

Oregon Department of Transportation (ODOT) HSIP Countermeasures and Crash Reduction Factors

The [Highway Safety Improvement Program](#) (HSIP) is a federal program designed to achieve a significant reduction in traffic fatalities and serious injuries on all public roads. The HSIP requires a data-driven, strategic approach to improving highway safety. In Oregon, the HSIP program funds the All Roads Transportation Safety (ARTS) Program, an application-based program providing funding to address safety concerns on public roadways within the State. The intent of the Crash Reduction Factor (CRF) countermeasure table and appendix is to provide safety practitioners, intending to use HSIP funding, with a list of effective countermeasures that are appropriate improvements to many common safety issues. The countermeasures in this appendix are strategies intended to reduce crash frequency or severity on the road. For road safety engineers, this is typically a physical change to the infrastructure of a road section or intersection, such as the addition of signs, signals, or markings, or a change in roadway design.

Use of these countermeasures is required for the ARTS program and allows applications to be evaluated consistently and fairly. The countermeasures have been sorted into 2 primary categories: countermeasures eligible for Hotspot Funding and countermeasures eligible for Systemic Funding. Systemic Funding is further divided into Roadway Departure, Intersection and Bicycle & Pedestrian for informational use only. It is important to note that a maximum of four countermeasures can be applied in one application. While systemic and Hotspot countermeasures may be applicable at the same location, ODOT asks applicants to submit separate applications for hotspot and for systemic measures during this round. Once approved for funding, the measures can be combined under one project if desired. Separate applications allow similar comparisons of benefits for both methods.

The Excel Table (available on the ARTS website) summarizes the CRF's in tabular form and the Appendix below describes in more detail where the countermeasure should be used, why they are effective and potential impediments to the implementation. The appendix also includes information on the type of crashes where the countermeasure is best used, the CRF value to use in the benefit-cost analysis and the acknowledged range of their overall effectiveness based on the research available. The fixed set of CRFs included in these tables are intended to allow for all projects to be evaluated consistently and fairly throughout the project selection process.

ODOT recognizes that there may be countermeasures that are not included on the list where CRF's have not been established yet. This list will be periodically reevaluated by ODOT to include more recent and/or reliable CRF countermeasures and values as new safety research data becomes available. ODOT is interested in any feedback and suggestions from safety practitioners on the overall countermeasure list as well as specific details of individual countermeasures. Please use the form provided at this website to submit your suggestion: <https://www.oregon.gov/odot/Forms/2ODOT/7345160.pdf>.



Please send all other feedback and suggestions to Christina McDaniel-Wilson (christina.a.mcdaniel-wilson@odot.state.or.us). They will be considered for inclusion in the next HSIP process for the next STIP cycle. Where not otherwise specified, ODOT uses some of the following references to establish the summarized CRF List and Appendix. Safety Practitioners are encouraged to utilize these references to better understand the listed countermeasures and the details surrounding their application.

- The Crash Modification Factors Clearinghouse (<http://www.cmfclearinghouse.org/>)
- FHWA's proven Safety Countermeasures: (<https://safety.fhwa.dot.gov/provencountermeasures>)
- Highway Safety Manual (HSM), First Edition, 2010 (<http://www.highwaysafetymanual.org>)
- FHWA Desktop Reference for Crash Reduction Factors
(<http://safety.fhwa.dot.gov/tools/crf/resources/fhwasa08011/>)
- Manual for Selecting Safety Improvements on High Risk Rural Roads
(http://safety.fhwa.dot.gov/hsip/hrrr/manual/hrrr_2014.pdf)

For more information on the All Roads Transportation Safety (ARTS) program, please see the following web link: <https://www.oregon.gov/odot/Engineering/Pages/ARTS.aspx>

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CRF Table:

			Green = Crash Specific				Blue = Area Type Specific					
Hotspot or Systemic Application Type	Countermeasure Number	Countermeasure	Crash Type	Injury, PDO or All	Service Life (Years)	Existing Intersection Traffic Control	Urban or Rural	CRF %	Range of CRF	Reference	Proven Safety Countermeasure	ADA Trigger
Hotspot	H1	Median U-Turn Intersection Treatment	All	All Injury (Excludes PDO's)	20	Signalized or Unsignalized	Urban or Rural	30	30%	Synthesis of the Median U-Turn Intersection Treatment (FHWA-HRT-07-033) FHWA-HRT-07-033, FHWA Proven Safety Countermeasures (https://safety.fhwa.dot.gov/provencountermeasures/reduced_left/)	Y- Reduced Left-Turn Conflict Intersections	
Hotspot	H2	Right Turn Lane on Single Major Road Approach: Unsignalized Intersection (3- or 4-leg)	All	All	20	Unsignalized	Urban or Rural	14	14 - 26%	HSM, CMF Clearinghouse (CMF ID: 285)	Y- Left and Right Turn Lanes at Two-Way Stop-Controlled Intersections	Likely
Hotspot	H3	Right Turn Lane on Both Major Road Approaches: Unsignalized Intersection (3- or 4-leg)	All	All	20	Unsignalized	Urban or Rural	26	14 - 26%	HSM, CMF Clearinghouse (CMF ID:289)	Y- Left and Right Turn Lanes at Two-Way Stop-Controlled Intersections	Likely
Hotspot	H4	Right Turn Lane on Single Major Road Approaches: Signalized Intersection (3- or 4-leg)	All	All	20	Signalized	Urban or Rural	4	4 - 9%	HSM, CMF Clearinghouse (CMF ID: 286)		Likely
Hotspot	H5	Right Turn Lane on Both Major Road Approaches: Signalized Intersection (3- or 4-leg)	All	All	20	Signalized	Urban or Rural	8	4 - 9%	HSM, CMF Clearinghouse (CMF ID: 290)		Likely
Hotspot	H6	Channelized Right Turn Lane with Raised Median	All	All Injury (Excludes PDO's)	20	Signalized or Unsignalized	Urban or Rural	35	25 - 50%	FHWA Desktop reference Crash Reductions Factors, FHWA-SA-13-027 (2013)		Likely
Hotspot	H7	Left Turn Lane on Single Major Road Approach: Urban, Unsignalized Intersection (3-leg)	All	All	20	Unsignalized	Urban	33	33 - 55%	HSM, CMF Clearinghouse (CMF ID: 254)	Y- Left and Right Turn Lanes at Two-Way Stop-Controlled Intersections	Likely
Hotspot	H8	Left Turn Lane on Both Major Road Approaches: Urban, Unsignalized Intersection (4-leg)	All	All	20	Unsignalized	Urban	47	47 - 58%	HSM, CMF Clearinghouse (CMF ID: 269)	Y- Left and Right Turn Lanes at Two-Way Stop-Controlled Intersections	Likely
Hotspot	H9	Left Turn Lane on Single Major Road Approach: Rural, Unsignalized Intersection (3-leg)	All	All	20	Unsignalized	Rural	44	33 - 55%	HSM, CMF Clearinghouse (CMF ID: 253)	Y- Left and Right Turn Lanes at Two-Way Stop-Controlled Intersections	
Hotspot	H10	Left Turn Lane on Both Major Road Approaches: Rural, Unsignalized Intersection (4-leg)	All	All	20	Unsignalized	Rural	48	47 - 58%	HSM, CMF Clearinghouse (CMF ID: 268)	Y- Left and Right Turn Lanes at Two-Way Stop-Controlled Intersections	
Hotspot	H11	Left Turn Lane on Single Major Road Approach: Urban, Signalized Intersection (3-leg)	All	All	20	Signalized	Urban	7	7 - 15%	HSM, CMF Clearinghouse (CMF ID: 4644)		Likely
Hotspot	H12	Left Turn Lane on Single Major Road Approach, Urban, Signalized Intersection (4-leg)	All	All	20	Signalized	Urban	10	10%	HSM, CMF Clearinghouse (CMF ID: 262)		
Hotspot	H13	Left Turn Lane on Both Major Road Approaches: Urban, Signalized Intersection (4-leg)	All	All	20	Signalized	Urban	19	17 - 48%	HSM, CMF Clearinghouse (CMF ID: 270)		Likely

