Field Indicators of Flood Prone Road Stream Crossings

Stream Crossing Location: **Field Date:** **Culvert ID #:**

Culvert dimensions:

Natural channel bankfull width (defined on page 2):

Stream flow: [Lower than normal] [Normal flow] [Channel close to overtopping] [Water out of banks]

High-risk watersheds*

- ☐ High gradient (>1%)
- ☐ Forested area with a high potential for woody debris transport
- ☐ Soil type with limited water infiltration (silt, clay, or shallow depth to bedrock)
- ☐ Limited watershed storage in wetlands, lakes, & floodplains
- ☐ Watershed changes resulting in increased runoff (urbanization, development, land clearing, etc.)

Culvert risk indicators

- ☐ Current culvert had a short service life (in place 30 years or less) Age of culvert: _____
- ☐ Signs of road overtopping **(Table 1)**
- ☐ Proposals to raise the grade of the road at the culvert or an overtopping area
- ☐ Road core in poor condition **(Table 2)**
- ☐ Deep road fill (>5 feet) over the top of the culvert* Ft. of fill over culvert:_____
- ☐ Culvert material poor condition (corrosion, abrasion, and/or deformation)
- ☐ Total width of the culvert(s) opening is significantly narrower than the natural channel bankfull width
- ☐ Large woody debris in the channel and/or blocking the culvert inlet **(Figure 1)**
- ☐ Stream bottom downstream is significantly lower (>2 ft.) compared to upstream **(Figure 2)***
- ☐ Entrenched channel **(Figure 3)***
- ☐ Perched culvert outlet **(Figure 4)***
- ☐ Significant outlet scouring **(Figure 5)***
- ☐ Speed of water at the culvert is much faster compared to the natural channel
- ☐ Water surface upstream is significantly higher (impounded) compared to downstream*
- ☐ Culvert aligns poorly with the stream channel **(Figure 6)***
- ☐ Significant road gravel in the channel & floodplain downstream **(Figure 7)**

Number of Risk Factors Identified

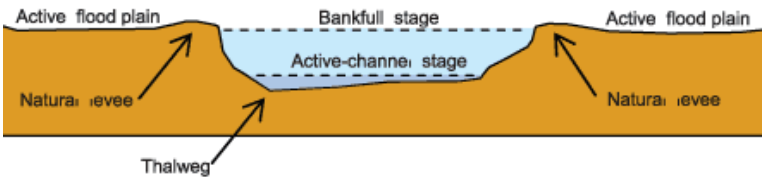
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

**Items marked with an asterix (*) can be field checked, or assistance may be available to evaluate these factors region wide using LiDAR and GIS data.*

<u>There are many factors that need to be evaluated on road stream crossing projects.</u> Road issues may include ADT, dead end roads, emergency services, utilities, available cover, impact of downstream structures, etc. Water resource issues may include fisheries, water quality, wild rice, endangered resources, mapped floodplains, etc.

<u>The DNR Transportation Liaison</u> may be able to assist with evaluation of road stream crossing risk factors for culvert replacement projects or to help to set up culvert inventory efforts to identify high priority sites.

<u>Definition of natural channel bankfull width:</u> The width of the channel when the water is at the top of its banks and any further water rise would result in water moving into the floodplain. A site where the stream is significantly wider than the culvert(s) span generally has a much higher risk of flood failure due to the limited ability of the culvert(s) to pass water, sediment, and woody debris. To evaluate flood risk based on the amount of stream constriction, the stream bankfull width should be measured in an area of the stream away from the influence of the culvert.



<u>Table 1: Signs of road overtopping.</u>

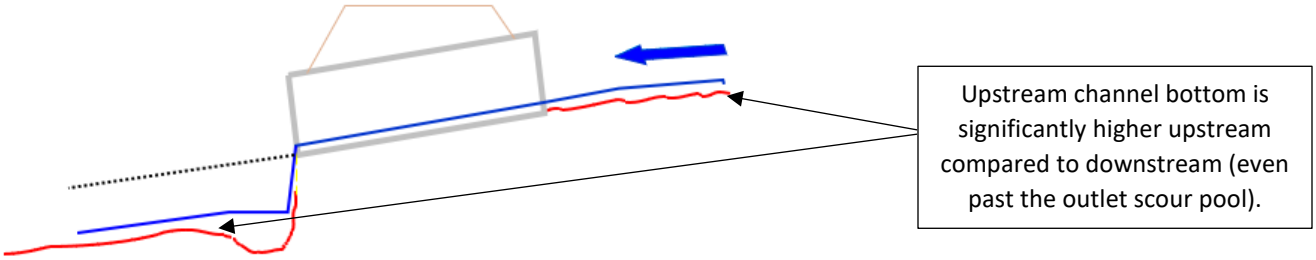
Road shoulder erosion on outlet side	Pattern of flattened vegetation after a heavy rainfall	Pattern of erosion on the surface of gravel roads
Gravel deposits in the channel and floodplain downstream of the culvert	Elevation of debris lines compared to road elevation	Asphalt covering the entire road shoulder slopes to protect the road during overtopping

<u>Table 2: Signs of poor road core condition.</u> *These factors indicate reduced road core integrity and reduced ability to withstand the forces of flood water and debris.*

