MODULE 8: INSTALLATION OF AN OPEN-BOTTOM CULVERT AND BRIDGE CONSTRUCTION TIER REVIEW APPROACH

TIER 1 (5-day review)

- **New open-bottom culverts** (max length 25 m, max drainage area 20 km^2)
- **Replacing open-bottom culverts** (max length 30 m, max drainage area 20 km^2)
- **Replacing a closed-bottom culvert with an open-bottom culvert or bridge** (max length for culvert 30 m, max drainage area 20 km^2)
- **Removing (decommissioning) open-bottom culverts and bridges**
- **Temporary bridge over a watercourse or wetland**
- **Temporary wetland crossing** (footprint less than 100 sq. m)

TIER 3 (requires a standard WAWA permit)

- Any crossing not sized for the 1 in 100-year flood event
- Constructing a bridge with instream support(s)
- Any alterations resulting in a permanent wetland impact greater than 100 sq. m
- Any alterations in and within 30 m of a provincially significant wetland (PSW)
- Any alterations within a designated watershed or wellfield used as a source for public water supply
- Replacing an open-bottom culvert where there is an aquatic species (or habitat) at risk under the ***Species at Risk Act*** where there is a reduction of end-area or extension of infrastructure footprint
- Any other activity not approved under Tier 1 or exceeding the guidelines

8.0 INSTALLATION OF AN OPEN-BOTTOM CULVERT AND BRIDGE CONSTRUCTION

Open-bottom culverts and bridges are the preferred crossing structures for fish passage simply because the natural stream bed is maintained. These structures are not constrained by watercourse gradient and choosing one of these options will expedite the approval process as less review is required.

8.1 OPEN-BOTTOM CULVERTS

A properly sized culvert should not impede fish passage, increase the velocity of the stream flow, or alter the aquatic habitat. In situations where the span of an open-bottom culvert is inadequate, thereby constricting the flow, the increase in stream flow velocity may result in stream bed scour and/or undermining of the footings, potentially causing the structure to fail.

8.1.1 Basic Standards

The following steps should be followed to determine the minimum waterway opening required under an open-bottom culvert for the stream flow to pass through.

- A properly sized culvert must have the capacity to accommodate a 1 in 100-year runoff event. This does not mean it will occur only once in every 100 years. It means that there is a one percent probability of such an event occurring in any given year.
- All instream (*i.e.* below the bankfull width of a watercourse, whether wetted or not) work must be carried out in isolation of the stream flow.
- Open-bottom culverts must have a minimum span of 1.2 metre (4 ft).
- The maximum length permitted for all types of **new** culvert installations is 25 metres (82 ft). **Note**: The realignment of a stream beyond the upstream and downstream control riffles (see Section 7.4 *Fish Passage*) is not permitted under the Watercourse Alteration Certification Program. In addition, the control riffles must not be altered in any way. If this criterion cannot be met, an application for a standard watercourse and wetland alteration permit must be made using the online application program.

8.2 OPEN-BOTTOM CULVERT SIZING

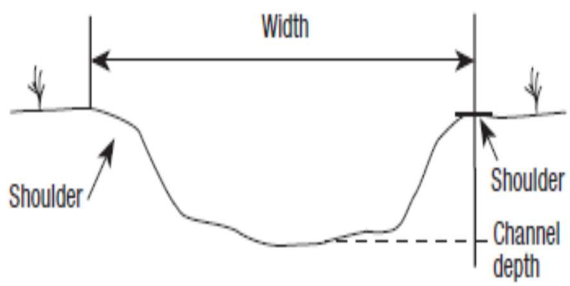
Maximum Design Velocity is the maximum stream flow velocity a bridge or open-bottom culvert can withstand without shortening the life of the structure.

Waterway Opening (a) is the cross-sectional area of an open-bottom culvert throughout which the stream flow can pass through, also known as the end area.

The first step in determining the proper size of an open-bottom culvert is to calculate the minimum span required by using the following formula. See Figure 8-1 and Example 8-1.

Minimum Span = (1.2 x width of channel*) + 0.6 m
*shoulder to shoulder (bankfull) width (see Section 1.3.5 *Determining Channel Width*)

Figure 8-1 Watercourse channel cross-section



EXAMPLE 8-1
CALCULATING MINIMUM OPEN-BOTTOM CULVERT SPAN

What is the minimum span required for an open-bottom culvert if the shoulder to shoulder width of the watercourse is 1.8 metre?

Span = (1.2 x width of channel) + 0.6 m
= (1.2 x 1.8 m) + 0.6 m = 2.76 m
= 2.76 m x 1000
= 2760 mm

The minimum span required for an open-bottom culvert is 2760 millimetres.

With the minimum span calculated on site, the next step is to determine the minimum waterway opening (m^2) required to accommodate the 1 in 100-year runoff event.

The maximum acceptable flow velocity through open-bottom culverts is 3 m/sec (9.8 ft/sec). If the velocity at which a 1 in 100-year runoff event design is going to flow through the structure exceeds this limit, the end area of the open-bottom culvert must be increased.

Determine the minimum waterway opening by calculating design flow (see Section 7.3.1 *Calculating Diameter: Parameters*) and divide by the maximum velocity of 3 m/sec. See Example 8-2.

EXAMPLE 8-2
CALCULATING SIZE OF OPEN-BOTTOM CULVERT BY CONFIRMING MINIMUM WATERWAY OPENING

What is the minimum waterway opening required for an open-bottom culvert with a calculated design flow of 4.5 m^3/sec?

$$\text{Waterway Opening } (m^2) = \frac{4.5\ m^3/sec}{3.0\ m/sec}$$

$$= 1.5\ m^2$$

Manufacturer's open-bottom arch sizes are often listed as rise x span along with corresponding end area (m^2) for each size. There are multiple options to customize the dimensions of the open-bottom culvert to a specific site. Use this information to locate sizing options using 1.5 m^2 as your minimum waterway opening size. Keep in mind that the span must also be 1.2 times the bankfull width.