			Green = Crash Specific				Blue = Area Type Specific					
Hotspot or Systemic Application Type	Countermeasure Number	Countermeasure	Crash Type	Injury, PDO or All	Service Life (Years)	Existing Intersection Traffic Control	Urban or Rural	CRF %	Range of CRF	Reference	Proven Safety Countermeasure	ADA Trigger
Hotspot	H14	Left Turn Lane on Single Major Road Approach: Rural, Signalized Intersection (3-leg)	All	All	20	Signalized	Rural	15	7 - 15%	HSM, CMF Clearinghouse (CMF ID: 4643)		Likely
Hotspot	H15	Left Turn Lane on Single Major Road Approach, Rural, Signalized Intersection (4-leg)	All	All	20	Signalized	Rural	18	18%	HSM		
Hotspot	H16	Left Turn Lane on Both Major Road Approaches: Rural, Signalized Intersection (4-leg)	All	All	20	Signalized	Rural	33	17 - 48%	HSM		Likely
Hotspot	H17	Channelized Left Turn Lane with Raised Median on All Approaches (3- or 4-leg)	All	All Injury (Excludes PDO's)	20	Signalized or Unsignalized	Urban or Rural	27	4 - 27%	HSM, CMF Clearinghouse (CMF ID: 249)		Likely
Hotspot	H18	Install Roundabout from Minor Road Stop Control	All	All Injury (Excludes PDO's)	20	Unsignalized	Urban or Rural	82	19 - 82%	HSM, CMF Clearinghouse (CMF ID: 228)	Y- Roundabouts	Likely
Hotspot	H19	Install Roundabout from Signalized Intersection	All	All Injury (Excludes PDO's)	20	Signalized	Urban or Rural	78	48 - 78%	HSM, CMF Clearinghouse (CMF ID: 226)	Y- Roundabouts	Likely
Hotspot	H20	Convert to All-Way Stop Control (From Urban 2-Way or Yield Control)	Angle	All	10	Unsignalized	Urban	75	18 - 75%	HSM, CMF Clearinghouse (CMF ID: 310)		
Hotspot	H21	Convert to All-Way Stop Control (From Rural 2-Way or Yield Control)	All	All	10	Unsignalized	Rural	48	18 - 75%	HSM, CMF Clearinghouse (CMF ID: 315)		
Hotspot	H22	Install Urban Traffic Signal	Angle	All	20	Unsignalized	Urban	67	-143 - 77%	HSM, CMF Clearinghouse (CMF ID: 323)		Likely
Hotspot	H23	Install Urban Traffic Signal	Rear End	All	20	Unsignalized	Urban	-143	-143 - 77%	HSM, CMF Clearinghouse (CMF ID: 324)		Likely
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Hotspot	H25	Install Rural Traffic Signal	Rear End	All	20	Unsignalized	Rural	-58	-58 - 77%	HSM, CMF Clearinghouse (CMF ID: 328)		Likely
Hotspot	H26	Convert 4-Leg Intersection to Two 3-Leg Intersections (Minor St ADT is 15-30% of Total Entering Traffic)	All	All Injury (Excludes PDO's)	20	Unsignalized	Urban or Rural	25	10 - 33%	HSM, CMF Clearinghouse (CMF ID: 201)		Likely
Hotspot	H27	Convert 4-Leg Intersection to Two 3-Leg Intersections (Minor St ADT is 30% + of Total Entering Traffic)	All	All Injury (Excludes PDO's)	20	Unsignalized	Urban or Rural	33	10 - 33%	HSM, CMF Clearinghouse (CMF ID: 202)		Likely

