DOWNSTREAM EFFECTS OF CULVERT AND BRIDGE REPLACEMENT

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RESEARCH

Introduction

The replacement of a culvert or bridge with a larger structure yields two benefits in all cases. The first benefit is less frequent flooding of the roadway and/or upstream structures due to lower headwater levels. The second benefit is a lesser potential for scour through the bridge opening or at the culvert outlet due to lower velocities through the larger opening. Downstream impacts, if any, are project-specific.

Project Objective

This report presents a framework for evaluation of likely impacts on downstream flooding and channel erosion. Two methods for predicting changes in flood peaks are presented and demonstrated in examples.

Project Description

The first method, which requires flood hydrograph simulation and reservoir routing, is applicable to all cases. The second method, which does not require hydrograph simulation or routing, is applicable to culverts that operate under inlet control with no roadway overtopping.

If the roadway over the existing structure is overtopped by floods, enlargement of the structure will increase the flow through the structure and decrease or eliminate the roadway overflow. However, the peak flow in the channel directly downstream of the structure will not necessarily change. If the stream crossing includes a relief structure located some distance from the main structure, or if roadway overtopping occurs at some distance from the main structure, split flow can occur for a short distance downstream of the crossing. Enlargement of the main structure will increase the flow through the main structure and reduce or eliminate the split flow.

If peak flows through the existing structure are affected by detention storage, enlargement of the structure will increase the peak flows. The peak flows through the enlarged structure will also occur sooner, which may be significant in an analysis of downstream flooding. The increase in peak flow, if any, diminishes with distance downstream from the enlarged structure due channel and overbank storage and lateral inflows. The new streamflow characteristics will more closely resemble the natural conditions that existed before the highway was constructed. If the peak flows through the existing structure are unaffected by detention storage or split flow, enlargement of the structure will not increase the peak flows directly downstream. Few culverts and even fewer bridges are affected significantly by detention storage.

Project Results

The effect of detention storage on downstream sediment transport is investigated computationally. Our analysis shows that a reduction in detention storage results in an increase in the volume of sediment that the flood can transport. This increase in sediment transport capacity may lead to an increase in channel erosion downstream of the structure. However, reliable quantitative predictions of erosional impacts are not possible. If peak flows through an existing structure are unaffected by detention storage or split flow, enlargement of the structure will not increase erosion downstream.

Report Information

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