Another way to confirm the size of an open-bottom culvert is to calculate the velocity (m/sec) through the site in the event of a 1 in 100-year runoff event:

$$\textbf{Flow velocity (v)} = \frac{\textbf{Design Flow (Q)}}{\textbf{Waterway Opening (a)}}$$

If the result in the flow velocity calculation is a value higher than the max acceptable velocity of 3 m/sec, then the waterway opening must be made larger.

CALCULATING DESIGN FLOW

To calculate the design flow (Q), you must first determine the drainage area. See *Section 7.3.1 Calculating Diameter: Parameters for the steps in determining the drainage area.*

Bolted corrugated steel sheets or structural plate arches used in the construction of bridges or other open-bottom structures must meet the requirements of CSA G401-14 Corrugated Steel Pipe Products. If the manufacturer has not designed the structure, it must be designed, and the plans stamped by a professional engineer licensed to practice in New Brunswick.

8.3 OPEN-BOTTOM CULVERT INSTALLATION

The steps for installing an open-bottom culvert have been separated into the following categories:

- Timing of Installation
- Environmental Considerations
- General Practices
- Working in Isolation of the Stream Flow
- Installation
- Stabilization
- Road Approaches
- Replacing a Closed-Bottom Culvert with an Open-Bottom Culvert

8.3.1 Timing of Installation

All open-bottom culvert installations must be carried out between June 1st and September 30th of the same year, preferably during low flow conditions. The construction should proceed diligently to help prevent any unnecessary environmental problems and minimize impacts to fish.

Note: Longer projects benefit from water-control methods which provide fish passage (*e.g.* a diversion channel).

Work and project extensions outside of this window will not be approved through the Watercourse Alteration Certification Program. If there are unforeseen issues that prevent the project from being completed prior to the September 30th deadline, DELG should be contacted as soon as possible to discuss next steps.

8.3.2 Environmental Considerations

Erosion/sedimentation and fish passage are two of the environmental issues that must be addressed with this type of structure. An open-bottom culvert avoids the requirement for fish passage facilities provided it is installed such that the structure, including the footings, is landward of the shoulders of the banks of the watercourse. See Figure 8-2.

The pre-construction stability of the banks and bed of the watercourse is a concern and must be considered during installation.

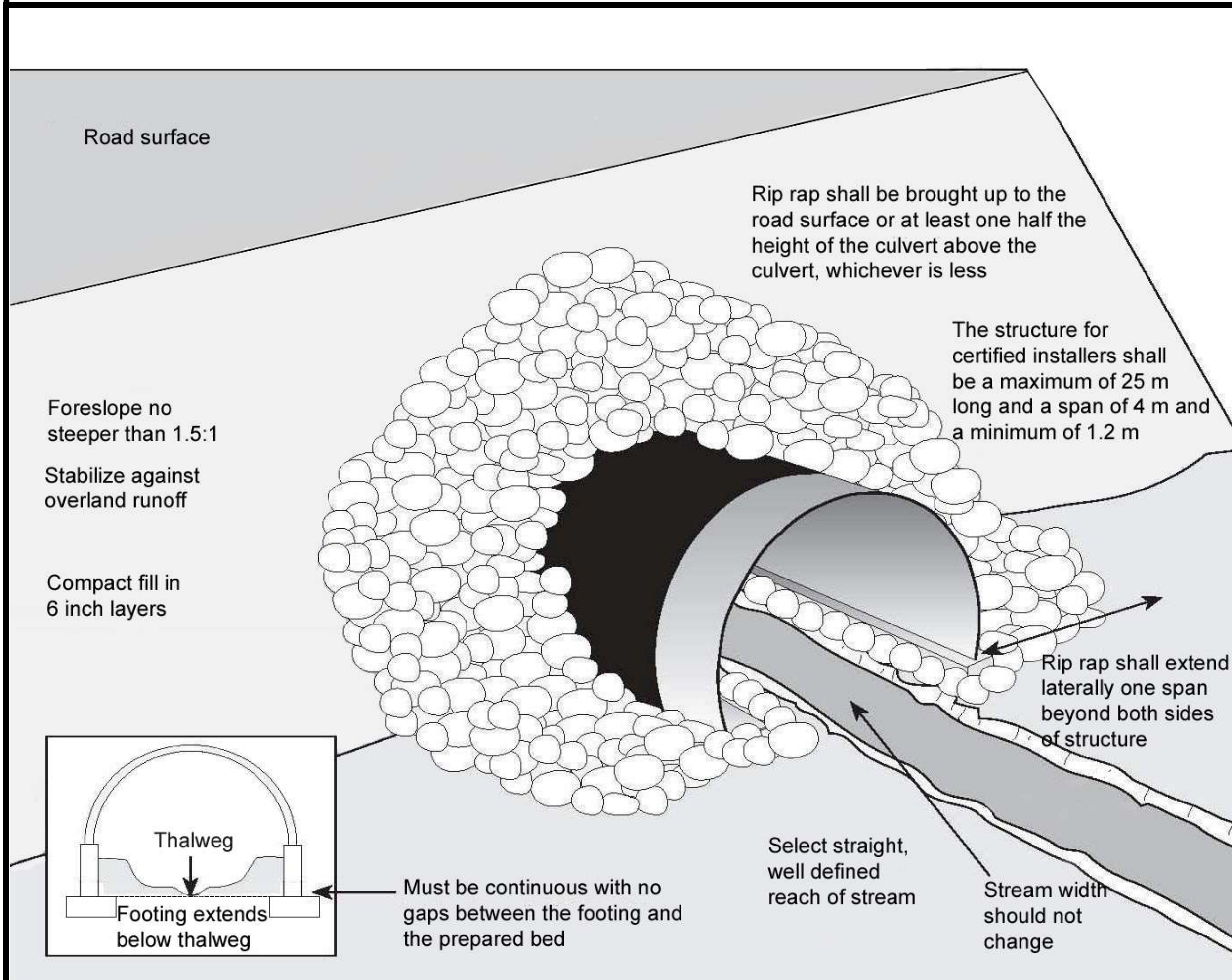
This type of structure is less likely to be dammed by beavers than closed-bottom culverts.