			Green = Crash Specific				Blue = Area Type Specific					
Hotspot or Systemic Application Type	Countermeasure Number	Countermeasure	Crash Type	Injury, PDO or All	Service Life (Years)	Existing Intersection Traffic Control	Urban or Rural	CRF %	Range of CRF	Reference	Proven Safety Countermeasure	ADA Trigger
Hotspot	H28	Install Rural Median Acceleration Lane	All	All Injury (Excludes PDO's)	20	Unsignalized	Rural	45	20 - 79%	CMF Clearinghouse (CMF ID: 2755), NCHRP 650		
Hotspot	H29	Install Lighting at Intersection	Night	All Injury (Excludes PDO's)	20	Signalized or Unsignalized	Urban or Rural	38	31 - 38%	HSM, CMF Clearinghouse (CMF ID: 433)		Likely
Hotspot	H30	Install Lighting on a Roadway Segment	Night	All Injury (Excludes PDO's)	20	None - Roadway	Urban or Rural	28	17 - 29%	HSM, CMF Clearinghouse (CMF ID: 192)		
Hotspot	H31	Install Any Type of Median Barrier	All	All Injury (Excludes PDO's)	20	None - Roadway	Urban or Rural	30	-24 - 43%	HSM, CMF Clearinghouse (CMF ID: 43)	Y- Median Barriers	Likely
Hotspot	H32	Install New Guardrail (Not Median Barrier Application)	Run off the Road	All Injury (Excludes PDO's)	20	None - Roadway	Urban or Rural	47	44 - 47%	CMF Clearinghouse (CMF ID: 38)	Y- Roadside Design Improvements at Curves	
Hotspot	H33	Install Two Way Left Turn Lane on 2-Lane Road	Rear End	All	20	None - Roadway	Urban or Rural	39	-5 - 53.1%	CMF Clearinghouse (CMF ID: 2351)		
Hotspot	H34	Reduce Urban Driveways from 48 to 26 - 48 per mile	All	All Injury (Excludes PDO's)	20	None - Roadway	Urban	29	25 - 31%	HSM, CMF Clearinghouse (CMF ID: 177)	Y- Corridor Access Management	Likely
Hotspot	H35	Reduce Urban Driveways from 26 - 48 to 10 - 24 per mile	All	All Injury (Excludes PDO's)	20	None - Roadway	Urban	31	25 - 31%	HSM, CMF Clearinghouse (CMF ID: 178)	Y- Corridor Access Management	Likely
Hotspot	H36	Reduce Urban Driveways from 10 - 24 to less than 10 per mile	All	All Injury (Excludes PDO's)	20	None - Roadway	Urban	25	25 - 31%	HSM, CMF Clearinghouse (CMF ID: 179)	Y- Corridor Access Management	Likely
Hotspot	H37	Provide a Raised Median, Urban 2-Lane Road	All	All Injury (Excludes PDO's)	20	None - Roadway	Urban	39	39%	HSM, CMF Clearinghouse (CMF ID: 21)		Likely
Hotspot	H38	Provide a Raised Median, Urban Multi-Lane Road	All	All Injury (Excludes PDO's)	20	None - Roadway	Urban	22	0 - 22%	HSM, CMF Clearinghouse (CMF ID: 22)		Likely
Hotspot	H39	Provide a Raised Median, Rural Multi-Lane Road	All	All Injury (Excludes PDO's)	20	None - Roadway	Rural	12	0 - 22%	HSM, CMF Clearinghouse (CMF ID: 24)		Likely
Hotspot	H40	Install Traversable Median (4 ft. or more)	All	All	20	None - Roadway	Urban or Rural	12	12 - 30%	Engineering Judgement		Likely
Hotspot	H41	Install Passing Lane or Climbing Lane on Rural, 2-Lane Roadway	All	All Injury (Excludes PDO's)	20	None - Roadway	Rural	25	25 - 35%	HSM		

