Wrong Way Driving Toolbox

A Resource of Engineering Strategies to Reduce Wrong Way Movements at Freeway Interchanges

Developed for the

North Carolina Department of Transportation

by the

UNC Highway Safety Research Center

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Introduction
This toolbox presents strategies that can be used to reduce wrong way driving on freeways. It was developed for NCDOT by Daniel Carter at the UNC Highway Safety Research Center as a deliverable for research project 2017-12, *Strategies to Reduce Wrong Way Movements*.

Scope

- This toolbox focuses on engineering strategies to prevent wrong way driving. Other types of efforts to decrease wrong way driving, such as enforcement and education, would be beneficial, particularly related to drunk driving (a major factor in wrong way driving), but are not covered in this document.
- The strategies in this toolbox are focused on changes that can be made to individual freeway interchanges to reduce wrong way movements. Strategies such as a corridor-level monitoring and manned response teams are not included.
- It is assumed that MUTCD-required features such as DO NOT ENTER and ONE WAY signs are already present.

Layout
Each strategy is summarized on a single page. The page will display the name of the strategy, a description of the strategy, an example photo or graphic, and any relevant additional information regarding the use of the strategy.

Resources
The following resources were consulted in the development of this toolbox (full citations available in the reference section):

- Guidelines for Reducing Wrong-Way Crashes on Freeways (Zhou and Rouholamin, 2014)
- Wrong Way Crashes: Statewide Study of Wrong Way Crashes on Freeways in North Carolina (Braam, 2006)
- Countermeasures for Wrong-Way Movement on Freeways (Cooner et al., 2004)
- Assessment of the Effectiveness of Wrong Way Driving Countermeasures and Mitigation Methods (Finley et al., 2014)
- Wrong Way Driving Road Safety Audit Prompt List (FHWA, 2013)
- “Where These Drivers Went Wrong” (Morena and Leix, 2012)
- Wrong Way Driving, Highway Special Investigation Report (NTSB, 2012)
- “Stop. You're Going The Wrong Way!” (Moler, 2002)

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Install WRONG WAY signs

Description

Install WRONG WAY sign(s) as a supplement to the DO NOT ENTER sign at locations where wrong way movements are not physically prevented. MUTCD guidance recommends that a WRONG WAY sign (R5-1a) should be placed at a location along the exit ramp or the one-way roadway farther from the crossroad than the DO NOT ENTER sign.

US-52 / Pilot Mountain Pkwy at S. Key St, Pilot Mountain, NC (Source: Google Streetview)

Additional Information

- Wrong way sign can be placed on separate pole or mounted on back of exit ramp sign.
- Additional WRONG WAY signs can be placed along the exit ramp, facing potential wrong way drivers.
- MUTCD Section 2B.38

Lower WRONG WAY or DO NOT ENTER signs

Description

Lower the sign height of WRONG WAY or DO NOT ENTER signs. A lower sign height is more conspicuous to a driver and may be particularly beneficial for impaired and older drivers who have a tendency to look for visual cues near the pavement surface. The MUTCD states that the signs may be installed at a minimum mounting height of 3 feet, measured vertically from the bottom of the sign to the elevation of the near edge of the pavement.

Source: Cooner et al., 2004

Additional Information

- Consider the possible presence of parked vehicles, vegetation, and other sight obstructions when lowering signs.
- In some northern states, there is concern about snow accumulation blocking the visibility of a low sign. For most of North Carolina this is a rare concern, however, some mountainous districts may need to consider snow accumulation when setting low sign heights.
- Lowered sign height is a countermeasure used in California, Georgia, Michigan, Virginia, and Texas (Dallas area).
- MUTCD Section 2B.41

Install reflective strips on WRONG WAY or DO NOT ENTER sign supports

Description

Install reflective red strips on supports for WRONG WAY and DO NOT ENTER signs to increase conspicuity.