8.3.3 General Practices

The realignment of a stream beyond the upstream and downstream control riffles (see Section 7.4 *Fish Passage*) is not permitted under the Watercourse Alteration Certification Program. In addition, the control riffles must not be altered in any way. If this criterion cannot be met, an application for a standard watercourse and wetland alteration permit must be made using the online application program.

The span of an open-bottom culvert must be at least 1.2 metre (4 ft).

Figure 8-2 Open-bottom culvert – new installation



The following must be followed when using machinery in or near a watercourse.

- A backhoe or an excavator must be used to prepare a firm bed for the placement of the structure
- All work must be carried out with machinery stationed outside the wetted portion of the channel (fording is not permitted)
- Machinery must be in good working order and must not be leaking any fuel, lubricants, or hydraulic fluid and must be cleaned/degreased to prevent any deleterious substance from contaminating the wetland and to help minimize the spread of invasive plant species
- Machinery must not be washed/refueled in or near a watercourse/wetland; this practice is not limited to the crossing site but anywhere that contaminated overland runoff seeps or drains into a watercourse/wetland

Prior to the culvert being installed, if machinery must cross the watercourse, it must do so using a temporary or portable bridge that completely spans the channel to minimize the potential for erosion and sedimentation. See Section 8.10 *Temporary Bridges* for the associated guidelines. Machinery must not ford a watercourse at any time during the installation, replacement, or maintenance of watercourse crossings.

Clearing and grubbing activities within 30 metres (100 ft) of the watercourse must be limited to the footprint on the approaches and the roadside ditches (if included). Clearing activities may occur prior to June 1st (to avoid the nesting season) if all other applicable federal and provincial requirements are met. Grubbing shall not take place until construction of the crossing is ready to begin

8.3.4 <u>Working in Isolation of the Stream Flow</u>

All activities in the wetted footprint of the channel must be carried out in isolation of the stream flow.

When working in a watercourse, it is necessary to isolate the work site from the stream flow to reduce the impact of silt and fine particulate matter on fish and their habitat. Effective techniques of water control include using cofferdams in combination with a pump-around system and temporary diversion channels. See Section 6.1 *Water Control Measures when Working in a Watercourse* for more details.

8.3.5 <u>Installation</u>

Prefabricated structures must be installed using machinery that can lift the components into place. Prefabricated structures must not be dragged across a watercourse into position.

The crossing must be installed over a reach of stream channel that is relatively straight and well defined.

Open-bottom culverts must be founded on continuous footings/stem walls. The footings must be placed on a compacted bed of gravel to provide uniform support. The footings may be steel, concrete, rigid plastic, wood that is rot-resistant such as hemlock and tamarack, or other materials that will provide adequate support of the structure.

The footings must be buried below the thalweg such that the base of the footing is below the possible depth of scour. Otherwise, the foundation must be designed by a professional engineer licensed to practice in New Brunswick.

All backfill material over the footing or against the channel side of the stem wall must be capped with rock without constricting the channel.

The height of cover and compaction around the structure must be in accordance with the manufacturer's specifications.

8.3.6 Stabilization

Rip-rap and/or a headwall must extend along the foreslope on both sides of the structure at least one span width. Erosion protection must also extend up to the shoulder of the road or half the rise above the top of the arch, whichever is less. If the rip-rap does not extend up to the road shoulder, the remainder of the foreslopes above the rip-rap must be no steeper than 1.5 horizontal to 1 vertical and must be stabilized against surface runoff. *See* Figure 8-3*.*

The following information is specific to each stabilization technique.

Rip-rap

Rip-rap is defined as durable broken rock, cobble or boulders placed over exposed soil to provide an erosion-resistant cover.

- Rip-rap must be clean, durable, non-ore-bearing, and non-toxic rock, and must not be obtained from a watercourse nor from within 30 metres (100 ft) of a watercourse/wetland.
- Rip-rap must be irregular in shape, with at least 70% of the material having a smallest dimension of not less than 15 centimetres (6 in).
- The foreslopes the rip-rap is to be placed on must be no steeper than 1.5 horizontal to 1 vertical.
- The minimum thickness of the layer of rip-rap must be 1.33 times the maximum rock size used.
- Rip-rap must be placed with machinery capable of controlling its placement and must not be dumped or pushed over the shoulder of the foreslope.

Headwalls

Headwalls are vertical walls that are aligned parallel to the roadway and tied into the slopes of the road embankment. Headwalls may be used alone or in conjunction with rip-rap. Headwalls are an effective means of achieving the desired road width, where factors are limiting the length of the culvert.

Headwalls are designed to:

- Retain the roadway embankment preventing fill material from entering the watercourse
- Anchor the culvert against potential buoyancy or uplifting
- Provide support to the culvert inlet and outlet to help maintain the shape and waterway opening of the culvert
- Increase the hydraulic efficiency of the culvert
- Prevent saturation of the backfill

When constructing headwalls:

- Excavate the location for the headwalls below the anticipated depth of scour
- Use squared timber, concrete, steel, gabions, etc. to construct the structure
- Tie the headwalls into the foreslope for stability

Wingwalls

Wingwalls are lateral walls similar to headwalls except that they extend upstream and downstream from the outside corners of the headwalls at an oblique angle to the road embankment.