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Hotspot or Systemic Application Type	Countermeasure Number	Countermeasure	Crash Type	Injury, PDO or All	Service Life (Years)	Existing Intersection Traffic Control	Urban or Rural	CRF %	Range of CRF	Reference	Proven Safety Countermeasure	ADA Trigger
Hotspot	H42	Widen Rural Paved Lane Width by 1 foot	All	All	20	None - Roadway	Rural	5	5%	CMF Clearinghouse (CMF ID: 3)	Y- Roadside Design Improvements at Curves	
Hotspot	H43	Flatten Horizontal Curve (Increase Radius)	All	All	20	None - Roadway	Urban or Rural	See table	15 - 78%	CMF Clearinghouse		
Hotspot	H44	Flatten Crest Vertical Curve	All	All	20	None - Roadway	Urban or Rural	20	20 - 51%	CMF Clearinghouse (CMF ID: 720, 721), FHWA Desktop Reference for Crash Reductions Factors FHWA-SA-08-011		
Hotspot	H45	Improve Superelevation Variance (SV) on Rural Curves (Between 0.01 and 0.02)	All	All	20	None - Roadway	Rural	CRF = -600*(SV - 0.01)	N/A	HSM, CMF Clearinghouse (CMF ID: 5183)		
Hotspot	H46	Improve Superelevation Variance (SV) on Rural Curves (More than 0.02)	All	All	20	None - Roadway	Rural	CRF = -300*SV	N/A	HSM, CMF Clearinghouse (CMF ID: 5184)		
Hotspot	H47	Convert from Urban Two-Way to One-Way Traffic	All	All	20	None - Roadway	Urban	47	47%	CMF Clearinghouse		
Hotspot	H48	Increase Pavement Friction by Installing High Friction Surface Treatment - Curves Application	Wet Road	All	10	None - Roadway	Urban or Rural	52	20 - 68%	CMF Clearinghouse (CMF ID: 7901)	Y- Enhanced Delineation and Friction for Horizontal Curves	
Hotspot	H49	Increase Pavement Friction by Installing High Friction Surface Treatment - Ramps Application	Wet Road	All	10	None - Roadway	Urban or Rural	86	86%	CMF Clearinghouse (CMF ID: 7899)	Y- Enhanced Delineation and Friction for Horizontal Curves	
Hotspot	H50	Install Urban Variable Speed Limit Signs	All	All	10	None - Roadway	Urban	8	8%	CMF Clearinghouse (CMF ID: 8730)		
Hotspot	H51	Install Urban Variable Speed Limit Signs with Queue/Weather Warning System	All	All	10	None - Roadway	Urban	14	14%	Engineering Judgement		
Hotspot	H52	Install Rural Variable Speed Limit Signs	All	All	10	None - Roadway	Rural	20	20 - 30%	Engineering Judgement		
Hotspot	H53	Convert 4-Lane Roadway to 3-Lane Roadway with Center Turn Lane (Road Diet)	All	All	20	None - Roadway	Urban	29	29%	HSM, CMF clearinghouse (CMF ID: 199)	Y- Road Diets (Roadway Reconfiguration)	Likely
Hotspot	H54	Install Truck Escape Ramp	Truck	All	20	None - Roadway	Urban or Rural	20	33 - 75%	FHWA Desktop Reference for Crash Reductions Factors		
Hotspot	H55	Install Guide Signs	All	All	20	None - Roadway	Urban or Rural	15	15%	FHWA Desktop Reference for Crash Reductions Factors, North Carolina CMF List in CMF Clearinghouse		

