



# Project Summary

Texas Department of Transportation

## 0-6262: Signing Guidelines for Flooding Conditions and Warrants for Flooded Conditions Detection Systems

### *Background*

Each year, six to eight vehicle-related flood fatalities occur on Texas roadways. Experience has shown that a surprisingly small amount of water (less than 2 ft, depending on the speed and angle of the current, the design of the vehicle, and type of pavement surface) can wash a vehicle off a roadway during a flooding event. One reason why some drivers enter flooded roadway crossings is that they cannot adequately judge the speed and depth of the water covering the roadway. This research effort sought to assist the Texas Department of Transportation (TxDOT) in developing signing layouts to reduce the potential for drivers to enter flooded sections of highways. Specifically, this research examined several static and active warning sign systems that could be used to warn motorists at low water and flood-prone crossings. These signing treatments would be deployed both at the crossings themselves and in key decision points on roadways with multiple flood-prone crossings.

### *What the Researchers Did*

The research team first conducted a nationwide state-of-the-practice review of different signing and warning sign technologies that state and local agencies use to warn drivers about flooding at low water and flood-prone crossings. The researchers then conducted a series of focus groups throughout the state of Texas to determine signing and information needs of drivers when facing the decision to proceed through a flooded highway crossing or not. Using the results of these focus groups, the research team identified several candidate signing and warning sign strategies. The team tested these strategies in a series of driver comprehension surveys conducted in four cities in Texas. The researchers then used the findings of these surveys to develop recommended standard signing and warning sign treatments that TxDOT could deploy at flood-prone highway crossings.

### *What They Found*

The research team found several factors affecting drivers' decisions to cross flooded highways, including the speed and depth of the water and the availability and convenience of alternate routes. From the studies, the researchers provided the following recommendations:

#### *Research Performed by:*

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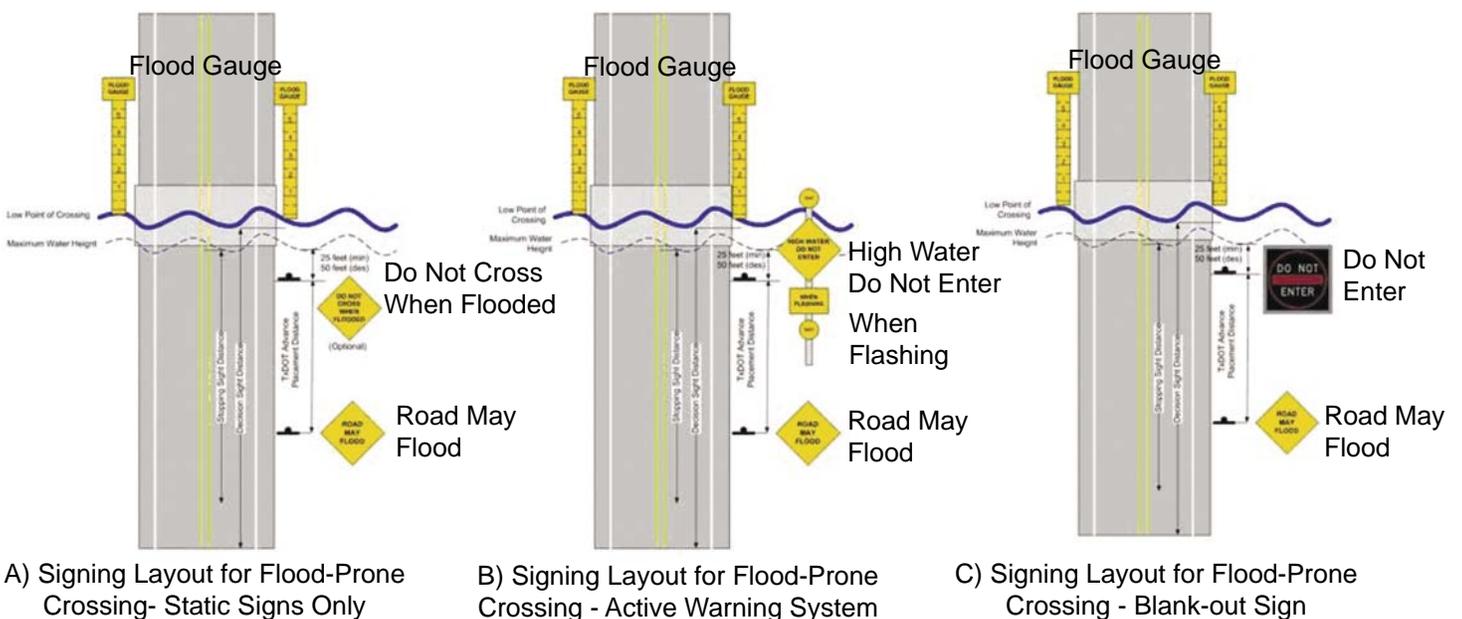
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- Every crossing should be equipped with a water depth gauge and an advance sign. The water depth gauge allows drivers to determine the depth of the crossing and the advance sign alerts drivers to the presence of a crossing.
- Drivers prefer strong signing treatments that give them positive guidance regarding what actions are needed (i.e., DO NOT CROSS WHEN FLOODED or HIGH WATER: DO NOT ENTER) over signing treatments that provide only informational messages (i.e., ROAD MAY FLOOD).
- Drivers also prefer conspicuous signs that are activated automatically by sensors than treatments which use only static signs. Use yellow flashers with active warning assemblies.
- Adding stop bars upstream of the crossing did not influence the drivers' decisions regarding whether or not to proceed through the crossing when flooded. Water level had a more significant impact on this decision.
- On roadways with multiple flood-prone crossings, drivers prefer warning messages that tell them at major decision points the status of each roadway crossing.

## What This Means

Using the results of the driver comprehension study, the research team developed several candidate options for improving the signing layouts for flood-prone crossings on Texas highways (see the figure below). The researchers believe that through the consistent application of these signing layouts, TxDOT can significantly reduce the potential for flood-related fatalities and high water rescues on flood-prone highways in Texas.



**This Figure Illustrates Recommended Signing Treatments for Flood-Prone Areas on Texas Highways**

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