The information listed in the headwalls section also applies to the construction of wingwalls.

8.3.7 Road Approaches

Road approaches should be straight and stable with a minimal slope for 30 metres (100 ft) on both sides of the watercourse crossing.

Locate off-takes or cross-drainage culverts at least 30 metres (100 ft) from watercourses/wetlands. If the topography permits, construct off-take ditches on both sides of the road.

Where property ownership allows, roadside ditches must end at least 30 metres (100 ft) from watercourses/wetlands and water directed through an off-take ditch. Ditches must never discharge directly into a watercourse/wetland.

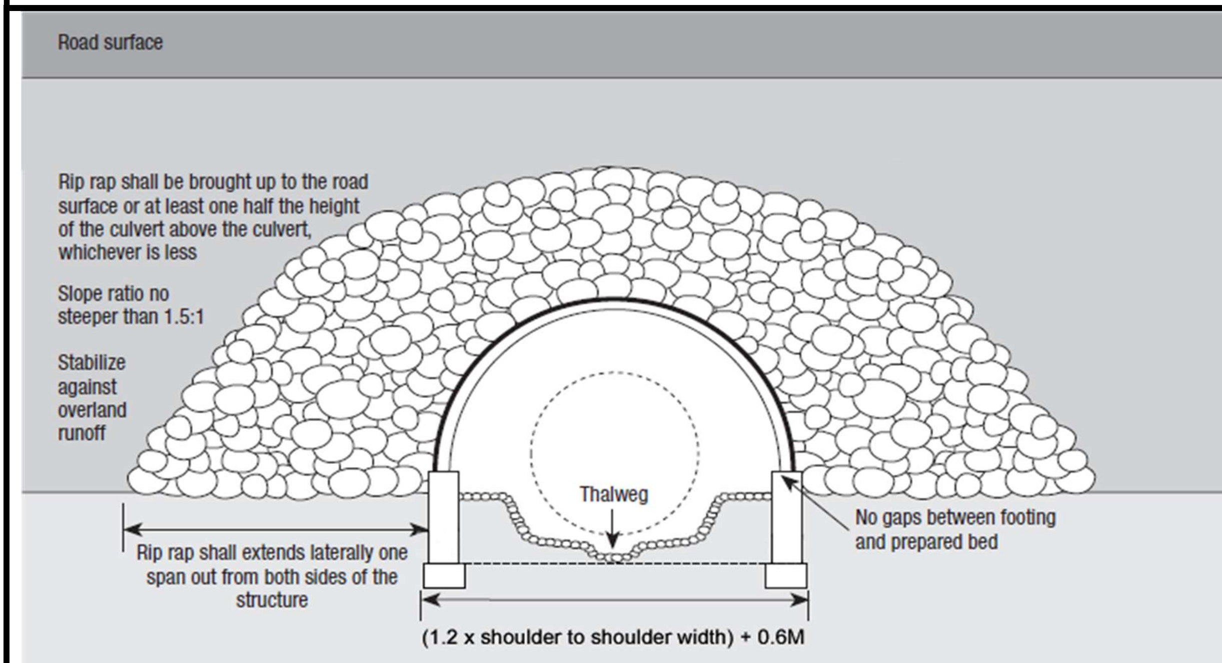
Clearing and grubbing activities within 30 metres (100 ft) of the watercourse must be limited to the footprint on the approaches and the roadside ditches (if included). Clearing activities may occur prior to June 1st (to avoid the nesting season) if all other applicable federal and provincial requirements are met. Grubbing shall not take place until construction of the crossing is ready to begin.

8.3.8 Replacing a Closed-Bottom Culvert with an Open-Bottom Culvert

In addition to the guidelines in Section 8.3 *Open-Bottom Culvert Installation*, the following guidelines must be followed.

When replacing a culvert, the length of the new culvert must not exceed 30 metres (100 ft).

Figure 8-3 Open-bottom culvert – replacement



The reconstructed channel must be restored to its natural grades and to the cross-section immediately upstream and downstream of the altered area (*i.e.* a reference reach outside of the impacted zone). See Figure 8-3.

The substrate in the new channel should be a mix consisting of rock that mimics what is present naturally in the watercourse or should use reclaimed stream bed material.

The new stream bed mix should have a wide range of particle sized and must include enough silts and fines (particles less than 2 mm in diameter) to fill interstitial spaces and create an impermeable surface. Fines should be washed into the stream bed with a hose until the water runs clear. If subsurface flow is still evident then more fines and washing may be required.

Small particle sizes are of critical importance for stream bed mixes as a lack of these fines can cause water to flow below the surface of the new channel. It should never be assumed that sediment will be transported from upstream to plug the stream bed as this process could take years.

8.4 BRIDGES VERSUS CLOSED-BOTTOM CULVERTS

8.4.1 Environmental Considerations

Bridges are the preferred watercourse crossing type from an environmental and fisheries standpoint for the following reasons:

- Bridges retain the natural stream bed
- Bridges maintain the cross-sectional area of the channel, therefore maintaining the natural flow regime
- Bridges rarely provide a barrier to fish passage
- Bridge construction requires less instream activity, therefore minimizing the potential for environmental impacts

8.4.2 Crossing Location Considerations

Generally, bridges should be chosen over culverts in areas where any of the following situations are encountered.

- The water is too deep to install a culvert efficiently
- The stream banks are high, requiring a large amount of cover material over the culvert
- The stream bed is soft and unable to support a culvert
- The crossing site contains valued fish habitat (pools, spawning areas, riffles, etc.)
- The watercourse is subject to rapid runoff, ice blockages, or debris dams, which may cause structural failure to a culvert and impede fish passage
- Beaver activity is a significant concern

8.5 PERMANENT BRIDGES

A bridge is defined as a structure built over a watercourse, the deck of which forms a link in the road, footpath, or railbed.

