

Title:
DFO Technical Standards

These technical standards are intended to be applied pursuant to paragraphs 2.1(3) and (4) of the *Authorizations Concerning Fish and Fish Habitat Protection Regulations*.



Fisheries and Oceans
Canada

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2026

Cat. No. Fs23-823/2026E-PDF ISBN 978-0-662-36940-0

Fisheries and Oceans Canada. 2026. DFO Technical
Standards. 17 pp.

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Chapter 1. Installation or Replacement of Watercourse Crossings

1.0 About This Technical Standard

This standard applies to the installation or replacement of the following types of watercourse crossings within freshwater fish bearing watercourses (rivers, streams) that will require work to be completed below the ordinary high water mark:

- **Bridges**
 - Bridges are comprised of abutments and a deck and can either have instream piers or be a single span. Clear-span bridges are those whose components can completely span a watercourse.
 - Includes instream works associated with installation or replacement of a bridge that are not captured by DFO's [Code of Practice for Clear Span Bridges: Construction, Maintenance and Decommissioning](#).
- **Open bottom culverts with instream work**
 - Open bottom arch/ box culverts are built on footings and span the watercourse, maintaining the natural stream bed and hydraulics.
- **Stream simulated culverts (closed bottom culverts with stream simulation)**
 - A stream simulated culvert is a closed-bottom culvert designed (round or box) to replicate the natural characteristics and processes of the watercourse within the structure. This approach involves constructing the culvert to match the natural channel's slope, width, alignment, and substrate composition, by embedding the culvert below the streambed and placing a mix of natural materials (e.g., gravel, cobble and boulders) in the structure. The objective is to create hydraulic and physical conditions (flow depth, velocity, roughness, and sediment transport) that are consistent with the natural watercourse.
- **Backwatered culverts**
 - A backwatered culvert is a closed bottom culvert where the natural/ undisturbed downstream riffle (also called the tailwater control) backwaters the entire culvert length with adequate water depth to provide fish passage.

This standard has a wide variety of potential applications including, but not limited to, projects within transportation corridors, projects associated with pipelines, forestry and resource roads, and utilities and municipal infrastructure.

Installation of a watercourse crossing is defined as installing a new structure where one has not existed before. **Replacement** is defined as removal of an existing structure and installation of a new one in its place (e.g., larger diameter, shorter length, different slope, elevation, or embedment). Culvert replacements with a longer culvert is not part of this standard.

If the project to install or replace a bridge or culvert does not meet the description above, this standard does not apply.

This standard **excludes** watercourse crossings in the following environments:

- Marine and tidally influenced environments
- Dynamic, braided watercourses or watercourses that are contiguous to large wetlands
- The distribution area of any listed molluscs where water is present
- The critical habitat or residences of any Aquatic Species At Risk (ASAR) unless a qualified environmental professional (QEP) confirms that there are no biophysical functions, features, and attributes present as described in the species' recovery strategy.

2.0 User Guide

2.1 Engaging the Necessary Professionals

A QEP is required to support the planning, design, installation and replacement of the watercourse crossing types covered in this standard. With a combination of formal education, professional provincial or territorial designations as required, and applied experience, QEPs can ensure that fish habitat is accurately characterized. The QEP must have experience working with licensed professional engineers (P.Eng.) and other specialists to apply on site construction and monitoring approaches to ensure fish and fish habitat requirements and conditions are effectively integrated into design solutions and construction approaches.

If the QEP is not also an engineer, ensure that all engineered designs are reviewed and/or approved by a qualified professional engineer.

2.2 Additional Proponent Obligations

Standards are not intended to replace or supersede applicable engineering standards or public safety requirements. Final design decisions shall be made by qualified professionals, taking into account site-specific conditions and all applicable legislative and engineering requirements.

Standards do not remove nor replace the obligation to comply with all applicable statutory and regulatory requirements of the *Fisheries Act*, the *Species at Risk Act*, the *United Nations Declaration on the Rights of Indigenous Peoples Act* or other federal, provincial, territorial or municipal legislation and policies including guidance regarding species and habitats managed by these jurisdictions.

2.3 Obtaining Further Information

If you are constructing a temporary crossing or a clear-span bridge and its components completely span the watercourse without altering its bed or banks, even during construction, the following may apply instead of this standard:

- [Code of Practice for Temporary Fords: Crossing](#)
- [Code of Practice for Clear Span Bridges: Construction, Maintenance and Decommissioning](#)

If a Code of Practice or this standard is not applicable to your project, you may contact your DFO region's [Fish and Fish Habitat Protection Program office](#) to assist you in determining the appropriate review process.

