

# TxDOT Project 0-6992: Traffic Safety Improvements at Low Water Crossings



**Kevin Balke (co-PI)**  
Texas A&M Transportation Institute,  
College Station, Texas

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# Acknowledgments

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**Project Panel:** Ab Maamar-Tayeb, Adam Jack, Adam Kaliszewski, Arturo Perez, Chris Cowen, Jianming Ma, John Bassett, John Gianotti, Joseph Muck, Ken Mora, RoseMarie Klee, Steve Chiu

## **TTI**

Chiara Dobrovln (PI), Adam Pike,  
David Florence, Hassan Charara,  
Nadeem Chaudhary, Stefan Hurlebaus,  
Subasish Das, Roger Bligh, Dick Zimmer  
Geza Pesti, Timothy Barrette

## **Southwest Research Institute**

Cameron Mott  
John Esposito  
Darin Parish  
Purser Sturgeon, II

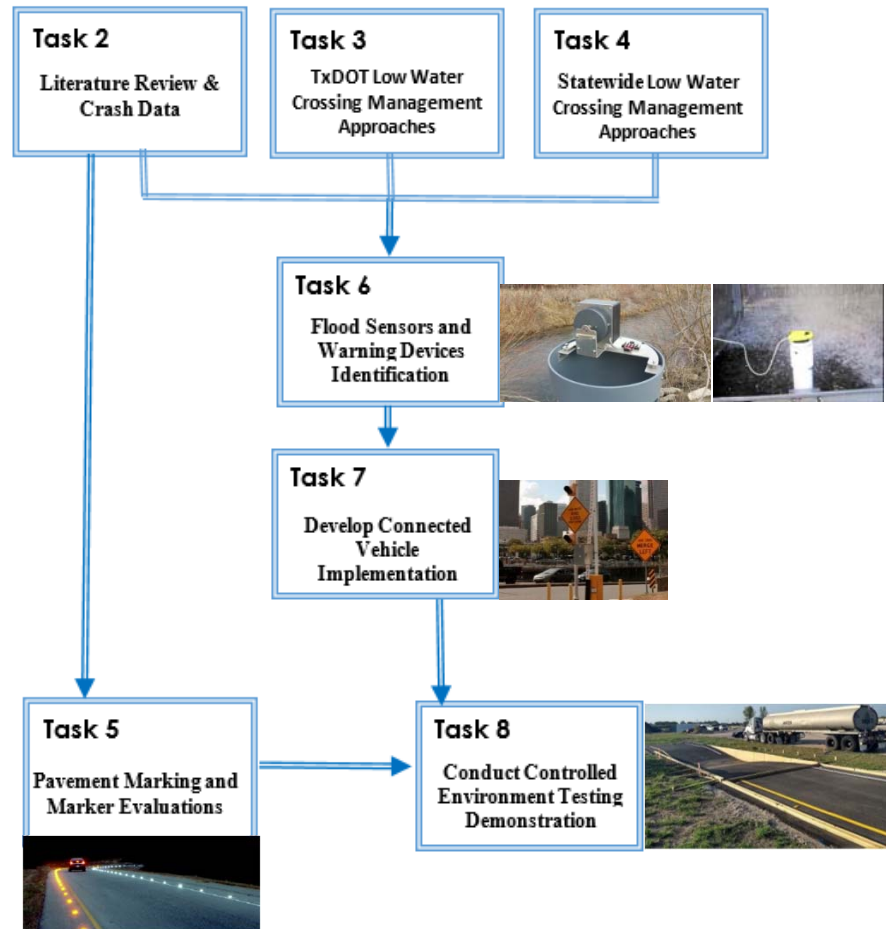


# Motivation

- Texas leads Nation in flood-related deaths
- Majority of deaths caused by motorists driving through moving water (Low Water Crossing, Nighttime)
- 18-24 inches of moving water sweep away truck, 6 inches for small car
- Impractical to raise /remove all low water crossings
- Low-cost means to better alert driving public to these risks