I-40 at New Hope Church Rd, Chapel Hill, NC (Source: Google Streetview)

Additional Information

- The MUTCD states that the strip of retroreflective material must be at least 2 inches in width and placed from the sign to within 2 feet above the edge of the roadway.
- The strip must be red for DO NOT ENTER and WRONG WAY signs.
- Reflective strips are used in Michigan and Rhode Island, among other states.
- MUTCD Section 2A.21

Install dynamic warning beacon for WRONG WAY or DO NOT ENTER signs

Description

Install a dynamic warning beacon to be activated when a wrong way movement is detected on an exit ramp. The warning beacon may consist of a blank out WRONG WAY sign or warning lights such as flashing LEDs around the border of a WRONG WAY or DO NOT ENTER sign. This dynamically activated warning beacon will alert drivers who have begun a wrong way movement.

Sources: WSDOT via Moler, 2002 (above), Rhode Island DOT (right)

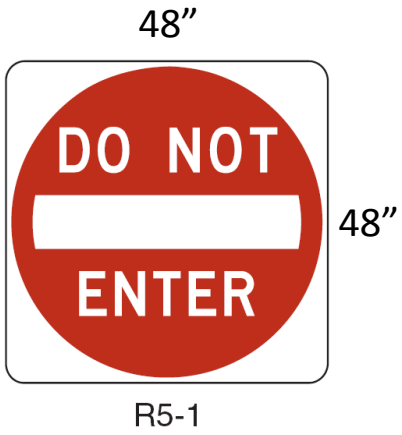
Additional Information

- Vehicles can be detected through pavement sensors, video, or radar.
- Dynamic warning beacons are used on signs in Rhode Island; San Antonio, Texas; and Seattle, Washington.
- MUTCD Section 4L.03

Increase size of WRONG WAY or DO NOT ENTER signs

Description

Replace existing WRONG WAY or DO NOT ENTER signs with maximum size signs. Maximizing the size of the signs will enhance their conspicuity, especially for older drivers at night. The MUTCD lists 48 inches by 48 inches as the maximum size for DO NOT ENTER signs and 42 inches by 30 inches for WRONG WAY signs.



Additional Information

- Additional DO NOT ENTER signs may be used for traffic approaching from an intersecting roadway (MUTCD Section 2B.37).
- A 2004 survey (Cooner et al.) showed that about half of the states used the maximum size for DO NOT ENTER signs (48 inches by 48 inches) and about a third of states used oversize WRONG WAY signs (42 inches by 30 inches).
- MUTCD Table 2B-1

Install Keep Right signs on medians at partial cloverleaf ramps

Description

Install a Keep Right sign placed at the median between the entrance and exit ramps of a partial cloverleaf interchange to guide drivers to avoid entering the exit ramp.

US-70 at US-117, Goldsboro, NC (Source: Google Streetview)

Additional Information

- MUTCD Section 5B.04

Install turn prohibition signs

Description

Install No Right Turn (R3-1) or No Left Turn (R3-2) signs to warn drivers away from entering exit ramps.

I-85 at Roxboro St, Durham, NC (Source: Google Streetview)

Additional Information

- Turn prohibition signs should be placed to be easily seen by drivers who might make a wrong way movement. At signalized intersections, they should be placed adjacent to the signal head for maximum visibility.
- No Right Turn signs should be placed over the road or at the right-hand corner of the intersection.
- No Left Turn signs should be placed over the road, at the far left-hand corner of the intersection, on a median, or in conjunction with the STOP sign or YIELD sign located on the near right-hand corner.
- Some states (e.g., California) do not use the turn prohibition signs in case they may be misunderstood by intoxicated drivers as directional arrows.
- MUTCD Section 2B.18

Install “Freeway Entrance” sign for on-ramp

Description

Install a Freeway Entrance sign (D13-3 or 13-3a) on entrance ramps near the crossroad to inform road users of the freeway entrance. This can be particularly helpful when an entrance ramp is directly adjacent to an exit ramp, such as at a partial cloverleaf.

US-70 at US-117, Goldsboro, NC (Source: Google Streetview)

Additional Information

- MUTCD Section 2D.46

Install wrong way pavement marking arrows

Description

Install arrow markings on exit ramps upstream of the ramp terminal to indicate the correct direction of travel. The arrow shape should be slender and elongated, which differs from a standard lane direction arrow.