Up to date information on all DFO standards can be found on the [Projects Near Water website](#).

2.4 Applying the Standard

Three distinct steps must be followed to apply the standard:

- (a) Identify the type of watercourse crossing that can be installed based on the site-specific information [Section 3]
- (b) Apply all of the measures when designing and installing or replacing the watercourse crossing type [Section 4], and
- (c) Provide a signed QEP attestation [Section 5].

3.0 Selection of Watercourse Crossing Type

The hierarchy of preference for watercourse crossing types is as follows:

1. Bridges
2. Open bottom arch / box culverts
3. Stream simulation culverts
4. Backwatered culverts.

To determine the allowable watercourse crossing type, the QEP must first conduct the necessary physical, biological, geomorphological, hydrological and hydraulic assessments (through desktop and field investigations) and categorize the fish habitat according to DFO guidance. This information will guide the QEP in determining the minimum watercourse crossing type that can be installed. Watercourse crossing types that are higher in the hierarchy can also be installed if they meet the established parameters in the DFO guidance.

The crossing type that can be installed under this standard when the project is a replacement will be determined according to the same hierarchy as above. At a minimum, bridges and culverts must be replaced with the same crossing type *and* length as long as the goal is to improve fish passage conditions and reduce potential pressures on the surrounding habitat.

4.0 Measures

This section outlines the measures that must be respected at the design, construction and post-construction phases of the installation or replacement of your watercourse crossing.

4.1 Design Measures

4.1.1 General Design Measures for all Crossing Types

- Ensure that the capacity of a watercourse crossing passes, at a minimum, a 1 in 100 year discharge event.
- Ensure the permanent alteration or destruction of the watercourse from installation or replacement of the crossing, below the ordinary high water mark, including abutments, piers and footings, does not exceed 250 squared metres (m²) for new installations and 150m² for replacements.

- Align crossing with the existing channel.
 - Install or replace crossing with minimal requirement to realign the stream to the inlet and/or outlet of the crossing.
 - Position the angle of approach at no less than a 45 degree angle to the watercourse.

4.1.2 Bridge Design Measures

- Size the height of the underside of the bridge to allow flood debris and ice floes to pass.
- Design abutments, wingwalls, and/or piers within the watercourse to prevent alterations to existing channel hydraulics and hydrogeomorphic processes.
 - Orient abutments, wingwalls and/or piers to prevent abrupt flow deflection and/or increase velocities.
 - Size and hydrodynamically shape the instream cross sectional area of abutments, wingwalls, and piers such that peak flood flows do not increase turbulence, bed scour or constrict the channel width or flow.
 - Position abutments, wingwalls and/or piers outside the low-flow channel (thalweg) of the watercourse.
- Armour any exposed banks of the watercourse that extend below the ordinary high water mark.
 - Key in the armour stone/ rip rap below the ordinary high water mark at the toe of slope to match the existing undisturbed stream bed.
 - Embed the armour stone/ rip rap into the bank of the watercourse to match the existing undisturbed stream banks.
- Design multi-column piers with solid web walls to prevent debris from snagging in high debris or ice prone rivers.

4.1.3 Open Bottom Arch/ Box Culvert with Instream Channel Reconstruction Design Measures

- Size the culvert to span, at a minimum, 1.2 times the bankfull width.
 - Base the calculations on the reference reach of the watercourse.
- Ensure that the water surface elevation at the peak design flow does not exceed 80% of the culvert opening (i.e., headwater depth ratio is less than 1).

- Extend the entire length of the arch or box footings below the depth of scour/ lowest vertical adjustment potential (LVAP).
- Mimic the natural features from the reference reach of the watercourse when altering the streambed or banks is necessary.
 - Use the Fuller Thompson method to appropriately size the substrate if the reference reach substrate size ranges are less than D84.
 - Match the slope of the unaltered reference reach within the altered channel bed of the culvert.
- Install large boulders in the reconstructed channel if the watercourse slope is greater than 2%.
 - Embed boulders larger or equal to 1.5 times the D100 in the reference reach at 30% of the boulder's diameter.
 - Alternate the boulders every 5 to 10 metres (m) within the bed of the channel.
- Install step pools where the slope of the reference reach is greater than 3% and less than or equal to 8%.
 - Key in the rock riffles of a step pool into both banks of the watercourse at a minimum of 1.0m.
 - Extend the rock riffles across the entire bankfull channel width perpendicular to the channel flow.
 - Embed the toe of the rock riffles below the LVAP.
 - Design the step pools where a vertical drop between rock riffles of less than or equal to 0.2m and less than or equal to 0.15m in watercourses where smelt or equivalent weaker swimmers are present.
 - Ensure the pool between the rock riffles is a minimum of 0.5m in depth.
 - Space the rock riffles at a minimum of 1.63m.
 - Grade the particle size of the rock riffles based on the reference reach, as follows:
 - D100 representing the largest armour stone;
 - D84 representing the primary armour layer; and
 - D50 representing the average size of the natural bed material or streambed mixture.
 - Include 5-10% fines in the mix with a diameter less than 80 millimetres (mm) in the particle distribution of the substrate matrix to seal the substrate and prevent interstitial flow.