8.5.1 Basic Standards

The Watercourse Alteration Certification Program allows for the construction of bridges that completely span the channel only. The program does **not** permit the construction of multiple span bridges or bridges requiring any instream supports. For these types of structures, an application for a standard watercourse and wetland alteration permit must be made using the online application program.

Single span bridge construction must comply with the following guidelines.

- A properly sized bridge must have the capacity to accommodate a 1 in 100-year runoff event. This does not mean it will occur only once in every 100 years. It means that there is a one percent probability of such an event occurring in any given year.
- Bridges must be designed such that the velocity of the stream flow through the structure at a peak flow of this magnitude does not exceed 3 m/sec (9.8 ft/sec).
- All work in the wetted portion of the watercourse work shall be isolated from the stream flow with cofferdam(s) such that there is an unobstructed area maintained throughout the construction that is of sufficient width to allow for fish passage and water flow. A good practice is to leave at least two-thirds of the channel unobstructed at all times. The height of the cofferdam(s) shall be sufficient so that it does not get overtopped during heavy rain or sudden high-water event. The bridge must cross the watercourse where the channel is straightest and narrowest, and the banks are stable. **Note**: During the construction of a new bridge, the realignment of a stream to ensure a 90-degree crossing or to straighten or alter the stream channel in any way is not permitted under the Watercourse Alteration Certification Program. If a stream realignment is being proposed, an application for a standard watercourse and wetland alteration permit must be made using the online application program.
- The abutments must be situated landward of the shoulder of the banks of the watercourse and aligned so as not to cause the flow to be directed into the banks of the watercourse.
- The base of the abutments must be set below the thalweg such that the base is below the possible depth of scour, or otherwise protected from scour by locating the abutments outside the expected high-water line and armoring them appropriately.
- The rise (distance from the stream bed to the underside of stringers) of bridges must provide sufficient clearance for ice flows, debris, and navigation (in compliance with the ***Canadian Navigable Waters Act***).

8.6 BRIDGE MATERIAL

Acceptable materials for constructing bridges include wood, concrete, or steel.

When using these materials in bridge construction, see Section 6.4 *Materials Used in and Near Watercourses and Wetlands* for more details.

8.7 BRIDGE SIZING

A properly sized bridge should not impede fish passage, increase the velocity of the stream flow, or alter the aquatic habitat. In situations where the span of a bridge is inadequate, thereby constricting the flow, the increase in stream flow velocity may result in stream bed scour and undermining of the abutments, potentially causing the bridge to fail.

Use the following steps to determine the minimum waterway opening required under a bridge for the stream flow to pass through.

- Calculate the design flow. To calculate the design flow, you must first determine the drainage area. See Section 7.3.1 *Calculating Diameter: Parameters* for the steps in determining the drainage area.
- Divide the design flow by 3 m/sec (9.8 ft/sec) to determine the minimum waterway opening required.

8.7.1 Calculating the Design Flow

Bridges must be designed with a hydraulic capacity large enough to pass a 1 in a 100-year runoff event.

Design flow is calculated using the drainage area as follows:

A = Drainage area upstream of the crossing location

Q = Design flow

For Drainage Areas ≤ 20 km^2 (8 mi^2)

Q (m^3/sec) = 1.64 A
Q (ft^3/sec) = 150 A

Once the design flow has been determined, calculate the minimum opening required under the bridge using the dimensions of the channel at the crossing location.

8.7.2 Calculating the Waterway Opening

The waterway opening represents the space (end area) that is available for the watercourse to pass under a bridge. This space is broken down into two rectangle parts. See Figure 8.4.

Part one is the large rectangle-shaped area above the top of the bank. See Figure 8-4. If a significant storm event occurs, this area will serve as overflow space, while also allowing large debris to pass through. Calculating the area (m^2 or ft^2) for this rectangle is completed by multiplying rise by span.

Rise (R) is the distance from the top of the stream bank to the underside of the stringers.

Span (S) is the horizontal distance between the stream side face of the abutments.

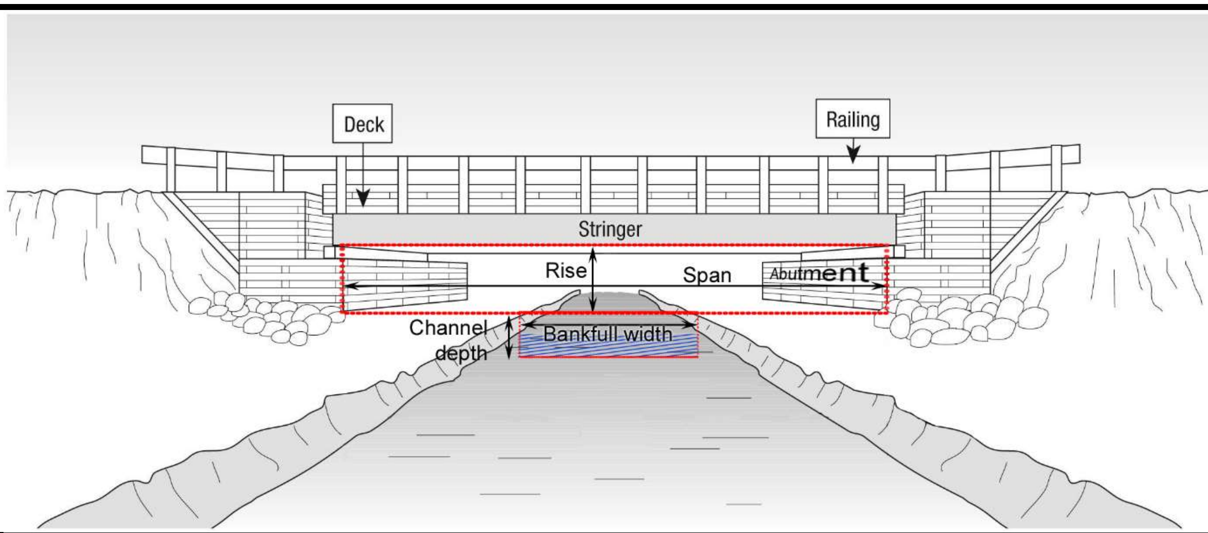
Part two is the smaller rectangle-shaped area representing the open end area of the watercourse. See Figure 8-4. Calculating the area (m^2 or ft^2) for this rectangle is completed by multiplying channel depth by bankfull width.