# Methodology



# Low Water Crossing Management Approaches – State of the Practice Review

- Developed a synthesis of relevant information by reviewing the research literature and state policy documents regarding low water crossing related issues.
- Review was further divided into following **categories**:
  - Safety Issues
  - Countermeasures and Design Alternatives
  - Behavioral Issues
  - Consequences

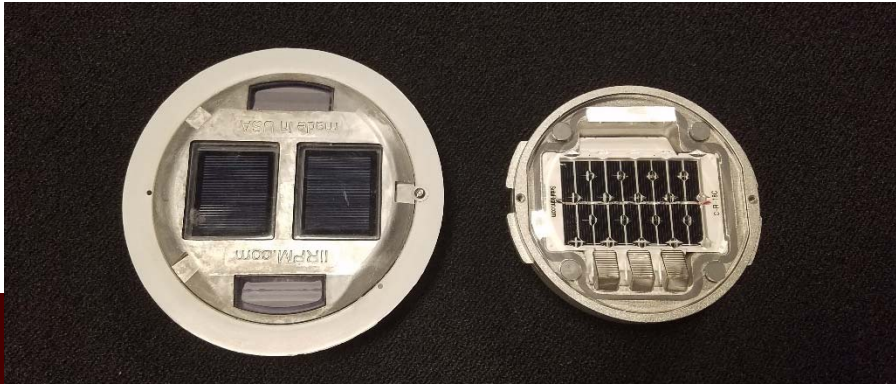
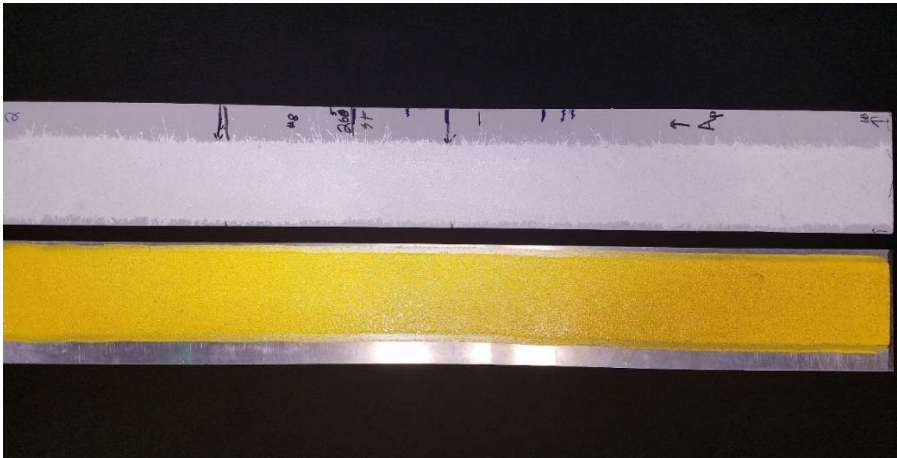
# Survey Management Approach

- Surveyed TxDOT and other national agencies
  - LWC design and countermeasure implementation protocol
  - Criteria and methods for diagnosing problems and choosing advanced alternatives,
  - LWC inventory and management approaches.
- Findings
  - **88% respondents** indicated that the area offices **do not have formal** LWC inventories
  - **44% respondents** indicate that the area offices **have developed** LWC design and countermeasure implementation protocols

# Pavement Marking/Marker Evaluations for Low Water Crossings

- 1) Evaluate visibility of markings and markers in dry and flooded conditions to determine if they provide adequate visibility to indicate the flooded condition
- 2) Evaluate impact of various factors on the treatment visibility
  - 1) Day vs night
  - 2) Water depth
  - 3) Water clarity
  - 4) Treatment type (standard markings, wet-weather markings, RRPMS, IIRPMS)