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Hotspot or Systemic Application Type	Countermeasure Number	Countermeasure	Crash Type	Injury, PDO or All	Service Life (Years)	Existing Intersection Traffic Control	Urban or Rural	CRF %	Range of CRF	Reference	Proven Safety Countermeasure	ADA Trigger
Hotspot	H56	Provide an Auxiliary Lane Between an Entrance Ramp and Exit Ramp (Freeway Interchange)	All	All	20	None - Roadway	Urban or Rural	20	20%	CMF Clearinghouse (CMF ID: 3898)		
Hotspot	H57	Extend Deceleration Lane by Approximately 100 ft (Freeway Interchange)	All	All	20	None - Roadway	Urban or Rural	7	7%	HSM, CMF Clearinghouse (CMF ID: 475)		
Hotspot	H58	Extend Acceleration Lane by Approximately 100 ft (Freeway Interchange)	All	All	20	None - Roadway	Urban or Rural	11	11%	CMF Clearinghouse (CMF ID: 474)		
Hotspot	H59	Add Acceleration Lane (Interchange)	All	All	20	None - Roadway	Urban or Rural	CRF = 100*(1-e(-2.59*L)) Where, L = Length of Acceleration Lane (in mile)	N/A	HSM		
Hotspot	H60	Reduce Intersection Skew Angle (Minor Street Stop-Controlled Intersections Only) on 3-Leg intersection	All	All	20	Unsignalized	Rural	3-Leg Stop-Control: CRF = 100*(e^0.0040*Skew Angle) existing (e^0.0040*Skew Angle) proposed	N/A	HSM		
Hotspot	H61	Reduce Intersection Skew Angle (Minor Street Stop-Controlled Intersections Only) on 4-Leg intersection	All	All	20	Unsignalized	Rural	4-Leg Stop-Control: CRF = 100*(1-e0.0054*ΔSkew Angle) Where, ΔSkew Angle = Proposed Skew Angle - Existing Skew Angle	N/A	HSM		
Hotspot	H62	Truck Priority System (Detection)	Angle and Rear-End	All	10	Signalized	Urban or Rural	9	9%	Field Evaluation of Detection-Control System, FHWA-HRT-14-058 (2015)		
Hotspot	H63	Dual/Double Left Turn Lanes	All	All Injury (Excludes PDO's)	20	Signalized	Urban or Rural	29	29%	FHWA-SA-13-027 (pg.11-17)		
Hotspot	H64	Convert Two-Way Left-Turn Lane to Raised Median	All	All	20	None - Roadway	Urban or Rural	47	47%	CMF Clearinghouse (CMF ID: 7771)		
Hotspot	H65	Install offset (buffered) right turn lane	Angle and Turning	All	20	None - Roadway	Rural	69	69%	CMF Clearinghouse (CMF ID: 2777), NCHRP report 650 (table 45, pg.122)		
Hotspot	H66	Install Speed Humps/Table (not on state highways)	All	All	20	None - Roadway	Urban	50	50%	CMF Clearinghouse (CMF ID: 134)		
Intersection Systemic	I1	Install Lighting at Intersection	Night	All Injury (Excludes PDO's)	20	Signalized or Unsignalized	Urban or Rural	38	31 - 38%	HSM, CMF Clearinghouse (CMF ID:433)		Likely
Intersection Systemic	I2	Improve Signal Hardware: Lenses, Reflectorized Back plates, Size, and Number	All	All	20	Signalized	Urban or Rural	20% for 2 Countermeasures from List 25% for 3-4 Countermeasures from List 30% for 5-6 Countermeasures from List	0 - 46%	Caltrans/Intersection Implementation Plan/Engineering Judgment	Y- Backplates with Retroreflective Borders	