Channel Depth (CD) is the distance from the top of the bank to the bottom of the channel (thalweg).

Bankfull Width (BFW) is the distance from the watercourse edge on one side to the watercourse edge on the other side.

The addition of these two rectangle parts equals the total waterway opening. See Example 8-3.

Figure 8-4 Parameters for calculating the waterway opening of a bridge



The formula for calculating the waterway opening is:

Waterway Opening (a) = (Rise (R) x Span (S)) + (Channel Depth (CD) x Bankfull Width (BFW))

8.7.3 Verifying Bridge Size – Does it Meet the Requirements?

The maximum acceptable design flow velocity under a bridge is 3 m/sec (9.8 ft/sec). If the maximum velocity exceeds this acceptable limit, the waterway opening of the bridge must be increased.

Maximum Design Flow Velocity is the maximum flow velocity a bridge can withstand without reducing the life of the structure.

The formula for calculating the flow velocity is:

$$\text{Flow velocity} = \frac{\text{Design Flow (Q)}}{\text{Waterway Opening (a)}}$$

In Example 8-3, the calculations determine if the waterway opening under a proposed bridge provides the adequate hydraulic capacity to pass a 1 in 100-year runoff event. However, this may not be the minimum span required for the structure.

Before finalizing the bridge design, the following must be factored in:

- The waterway opening must provide sufficient clearance to prevent ice blockage
- The rise (height) must provide sufficient clearance to keep the roadbed from being overtopped by floodwaters
- Where required, the rise (height) must provide sufficient clearance for navigation at all stages of flow. A minimum height of 120 centimetres (48 in) above the high-water mark is suggested.

EXAMPLE 8-3
CALCULATING DESIGN FLOW VELOCITY

What is the flow velocity for a site with a calculated design flow of 56.5 m^3/sec? The proposed bridge has a span of 8.0 m and a rise of 4.0 m. The watercourse channel has a bankfull width (BFW) of 4.0 m and a channel depth (CD) of 1.2 m.

Waterway Opening (a)	= Rise x Span		= CD x BFW
	= 8 m x 4 m	+	= 4 m x 1.2 m
	= 32 m^2		= 4.8 m^2

Waterway Opening (a) = 32 m^2 + 4.8 m^2

= 36.8 m^2

Flow velocity (m/sec) $= \frac{\text{Design Flow (Q)}}{\text{Waterway Opening (a)}}$

$= \frac{56.5\ m^3/sec}{36.8\ m^2}$

= 1.53 m/sec

The flow velocity is 1.53 m/sec.

If the bridge design does not meet the required hydraulic capacity or any of the preceding factors haven't been accounted for at the proposed crossing location, the waterway opening must be increased by adjusting either the rise or the span. In cases where the waterway opening under the bridge must be increased dramatically, the cost of the required structure may suggest choosing another crossing location.

8.7.4 Bridge Length

Under the Watercourse Alteration Certification Program, the following applies when determining the length of the bridge:

- The abutments must be situated landward of the shoulder of the banks of the watercourse and aligned so as not to cause the flow to be directed into the banks of the watercourse
- The bridge design must not include piers or other instream intermediate structural supports

8.8 BRIDGE CONSTRUCTION

The steps for constructing a bridge have been separated into the following categories. Information on each of these categories and their associated guidelines is provided below.

- Timing of Construction
- General Practices
- Working in Isolation of the Stream Flow
- Constructing Bridge Abutments
- Constructing a Bridge
- Protecting the Bridge Abutments
- Road Approaches

8.8.1 Timing of Construction

All instream (*i.e.* below the bankfull width of a watercourse, whether wetted or not) work, including the construction of the abutments, must be carried out between June 1st and September 30th of each year, preferably during low water conditions. Construction should proceed diligently to help minimize any unnecessary environmental problems.

Work and project extensions outside of this window will not be approved through the Watercourse Alteration Certification Program. If there are unforeseen issues that prevent the project from being completed prior to the September 30th deadline, DELG should be contacted as soon as possible to discuss next steps.

8.8.2 General Practices

The following must be followed when using machinery in or near a watercourse.

- All work must be carried out with machinery stationed outside the wetted portion of the channel (fording is not permitted)
- Machinery must be in good working order and must not be leaking any fuel, lubricants, or hydraulic fluid and must be cleaned/degreased to prevent any

deleterious substance from contaminating the wetland and to help minimize the spread of invasive plant species
- Machinery must not be washed/refueled in or near a watercourse/wetland; this practice is not limited to the crossing site but anywhere that contaminated overland runoff seeps or drains into a watercourse/wetland

Prior to the bridge being constructed, if machinery must cross the watercourse, it must do so using a temporary or portable bridge that completely spans the channel to minimize the potential for erosion and sedimentation. See Section 8.10 *Temporary Bridges* for the associated guidelines. Machinery must not ford a watercourse at any time during the installation, replacement, and maintenance of watercourse crossings.

