Maine Department of Transportation

Environmental Office

Design Guidance

Title: Culvert Sizing	Issue Date: May 21, 2015
Discipline: Hydrology	
Originators: Charlie Hebson, P.E.	
Approved By: Joyce Taylor, P.E.	

Background:

There is a real likelihood of increased peak flows over the expected life spans of structures now being installed (e.g., 80 – 100 years for reinforced concrete pipe). The challenge is to size structures so that they protect public safety and system integrity now as well as at the end of their useful life. The proposed standard delivers this resilience in a manner consistent with engineering practice and responsible allocation of department resources.

The current standard for sizing large culverts has $H_w/D <= 1.5$ at the 50-year peak flow (Q50). This standard has "worked" over the more recent historical recent, with remarkably rare failures of designed structures attributable to inadequate capacity.

Guidance:

There is concern that this design approach will not hold up under a scenario of increasing peak flows. Therefore, a new large culvert design is proposed, with preference given to sizing for Hw/D = 1 at the 100-year peak flow event (Q100). Peak flow hydrology equations are typically updated on a 20-year cycle. Thus, an 80-year culvert might experience 100 years of increasing peak flows. Using a 0.5 mi^2 watershed example, the old standard would give 4-ft diameter while the proposed standard would give 5-ft diameter ($H_w/D = 1$ and Q100). This 5-ft pipe has $H_w/D = 1.5$ at a flow that is 80% greater than the design Q100. Even with an 80% increase in design peak flow, the 5-ft pipe would be performing the same as the 4-ft pipe designed for unchanging "old" hydrology. Thus, the proposed standard delivers a level of resilience that is directly comparable to the current design standard that has "worked" over the period of historical engineering design (since the mid-60's or so).

To satisfy the regulatory requirement for an alternatives analysis and to show consideration of habitat for Atlantic salmon, Eastern brook trout, and other cold water aquatic species, each crossing project should consider sizing at the following hierarchy: 1.2 times the bankfull stream width (bfw), Q100, and Q50. In addition to the hydrological justification provided above, sizing structures at 1.2 bfw with either natural bottom (i.e. 3-sided structures) or stream simulation substrate design in the pipe is the regulatory preference and often results in a more streamlined resource agency review. Design selection should be based on the best engineering outcome, the best environmental outcome, and cost efficiency.