



2019 MINNESOTA TOWARDS ZERO DEATHS STATEWIDE CONFERENCE



CROW WING COUNTY CURVE ADVISORY SIGNING



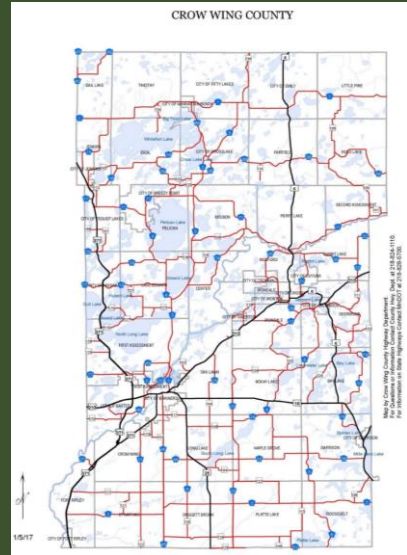
Recent projects:

- Chevrons
- Grooved-in markings
- Flashing stop signs
- Dynamic speed signs



- Due largely to lakes, straight roads are not a common occurrence in Crow Wing County.
- Overall on roughly 650 miles of roadway, there are approximately 1,000 horizontal curves.
- Along with pavement markings and chevrons, curve advisory speed limits represent an important safety measure for drivers.





Past Process:

- Two employees driving each curve multiple times.
- One driving, one “eye-balling” a slope meter and recording data.
- The process works, but has drawbacks – safety, accuracy, future data needs, etc.



New Process:



Curve Warning Evaluation

Mike Shomion

Curve Safety

- Roadway departures account for more than 50% of all traffic fatalities, over half of which occur at horizontal curves.
- There was an average of 18,779 fatalities between 2014 & 2016 due to roadway departure.
- 27%+ of all traffic fatalities deaths occur at horizontal curves in any year

FHWA Home / Safety / Roadway Departure / Roadway Departure Countermeasures	
Crash Facts	Roadway Departure Countermeasures
Technical Assistance/Tools	The FHWA's Roadway Departure Safety Program provides important information for transportation practitioners, decision makers, and others to assist them in preventing and reducing the severity of roadway departure crashes.
Policy/Guidance	
Research/Resources	Roadway departure crashes are frequently severe and account for the majority of highway fatalities. In 2009, there were 16,265 fatal roadway departure crashes resulting in 18,087 fatalities, which was 53 percent of the fatal crashes in the United States. A roadway departure crash is defined as a non-intersection crash which occurs after a vehicle crosses an edge line or a center line, or otherwise leaves the traveled way.
Retroreflectivity & Visibility	
Roadside Hardware	

- **Horizontal Curve Safety**

Horizontal curves are changes in the alignment or direction of the road, as opposed to vertical curves, which are a change in the slope. In 2008, more than 27 percent of fatal crashes occurred at horizontal curves, the vast majority (over 80 percent) were roadway departures. Due to the predominance of horizontal curves on typical rural roads, a higher percentage of fatal curve-related crashes occur on rural roads, particularly on two-lane roadways in rural areas. Fatality rates on rural roads are typically more than twice the rate than on urban roads, because of a number of infrastructure and non-infrastructure related issues.

- Advanced warning signs are the least expensive countermeasure, behind rumble strips, that can be used to reduce crashes at horizontal curves.
- 2012 Study showed that proper signing can reduce accidents

Curve Safety



Table 2C-5. Horizontal Alignment Sign Selection

Type of Horizontal Alignment Sign	Difference Between Speed Limit and Advisory Speed				
	5 mph	10 mph	15 mph	20 mph	25 mph or more
Turn (W1-1), Curve (W1-2), Reverse Turn (W1-3), S-curve (W1-4), Winding Road (W1-5), and Combination Horizontal Alignment/Intersection (W1-6) (see Section 2C.27 to determine which sign to use)	Recommended	Required	Required	Required	Required
Advisory Speed Plaque (W13-1P)	Recommended	Required	Required	Required	Required
Chevrons (W1-8) and/or One Direction Large Arrow (W1-6)	Optional	Recommended	Required	Required	Required
Exit Speed (W13-2) and Ramp Speed (W13-3) on exit ramp	Optional	Optional	Recommended	Required	

Note: Required means that the sign and/or plaque shall be used, recommended means that the sign should be used, and optional means that the sign and/or plaque may be used.
See Section 2C.06 for roadways with less than 1,000 ADT.



