# Culvert Sizing Considerations

Once a design discharge and corresponding design high water level for the channel have been determined, alternative culvert openings can be evaluated. Fixed rules, such as specified amounts of freeboard or degrees of constriction based on increase in mean velocity, can be easily applied to develop a culvert size. However, such rules do not necessarily optimize the crossing dimensions economically or take all of the site specific factors into account.

Alternatively, a range of culvert sizes could be evaluated based on predicted performance during the design flood. A starting point for developing the range of alternatives could be for the culvert span to equal the average width of the channel. The following list can be used to guide the assessment of predicted performance. Not all of these considerations will apply at all sites. Also, some of these considerations can be used qualitatively. Following this approach should quickly lead to an appropriate range of sizes for most sites.

*Upstream Flooding Impacts*

- Minimize impact on flood sensitive upstream developments
- Headloss through structure should not increase flood impact under design flood conditions

*Fish Passage*

- Must meet DFO passage requirements
- Should not adversely affect flow regime at level of permanent vegetation, marking the water level that is infrequently exceeded. At this level, the mean velocity in the culvert should be within 20% of the natural channel mean velocity.

*End Protection Works*

- Large increases in velocities at the culvert inlet and outlet may require extensive and expensive rock protection works to transition to the natural channel. These costs should be considered in the economic analysis of alternatives.
- Flow constriction should not result in bank erosion at downstream bends opposite the outlet
- Downstream scour holes should be avoided to minimize impact on downstream bank stability

*Uplift Failure*

- Culvert ends should be checked against uplift failure – hydrostatic uplift pressure applied to culvert should be less than the weight of the culvert end plus the weight of water on top of the end.
- Likely to occur when the upstream water level significantly exceeds the water level entering the barrel, often due to excessive headloss at the culvert inlet.
- Can be designed for by adding weight to the culvert ends or installing a cutoff wall

*Embankment Stability*

- Differential head across the roadway embankment should be limited to avoid excessive pressure causing the roadway to act like a dam when it was not designed to handle these forces.
- Differential head can be controlled by limiting the headloss through the structure

*Road Overtopping*

- If ponding at the inlet is considered, overtopping of the roadway at or near the crossing should be evaluated and impacts on infrastructure and road users considered
- If overtopping is considered acceptable, roadway should be designed to minimize failure and risk to public
- If overtopping is not acceptable, consider gradeline revisions or adjusting opening size

*Blockage*

- If drift or ice blockage potential during a flood is considered significant, a more generous opening should be considered.
- Although a larger size may not prevent a blockage, impacts should be reduced.

*Future Rehabilitation*

- For high fill and high traffic crossings, consideration should be given to increasing the culvert size to allow for future lining.