- Install a low flow channel (thalweg) in the bed of the channel and in the rock riffles that matches and ties into the natural undisturbed thalweg upstream and downstream of the crossing.
- Grade any imported streambed material.
 - Use a D84 grain size distribution for imported stream bed material.
 - Include 5-10% fines with a diameter less than 80 mm in the particle distribution of the substrate matrix to seal the substrate and prevent interstitial flow.
- Fill in the existing energy dissipation pool, if present, with the same simulated stream substrate matrix.
- Reuse abandoned local stream bed material when available.
- Install the culvert footings on a firm bed (i.e., avoid wet muck, muskeg, sod, frozen earth, permafrost or large rocks).
 - Excavate soft, unsuitable foundation material below the LVAP line.
 - Backfill with granular, unfrozen compacted material to reduce settling, hydrostatic uplifting or side movements of the culvert.
- Embed the footings below the LVAP line.

4.1.4 Stream Simulated Closed Bottom Culvert Design Measures

- Size culvert to span, at a minimum, 1.2 times the bankfull width.
 - Base the calculations on the reference reach of the watercourse.
- Size rounded or ovoid culverts (at the widest point) to be larger than 1.2m in diameter and 1.2m span by 1.2m rise for box culverts.
- Ensure that the water surface elevation at the peak design flow does not exceed 80% of the culvert opening (i.e. headwater depth ratio is less than 1).
- Size the culvert length to be less than or equal to 40m.
- Slope the culvert and simulated stream bed to match the slope of the unaltered reference reach.
 - Ensure the slope of the culvert with simulated stream bed is less than or equal to 3%.
- Embed the entire length of the culvert invert below the lower LVAP line, at a minimum of 250mm embedment or at 30% (vertical rise) of the diameter of the opening of a round culvert or 30% of the height of a box culvert, whichever is greater.

- Install large boulders in the simulated bed of the culvert, if the watercourse slope is greater than 2%.
 - Embed boulders larger or equal to 1.5 times the D100 in the reference reach at 30% of the boulder's diameter.
 - Alternate the boulders every 5 to 10 m within the bed of the channel.
- Install a low flow channel (thalweg) in the bed of the channel to match and tie into the natural undisturbed thalweg upstream and downstream of the crossing.
- Import of any streambed material must be well graded.
 - Use D84 grain size distribution for the substrate matrix.
 - Ensure the substrate matrix includes 5-10% fines with a diameter of less than 80mm in the particle distribution.
- Use the Fuller Thompson method to appropriately size the substrate if the reference reach substrate size ranges are less than D84.
- Reuse abandoned local stream bed material when available.
- Fill in the existing energy dissipation pool, if present, with the same simulated stream substrate matrix.
- Install the culvert on a firm bed (i.e. avoid wet muck, muskeg, sod, frozen earth, permafrost or large rocks).
 - Excavate any soft, unsuitable foundation material below the LVAP line.
 - Backfill with granular compacted material that is not frozen.
 - Backfill with compacted granular material to reduce settling, hydrostatic uplifting or side movements of the culvert.

4.1.5 Backwatered Closed Bottom Culvert Design Measures

- Size the culvert to span, at a minimum, the bankfull width.
 - Base the calculations on the reference reach of the watercourse.
- Ensure that the water surface elevation at the peak design flow does not exceed 80% of the culvert opening (i.e. headwater depth ratio is less than 1).
- Slope the culvert to match the slope of the unaltered reference reach.
 - Ensure slope is less than 1.5%.
 - Ensure culvert length does not exceed 10m.

- Embed culvert outlet invert elevation to be 0.2 times the diameter of the culvert below the thalweg of the undisturbed first natural riffle downstream of the culvert (tailwater control).
- Embed the culvert inlet invert to match the thalweg of the first undisturbed natural riffle upstream of the culvert crossing.