# Types of Markings and Markers Evaluated





# Initial Small Scale Testing



# Full Scale Testing

## Marking and Marker Evaluations

- Wet, Dry
- Day, Night

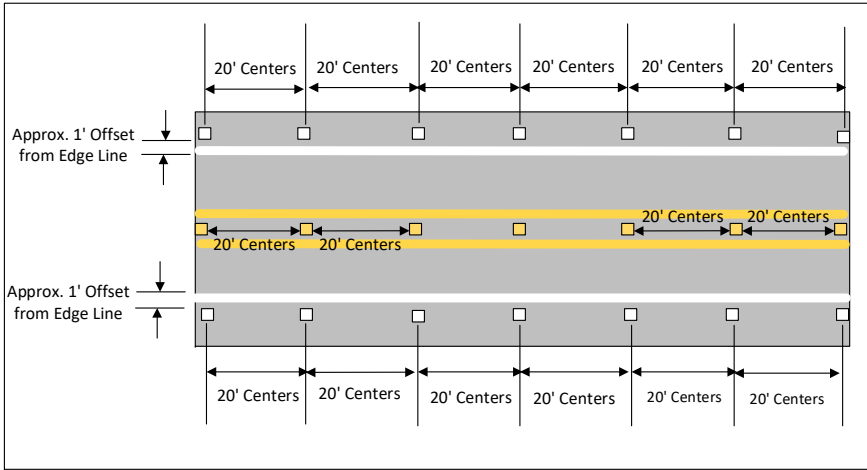


# Candidate LWC Delineation Enhancements

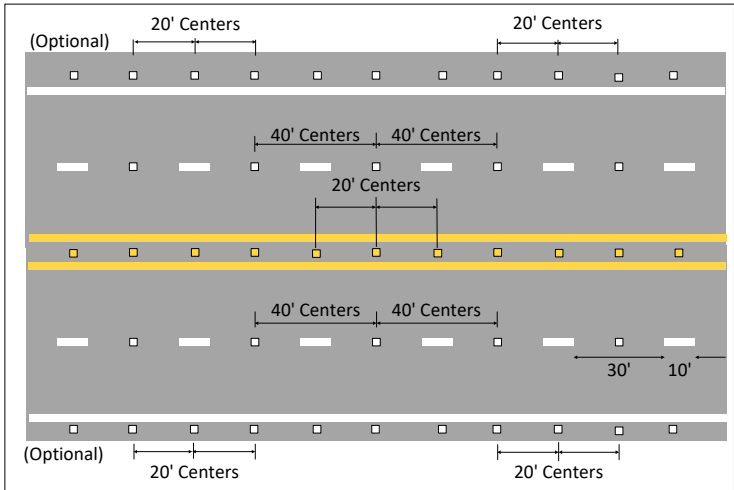
- Ensure standard marking through crossing are well maintained.
- Supplement with RRPM
  - Install offset white RRPMs on edge line (if possible)
  - Decrease spacing of yellow RRPMs
  - Extend through flood area
- Rationale: Driver will notice “gap” in marking when flooded
- Consider using Internally Illuminated Raised Pavement Markers (IIRPMs) at problematic locations
  - Activated during flood conditions
  - Longitudinal – yellow to delineate center line
  - Lateral – red to indicate stop and turn around condition
  - Requires request for experimentation



