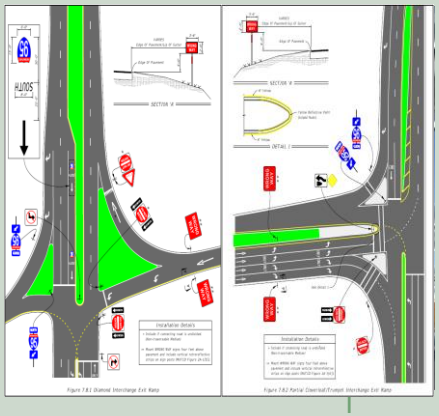
Wrong-Way Driving:
The Florida Experience

Traffic Engineering & Operations Office

Florida Department of Transportation

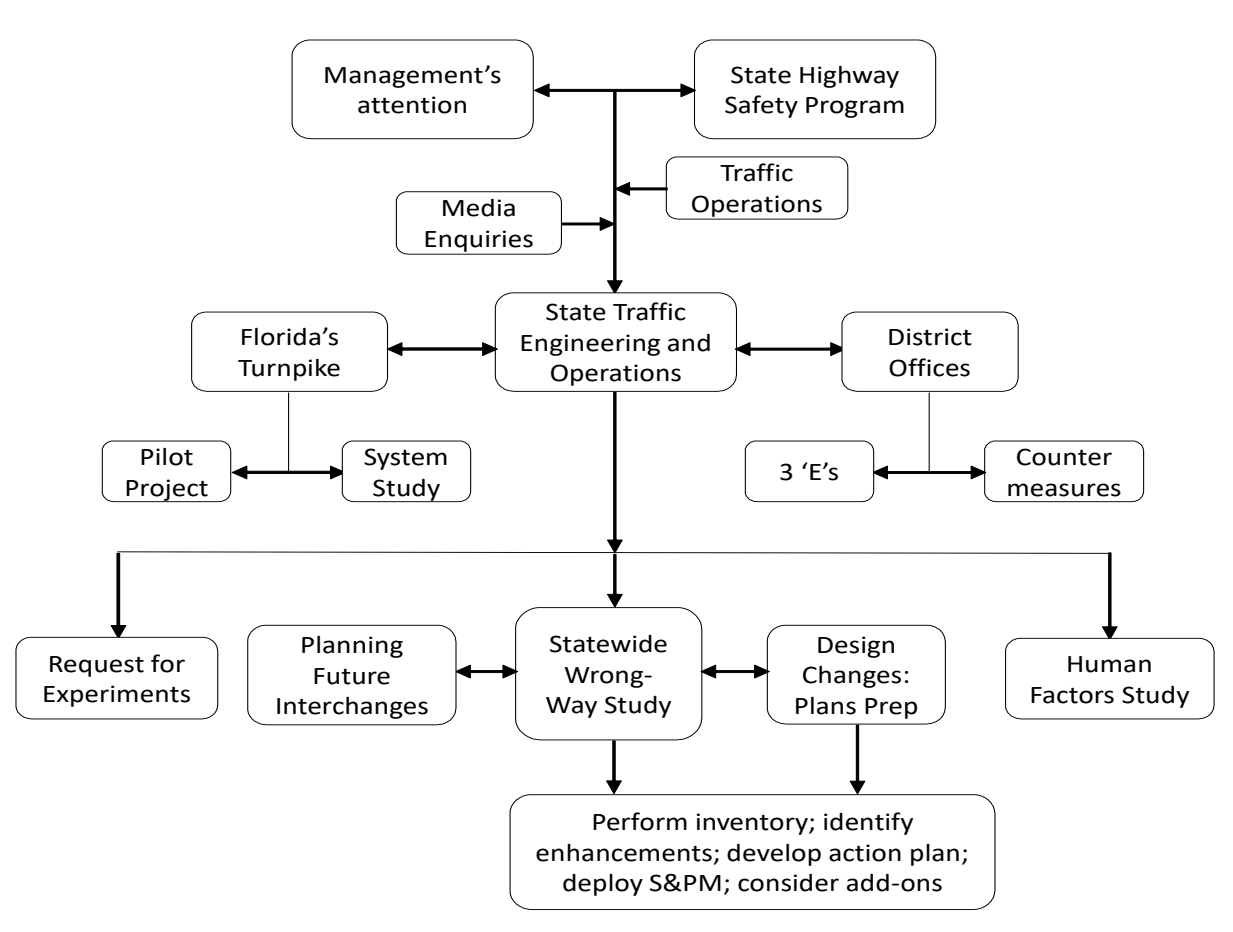
November 21, 2016



Overview

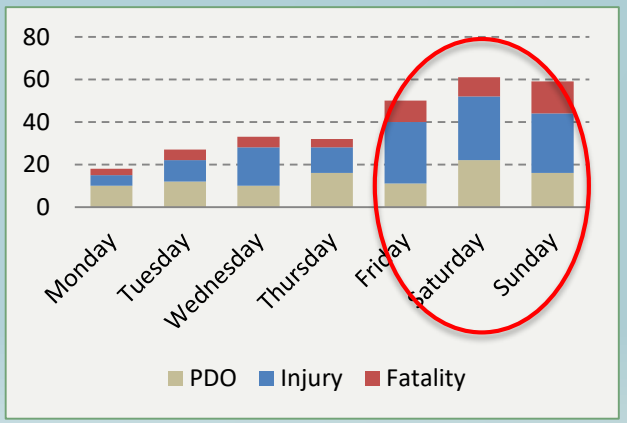
- FDOT Traffic Ops developed the statewide effort to address WWD.
- Discussions with the District Traffic Engineering & Operations Offices.
- Statewide crash data were analyzed.
- FTE and D3: developed and implemented pilot projects.
- D7 conducted a District-wide implementation and evaluation.
- All Districts evaluating WWD concerns and new standards.
- Design changes were developed with I-Pavement Shields.
- Red Rectangular Rapid Flashing Beacons (‘R’RRFB) ~ test in Tampa.
- Internally illuminated roadway pavement markers (IIRPM) ~ Panhadle.
- WWD module being developed for implementation in Sunguide.
- Recent Developments: expand RFE at FTE.

