Perennial Stream Culvert Requirements: Design and Delivery Strategies

INTRODUCTION

BANKFULL WIDTH AND CULVERT SIZING

Please elaborate on bankfull v. wrested vegetation.

What's the proper approach to mapped, even named perennial streams identified in the field flowing through low-gradient (often beaver-impounded) wetlands? Does culvert design need to anticipate stream bankfull and profile in the event of future change to wetlands/impoundment that would expose the bankfull channel?

How should the project team go through the process of agreeing on a bankfull width? How should the discussion be handled and how should each data source be weighted/considered during the discussion?

What do we do if the bankfull event calls for a culvert size that causes overtopping of the road?

Does the D-48 requirement to roundup the 20% embedment apply to box culverts? For example, should a 10-foot by 6-foot box culvert be embedded 2 feet?

To remove the guesswork for less experienced designers, are there plans to develop a Georgia map (by an experienced local hydrologist) that shows the equivalent regional curve to be used for different sections of Georgia?

Resiliency/sustainability benefit: interestingly, following catastrophic flooding from 2012 tropic storm Irene that wiped out more than 1,000 culvert crossings, the State of Vermont has come to rely on achieving aquatic passage as a performance indicator of achieving resiliency. Their mantra: "if it can pass fish, it can pass a flood."

INTRODUCTION

On July 28, 2021, Georgia DOT (GDOT) hosted a Microsoft Teams live event titled Perennial Stream Requirements: Design and Delivery Strategies. Learning objectives included the concept of bankfull width: definition, methodology, importance/relevance to design; how to design a culvert that complies with the Regional Conditions; how to address perennial stream culvert requirements, including diagrams, in Section 404 permit applications; and project delivery implications for projects with perennial stream culverts.

Session presenters developed the following responses to questions posed by attendees.

BANKFULL WIDTH AND CULVERT SIZING

Please elaborate on bankfull v. wrested vegetation.

Generally, these are unlikely to be at the same elevation. In most cases, bankfull elevation is beyond/above the point of wrested vegetation. Exceptions certainly exist but are probably uncommon. Instances where stream banks are very steep or even vertical, vegetation may be confined to the top-of-bank (which in turn may be beyond/above the bankfull elevation).

What's the approach to mapped, even named perennial streams identified in the field flowing through low-gradient (often beaver-impounded) wetlands? Does the culvert design need to anticipate stream bankfull and profile in the event of future change to wetlands/impoundment that would expose the bankfull channel?

From a Designer's perspective, a beaver dam is generally regarded as a temporary structure. Therefore, the recommended practice is to design a culvert as if the stream is flowing free. With regard to sizing the culvert, it is advisable to use the drainage area of the stream in conjunction with regional curves to predict bankfull measurements in the free-flowing condition. In contrast, if one relies on (a) field measurements or (b) hydraulic modeling of bankfull using existing topographic data, the bankfull measurements would instead reflect the impounded condition. For aquatic organism passage and for hydraulic design of the culvert, it is advisable to use the existing tail water condition. To compare this approach with related scenarios, consider designing a culvert with a manmade impoundment immediately upstream. In these instances, the culvert is designed as if there is no dam and therefore there is no reduction of peak flows because of the dam.

From an Ecologist's perspective, the best approach is generally to collect and document as much information on the existing conditions as possible. Where feasible and where access is permitted, Ecologists should evaluate upstream and downstream portions of the system, even at a distance from the project location, for stream-like reaches where it might be appropriate to collect bankfull measurements. If bankfull measurements cannot be collected, this should be documented. The information gathered on the existing condition has value. However, note that the existing impounded condition is not the free-flowing. Therefore, in situations like this, field

measurements collected by the Ecologist may not be suitable to rely upon for the sizing of the culvert.

How should the project team go through the process of agreeing on a bankfull width? How should the discussion be handled and how should each data source be weighted/considered during the discussion?

In most cases, the primary metric for determining bankfull width should be the width measured in the field by ecologists, followed by the width from hydraulic modeling, and finally the width from the regional curve equations. Some additional considerations: if stream is impaired or incised, fewer field indicators may be present and the hydraulic modeling may become the primary metric. If hydraulic modeling results in bankfull above the top of banks it should not be considered a good metric.

What do we do if the bankfull event calls for a culvert size that causes overtopping of the road?

Please keep in mind that the bankfull event drives only the culvert width, not the overall culvert size. GDOT design criteria for culverts, and requirements from other agencies such as FEMA still apply and are not removed or diminished by this additional bankfull width variable. Engineers should ideally select culvert sizes which can meet all criteria, evaluating various combinations of culvert size (width and height) and number of barrels. If this cannot be accomplished, the Regional Conditions to allow the flexibility to "tell our story" about why we are not able to meet certain criteria.

Does the D-48 requirement to roundup the 20% embedment apply to box culverts? For example, should a 10-foot by 60foot box culvert be embedded 2 feet?

The 20% embedment does apply to perennial stream culverts (both circular and box configurations). Yes, if your proposed box culvert height is 10 feet, your embedment depth would be 2 feet. The D-48 detail will be clarified with respect to rounding on the next update.

To remove the guesswork for less experienced designers, are there plans to develop a Georgia map (by an experienced local hydrologist) that shows the equivalent regional curve to be used for different sections of Georgia?

Yes, GDOT will develop a map of Georgia to assist engineers in selecting the best available regional curve equation to use on your project.

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Thank you for sharing Vermont's practice.