

Practical Design Guidelines for Replacement of Deficient Bridges with Low-Water Stream Crossings in the Rural Midwest

Many county-owned bridges in rural areas are deficient and in need of replacement. Counties cannot afford to replace all deficient bridges and must prioritize their expenditures. In many locations the type and volume of traffic is too low to justify the expense of a bridge replacement. This situation is worsening as the rural population declines. Some counties are closing low-volume roads rather than replacing deficient bridges. In some locations a low-water stream crossing might be a practical low-cost alternative to road closure.

County engineers and engineering consultants need engineering guidelines to assess the practicality of replacing a deficient bridge with a low-water crossing and to select the best type of crossing. They also need straightforward design procedures and general design details for common types of crossings. Some general guidance on low-water crossings can be found in reports by the U.S. Forest Service (2006) and Iowa State University (2003). However, these reports do not provide some of the specific information needed for site assessment and crossing design.

In this project, we will produce a report that provides practical engineering guidance for the replacement of deficient bridges with low-water stream crossings in the rural Midwest. The report will address the following issues.

1. Site assessment and economics. The suitability of a low-water crossing depends on many factors, including the traffic volume and type, the streamflow characteristics, the depth of the channel, and the stability of the stream bed. Low-water crossings can work well for roads with very low traffic volumes and streams with low banks, stable beds, little or no dry-weather flow, and infrequent and short-lived high flows. Many stream crossings in the rural Midwest would appear to meet these requirements. We will develop specific criteria for assessing these factors to determine whether a site is suitable for a low-water crossing. We will also investigate the regulatory and permitting issues associated with construction of low-water crossings.
2. Selection of crossing type. The two basic types of low-cost low-water crossings are the unvented ford and the vented ford. The unvented ford can be built at grade or raised. In locations where aquatic organism passage is required, a raised unvented ford would not be permitted. In a vented ford, one or more culvert pipes convey low flows under the crossing. Culvert pipes would likely need to be embedded to some extent to allow for aquatic organism passage.
3. Design of roadway profile and culvert pipes. For a vented ford, the culvert pipes are sized so that the stream overtops the road only infrequently and for short durations. The roadway profile must be kept relatively low – the crossing should not act as a dam or debris trap – and the vertical alignment of the roadway and approaches must be safe. We

will develop specific criteria and procedures for sizing the culvert pipes and setting the roadway profile.

4. Selection of crossing materials. Low-water crossings can be built of concrete, crushed stone, natural stone, stone reinforced with geogrid or geotextile, stone-filled gabions and other materials. The best choice depends on the composition and stability of the natural streambed and the availability and costs of the various options. Filters consisting of geotextile or natural materials may be necessary for some of these options. Many of these crossing options can be relatively inexpensive. We will provide guidelines for materials selection.

5. General design details. We will provide general design details for unvented fords and vented fords constructed of different materials. We will also provide guidance on signage of low-water crossings.