Standard pavement marking wrong way arrow, US-421 at US-421 Business / Boone Trail Rd, Sanford, NC (Source: Google)

Wrong way arrow using retroreflective red pavement markers (Source: Zhou and Roulamen, 2014)

Additional Information

- These markings may be standard pavement markings or bidirectional red-and-white raised pavement markers or other units that show red to wrong-way road users and white to other road users.
- MUTCD Section 2B.41 and Figure 3B-24

Install lane line extensions to guide turning traffic

Description

Extend the lane line as a dotted line to guide turning drivers to the correct freeway entrance. This can help prevent wrong way movements when an entrance ramp is directly adjacent to an exit ramp, such as at a partial cloverleaf. The marking should be a dotted line extension of the lane line consisting of 2-foot line segments and 2- to 6-foot gaps.

Source: Morena and Leix, 2012

Additional Information

- The line can be supplemented with reflective pavement markers to increase conspicuity at night.
- Michigan DOT identified this as a potential countermeasure for interchanges that had high probability of wrong way movements.
- MUTCD Section 3B.08

Install stop line at exit ramp terminal

Description

Install a stop line across the full width of the end of an exit ramp. A stop line is used to indicate the point behind which drivers must stop in compliance with a traffic signal, stop sign, or other traffic control requiring a stop. The presence of a stop bar at the end of an exit ramp can emphasize the fact that the lanes are from an exit ramp and should not be crossed in the opposite direction. This can be particularly helpful when an entrance ramp is directly adjacent to an exit ramp, such as at a partial cloverleaf.

US-421 at Pittsboro Goldston Rd, Goldston, NC (Source: Google Streetview)

Additional Information

- MUTCD Section 3B.16

Delineate median between ramp terminals

Description

Install an outline to an existing median. When adjacent exit ramp and entrance ramp terminals are separated by a narrow median, a yellow outline on the pavement can improve the conspicuity of the median and prevent drivers from entering the exit ramp.

I-40 Business at NC-66, Kernersville, NC (Source: Google Streetview)

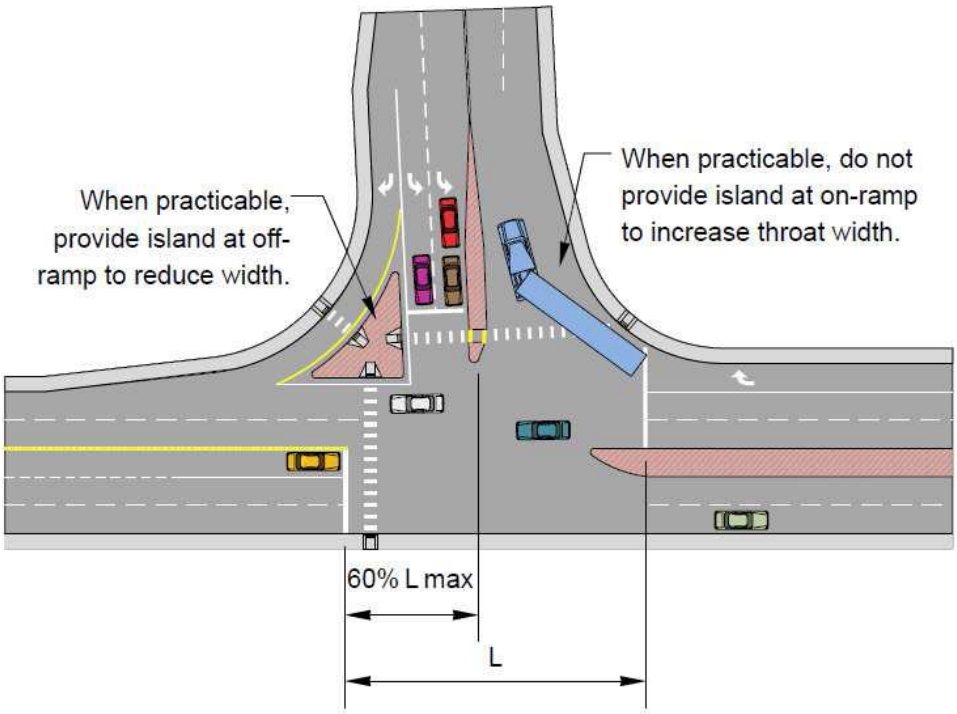
Additional Information

- This delineation can be used together with a Keep Right sign to improve median conspicuity.