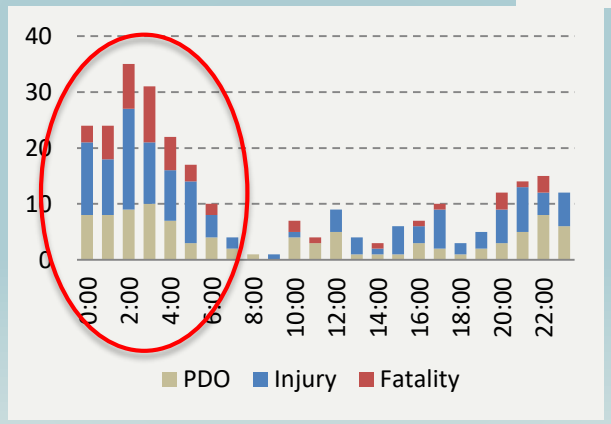
Our Process

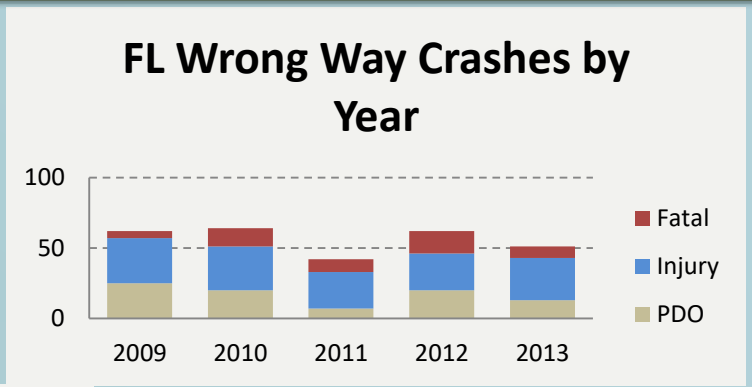

Management's attention
State Highway Safety Program
Traffic Operations
Media Enquiries
State Traffic Engineering and Operations
Florida's Turnpike
District Offices
Pilot Project
System Study
3 'E's
Counter measures
Request for Experiments
Planning Future Interchanges
Statewide Wrong-Way Study
Design Changes: Plans Prep
Human Factors Study
Perform inventory; identify enhancements; develop action plan; deploy S&PM; consider add-ons

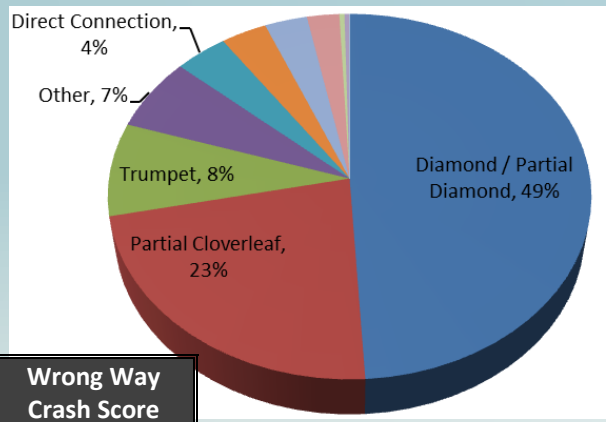
Crash Summary

- 280 statewide wrong way crashes (2009-2013)
  - 30% PDO
  - 52% Injury (411 injuries)
  - 18% Fatality (75 fatalities)



