

Low water stream crossings: Affordable alternative to bridge replacement

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MOST IOWA counties have low volume roads with at least one structurally deficient or obsolete bridge; in some counties, the percentage of faulty bridges may be as high as 62 percent. Replacing all such bridges with structures of similar size would require large capital expenditures that many counties simply can't afford.

Fortunately, in certain situations, constructing low water stream crossings (LWSCs) may be an acceptable, low cost alternative. LWSCs are particularly suitable across streams where the normal depth of flow is relatively low.

A recent ISU study provides recommendations for selecting, designing, and constructing LWSCs. The study, *Low Water Stream Crossings: Design and Construction Recommendations*, involved an extensive literature search, a survey of Iowa county engineers, and innovative analytical studies. It was sponsored by the Iowa Highway Research Board (TR-453) and conducted by Robert Lohnes, university professor, and Roy Gu, associate professor, in the Department of Civil and Construction Engineering, with Tom McDonald, safety circuit rider at CTRE.

LWSC sites, types, and designs should be selected carefully, because such crossings may be flooded periodically, requiring the road to be temporarily closed to traffic.

Determining LWSC candidates

The following factors should be considered when identifying potential LWSC sites:

Road use. Average daily traffic (ADT) of less than five vehicles is ideal. A LWSC should not be constructed along roads that provide critical travel routes or where a future increase in traffic is expected.

Road type. LWSCs are recommended only on unpaved or primitive roads, field access roads, roads with no inhabitable dwellings, low traffic volume roads, and roads with alternative routes available during flooding.

Roadway geometry. Approach grades should be less than 10 percent. Projected height between road approach and LWSC surface should be less than 12 feet.

Stream characteristics. Stream channel should be stable with regard to both degradation and lateral migration.

Cost. The cost of constructing an LWSC should be considerably less than the cost of replacing a bridge/culvert.

Selecting LWSC type

Once a site has been determined to be an LWSC candidate, the type of crossing should be selected. There are three common types of LWSCs: unvented fords, vented fords, and low water bridges.

- **Unvented fords** are constructed of crushed stone, riprap, or precast concrete slabs to provide a stream crossing without the use of pipes.

Unvented fords are best suited for streams that are dry most of the year or where normal streamflow is less than six inches deep, at a low velocity. Unvented fords are the least costly of the three LWSC types.

- **Vented fords** (see photo, top right) use pipes under the crossing to accommodate low flows without overtopping the road. High water will periodically flow over the crossing. The pipes or culverts may be embedded in earth fill, aggregate, riprap, or portland cement concrete.

Vented fords should be considered where the normal depth of flow is calculated to exceed six inches over a raised unvented ford. A vented ford can usually be constructed for \$15,000–\$20,000.

- **Low water bridges** (see photo, bottom right) are flat-slab bridge decks constructed at about the elevation of the adjacent stream banks, with a smooth cross section designed to allow high water to flow over the bridge surface without damaging the structure.

Low water bridges are the recommended LWSC choice where normal stream flows exceed the capacity of a vented ford or where the watershed has a high potential for debris that might clog the pipes of a vented ford. A low water bridge is also an appropriate alternative where the ADT exceeds five vehicles per day or where the road is relatively important, regardless of stream size. A normal low water bridge costs about \$40,000–\$50,000 to construct.



Vented ford with pipes
(Tama County, Iowa)

The Iowa Code gives boards of supervisors authority to establish reduced maintenance levels for certain roads under their jurisdiction. It is under this authority that decisions to construct LWSCs can be made.

Design and construction considerations

Specific recommendations for material selection, design, construction, and signing for each of the LWSC types are given in the *Low Water Stream Crossings* report. The following elements should be considered in any LWSC design:

- Roadway approaches should be designed to provide a smooth transition, with acceptable approach grades of less than 10 percent.
- The approach should have a 750-foot minimum sight distance for warning signs.
- The channel cross section should not be altered.
- Vegetation should be established to provide stream bank protection.
- Stream bank height should not exceed 12 feet.
- Height of crossing above stream bed should be less than four feet.
- Overtopping depth for normal flow should be less than or equal to six inches.

In addition, for vented and unvented fords, cutoff walls and minimum 4:1 sidewalls (foreslopes) should be provided for core material protection and safety. Aprons should be included with pipes.

Limiting liability

The Code of Iowa Section 309.79 states that all bridges and culverts must comply with design standards and specifications furnished to local agencies by the Iowa DOT.

However, the Code also gives boards of supervisors authority to establish reduced maintenance levels for certain roads under their jurisdiction. It is under this authority that decisions to construct LWSCs can be made.

To minimize exposure to tort liability, local agencies using low water stream crossings should adopt reasonable selection and design criteria and provide adequate warning ahead of these structures to road users. Recommended placement of “Flood Area Ahead,” “Impassable During High Water,” and “Do Not Enter When Flooded” signs is provided in the report. Proper placement of these signs, along with an illustration of a suggested typical layout for signing an LWSC, is also described in *Iowa Traffic Control Devices and Pavement Markings: A Manual for Cities and Counties* (TCD manual), an Iowa Highway Research Board sponsored project (TR-441).

For more information

The *Low Water Stream Crossings* report is available on CTRE’s website, www.ctre.iastate.edu/research/search.cfm. The TCD manual is also online: www.ctre.iastate.edu/pubs/itcd/index.htm.

For more information, contact Dr. Lohnes, 515-294-8746, rlohn@iastate.edu; or Dr. Gu, 515-294-4534, roygu@iastate.edu; or Tom McDonald, 515-294-6384, tmcdonal@iastate.edu.



Low water bridge
(Benton County, Iowa)