4.2 Construction Measures

4.2.1 General Construction Measures for all Crossing Types

- No clearing or grubbing operations must occur within 15m of a watercourse unless installation or replacement of the crossing is to commence within 30 days.
- Carry out the project in accordance with [timing windows](#).
- Follow [in-water site isolation standard](#) if installation or replacement of the crossing, including infilling, dredging or concrete form work, is occurring below the ordinary high water mark. The site must be isolated in order to work in the dry.
- Follow [interim fish capture and relocation standard](#) if site isolation or dewatering is conducted.
- Follow [interim water intake end-of-pipe fish screens standard](#) if site isolation or dewatering are conducted.
- Follow [interim planning for land-based erosion and sediment control standard](#).
- Follow [best management practices](#) to reduce the risk of deleterious substances entering the watercourse.
- Re-vegetate the affected riparian zone with native species suitable for the project site.
- Inspect structure and surrounding area post-construction and then seasonally over a minimum of one calendar year (i.e. during spring ice break up, prior to winter freeze, heavy rains).
 - Repair the structure as required.
 - Remove any debris caught on piers or at the entrance to culverts.

4.2.2 Bridge Construction Measures

- Remove existing piers from below the ordinary high water mark two feet below the streambed or below the LVAP line, whichever elevation is lower.

- Construct temporary access road minimizing disturbance to the bed and banks of the watercourse if access from land is not possible.
 - Ensure that the total instream footprint below the ordinary high water mark for the temporary access road is less than 100m².
 - Install within no more than 1/3 of the bankfull width below the ordinary high water mark of the watercourse.
 - Cap with clean armour stone with less than 2% fines.
- Remove temporary access road immediately after use.
 - Restore riverbed and bank to preconstruction conditions.
 - Restore the bed and banks, gradient and contour affected by the project.

4.2.3 Open Bottom Arch/ Box Culvert With Instream Channel Reconstruction and Stream Simulation Culvert Construction Measures

- Key in the channel with the existing undisturbed stream banks, upstream and downstream of the crossing, to prevent scour or undermining of the culvert.
- Integrate the bed of the channel with the natural undisturbed channel without creating a constriction to flow at the inlet or outlet of the culvert or a drop at the outlet.
- Conduct a leak-tightness test prior to removing any water control measures to ensure the majority of the fines have been washed in between the rocks and water stays atop the new channel.
 - Pump water into the constructed channel and monitor the channel for leaks and seepage between the interstitial spaces of the substrate.
- Do not place fabric liners (e.g., geotextile) fabric below the ordinary high water mark.

5.0 Qualified Environmental Professional Attestation

When submitting a project for review, a QEP must attest to the following:

- The necessary physical, biological, geomorphological, hydrological and hydraulic assessments have been conducted, per DFO guidance. These assessments inform the habitat categorization and the choice of watercourse crossing type according to the process outlined in this standard.

- All general measures and watercourse crossing type design and construction measures can be applied and are integrated into plans, specification drawings and other relevant documents.
- Any other written recommendations or specifications prepared by a QEP or design engineer that the QEP considers appropriate are integrated into plans, specification drawings and other relevant documents.
- All engineered designs have been reviewed and / or approved by a qualified professional engineer.

The project is not expected to result in any impacts to aquatic species at risk, their residences, or critical habitat (as defined by the *Species at Risk Act*).

6.0 Definitions

The following definitions are to be employed for the purposes of this standard:

Abutment – A substructure that supports the ends of a bridge span such as a retaining structure, wall or crib.

Approach – The area of trail/ road surface immediately preceding a bridge [deck](#) that provides a transition from the trail/road to the bridge.

Aquatic species at risk (ASAR): Any aquatic species listed under Schedule 1 of the *Species at Risk Act* as endangered, threatened or extirpated.

Aquatic species at risk critical habitat : habitat necessary for the survival or recovery of a listed species, but only where—and to the extent—that habitat is formally identified in a recovery strategy or action plan.

Aquatic species at risk residence: Refers to a discrete structure or place used by a listed species, often involves energy investment by this species (e.g., nest building), and supports a specific life function (e.g., spawning, rearing).

Bankfull width: Bankfull width is the width of a stream channel at the stage where water fills the channel to the top of its banks before spilling onto the floodplain. It represents the active channel width associated with the bankfull discharge, which is the flow that shapes channel morphology and transports sediment. It is identified using field indicators such as breaks in bank slope, changes in vegetation, and the upper limits of depositional features. It is also an indicator of a 1 in 2 year flood flow return level.

D84: is a specific metric in sedimentology and fluvial geomorphology indicating that 84% of the sediment particles in a sample are smaller than this diameter.

D100: is the maximum size/ diameter of rock found within a specific sediment sample or riverbed.