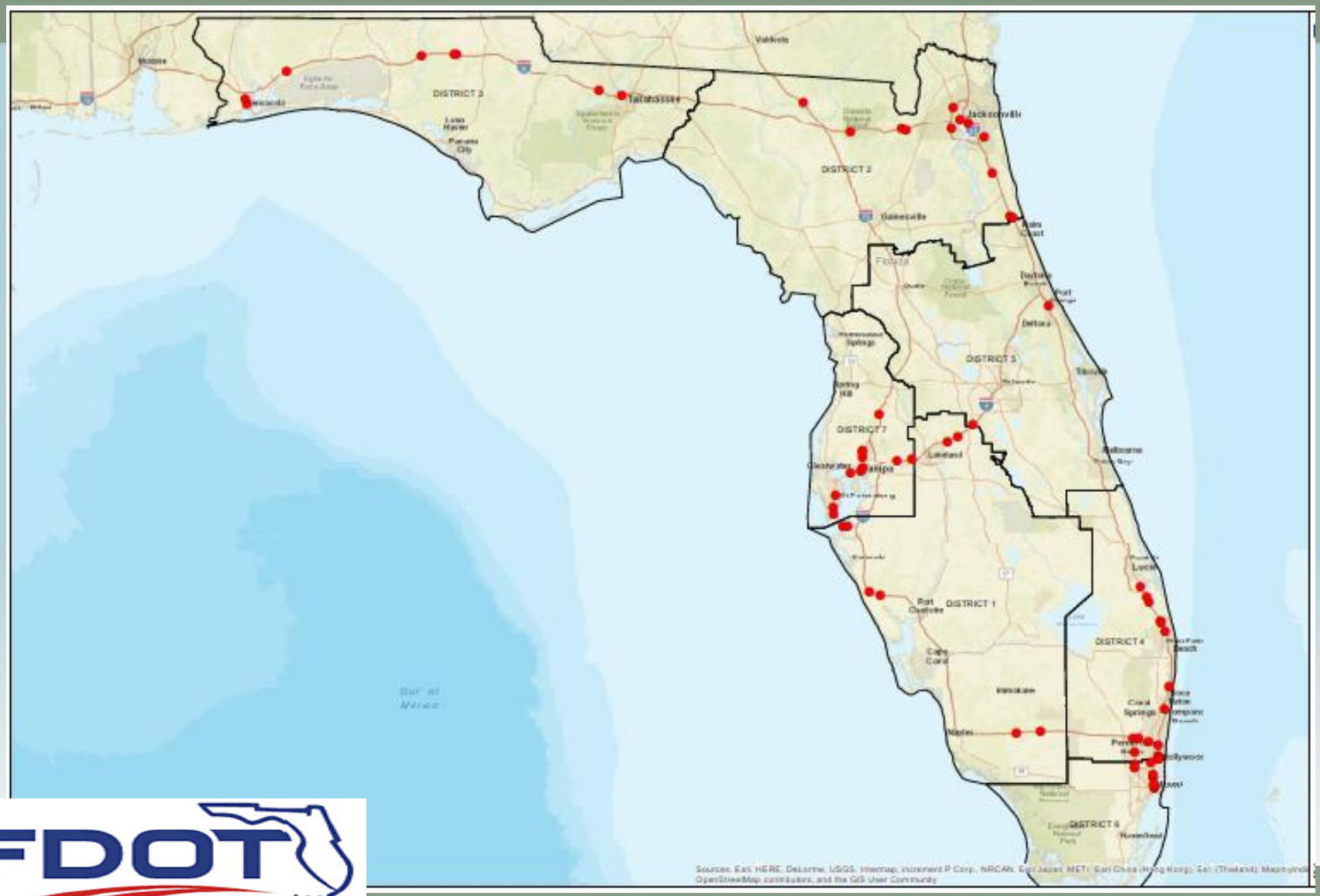




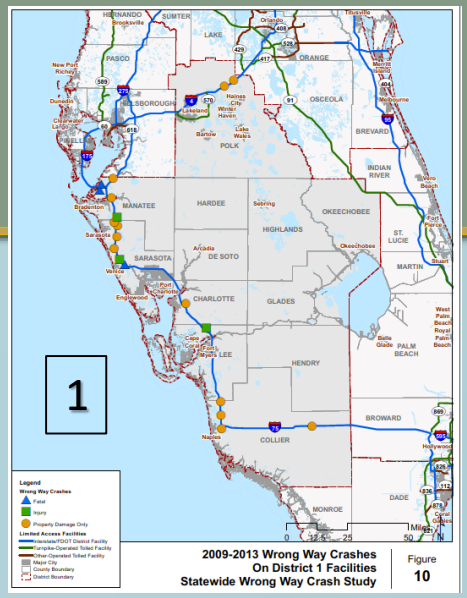


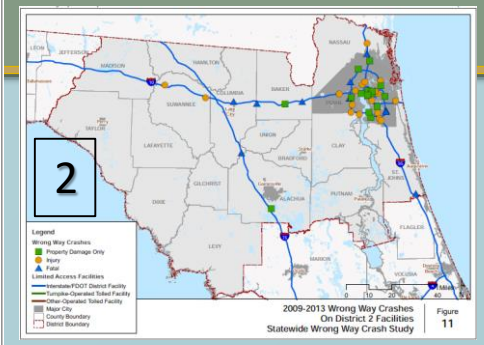
Interchange Type	Statewide Distribution Proportion	Wrong Way Crash Score Proportion
Diamond/Partial Diamond	55.7%	49.1%
2 Quadrant/Partial Cloverleaf	25.5%	22.7%
Trumpet	6.0%	8.3%
Direct Connection Design	5.7%	3.9%
Y Intersection	3.0%	3.1%

