Stream Crossings and Climate Change: Part 2

Bulletin Synopsis *September 2014*

This bulletin provides detail on designing and sizing stream crossings that perform well in a changing climate.

Bankfull – The point at which the stream channel transitions into the floodplain

Normal high water mark – The line where vegetation changes from primarily aquatic to primarily terrestrial.

Peak flows (rough rules of thumb):
10-year peak = ~2.5 x normal high water flow
25-year peak = ~3.5 x normal high water flow
50-year peak = ~4.5 x normal high water flow

Determine the Opening Size

(*for water flow only, without necessarily maintaining stream characteristics*)

The normal high water mark provides a reference for identifying the minimum opening size needed to accommodate a given size storm.

To calculate desired opening size (in square feet):

(1) Calculate the area of the stream bed (stream width at normal high water mark x average depth)
(2) Multiply by storm size you want to accommodate – see box, right (e.g. 2.5 for 10-year storm)

If a round culvert is to be used, it can be selected from the chart below (green = more commonly used sizes):

Dia inches	6	12	15	18	21	24	30	36	42	48	54	60	66	72
Opening sq ft	0.20	0.80	1.25	1.75	2.40	3.15	4.90	7.05	9.60	12.55	15.90	19.65	23.75	28.26
Width feet	0.50	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00
Ratio of opening to next smaller size		4	1.56	1.4	1.37	1.31	1.56	1.44	1.36	1.31	1.27	1.24	1.21	1.19

- Going up one culvert size will accommodate peak flows up to 15% larger than historic norms.
- Embedding a culvert (to match stream elevation and allow for inclusion of natural substrate) may reduce culvert volume by up to 35% and require sizing up to maintain desired flow capacity.
- For opening sizes above 20 square feet, structures other than culverts are typically used.
- For a pipe arch, double the calculated opening size (above).

Design the Crossing

A very useful easy tool for estimating changes in stream flow is the USGS StreamStats Program. It provides a GIS-based interface for stream gage data and includes tools to estimate flows at non-gaged locations. Another helpful resource, from Maine Audubon, can be downloaded here.

Temporary Crossings (plan to be removed at the end of the current operation) have some general advantages, including (1) limited exposure to flood events, (2) limiting unauthorized property access, and (3) avoiding permanent stream corridor alteration. These use to be designed for a 10 year flow, but with larger deluges becoming more common, designing for 20 to 40 year flows often makes sense.

Permanent Crossings merit detailed design due to cost, greater potential for exposure to large flood events, and potential for long-term stream impacts. Use the USGS StreamStats Program or other hydrologic calculations to improve resiliency to large storm events, maximize stream connectivity, and preserve habitat value:

- Locate a reference stream reach that is similar to the stream segment to be spanned (in terms of width, slope, and materials) and use it as a pattern for the reconstructed stream segment.
- Identify stable endpoints for the crossing structure and span the bankfull width of the channel.
- Match slope and elevation of the stream, embed culverts, or use open bottom structures to maximize connectivity.
- Use substrate in the crossing that matches upstream and downstream reaches.
- Build overflow sections surfaced with cobble into roadbeds on either side of the crossing to accommodate exceptional flows.

A note about cross drainage culverts – These are ditch relief culverts. Based on increased deluge events, increase them one size from what has normally been done. For most forest roads this means moving from 12" to 15" or from 15" to 18", depending on spacing and terrain.

Click on the sub-headings above to go directly to the corresponding section of the full bulletin, or read the full bulletin online:
http://climatesmartnetwork.org/2014/09/stream-crossings-and-climate-change-part-2/