ROADWAY OVERTOPPING AND FLOODING

[Plastic Culvert Overview Flowchart] [Structural Defects Flowchart (Plastic)]
[Bedding Deficiencies Flowchart (Plastic)] [Hydraulic Capacity Flowchart (Plastic)]

1. SUMMARY

If roadway overtopping frequency is greater than selected based on economics of hydraulic design (see 2.2.6), the existing culvert may have insufficient design capacity for the projected peak flow conditions and may need to be re-designed.

Pelivanoski and Ivanoski (2010) described a case study of culvert redesign where seasonal storm events were repeatedly causing flooding. The box-culvert was originally designed to carry flows for the projected 100-yr peak flow conditions in the creek from one side of the road to the other without allowing the headwater depths to exceed acceptable levels, however. The culvert was also clogged with sand which further reduced the capacity of the culvert. Hydraulic analysis showed that even after the sediment removal (which would restore the original cross-section area of the culvert) the culvert would still not have the capacity to carry the maximum flood water. The solution was to open another culvert next to the current one.

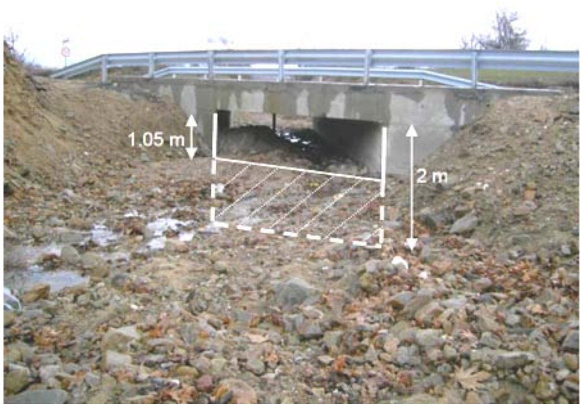

Figure 1. Reduction of the culvert height from original 6.5 ft to 3.5 ft due to debris (Pelivanoski and Ivanoski, 2010)

Modifying inlet geometry (improved inlets) can enhance the culvert hydraulic performance. Although the improved inlets are often considered more costly then installing a larger culvert, for some conditions they may offer a better option.

FHWA's *HEC No.13: Hydraulic Design of Improved Inlets for Culverts* **(**Harrison at al., 1972) includes extensive research and test results for improving culvert flow capacity by modifying inlet geometry. The publication contains design examples and numerous charts and graphs. Improved inlets are bevels, side-tapers, and slope-tapers, which are modifications to the culvert entrance geometry. These improvements can greatly increase the performance of a culvert which is operating under inlet control. Design charts, tables and computation sheets are provided in the manual.

Grimaldi (1995) documented procedures to enhance culvert flow characteristics by making modifications to the inlet of culverts as a majority of culverts on Forest Service roads were found to flow under inlet control. Five different inlet treatments were considered: projecting inlet, mitered inlet, headwall and wingwall, beveled ring inlet, and side-tapered inlet.

Stormwater detention facilities (e.g., reservoirs, wet ponds) can be built immediately upstream of the existing culvert to produce a lower peak runoff rate at the culvert than it would occur without the facility. FHWA's HEC 22 (Brown et al., 2001) presented procedures for the design of stormwater detention facilities. FHWA's HDS No.5 (Norman et al., 2005) explained basics of storage routing, including a concept and the application to culvert design.

Channel aggradation (the vertical raising of the streambed over relatively long distances and time frames primarily due to sediment deposited from the streamflow) can contribute to an increased risk of flooding downstream of culverts. A manual by the U.S. Army Corps of Engineers (Watson et al., 1999) covered channel modification activities, including sediment control activities: sediment removal (dredging), the implementation of streambank and channel stability projects, better construction methods, trapping or storing sediments, structures for diverting flow, construction of sediment retention dams, and increased use of protective vegetation.

Some modifications (e.g., installation of baffles for fish passage that reduce the water velocity within and downstream of the culvert) can decrease the culvert's ability to convey water and increase the risk of flood damage above or below the site.

2. REFERENCES

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