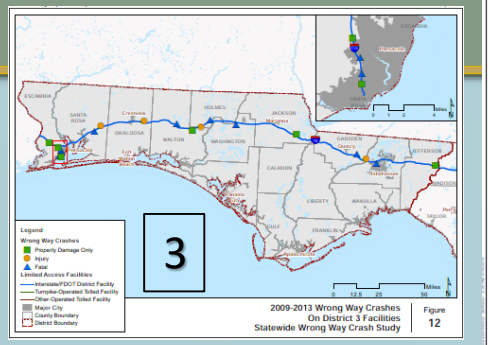
Geo-locations of WWD

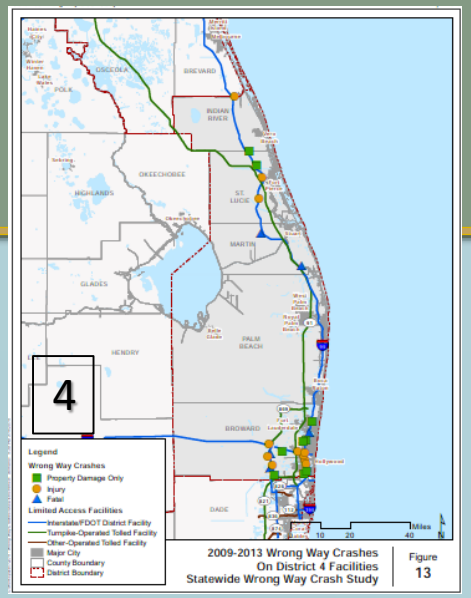


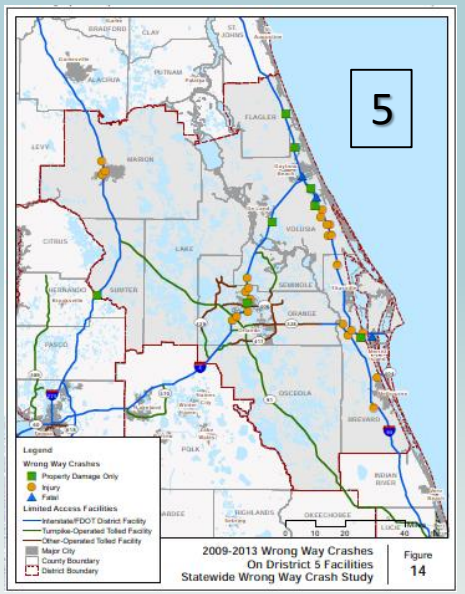
Geo distribution

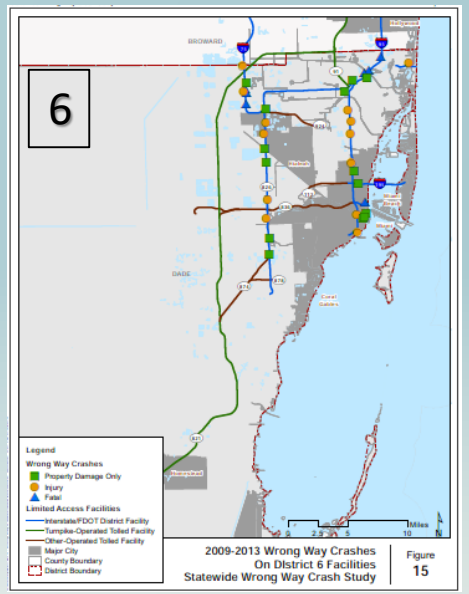


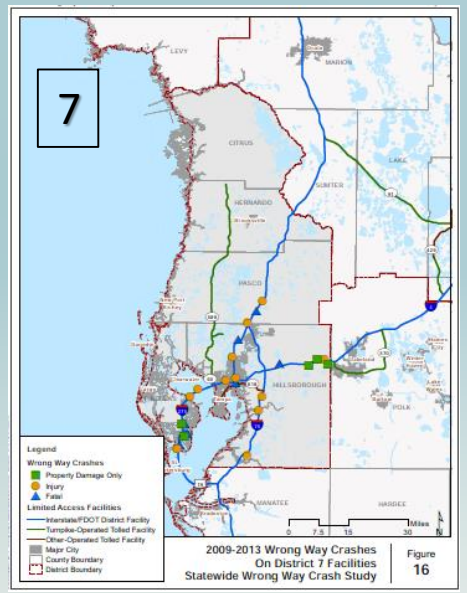


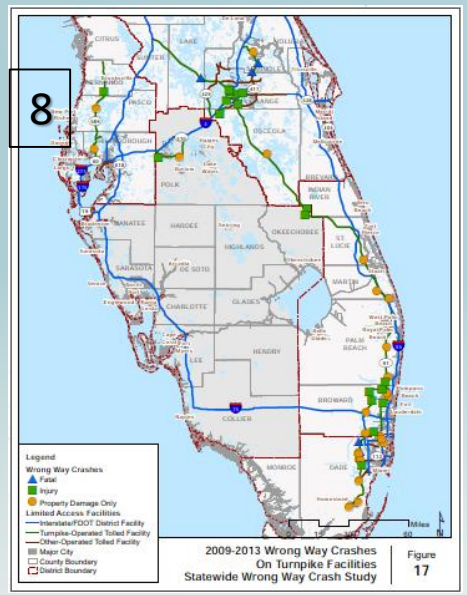






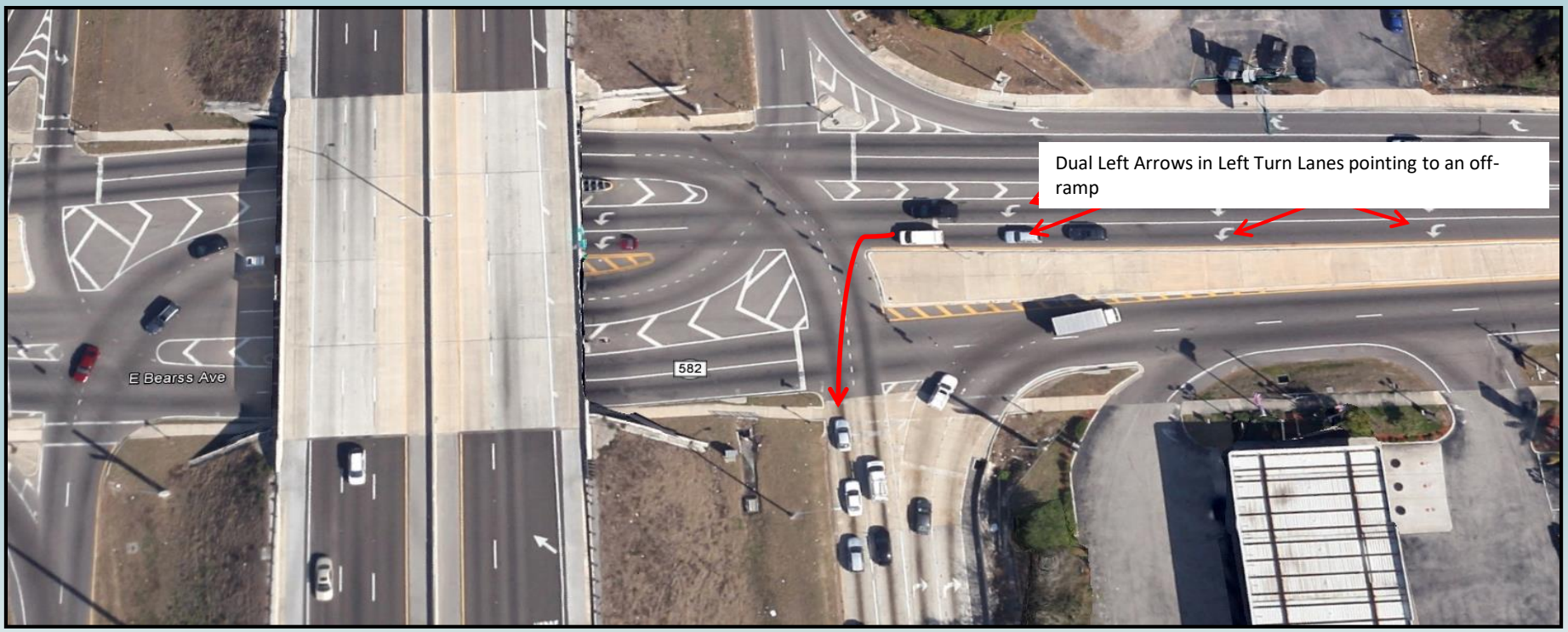






FDOT

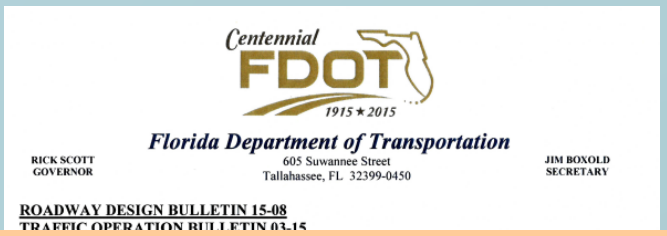
Arterial Treatment: E Bears Ave @ I-275, Dual Lefts



Interstate Shields with a Straight Arrow

FDOT Plans Prep Manual

http://www.fdot.gov/roadway/PPMManual/2017/Volume1/Chap07.pdf



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Florida Department of Transportation

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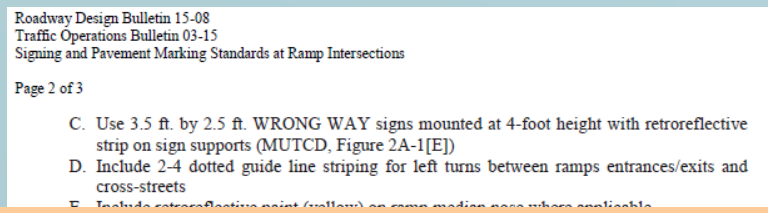
JIM BOXOLD
SECRETARY