# Proposed Delineation Details

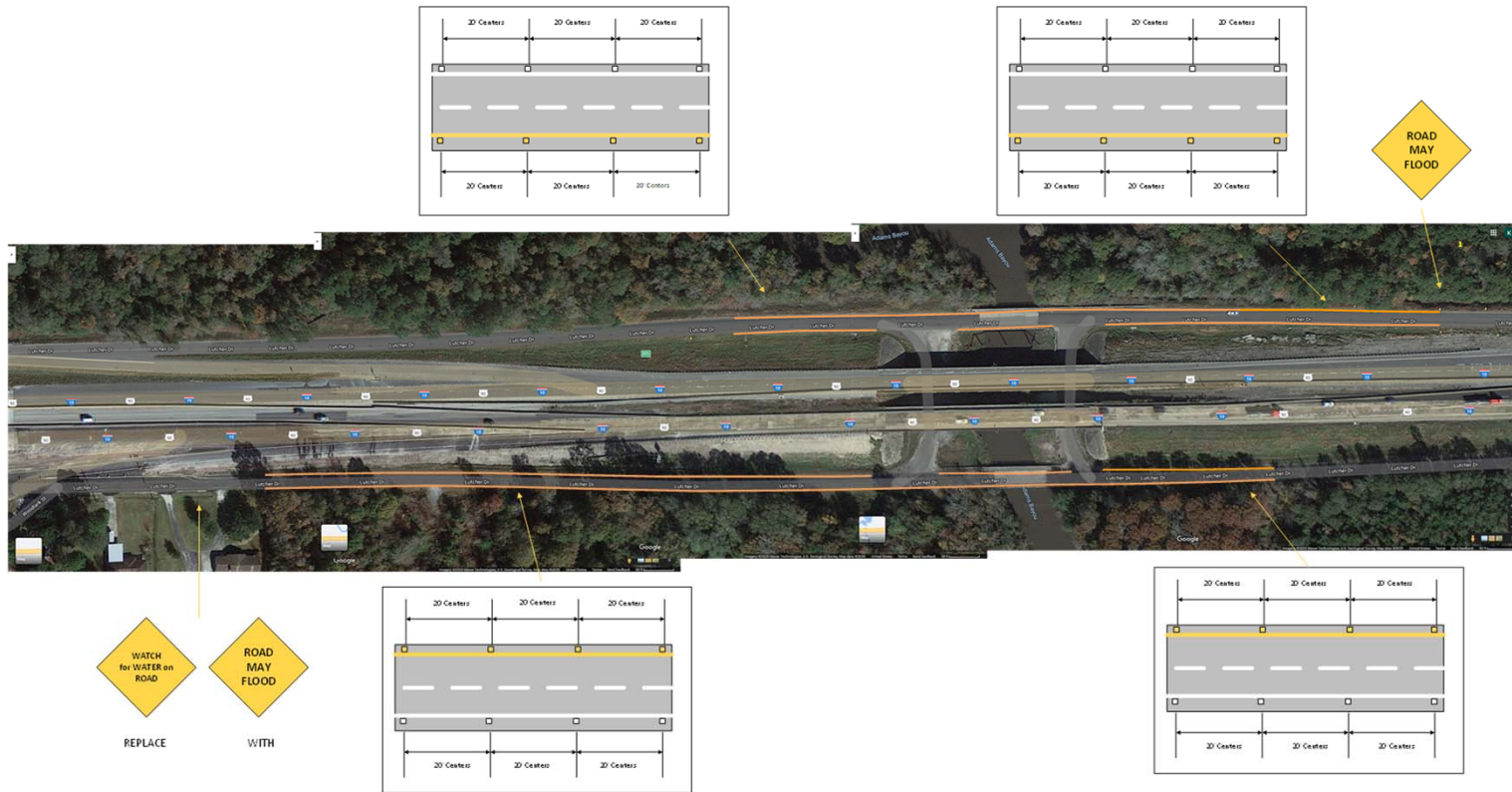


Two-Lane, Undivided



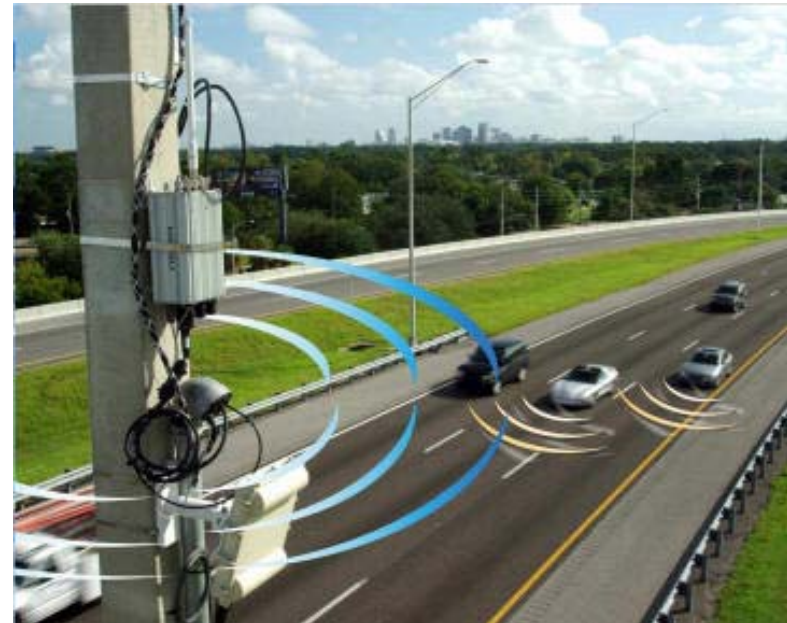
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# Developed Proposed LWC Enhancement