Clearing and grubbing activities within 30 metres (100 ft) of the watercourse must be limited to the footprint on the approaches and the roadside ditches (if included). Clearing activities may occur prior to June 1st (to avoid the nesting season) if all other applicable federal and provincial requirements are met. Grubbing shall not take place until construction of the crossing is ready to begin.

8.8.3 Working in Isolation of the Stream Flow

All activities in the wetted portion of the channel must be carried out in isolation of the stream flow. See Section 6.1 *Water Control Measures when Working in a Watercourse* for more details.

8.8.4 Constructing Bridge Abutments

Abutments are the component of the bridge that the stringers are founded on, which also retain and help protect the banks of the watercourse from the pressure of the traffic using the bridge. Abutments are generally constructed from concrete, wood, steel, or aluminum.

Acceptable types of abutments include:

- Pre-manufactured galvanized steel abutment
- Cast-in-place concrete
- Squared timber crib
- Pre-cast concrete or other earth retaining products designed specifically for abutments

The following guidelines must be followed when constructing bridge abutments:

- The abutments must be situated landward of the shoulder of the banks of the watercourse and aligned so as not to cause the flow to be directed into the banks of the watercourse

- Set the base of the abutments below the thalweg such that the base is below the possible depth of scour, or otherwise protected from scour by locating the abutments outside the expected high-water line and armoring them appropriately.
- Use clean backfill material that is uniformly graded, free-draining, or pit run gravel, which allows for good compaction
- Ideally, complete construction of one abutment before starting to construct the other one

Prepare the foundation, using the following procedure:

- Excavate the footprint for the abutment below the possible depth of scour
  - If firm material is being removed, excavate to a minimum depth of 30 centimetres (12 in) below the thalweg of the stream bed
  - If soft material is being removed, excavate to solid ground
- Where an abutment will not be founded on bedrock, level the base of the excavation with a minimum of 15 centimetres (6 in) thick layer of well-compacted gravel

8.8.5 Constructing a Bridge

Before construction commences, ensure the site is isolated from stream flow. See Section 6.1 *Water Control Measures when Working in a Watercourse* for more details.

Note: This section contains general guidelines on the construction of a bridge. Other methods may be acceptable following the review of design plans by the New Brunswick Department of Environment and Local Government.

Place a sill (bearing plate) inside the completed abutments parallel to the top face timber (panel). The timber sills (bearing plate) or concrete pads support the end of the stringers.

Place butt plates behind the sills to allow for proper backfilling of the road approach and to prevent the stringers from sliding off the sills.

Span the abutments with stringers that are aligned with the approaches.

Place cross-decking perpendicular to the stringers. The cross-decking should overhang the outside of the stringers equally on both sides of the bridge.

If placing travel planking or wheel runs, they should be perpendicular to the cross-decking to protect the deck from wear.

- Travel planking should be wide enough and spaced the proper distance to accommodate any vehicle that will be travelling across the bridge.

Place curbing and guide rails along both sides of the bridge as a guide to traffic.

8.8.6 Protecting the Bridge Abutments

The upstream and downstream corners of the bridge abutments must be stabilized using either rip-rap or wingwalls to help protect them from scouring or undermining.

Rip-rap

Rip-rap is defined as durable broken rock, cobbles or boulders placed over exposed soil to provide an erosion-resistant cover.

- Rip-rap must be clean, durable, non-ore-bearing, and non-toxic rock, and must not be obtained from a watercourse nor from within 30 metres (100 ft) of a watercourse/wetland.
- Rip-rap must be irregular in shape, with at least 70% of the material having the smallest dimension of not less than 15 centimetres (6 in).
- Rip-rap must be placed around the corners of the bridge but must not encroach beyond the toe of the present-day bank of the watercourse and must not cover any of the exposed mineral/organic soil substrate.
- The foreslopes the rip-rap is to be placed on must be no steeper than 1.5 horizontal to 1 vertical.
- The minimum thickness of the layer of rip-rap must be 1.33 times the maximum rock size used.
- Rip-rap must be placed with machinery capable of controlling its placement and must not be dumped or pushed over the shoulder of the foreslope.

Wingwalls

Wingwalls are lateral walls that extend obliquely from the upstream and downstream corners of the abutments providing erosion protection, bank stabilization and structural integrity.

To construct wingwalls:

- Excavate the footprint for the wingwalls below the anticipated depth of scour to approximately the same depth the base of the abutments is set at
- Use tiebacks to hold wingwalls in place
- As a minimum, wingwalls must be constructed to the height of the shoulder of the banks of the watercourse

8.8.7 Road Approaches

The top of the bridge should be slightly higher than the level of the approaches to allow floodwater to overtop the road rather than damage the bridge.

For additional information with regards to road approaches, see Section 7.8.6 *Road Approaches*.

8.9 REPLACING BRIDGES

The following sections provide guidelines on replacing a single-span bridge.

8.9.1 Replacing a Closed-Bottom Culvert with a Bridge

When replacing a closed-bottom culvert with a bridge, the guidelines for permanent bridge construction must be followed, in addition to the guidelines of reconstructing a channel. See Section 8.3.8 *Replacing a Closed-Bottom Culvert with an Open-Bottom Culvert*.

8.9.2 Replacing the Decking of a Bridge

The replacement of a deck on a bridge is not considered an “alteration” and therefore, does not require a watercourse and wetland alteration permit, provided the following conditions can be met:

- The stringers of the bridge must not be altered
- The only components of the structure being replaced are the cross-decking, travel planking, curbing, posts for signage, and/or guide rails
- No debris must be allowed to fall into the water
- No machinery must enter a wetland or the wetted portion of the watercourse

Placing a temporary superstructure over an existing watercourse crossing is not considered re-decking. This activity is only permitted if the following can be met:

- The new superstructure must be temporary and only stay in place for one season; **it must be removed before the next freshet**
- The pre-existing structure must be able to accommodate a 1 in 2-year runoff event

An application for a Watercourse and Wetland Alteration for bridge maintenance must be submitted through the online application system for this activity.