ROADWAY DESIGN BULLETIN 15-08
TRAFFIC OPERATION BULLETIN 03-15



Roadway Design Bulletin 15-08
Traffic Operations Bulletin 03-15
Signing and Pavement Marking Standards at Ramp Intersections

Page 2 of 3

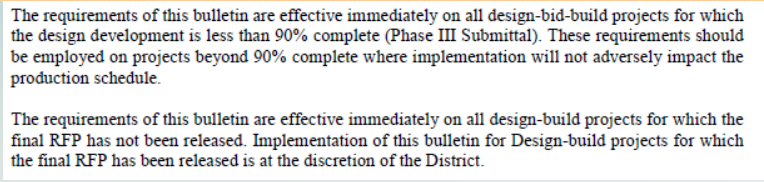
C. Use 3.5 ft. by 2.5 ft. WRONG WAY signs mounted at 4-foot height with retroreflective strip on sign supports (MUTCD, Figure 2A-1[E])
D. Include 2-4 dotted guide line striping for left turns between ramps entrances/exits and cross-streets

A. Include MUTCD "optional" signs
• Second DO NOT ENTER sign; • Second WRONG WAY sign; • ONE WAY signs
B. Include NO RIGHT TURN and NO LEFT TURN signs
C. Use 3.5 ft. by 2.5 ft. WRONG WAY signs mounted at 4-foot height with retroreflective strip on sign supports (MUTCD, Figure 2A-1[E])
D. Include 2-4 dotted guide striping for left turns between ramps and cross-streets.
E. Include retroreflective paint (yellow) on ramp median nose where applicable
F. Include a straight arrow and route interstate shield pavement marking in left-turn lanes
G. Include a straight arrow and ONLY pavement message in outside lane approaching ramp exit

A. Include MUTCD "optional" signs
- Second DO NOT ENTER sign
- Second WRONG WAY sign
- ONE WAY signs

B. Include NO RIGHT TURN and NO LEFT TURN signs

www.dot.state.fl.us



The requirements of this bulletin are effective immediately on all design-bid-build projects for which the design development is less than 90% complete (Phase III Submittal). These requirements should be employed on projects beyond 90% complete where implementation will not adversely impact the production schedule.

The requirements of this bulletin are effective immediately on all design-build projects for which the final RFP has not been released. Implementation of this bulletin for Design-build projects for which the final RFP has been released is at the discretion of the District.

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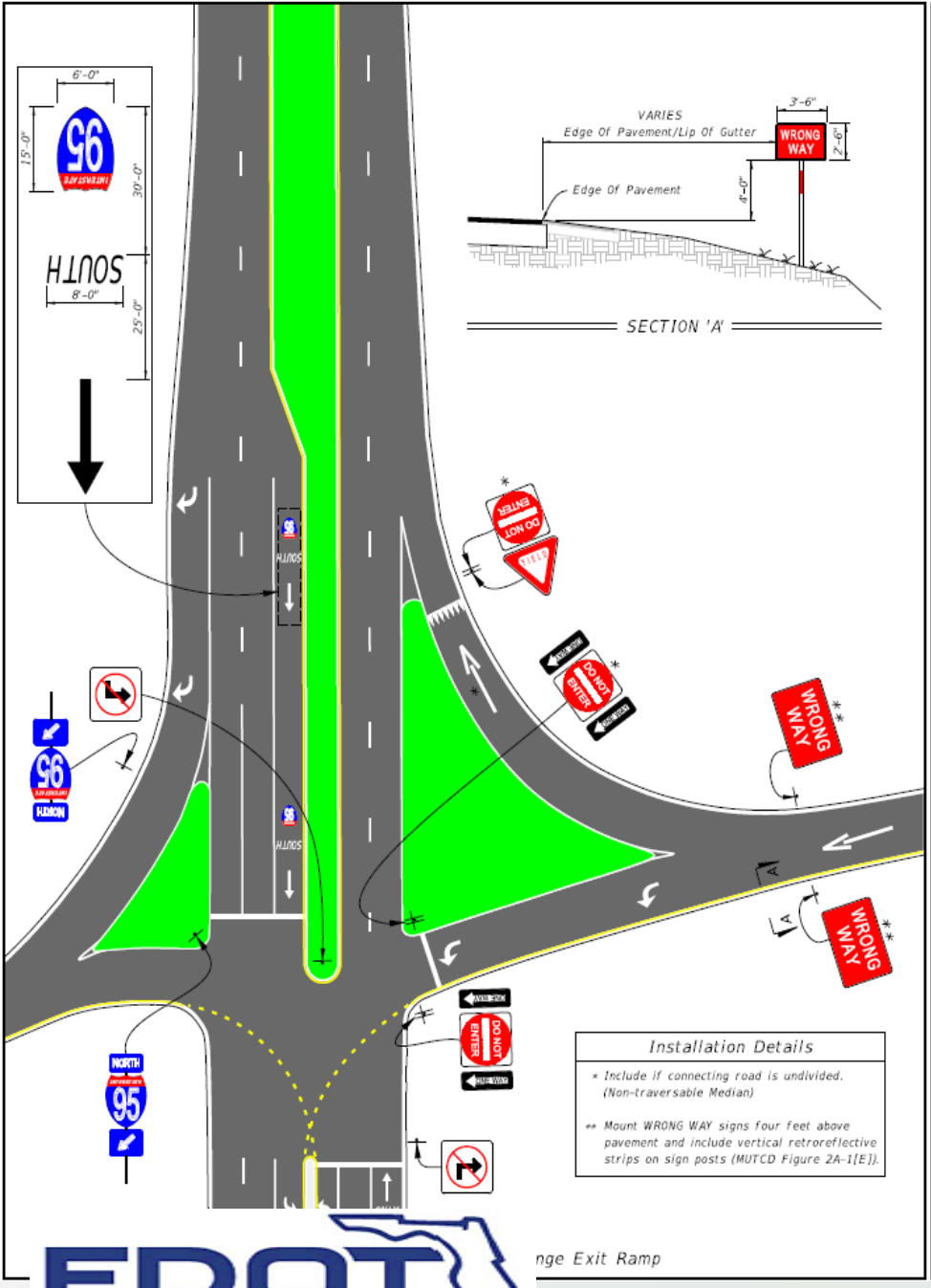