Deleterious substance: Any substance that, if added to water, would degrade, alter, or form part of a process of degradation/alteration to the quality of that water so that it is rendered or possibly rendered deleterious to fish, fish habitat, or to the human use of fish that frequent that water. For example: fuel, lubricants, paint, primers, rust, solvents, degreasers, antifreeze, uncured concrete, foam, creosote, chlorinated water, herbicides, etc.

Deck : The flat horizontal platform which accommodates the active or travelled surface of the bridge. It usually consists of timber, concrete or metal spanning perpendicular to and connected to supporting longitudinal beams, trusses or girders.

Dimensions for bridges:

- Length (Overall/Total) - The longitudinal distance from one end of the bridge to the other measured along the decking in the direction of the traffic flow.
- Width (Overall) - The distance measured perpendicular to the travel direction laterally across the bridge, parallel to the watercourse.
- Height – the greatest perpendicular distance measured from the top of the deck to the streambed directly below the bridge.

Fuller Thompson method for substrate sizing: this method is used to calculate substrate sizing based on the reference reach and maximum size of the substrate matrix:

- $P/100 = [D/D100]^m$
Where:
- P : percentage of particles sized less than D;
- D : particle size;
- D100 : largest particle size (is also equal to $2.5 \cdot D84$);
- m : parameter that modulates the particle size distribution.
- The m value recommended range is: 0.45 and 0.7. The substrate matrix must also have a minimum of 5%-10% of fine particles with a diameter less than 80 mm.

Lowest vertical adjustment potential (LVAP): The LVAP is the lowest estimated elevation to which a streambed is expected to erode or scour over the design life of a watercourse crossing.

Ordinary high water mark: The usual or average level to which a body of water rises at its highest point and remains for sufficient time to change the characteristics of the land. In flowing waters (for example, rivers and streams) this refers to the ‘active channel/bankfull level’ which is often the 1:2 year flood flow return level. In inland lakes, wetlands or marine environments, it refers to those parts of the water body, bed, and banks that are frequently flooded by water leaving a mark on the land. It’s where the natural vegetation changes from mostly aquatic vegetation to terrestrial vegetation (excepting water tolerant species). For reservoirs, this refers to normal high operating levels (meaning, full supply level).

Pier: A substructure located between abutments used to transfer superstructure loads from the spans it supports to the foundation.

Qualified environmental professional (QEP): A person experienced in identifying and analyzing risks to fish and fish habitat generated from various works, undertakings or activities conducted in or near water, and implementing management measures to avoid and mitigate those risks. They possess a post-secondary degree or diploma in biological, geophysical or environmental sciences and are referred to as:

- aquatic scientists
- aquatic biologists
- environmental consultants
- fisheries biologist
- fisheries technicians
- fluvial geomorphologists
- natural resource consultants

Reference reach: Is the location of the work to be completed. If works are to be completed on an existing watercourse crossing and assessment of the crossing location cannot be completed, at least one natural, unaltered reach (not separated by major tributaries) that reflects the characteristics of the proposed crossing location is identified to serve as a template. The longitudinal profile of the reference reach is to:

- Extend 150m upstream and downstream from the centre line of a proposed watercourse crossing right of way (ROW); or
- Extend 100m upstream and downstream from the zone of influence of an existing crossing.
- Cross sectional measurements of the watercourse are to be taken a minimum of 3 times, in 3 separate locations along the footprint of a new crossing; and

- At least once upstream and downstream at the existing or proposed crossing location (once within the zone of influence and then once more outside of the zone of influence).
- Elevations are to be taken in the deepest part of the stream bed (thalweg).

Riparian vegetation: Occurs adjacent to the water body and directly contributes to fish habitat by providing shade, cover and areas for spawning and food production.

Riparian zone: Area located between a watercourse or water body's ordinary high water mark and upland area. The width of the riparian zone may be further defined by provincial, territorial or municipal regulations or guidelines.

Transportation corridor: a designated, continuous, linear tract of land and its associated infrastructure, including but not limited to, roadways, railways, and utility rights-of-way. This includes all integrated watercourse crossings (such as bridges, culverts, and causeways), managed as a single asset network for the movement of persons, goods, and services.

Wingwall: a reinforced retaining structure that extends outward from the main abutments (the supports at the ends of a bridge). Its primary purpose is to hold back and stabilize the approach roadway embankment, while also guiding water flow beneath the bridge to prevent soil erosion.

Zone of influence: The area upstream and downstream of a watercourse crossing that has been unnaturally altered due to the existing crossing. The observed elevation, depth, and width of the watercourse in this immediate area is not representative of the natural watercourse conditions.