8.10 TEMPORARY BRIDGES

Temporary bridges are either pre-fabricated structures or structures fabricated on-site that provides access across the watercourse for a limited period of time. They are generally used to either:

- Provide the machinery with access across a watercourse while a permanent crossing structure is being constructed
- Provide temporary access across a watercourse for short term use

Note: Although most modular panel bridges are temporary in nature, the guidelines for a permanent bridge should be followed as these structures will likely be in place over the freshet season(s) before a permanent bridge is constructed. See Sections 8.5 to 8.8 for more information.

The steps for constructing a temporary bridge have been separated into the following categories:

- General Practices
- Temporary Bridge Construction

8.10.1 General Practices

Under the Watercourse Alteration Certification Program, temporary bridges are not permitted in a wetland or in or within 30 metres (100 ft) of a provincially significant wetland (PSW). **Note**: The references to wetlands in the following guidelines apply to only those that are not considered PSWs. There is to be no permanent impact to a wetland during the installation of a temporary bridge.

- Temporary bridges may be installed and left in place between June 1st and March 19th only, whenever the stream flow is confined to the channel. The bridge must be fabricated such that the components that span the channel can be quickly and easily removed.
- During mild weather and/or precipitation events, which may occur during the permitted timeframe when the temporary bridge may be in place, the water level beneath the structure must be closely monitored. The bridge must be removed before the water level reaches its underside. The temporary bridge may be reinstalled following the high flow event once the stream flow is contained within the channel banks.
- Construction of the temporary bridge must not involve any instream work or stationing of machinery in the wetted portion of the channel or in a wetland.
- At the first evidence of machinery causing ruts within 30 metres (100 ft) of a watercourse/wetland, the machinery must not advance any further, and the ruts must be immediately smooth graded and blanketed with mulch or slash.
- Soil disturbance and fill placement within 30 metres (100 ft) of a watercourse/wetland must be limited to the footprint required to prepare a stable foundation for the structure.
- No grubbing must take place within 30 metres (100 ft) of a watercourse/wetland.
- The cleared width of the approaches to the crossing must not exceed 1.5 times the width of the temporary bridge.
    - The approaches to the crossing must be stabilized against erosion by using brush mats or clean material unless bedrock is suitable to protect from rutting. Stabilization should extend back at least 30 metres (100 ft) on both sides of the crossing.
- To minimize erosion and siltation, temporary crossings must be limited to a single location perpendicular to the channel where the banks are firm and stable, and the channel is narrow.

- Prefabricated structures must be lifted into place over the channel and removed in the same manner.
- Construction materials must not be treated with creosote or other toxic products. Treated timbers must be air-dried for the length of time specified by the manufacturer for safe use in, over, or near aquatic environment.
- The span of the temporary bridge must be wide enough to ensure that any soil disturbance required to prepare a stable foundation does not result in placing any material below the shoulder of the banks of the watercourse.
- The supporting structure or other types of foundation materials must be placed at least 0.5 metre (20 in) back from the shoulder of the banks of the watercourse. The underside of the stringers must be at least 250 millimetres (10 in) above the shoulder of the banks of the watercourse or 750 millimetres (30 in) above the stream bed, whichever is greater.
- Temporary bridges composed of a single supporting structure (*e.g.* square timber) on both sides of the watercourse must have spacers attached to the underside of the stringers to maintain the span between them.
- Bridge decking must be tightly laminated together. Any soil that accumulates on the deck must be removed in such a way that it does not enter the stream flow. At unstable (*e.g.* muddy) approaches, once the stringers are spanning the channel, an impervious membrane must be placed between the stringers and the decking to prevent debris/mud from entering the stream flow.
- Harvested timber must not be skidded across a temporary bridge.
- When it is no longer needed, all components of the temporary bridge must be removed within three working days, and all exposed erodible soil must be stabilized with mulch, erosion control blankets, or other engineered products designed to prevent erosion and the runoff of suspended sediment into the watercourse/wetland.

8.10.2 Temporary Bridge Construction

Bridge with Runners Founded on a Single Supporting Structure (*e.g.* square timber)

To construct:

- Place both structural supports parallel to the watercourse, at least 0.5 metre (20 in) landward of the shoulder of the banks of the watercourse. Structural supports should be at least 4 metres (13 ft) long and have a minimum dimension of 25 centimetres (10 in).
- Attach deck timbers that are squared on abutting sides/edges, and spiked in place tightly together, perpendicular to the runners to help make the structure more rigid and to prevent any debris generated from entering the watercourse.
- Place travel planking or wheel runs perpendicular to the deck timbers to protect the deck from wear.
- Maintain the crossing to ensure the material does not build up on the runners/decking, and the stream banks remain stable.

To remove:

- First, clean off the bridge surface.
- Completely remove the structure and all construction materials from the crossing site. If the structural supports are not embedded below grade, they should also be removed.
- All exposed soil must be permanently stabilized with non-invasive perennial vegetation native to the area and blanketed with mulch or blanketed with an engineered erosion control product designed to prevent the generation of suspended sediment due to rain or overland runoff events.
- Use siltation and erosion prevention devices outlined in Section 6.2 *Erosion Prevention and Sedimentation Management* on the approaches to the decommissioned crossing.

Portable Bridges

Portable bridges should not be used for spans exceeding 10 metres (33 ft). These structures may include a pre-fabricated superstructure consisting of laminated decking (squared on the abutting sides/edges) attached to stringers, flatbed trailers, etc.

To install:

- Establish a structural support abutment, as described in the previous section
- Lift the portable bridge onto the abutments

To remove:

See *Bridge with Runners Founded on a Single Supporting Structure (e.g. square timber)* above.