Chapter 3: Environmental Guidelines for Watercourse Crossings

Water Resources Management Division
Water Rights, Investigations, and Modelling Section
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3.0 WATERCOURSE CROSSINGS

3.l General

This section consists of general information and preferred methods for planning and installing watercourse crossings. For the purpose of these guidelines watercourse crossings are placed in three categories:

- Bridges, Culverts and Fording

More specific technical information and recommended practices for installing these types of watercourse crossings are contained in:

Chapter 4 - Bridges
Chapter 5 - Culverts
Chapter 6 - Fording

Any watercourse crossing has the potential to alter the existing natural flow regime for the entire range of low to high flow conditions. The alteration of natural stream flow, if carried out improperly, can result in many types of serious problems. Improperly installed watercourse crossings can result in extensive loss and damage to public and private property, danger to human life, as well as damage to the environment in general through flooding, erosion, and washouts.

While installations such as culverts always alter natural flow it is preferred that watercourse crossings be appropriately designed to alter the natural flow regime as little as possible. The final decision as to permitting any stream alterations through the installation of a crossing rests with the Minister of the Department.

3.2 Selection of Route and Crossing Site

In planning linear facilities such as roads, pipelines, railways or transmission lines which require crossings of watercourses, consideration is required in the route selection and corridor location to mitigate the impact of the development on water resources.

Route selection should be made to:

- Minimize the number of watercourse crossings.
- Avoid wetlands or floodplain areas.
- Maintain substantial buffer strips on all bodies of water.

3.0 WATERCOURSE CROSSINGS

In selecting a site for a proposed major watercourse crossing, it is important to examine the physical characteristics of the watercourse and its drainage basin and to identify the site which will provide the best features and conditions for a crossing.

The site selected should enable construction of an economical and easily maintained crossing, be suitable for routing and approach requirements, consider the nature of the waterway and its environment, and minimize the use of such training works as may be necessary to deal with adverse natural features.

Where there is a choice between alternative crossing sites on a watercourse the crossing should be located:

- where the stream is straight, unobstructed and well defined;
- on an existing right-of-way if one exits;
- where stable geological and soil conditions are present;
- where a minimum of scour, deposition or displacement of sediments are expected to occur at or near a crossing;
- where possible effects on other existing bridges and hydraulic structures can be avoided;
- where it is possible to minimize the risk of damage from environmental hazards such as floods, landslides, or avalanches;
- where aesthetic conditions are favourable;
- away and preferably downstream from areas such as fish spawning sites or water use intakes.

3.3 Types of Crossings

3.3.1 Distinction Between Culverts & Bridges

For the most part, the term culvert has become synonymous with galvanized corrugated steel pipe products although concrete pipe culverts still find limited use mostly for smaller size drainage installations. Installations which maintain the original natural stream bed are not considered to be culverts in these guidelines. (See definitions in Appendix "culvert", "bridge"). Poured in place concrete structures which form two sides and a top over a watercourse but maintain a natural channel bed have been referred to elsewhere as "box culverts". The term is a misnomer as these structures more closely resemble bridges in their construction, installation procedures, and hydraulic effects on flow in the channel. Similarly, structural plate arches, although they utilize corrugated steel, are considered for the purpose of these guidelines to be classed as bridge installations as they require concrete foundations and allow a natural channel bed. For further information on concrete box structures or structural steel plate arch structures refer to *Chapter 4, "Bridges"*.

3.3.2 Preference of Bridges over Culvert Crossings

Bridges and bridge-type structures are environmentally preferred to culverts as a means of stream crossing. The following reasons are cited:

- Culvert installations usually result in the loss of a section of natural stream bed, whereas bridges leave the channel bed relatively unaltered.

- Confining stream flow to culverts can result in an extensive alteration of the flow regime which can result in problems such as erosion, or scouring at outlet or deposition of material at the inlet of the installation.

- Bridges usually provide better capacity to accommodate high flows than would a culvert crossing. Inadequate capacity can result in serious problems such as washouts and flooding.

- Bridges provide better inlet and outlet conditions than culverts thereby allowing safer passage of debris without causing constrictions and blockages.

- Culverts often create total or partial barriers to fish migration which is rarely a problem in bridge installations.

3.3.3 Timber "Culverts"

The use of logs or timber to construct an enclosed structure under road fill also known as timber culverts, is not considered an acceptable method of stream crossing. Such structures do not provide long term service and their final demise usually results in the collapse of the road material into the stream with such problems as siltation and deposition downstream, washout of the road, or the blocking of the stream with associated flooding.

3.3.4 Choose a Type of Crossing Appropriate for the Site Conditions

Prior to the construction of watercourse crossings careful study and examination of the environmental implications of each proposed crossing should be undertaken.

The decision to install a bridge or culverts for a proposed crossing should be made only after examining the hydraulic implications of the proposed structure with respect to the hydrology, physical conditions and features of the proposed site. Generally these factors include but are not limited to:

- Quantity or volume of peak flows
- Depth of flow

- Flow velocity
- Low flow characteristics

This will provide an indication of the appropriateness and ability of the structure to perform satisfactorily under those particular conditions identified. These are the determining factors to be considered in deciding between a bridge or culvert installation and the decision should not be based primarily on economic considerations.

3.3.5 Temporary Crossings

These guidelines have not made a substantial distinction between permanent and temporary watercourse crossings as all installations are expected to provide satisfactory performance during the intended period of use. In this regard the design capacity of a crossing may vary from an installation which is to be used only for several weeks during low flow summer conditions and subsequently removed, to installations which must safely accommodate high spring runoff or provide many years of satisfactory service for a major highway.

