locations along a given channel reach at a given instant.
- Technically, this flow condition is only achieved in a channel of uniform (constant) cross-section and constant gradient; however, uniform flow conditions are assumed to exist if the channel cross-section and/or channel gradient vary gradually.



Uniform velocity

Uniform velocity

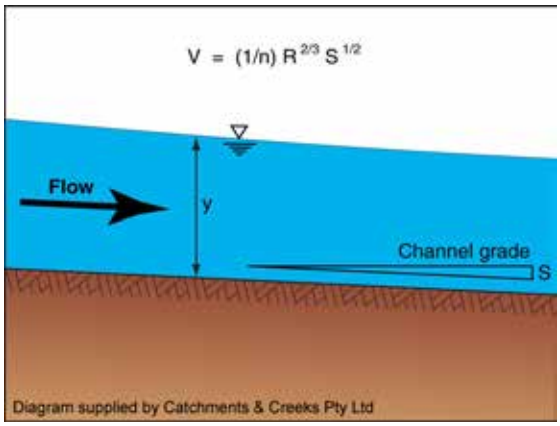
- The average cross-sectional velocity (V) at which uniform flow occurs at a given discharge in a channel of given cross-section, slope and roughness.
- Also known as NORMAL VELOCITY.

Looking upstream

Upstream

- Any location or activity that exists within, or moves towards, the higher part of a channel or watercourse relative to a given reference point within the channel or watercourse.

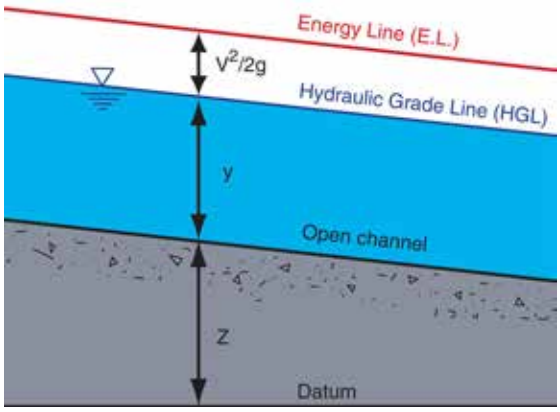
V–terms



Average velocity defined by Manning's Eqn

Velocity

- The rate of movement of water flowing past a point in a specific direction.
- Normally defined as an 'average' value, defined as total discharge divided by total flow area.
- Sometimes reference is made to the 'local' flow velocity, which is measured at a specific location within a given cross-section.



Velocity head in uniform flow

Velocity head

- A measure of the kinetic energy of flow in a pipe or channel obtained by dividing the square of the velocity by twice the acceleration of gravity ($V^2/2g$).
- The 'local' velocity head measured at a point along a streamline is determined using the local flow velocity at that point.
- The average velocity head at a given cross-section is determined by using the 'average' flow velocity at that cross-section.

Vertical-slot fishway

Vertical-slot fishway

- A fishway formed by a series of grouped vertical plate baffles with each group set a specified distance apart, and within each group of baffles a vertical slot is formed of specified width.

W–terms

Water body

Water body

- Any surface water of a landscape, including:
  - all waters subject to tidal flow
  - lakes, rivers, streams (perennial or ephemeral), watercourses (natural or constructed), mudflats, sandflats, wetlands, sloughs, wet meadows, or natural ponds
  - the bed, banks and wetted surface of such water bodies that allows a distinction to be made between the different types of water bodies.

Sand-based watercourse

Watercourse

- A channel with defined bed and banks, including any gullies and culverts associated with the channel, down which surface water flows on a permanent or semi-permanent basis or at least, under natural conditions, for a substantial time following periods of heavy rainfall within its catchment.
- A term commonly interchangeable with the term ‘waterway’.
- The legal definition may vary from state to state, and region to region.

Natural waterfall in an urban creek

Waterfall

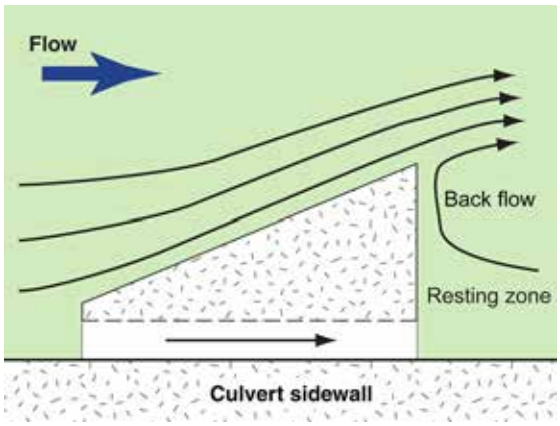
- A steep fall, cascade, or flow of water from a height.
- The term is normally limited to the description of natural land features.
- The term ‘vertical drop structure’ is more commonly applied to constructed features that resemble waterfalls.

Navigable waterway

Waterway

- A river, canal, or other body of water used as a route or way of travel or transport (i.e. navigable channel), including the area available for water to pass through or under a structure such as a bridge or culvert.
- A term commonly interchangeable with the term ‘watercourse’.
- The legal definition may vary from state to state, and region to region.

W–terms



Wedge-shaped sidewall baffle

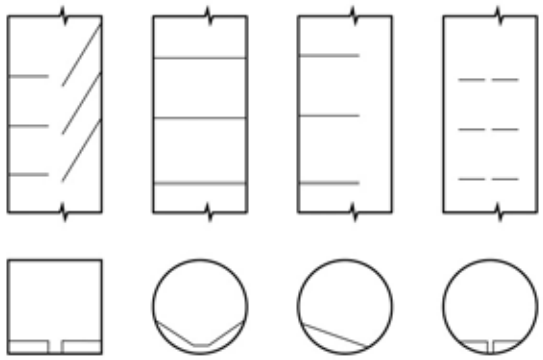
Wedged sidewall baffle

- A sidewall baffle formed with a wedged-shaped cross-section specifically to reduce the risk of woody debris blockage within culverts.

Brightview weir, Locker valley, Qld

Weir

- A structure or wall built across a channel, drain or watercourse to raise the water level to allow diversion or measurement of flows.
- Weirs may be either sharp-crested or broad-crested, and may operate in either a state of free discharge, or a submerged or drowned state.



Types of weir baffles

Weir baffle

- A vertical or near-vertical plate weir primarily fixed to the bed of a channel or conduit over or around which water can flow.
- Weir baffles include:
  - full-width floor baffles
  - partial-width floor baffles
  - offset-baffles
  - slotted-baffles

A culvert containing both wet and dry cells

Wet cell

- A conduit within a multi-cell culvert that is expected to pass water during base flow conditions.
- Wet and dry cells are introduced into culverts to promote the passage of both terrestrial and aquatic fauna.
- Normal design philosophy is to limit the total bed width of the wet cells to the average bed width of the watercourse.

W–terms

Culvert with wing walls under construction

Wing wall

- The extension of an abutment wall as in a bridge, or of an end wall in a culvert, used for retaining the side slopes of the earth filling. [Australian Standard, AS1348-2002]

Wholly rough flow conditions

Wholly rough turbulent flow

- A flow condition that incorporates strong turbulence and eddies that extend from the bed to the water surface.
- A fully mixed flow condition that has no discernible layers or stratification.
- Known also as TURBULENT FLOW or ROUGH TURBULENT FLOW.
- The alternative is 'smooth turbulent flow' where flow turbulence and eddies are limited to regions or layers, but full depth mixing still occurs.

Wholly rough channel flow

Wholly rough riffle flow

Wholly rough outlet jetting

Wholly rough culvert outlet jet