nge Exit Ramp

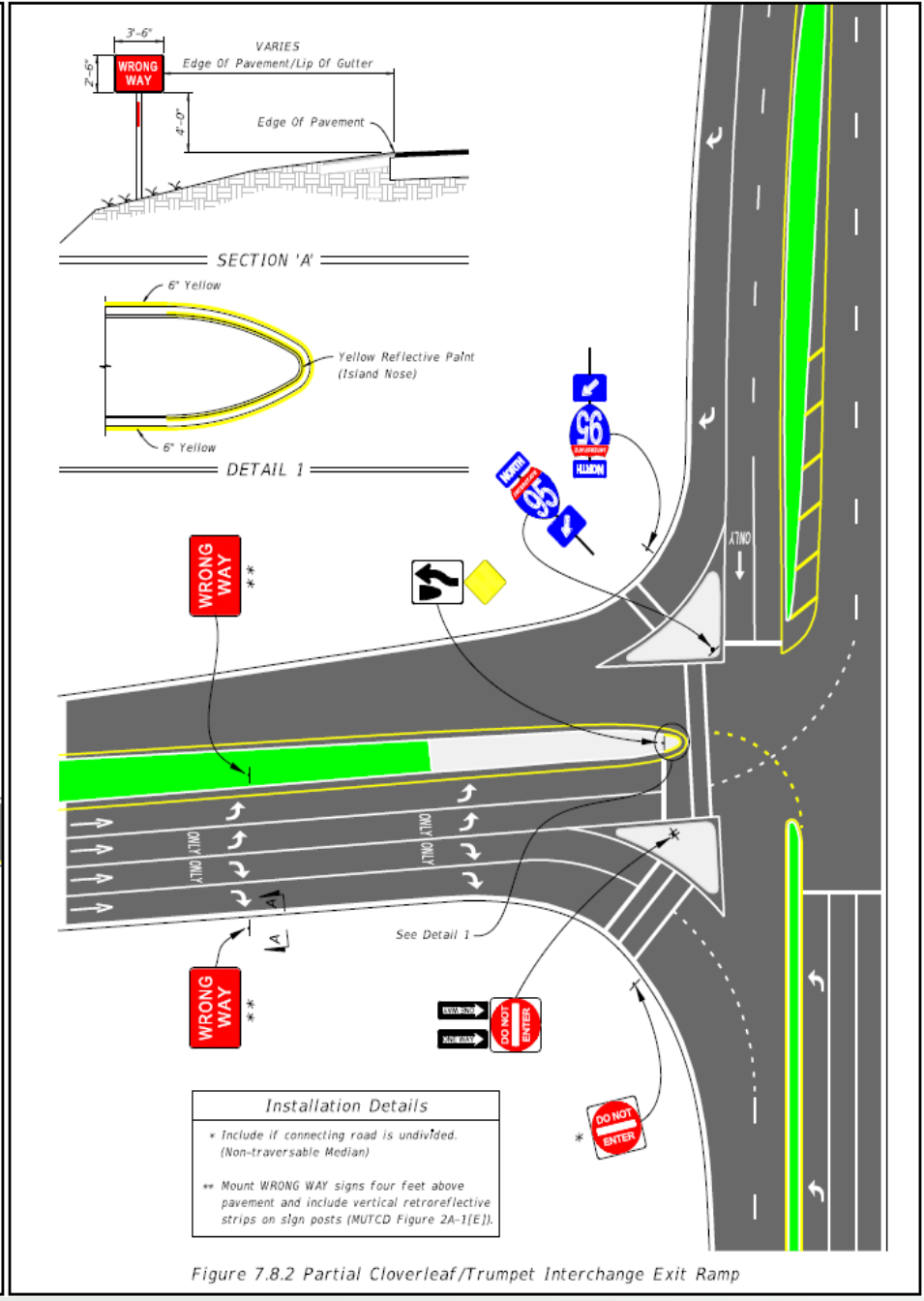

Figure 7.8.2 Partial Cloverleaf/Trumpet Interchange Exit Ramp

D7 Red RRFB in Tampa Bay Area - NB I-275 @ Fowler

D3 Internally Illuminated Roadway Pavement Markers

Research

- Arterials – more likely to have WWD
- Freeways – more likely to have fatal WWDs
- BAC a big factor in impact when WWDs occur
- Rural areas also need a closer look
- Roadway lighting is being already visited by FDOT
- We are contributing to the national knowledge pool
- ITE Journal - May 2016 Case Study

Research

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Addressing wrong-way driving as a matter of policy: The Florida Experience

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Design and planning

ABSTRACT

Wrong-way driving (WWD) incidents garner considerable interest from the media, elected representatives, and policy makers. Almost a half-century after Hulbert and Beers (1966), the National Transportation Safety Board and others continue to research WWD countermeasures. The recent increase in WWD re-kindled a national discussion in the United States of America, and is bringing about a significant change in the approach to addressing this crash type. The main purpose of this work is to present a policy-oriented framework toward addressing WWDs in a systematic manner and to suggest a systemic discipline for transforming policy objectives to actionable outcomes. To accomplish this goal, the leadership of the Florida Department of Transportation played a pivotal role in converting strategy to reality by promoting organizational linkages and active collaboration. The method included: (a) implementing pilot projects; (b) conducting a statewide study with crash evaluation and field reviews, identifying interchange types, and developing countermeasures; (c) evaluating and deploying experimental devices specifically approved by the Federal Highway Administration; (d) conceptualizing a human factors study; (e) transforming recommendations to design guidance; (f) discussing with planners on interchange types susceptible to WWDs; (g) retrofitting exit ramps with the recommended countermeasures; and (h) leveraging the media to promote awareness and to educate the public about the dangers of driving under the influence. The result of this policy push is that, from an engineering view point, design changes were made; from an education perspective, WWD awareness was prioritized; and from an enforcement angle, the Florida Highway Patrol proactively detects and addresses WWD crashes.