Move cross street left turn stop lines forward

Description

Move the stop lines for cross street left-turning traffic forward at signalized intersections where entrance and exit ramps are adjacent, such as at a partial cloverleaf. This will allow left-turning cross street drivers to have a better view of the entrance ramp and deter them from turning onto the exit ramp.



Source: Washington State DOT Design Manual 2013, as presented in Zhou and Rouholamin, 2014

Additional Information

- Washington State DOT recommends that the stop line for left turning traffic be placed approximately equidistant from the center of the intersection as the opposing stop line (60% maximum).

Install channelizing island on exit ramp terminal

Description

Install a channelizing island at the end of an exit ramp. This serves to narrow the effective width of the exit ramp terminal and make it less tempting to entry by wrong way drivers.

I-40 at NC-210, Rocky Point, NC (Source: Google Streetview)

Additional Information

- The island should be made sufficiently visible to deter wrong way movements and to avoid being struck. Reflective devices should be used to increase the nighttime conspicuity of the island.
- The island should be high enough (i.e., 4 inches or greater) to prevent traffic movements.

Install median to discourage left-turn wrong way entry onto exit ramps

Description

A non-traversable median on the cross street can deter drivers from making a left turn and entering an exit ramp.

I-77 at US-21 / Turnersburg Hwy, Troutman, NC (Source: Google Streetview)

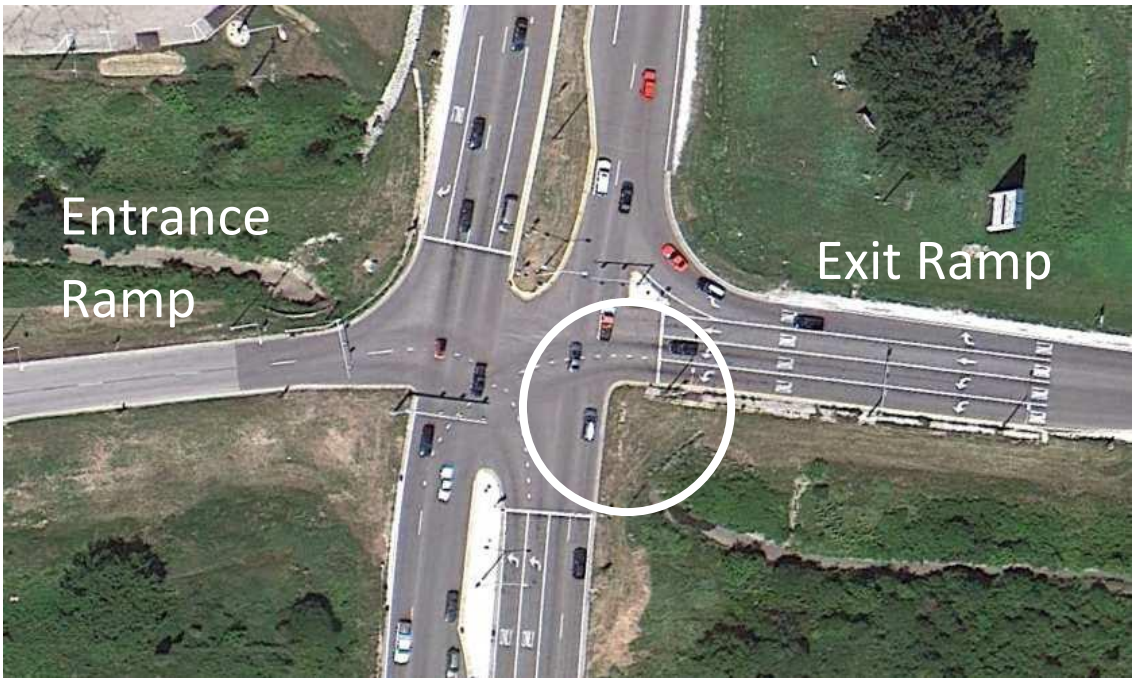
Additional Information

None.