Where watercourse crossings are installed to provide service for a period of less than one year and the installations are not required to pass peak spring runoff, the following guidelines should be followed:

- The installation should provide adequate capacity to safely accommodate design flows without causing erosion, flooding, or other environmental problems.

- The installation should be carried out with the least amount of disturbance to the channel bed, banks, and adjacent vegetation and property.

- Upon completion of its intended function, the crossing and all associated works and material should be removed from the vicinity of the channel.

- Site restoration involving revegetation and stabilization of all disturbed areas should be carried out to return the channel to its previous condition. Further details on this are contained in *Chapter 11, "Restoration and Stabilization"*.

3.3.6 Choosing Between a Fording, or a Structural Crossing

There are a number of environmental factors to consider in deciding whether to ford a watercourse or provide an installation such as a bridge or culvert.

If a location with stable channel bed and banks has been identified, the flow is not too deep, and very infrequent use is anticipated, fording may be an acceptable alternative to installing a bridge or culvert.
In some instances the installation of a bridge or culvert and its subsequent removal would result in greater channel disruption and more potential for environmental problems than the installation of a fording site.

One of the initial factors to consider is the frequency and period of use of the proposed crossing. In instances where the fording would only involve crossing a watercourse to gain access into an area and subsequent return from the area, (two fording operations per piece of equipment), the installation of bridges or culverts may not be warranted provided the fording would not create environmental problems or conflict with downstream water users.

Details regarding the installation of fording sites and guidelines for their use are contained in *Chapter 6, "Fording"*.

3.4 Design Flow and Water Level

To design and construct an adequate watercourse crossing and provide appropriate environmental mitigation, it is essential that the flow regime at the crossing location be determined. The important flow characteristics are the timing and magnitude of the annual peak and low flow period, the range of flows which may be encountered, and flow velocities. Also of concern in some regions are the dates of freeze-up and break-up and the potential for ice blockage of culverts.

3.4.1 Return Period

The streamflow characteristic of major importance is the peak or flood flow usually related to a certain probability of being equalled or exceeded in terms of a "return period". Determining a design peak flow with a certain return period allows one to assess the probability that a crossing structure could be damaged or destroyed within a selected time period. For example, a 50-year return period peak flow will be equalled or exceeded, on the average, once in a 50-year period. The probability or risk of a 50-year return period peak flow occurring in the 25-year "life" of a structure is about 40%; the probability of a 100-year return period event occurring is about 22%.

3.4.2 Design Data

The main source of data for the analyses used to estimate peak flow is the hydrometric station network operated by Water Survey of Canada under the cost shared Canada - Newfoundland Hydrometric Surveys Agreement. The peak flow magnitude can be estimated by regionalization methods, or empirical formulae which relate peak flow to precipitation input. The method

used will depend on the climate, watershed characteristics (especially drainage area) and the data available.

3.4.3 Site Inspection

Much information required for the design of a stream crossing can only be obtained from a site inspection. Physical measurements of the stream include width, depth and flow velocity. Such measurements must include up- and downstream sections and these must be compared in terms of elevation in order to determine the channel slope. In addition a field inspection should establish:

- type and grading of bed material,
- existence of shoals and their composition,
- the material forming the banks,
- vegetation on the banks,
- steepness of banks and evidence of bank erosion,
- debris marks on shrubs, trees or banks which may indicate the water level of recent floods,
- elevation of ice scars.

Much of this information is vital to confirm the appropriateness of the hydraulic as well as the structural design.

3.5 General Installation Procedures

Design and the actual installation of a watercourse crossing are separate components often handled by different persons or agencies (engineers/owners vs. contractors). Invariably, it is necessary to consider the installation methods in the design of the crossing, thus a team effort is needed to ensure that a project is carried out in an environmentally acceptable manner. A crossing design must be such that it can have a realistic chance of being installed with a minimum of environmental disruption.

The contractor usually has the sole responsibility for the day to day construction effort. In this regard it usually falls upon the contractor to ensure that pollution, siltation, drainage problems and general disturbance be minimized. Each crossing installation is unique and a well-planned installation procedure as well as rules, specifications and regulations governing the site work are essential. More details about construction practices are given in *Chapter 10, "General Construction Practices"*.

3.5.1 Low Flow Conditions

It is preferred that all watercourse crossings be installed during times of low flow conditions during the summer months. Where flows must be diverted or confined to allow work to proceed in a portion of the channel, high flow conditions can create problems of erosion and flooding. Watercourse crossings installed during the summer months also will allow adequate time for stabilization and revegetation of disturbed areas before higher flows of the fall months occur.

3.5.2 Reduce Time Spent With In-Stream Work

The installation of any watercourse crossing should be carried out as quickly as possible to prevent prolonged channel disruption or exposure of vulnerable areas to erosion. The extent of channel disruption and other environmental problems such as siltation often relates directly to the amount of time spent with instream works.

3.5.3 Watercourse Crossings and Fish Habitat

The installation of watercourse crossings has the potential to impede or block fish migration and destroy fish populations or fish habitat. In particular, culvert installations if improperly installed can create structural and flow velocity barriers to the passage of fish. The installation of bridges, culverts, and fording sites if improperly carried out can result in siltation and pollution which can kill fish or incubating eggs and ruin spawning locations.

The installation of watercourse crossings in areas of fish habitat should be scheduled to avoid instream work during periods of high environmental sensitivity such as fish migration, spawning, fish egg incubation and fry emergence. The installation should not impede fish migration or effect fish or incubating eggs.

The Federal Fisheries Act contains clauses which govern the alteration of fish habitat. Therefore, approval from Fisheries and Oceans, Canada, may be required in addition to approval from the Department.