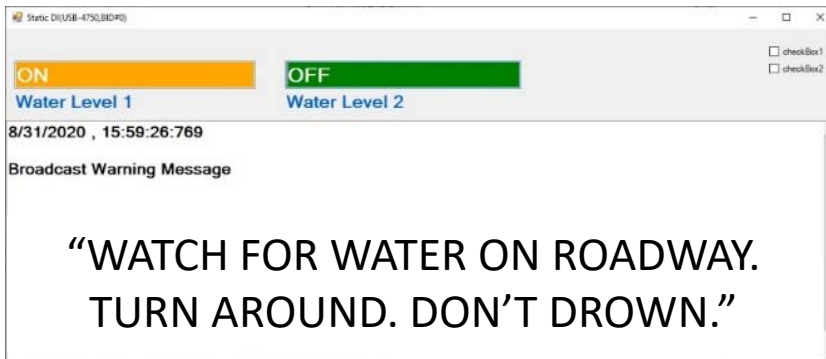


# Application of CV Technologies to Low-Water Crossings

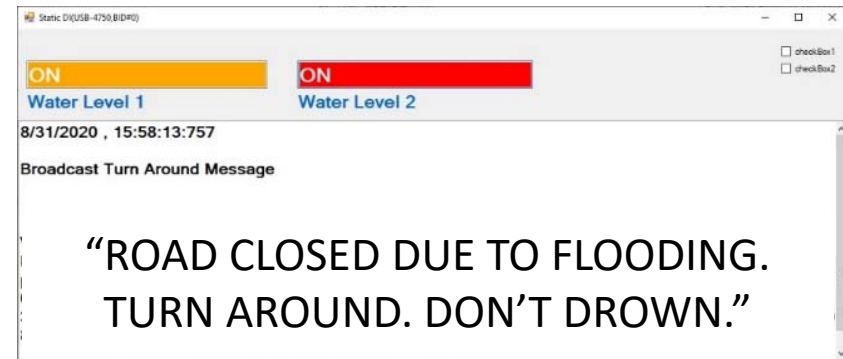
- Explore the use of Connected Vehicle technology
- Links infrastructure and vehicles through dedicated short-range communications
- Allows alerts and messages to be broadcast directly to vehicles
- Two deployment options
  - Standalone deployment
  - Integrated with the Lonestar software through a TMC