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1. Introduction

The Special Investigation Report of the National Transportation Safety Board (NTSB, 2012) noted that, during 2004–2009, annually 357 wrong-way driving (WWD) fatalities occurred and constituted about 2.8% of all fatal crashes on divided highways in the United States of America. With states defining alcohol-impairment at a blood alcohol concentration (BAC) at or above 0.08%, it was alarming to note that 69% of the wrong-way drivers were impaired. The NTSB Report helps infer that the odds of a 70-plus year-old being involved in a WWD crash are greater than the odds of being involved in a non-WWD crash. WWD is not a novel phenomenon, for it was discussed a half-century ago by Hulbert and Beers (1966) and Tamburri (1969); the former studied the impact of signing and pavement markings (S&PM) countermeasures, while the latter interviewed wrong-way drivers and evaluated the effectiveness of countermeasures installed on California freeways and expressways. International discussion (Brevoord, 1984; De Niet and Blokpoel, 2000; Sagberg, 2003; Scaramuzza and Cavegn, 2007; Xing, 2015) provides useful hints on the breakdown of WWD incidence with respect to actual wrong-way entries from the exit ramps and actual turn movements on freeways; by proxy, the 'unintentional' versus 'deliberate' maneuvers provide an interesting avenue for researching the causes and remedies of WWD. Several other works (Gabriel, 1974; Shepard, 1976; Vaswani, 1977; Copelan, 1989) to the more recent studies (Zhou et al., 2014) explored the use of crash data and traditional traffic control devices to counter WWD incidence. Interestingly, the potential use of technology to address WWDs was explored 45 years ago (Friebele et al., 1971; Forthoffer et al., 1996).

These works were mostly studied more than a decade ago, and have mainly addressed specific technical aspects. That said, some of the ground-breaking works from Europe provided a holistic perspective for addressing road traffic crashes from a policy angle. Examples include the 'Vision Zero' initiative introduced by the Swedish Parliament in 1997 with an aim toward zero fatalities (Whitelegg and Haq, 2006) with a discussion on its applications (Tingvall and Haworth, 1999), and a systems management approach (Larsson et al., 2010) including the need for cultural change (Johnston, 2010). Other important works also studied the impact

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The odds of wrong-way crashes and resulting fatalities: A comprehensive analysis

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ABSTRACT

The United States of America and other nations are grappling with the incidence of wrong-way driving (WWD). The issue is as important today (NTSB, 2012) as it was a half-century ago (Hulbert and Beers, 1966). In the absence of a comprehensive analysis, any effort to implement WWD countermeasures can be counterproductive. Hence, this effort began with the express intent to identify the factors that cause WWD crashes and fatalities. This work is sizeable in that it evaluated one million complete crash records from Florida. The methodology comprised (a) administering a survey on the perceptions about WWD; (b) developing binomial logistic models for computing the odds of WWD crashes, and of fatal crashes within the WWD space; (c) analyzing the contributing variables; and (d) comparing perceptions with crash analysis results. The study parameters included driver's age, gender, licensing state, physical defect, blood alcohol concentration, vehicle use, seatbelt compliance, day and time of crash, roadway lighting, facility type, weather conditions, road geometrics, and traffic volumes. Individual variable analysis of 23 parameters and the model development process included the determination of odds ratios and statistical tests for the predictive power and goodness-of-fit. The results of this work are generally consistent with expectation, yet surprising at times. This work concludes with decision-making inputs to the scientist, policy-maker and practitioner on the need for effectively engineering the roads, actively educating people about wrong-way driving, and strictly enforcing traffic laws, rules and regulations.

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1. Introduction

Analysis and countermeasures development of wrong-way driving(WWD) is not new, for it was discussed a half-century ago by Hulbert and Beers (1966) and Tamburri (1969). Tamburri noted that more than 50% of WWD incidents on California freeways resulted from drivers entering via the exit ramps and that 60% of fatal and injury WWD incidents occurred where sight distance was 1200 feet or less. Elsewhere (Friebele et al., 1971), while 0.2% of all crashes in Texas were WWD-related, about 1.4% of fatal crashes resulted from WWD. More recently, the National Transportation Safety Board (NTSB, 2012) noted that during 2004–2009, on an average, there were about 357 WWD fatalities per year in the United States of America, and that they comprised about 2.8% of all fatal crashes on divided highways. The NTSB Report also noted that 69% of the WWD drivers were impaired and that the 70-plus year-olds are at a particularly high risk. The impact of alcohol and drugs, and the need for accommodating the elderly driver were also stressed by Poulsen et al. (2014) and Sagberg (2003). Experiences from France (Kemel, 2015) and the Netherlands (De Niet and Blokpoel, 2000) provide a comprehensive background on WWD incidence in the European Union. These works provided an over-arching view to addressing road crashes from a policy perspective. For instance, the Swedish Parliament's 'Vision Zero' initiative aimed at zero fatalities (Whitelegg and Haq, 2006) with its applications (Tingvall and Haworth, 1999) and a systems management approach (Larsson et al., 2010) including the need for cultural change (Johnston, 2010). Other efforts studied the impact of 'Vision Zero' (Elvik, 1999; Elvik and Amundsen, 2000). The Netherlands also developed policy-oriented programs to reduce road traffi crashes (Wegman et al., 2005; Wegman et al., 2008) followed by an after-study ten years later (Weijermars and Wegman, 2011). These works differ from that of the United States in that they combined policy with practice, but may have lacked the rigor that is required for proposing a comprehensive crash data-evaluation-based solution framework.

The key to any WWD analysis is to eventually consider the use of the traffic control devices to counter WWD incidence

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CASE STUDY

Wrong-Way Driving Mitigation:

A Holistic Approach in Florida, USA

By Raj Ponnaluri, Ph.D., P.E., PTOE and Fred Heery Sr., P.E.