Reduce corner radius

Description

Reduce the radius of intersection corners at exit ramp terminals. A smaller radius corner can discourage drivers from making a turn that would begin a wrong way movement. A tight corner at the left edge of an exit ramp and right edge of a cross street can serve to discourage wrong way turns.



Source: Zhou and Rouholamin, 2014

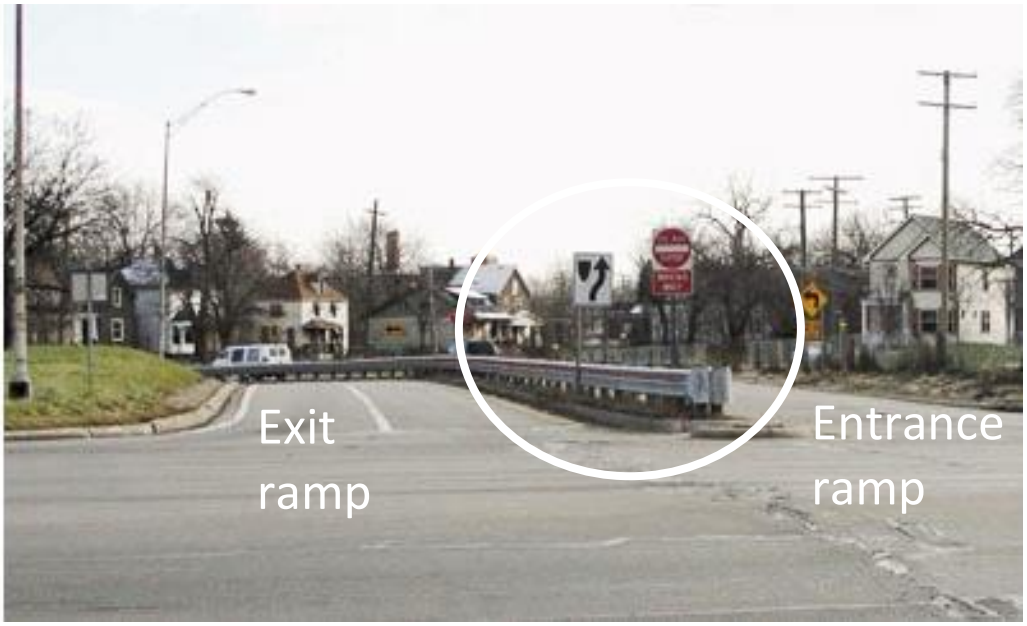
Additional Information

None.

Retract median barrier between entrance and exit ramps

Description

Retract a median barrier to remove visual obstruction. When a median barrier separating adjacent entrance and exit ramps extends all the way to the cross street intersection, it can obscure the drivers' view of the entrance ramp, leading them to think that the exit ramp is the only way onto the freeway. Shortening the median barrier will allow a clear view of the entrance ramp.



Source: Michigan DOT via Morena and Leix, 2012

Additional Information

None.

Install roundabout at ramp terminal

Description

Install a roundabout at the intersection of an exit ramp and a cross street. The directional and channelized nature of a roundabout will make wrong way movements very difficult to accomplish.

US-1 / US-501 at Hawkins Ave, Sanford, NC (Source: Google)

Additional Information

- Although this strategy is included in this toolbox for preventing wrong way movements, roundabouts can have significant safety benefits for all movements at the ramp intersection. Additionally, depending on the volumes of the ramp and cross street, they may reduce delay.

Provide uniform lighting at ramp intersection

Description

Provide lighting or additional lighting at ramp terminal intersections. Ensure that lighting at the ramp terminal intersection is configured in a way that uniformly lights the intersection. Non-uniform lighting that obscures the entrance ramp could confuse drivers and lead to wrong way movements.

Example of uniform ramp lighting from site visits conducted under Zhou et al., 2012

Additional Information

None.

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