## LEVEL 1: ALERT MESSAGE



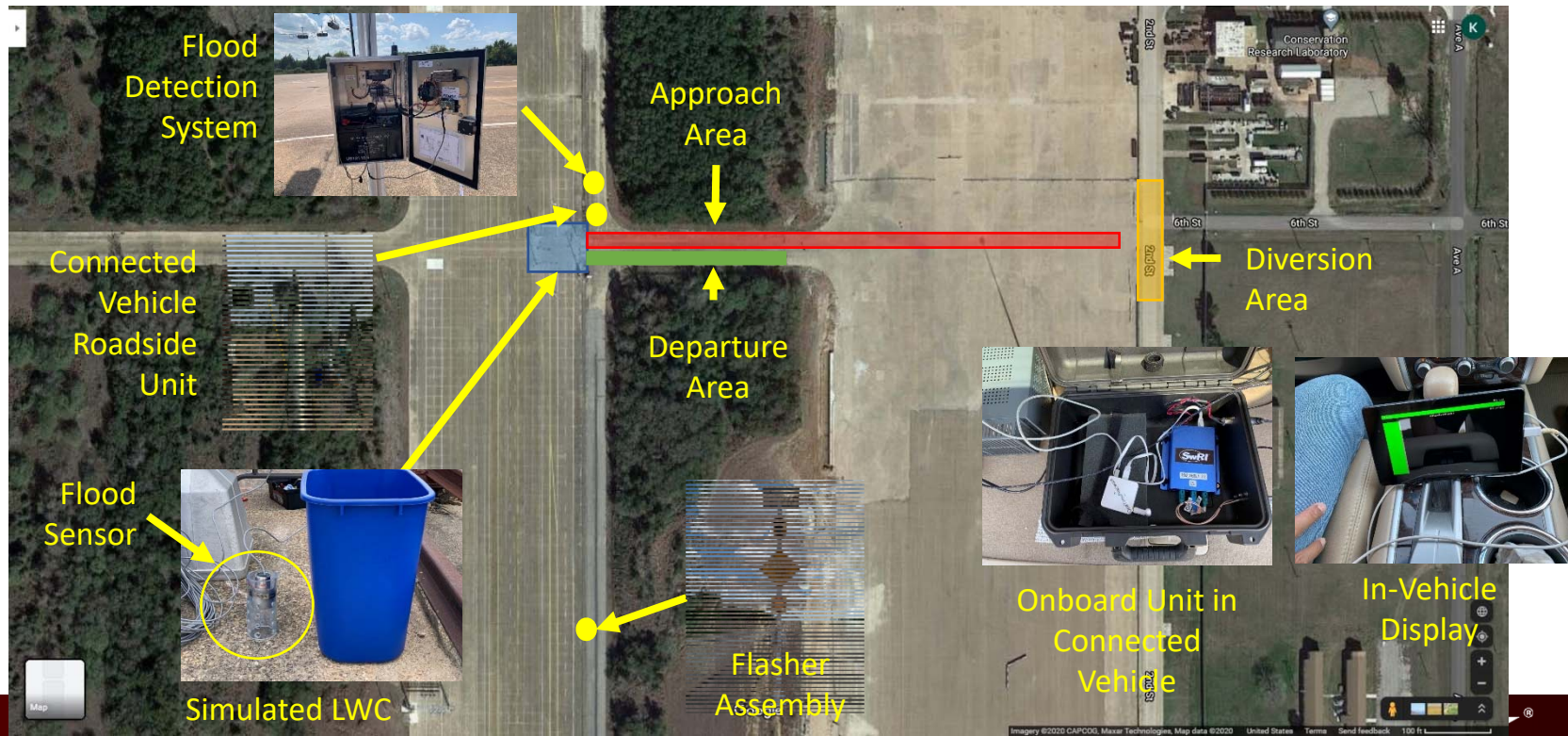
## LEVEL 2: WARNING MESSAGE



## DIVERSION MESSAGE



# Connected Vehicle Testbed Deployment





# Summary of Results

- The research explored strategies and techniques designed to discourage motorists from entering flooded grade crossings resulting in lives saved.
- Increased the level of knowledge of TxDOT personnel related to the issues and potential solutions for improving safety at LWCs on TxDOT highways.
- The research has the potential to improve the quality of life for Texas motor vehicle operators. The public benefits from more precise and accurate information about the status of the hazards associated with flooded crossings.
- The project also demonstrated how TxDOT could integrate advanced technologies for disseminating warnings and alerts to drivers directly in their vehicle.

# TxDOT Products

Product P1. Webinar Presentation

Product P2. Guidelines for Enhancing Delineation at TxDOT LWCs

Product P3. Cross Reference Database to identify suitable locations for the implementation of LWC countermeasures

R1A. Research Report (Including VoR)

PSR. Project Summary Report

R1B. Research Report



Chiara Dobrovolny, Ph.D. (PI)  
*Research Scientist*  
*Texas A&M Transportation Institute*  
*Ph.: 979-317-2687*  
*E-mail: [c-silvestri@tti.tamu.edu](mailto:c-silvestri@tti.tamu.edu)*

Chris Glancy (PM)  
*Texas Department of Transportation*  
*Ph.: 512-416-4747*  
*E-mail: [Chris.Glancy@txdot.gov](mailto:Chris.Glancy@txdot.gov)*