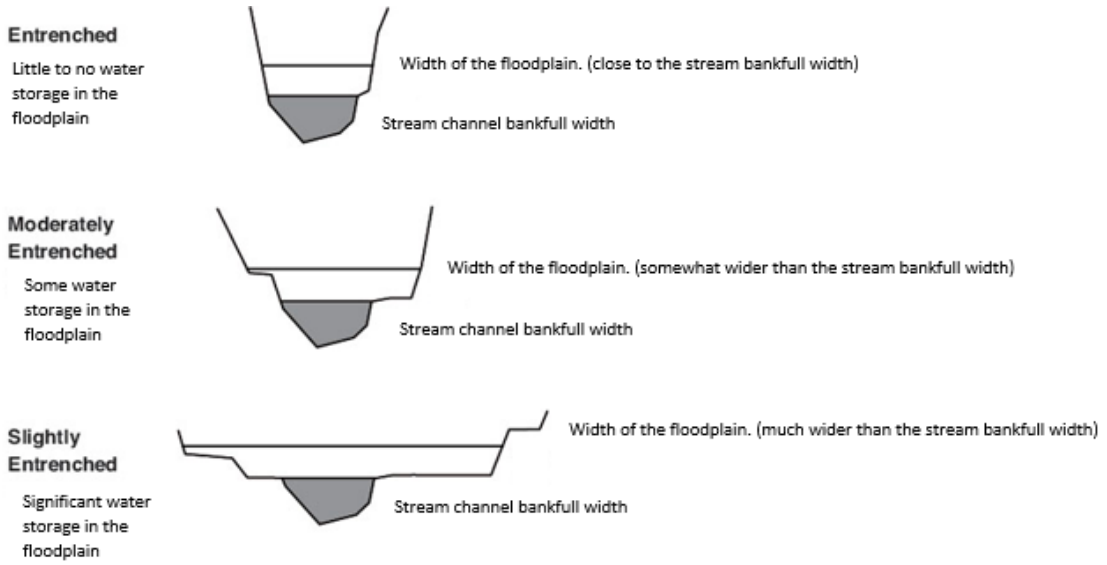
Piping of water around culvert	Undermining of the culvert inlet or outlet	Very steep road shoulder slopes
Road shoulder erosion	Sink holes in the road surface or shoulders	Unsuitable road core material
Lack of vegetation and/or riprap to stabilize shoulders	Shifting of the road surface or shoulders	

<u>Figure 1: Large woody debris issues.</u> *Woody debris blocking the culvert is a common cause of culvert failure. Most of the woody material transported during flood events is shorter than the natural streambank width. Risk of culvert failure is greatly reduced by structures that do not constrict the natural stream width and allow woody debris passage.*

<u>Figure 2: Significant change in stream bottom elevation.</u> *Where there the stream bottom is much higher upstream of the road compared to downstream, this can indicate an unstable stream channel condition that may continue to change dramatically during a flood. This has the potential to destabilize the road/ culvert. Care must also be taken if a new culvert is larger or set lower due to the risk of creating additional channel and streambank changes upstream.*



<u>Figure 3: Entrenched channels.</u> *Flood prone areas include entrenched streams where the floodplain width is close to the bankfull width of the stream channel. Since entrenched streams are not well connected to a wider floodplain (and have no room for water to spread out and slow down), flood waters rise quickly and move fast. During a flood event, the water moving in entrenched streams carries a lot of energy to erode streambanks, uproot trees, and washout roadways.*



<u>Figure 4: Perched culvert outlets.</u> *This indicates that the culvert has limited ability to convey a wide range of flows and/or backs up water even during non-flood flows to make the crossing more susceptible to failure.*

Figure 5: Outlet scouring. *Large pool that has formed at the outlet that is much wider than the natural stream channel width. This indicates that the culvert has limited ability to convey a wide range of flows.*

Figure 6: Poor culvert alignment. *Poor alignment can significantly decrease the ability of the crossing to convey flows downstream of the road. A significant "angle of attack", as shown below, can greatly increase the flood and debris energy acting to destabilize the road core.*

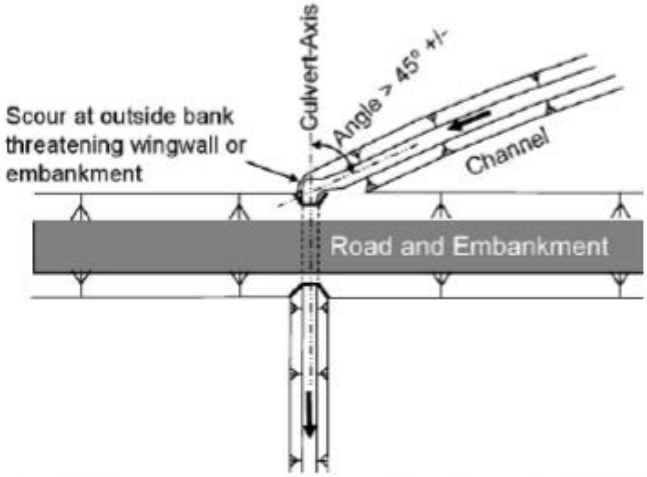


Figure 3.3.1. Poor culvert to channel alignment. (From Hunt et al. (FHWA) 2010)

Figure 7: Road gravel in channel and floodplain downstream of culvert. *Heavy sediment loading can decrease the ability of the channel and floodplain to convey flows downstream making future flooding issues more frequent.*