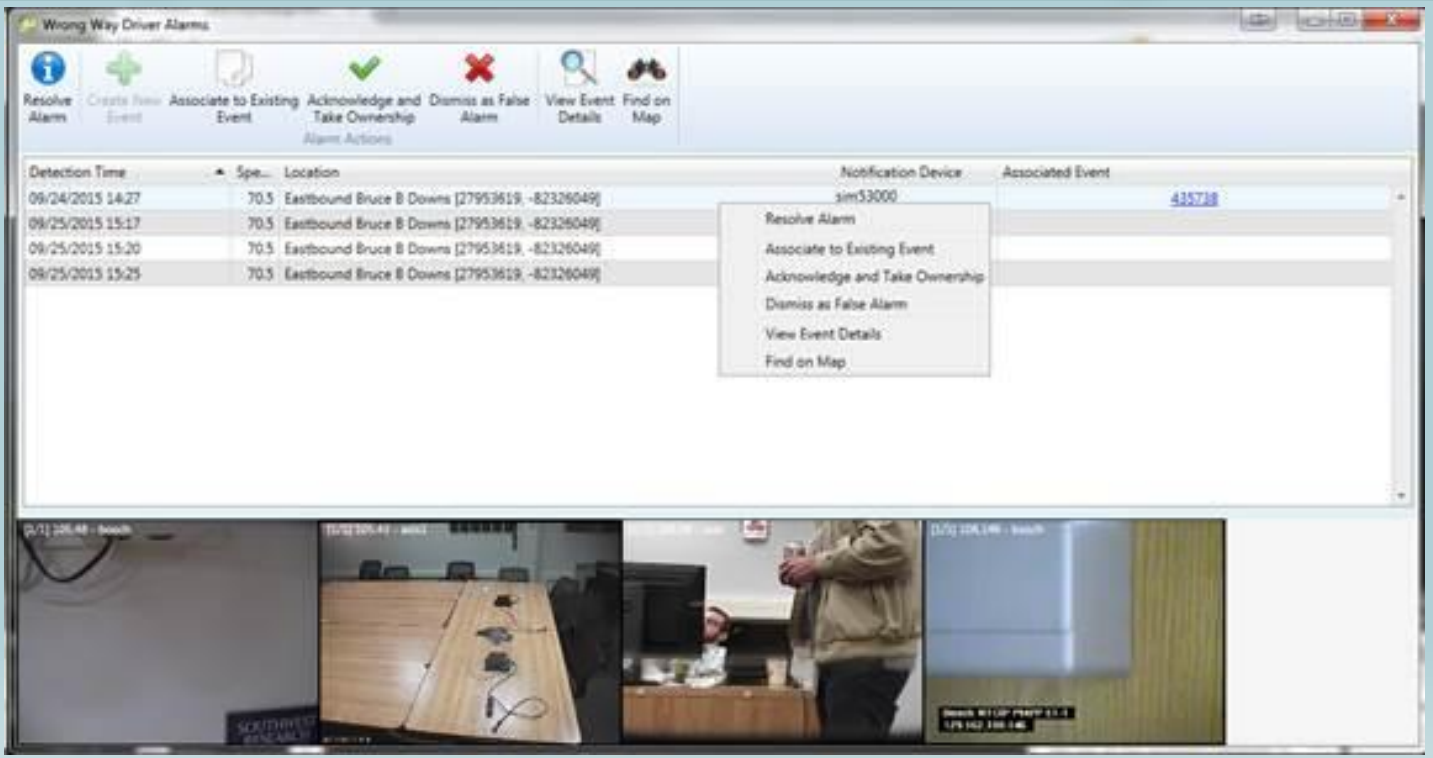
In the National Transportation Safety Board's seminal work on wrong-way driving, it observed that during the period from 2004–2009, on average, there were 357 wrong-way driving (WWD) fatalities per year, and these accounted for about 2.8 percent of all fatal crashes on divided highways.[1] The report also stressed the concerns with alcohol use and the likelihood of the elderly being involved in WWD incidents. In fact, published literature shows that WWD is not new and that field studies were conducted for decades.[2–7] Most of these studies evaluated the impact of countermeasures, mainly signing and pavement markings (S&PM), while others interviewed drivers and studied the effectiveness of WWD countermeasures. Some efforts considered technology measures between 45 and 20 years ago.[8,9] More recent studies focused on statistical characteristics and countermeasures for WWD, while another work, "Addressing Wrong-way Driving as a Matter of Policy: The Florida Experience," delved into the likelihood and odds of specific factors leading to wrong-way incidence.[10–14] A key conclusion from this work was that the likelihood of a WWD fatal crash, when compared to other crash types, was higher on limited access facilities than on non-limited access roadways. Thus, the likelihood of a fatal crash on freeways is what seems to attract attention to the problem.

FDOT

Cues That Can Help

Driver Impairment
(Alcohol, Drug, Cognitive)

Sunguide: New Alert Dialog



- Notifications with Alerts
- Cameras near alerts will move to pre-defined preset

Ideas we hear about

- Pavement rental car center type strips.
- Bollards that rise up.
- Delineators.
- Mast arms with flashing red signal indications.

FDOT

Responses

- Spike strips were considered by the industry; but they can pose safety and maintenance challenges.
- Findings of the Texas DOT, as detailed here.
- http://www.transguide.dot.state.tx.us/sat/wwd/content/EngineeringAnalysisSpikeStrips.pdf
- Mast arms can be confused with traffic signals.
- Delineators being tested.

- POINT: Take a closer look at suggestions.

Progress: Districts

- All Districts were party to new standards development.
- All Districts asked for and have inventory sheets.
- Districts started inventorying to identify gaps ~ at various levels.
- Extensive coordination with FHP, law enforcement, advocacy

WWD Countermeasures for Evaluation

1. Newly-developed S&PM standards
2. Red RRFBs
3. Internally illuminated roadway pavement markers
4. Detection-triggered LED lights around “WRONG WAY” signs
5. Detection-triggered blankout signs that flash “WRONG WAY”
6. Delineators along exit ramps
7. Wig/wag flashing beacons

1. S&PM

Previous Condition

Countermeasure #1

2 thru 7

Red RRFBs

Countermeasure #2

Detection-triggered LED lights around "WRONG WAY signs

Countermeasure #4

Detection-triggered blankout signs

Countermeasure #5

Wig-Wag flashing beacons

Countermeasure #7

IIRPM

Countermeasure #3

Delineators along exit ramps

Countermeasure #6

TSM&O
Transportation Systems Management & Operations
Managing and Operating for an Efficient Transportation System

In Summary

- Holistic – explore all avenues
- Methodical – one step at a time
- WWD is a quickly moving subject area
- Industry is extremely active with new devices
- Research is underway
- Consider *video analytics*, *situational awareness* as we move forward
- You may begin ad hoc initially, but make it comprehensive over time
- Strong Engineering, Education and Enforcement efforts

Thank you

Raj Ponnaluri, PhD, P.E, PTOE

Traffic Engineering & Operations Office

Florida Department of Transportation