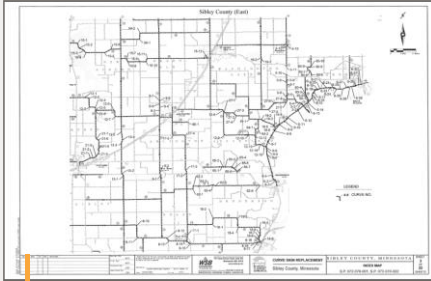
2009 MUTCD Section No. (a)	2009 MUTCD Section title	Specific provision	Effective Date
2A.08	Maintaining Minimum Retroreflectivity	Implementation and continued use of an assessment or management method that is designed to maintain regulatory and warning sign retroreflectivity at or above the established minimum levels (see Paragraph 2).	2 years of
2A.19	Lateral Offset	Crashworthiness of sign supports on roads with posted speed limit of 50 mph or higher (see Paragraph 2).	January 17, 2013 (date established in the 2009 MUTCD)
2B.40	ONE WAY Signs (R6-1, R6-2)	New requirements in the 2009 MUTCD for the number and locations of ONE WAY signs (see Paragraphs 4, 8, and 10).	December 31, 2019.
2C.06 through 2C.14	Horizontal Alignment Warning Signs	Revised requirements in the 2009 MUTCD regarding the use of various horizontal alignment signs (see Table 2C-5).	December 31, 2019.

MUTCD Mandate

Compliance Date: December 31, 2019

- MUTCD mandates that all horizontal curves with 1,000 ADT be assessed for curve warning signing by December 31, 2019
- Table 2C-5 *changes the sign requirements*, replacing 10 degree with 12/14/16 degree standard
- New chevron requirements
 - Require the radius of the curve
 - Lower speed differentials
 - New spacing requirements
- Incorrect signs to be removed*

Past Experiences



Sibley County

- Aerial radius measurement with assumed cross slope
- Over 200 curves resigned



North Dakota DOT

- Over 1400 curves
- Digital Accelerometer
- GIS maps for tracking

We needed a better solution





We needed a process that provided:

- Safe curve advisory speed for horizontal curves
- Curve geometry and characteristics
 - Radius and super-elevation
- Simple graphical sign placement for warning signs
- Individual curve reports
- Calibration records to assure quality
- Secure data storage
- Cloud service

CARS™



Curve Advisory Reporting Service

CARS Key Benefits

- *Met all of our requirements*
- *Safety*
 - Drive any speed with traffic
 - Continuous driving of roadway
 - No turning around
- *Accuracy and Uniformity*
 - Data collection and assessment is fully automated
- *Future Proofed Solution*
 - **Protected from speed limit and standards changes**
 - Cloud portal and individual curve reports for tort protection

Crow Wing County Contracts with:



for County Wide Curve Evaluation

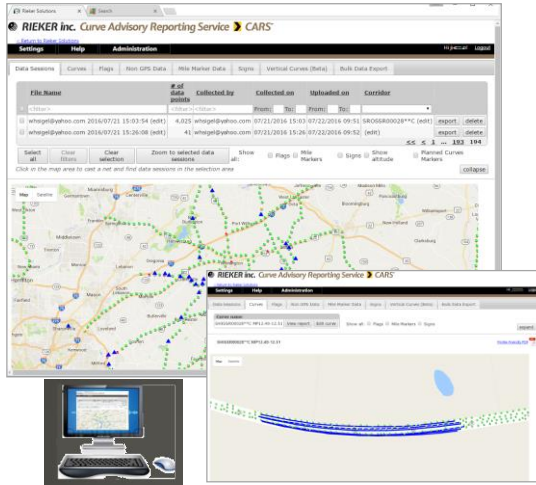
WSB's Tasks

- *Provide all data collection using the CARS system on county roads.*
- *Process collected data using the CARS system*
- Deliverables
 - Curve reports for each curve
 - Simple spreadsheet with all curve outputs
 - Spreadsheets with all data collected
 - GIS map and database

Data Collection

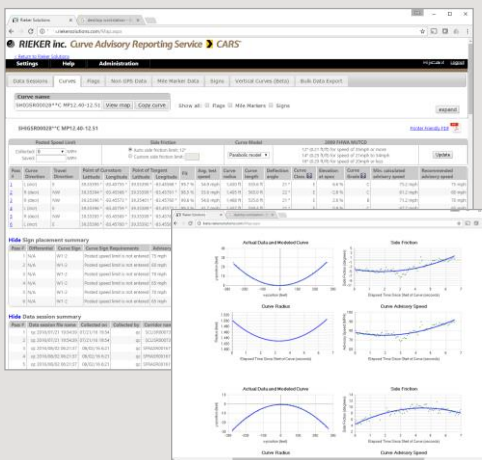
- Minimum of 2 passes in each direction
- Continuous driving of corridors
- Rush Hour Driving
- Safety





Data Processing

- Intuitive system
- Best fit of curves
- Engineer reviewed

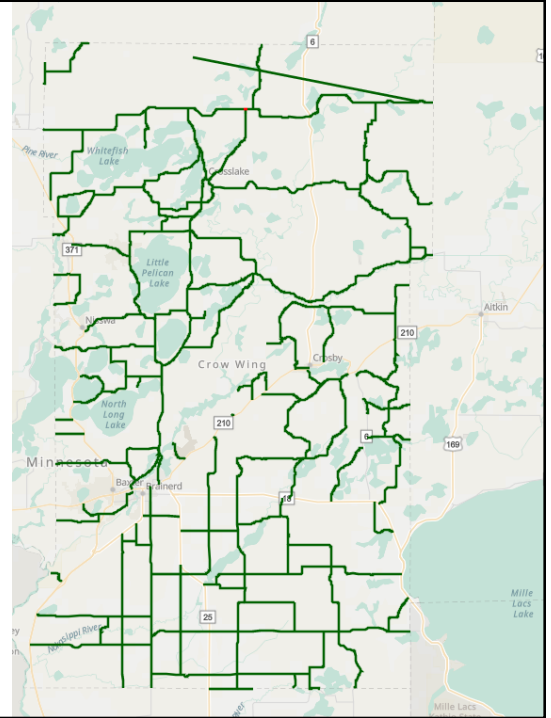


CARS Curve Report

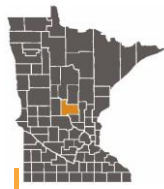
- Data export of all collected and processed data
- Detailed graphs and tables, all customizable
- Administrative and project management tools
- Test speed
- Data fit
- Curve and grade classifications
- Chevron requirements and spacing

Crow Wing County Evaluation Results

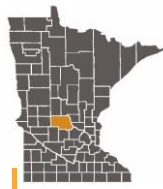
- 600 miles of County roads evaluated
 - Paved and gravel
- 933 curves evaluated with reports
- Data collection was 2 weeks
- Data processing was 2 weeks
- Rob's thoughts



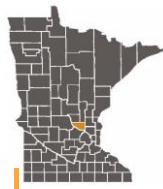
Others who have used this new method



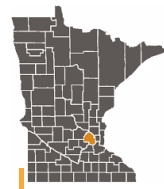
Morrison County



Stearns County



Sherburne County



Hennepin County



Questions?

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