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Hotspot or Systemic Application Type	Countermeasure Number	Countermeasure	Crash Type	Injury, PDO or All	Service Life (Years)	Existing Intersection Traffic Control	Urban or Rural	CRF %	Range of CRF	Reference	Proven Safety Countermeasure	ADA Trigger
Intersection Systemic	I3	Add 3-inch yellow retroreflective sheeting to signal backplates	All	All	10	Signalized	Urban	15	15%	CMF Clearinghouse (CMF ID: 1410), FHWA-SA-17-051, FHWA Proven Safety Countermeasure (https://safety.fhwa.dot.gov/provenco/untermeasures/blackplate/)	Y- Backplates with Retroreflective Borders	
Intersection Systemic	I4	Replace 8-inch red signal heads with 12-inch	Angle	All	10	Signalized	Urban or Rural	42	42%	CMF Clearinghouse (CMF ID: 2333)		
Intersection Systemic	I5	Increase Signal Head Quantity - Additional Primary Head	All	All	10	Signalized	Urban	28	28%	CMF Clearinghouse (CMF ID: 1414), 2005 FHWA-SA-13-027 (2013)		
Intersection Systemic	I6	Replace Incandescent Traffic Signal Bulbs with Light Emitting Diodes (LEDs)	Rear end	All	10	Signalized	Urban	17	17%	CMF Clearinghouse (CMF ID:4901), FHWA-HRT-13-070 (2013)		
Intersection Systemic	I7	Replace night time flash with stead operation	All	All	10	Signalized	Urban or Rural	48	48%	CMF Clearinghouse (CMF ID: 4887)		
Intersection Systemic	I8	Replace Doghouse with Flashing Yellow Arrow Signal Heads	Left Turning	All	20	Signalized	Urban or Rural	25	25%	CMF Clearinghouse, Safety Effectiveness of Flashing Yellow Arrow: Evaluation of 222 Signalized Intersections in North Carolina		
Intersection Systemic	I9	Replace Urban Permissive or Protected/Permissive Left Turns to Protected Only	Left Turning	All	20	Signalized	Urban	99	6 - 99%	HSM, CMF Clearinghouse (CMF ID: 333)		
Intersection Systemic	I10	Protected Left Turn - Split Side Street Signal Phasing	Left Turning	All	10	Signalized	Urban or Rural	70	70%	North Carolina CMF list in CMF Clearinghouse		
Intersection Systemic	I11	Replace Urban Permissive Left Turns to Protected/Permissive	Left Turning	All Injury (Excludes PDO's)	20	Signalized	Urban	16	6 -99%	HSM, CMF Clearinghouse (CMF ID: 4578)		
Intersection Systemic	I12	Change from permissive only to FYA - permissive only	Left Turning	All	10	Signalized	Urban or Rural	50	50%	CMF Clearinghouse (CMF ID: 7700)		
Intersection Systemic	I13	Install Adaptive Signal Timing of Urban Traffic Signals	All	All	10	Signalized	Urban	17	17%	CMF Clearinghouse		
Intersection Systemic	I14	Install Actuated Advance Warning Dilemma Zone Protection System at High Speed Signals (Microwave Detection)	All	All	10	Signalized	Urban or Rural	8	0 - 43.6%	CMF Clearinghouse (CMF ID: 4857)		
Intersection Systemic	I15	Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	All	All	10	Signalized or Unsignalized	Urban or Rural	13	10.2 - 13.3%	FHWA Desktop Reference for Crash Reductions Factors FHWA-SA-08-011		
Intersection Systemic	I16	Install Actuated/Coordinated Flashing Beacons as Advance Warning for Signalized Intersections	Rear End	All	10	Signalized	Urban or Rural	36	36 - 62%	CMF Clearinghouse (CMF ID: 1672), FHWA Desktop Reference for Crash Reductions Factors FHWA-SA-08-011		

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Hotspot or Systemic Application Type	Countermeasure Number	Countermeasure	Crash Type	Injury, PDO or All	Service Life (Years)	Existing Intersection Traffic Control	Urban or Rural	CRF %	Range of CRF	Reference	Proven Safety Countermeasure	ADA Trigger
Intersection Systemic	I17	Increase Triangle Sight Distance	All	All Injury (Excludes PDO's)	10	Signalized or Unsignalized	Urban or Rural	48	11 - 56%	CMF Clearinghouse (CMF ID: 307)		
Intersection Systemic	I18	Increase Pavement Friction by Installing High Friction Surface Treatment - Intersection or Segment Application	Wet Road	All	10	Signalized or Unsignalized	Urban or Rural	57	17 - 57%	CMF Clearinghouse (CMF ID: 195)		
Intersection Systemic	I19	Left Turning Traffic Calming Treatments (Left Turn Wedge), Posted Speeds < 35 MPH	Left Turning	All	20	Signalized	Urban	10	10%	Engineering Judgement		
Intersection Systemic	I20	Left Turning Traffic Calming Treatments (Hardened Centerline), posted speeds <35 MPH	Left Turning	All	20	Signalized	Urban	10	10%	Engineering Judgement		
Intersection Systemic	I21	Improve Intersection Warning: Stop Ahead Pavement Markings, Stop Ahead Signs, Larger Signs, Additional Stop Signs and/or Other Intersection Warning or Regulatory Signs	All	All	10	Unsignalized	Urban or Rural	20% for 1-2 Countermeasures from List 25% for 3-4 Countermeasures from List 30% for 5-7 Countermeasures from List	11 - 55%	Caltrans/Intersection Implementation Plan/Engineering Judgment	Y- Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections	
Intersection Systemic	I22	Install Advance Warning Signs (Signal Ahead)	Angle	All	10	Signalized	Urban	35	35%	CMF Clearinghouse (CMF ID: 1684), FHWA Desktop Reference for Crash Reductions Factors FHWA-SA-08-011		
Intersection Systemic	I23	Increase retroreflectivity of Stop Signs (reflective strips on sign post optional)	Angle	All	10	Unsignalized	Urban or Rural	7	7%	CMF Clearinghouse (CMF ID: 6048)	Y- Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections	
Intersection Systemic	I24	Provide Flashing Beacons at All-Way Stop Controlled Intersections	Angle	All	10	Unsignalized	Urban or Rural	28	5 - 58%	HSM, CMF Clearinghouse (CMF ID: 454)		
Intersection Systemic	I25	Provide Flashing Beacons at Minor Road Stop Controlled Intersections	Angle	All	10	Unsignalized	Urban or Rural	13	5 - 58%	HSM, CMF Clearinghouse (CMF ID: 449)		
Intersection Systemic	I26	Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	All	All	10	Unsignalized	Urban or Rural	27	27	CMF Clearinghouse (CMF ID: 8441)		
Intersection Systemic	I27	Install Transverse Rumble Strips on Stop Controlled Approach(es)	All	Fatal/Serious Injury (A)	10	Unsignalized	Urban or Rural	25	-36 - 33%	CMF Clearinghouse (CMF ID: 2705)		
Intersection Systemic	I28	Install 6 ft. or greater Raised Divider on Stop Approach (Splitter Island)	All	All	20	Unsignalized	Urban or Rural	15	15%	FHWA Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections		
Intersection Systemic	I29	Prohibit Right-Turn-On-Red	All	All	10	Signalized	Urban or Rural	9	9%	HSM		
Intersection Systemic	I30	Provide "Stop Ahead" pavement markings	All	All	10	Unsignalized	Rural	31	31%	HSM	Y- Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections	

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Hotspot or Systemic Application Type	Countermeasure Number	Countermeasure	Crash Type	Injury, PDO or All	Service Life (Years)	Existing Intersection Traffic Control	Urban or Rural	CRF %	Range of CRF	Reference	Proven Safety Countermeasure	ADA Trigger
Intersection Systemic	I31	Provide overhead lane-use signs	Rear end	All	10	Signalized	Urban or Rural	10	10%	Signalized Intersections: Information Guide. FHWA_HRT-04-091		
Intersection Systemic	I32	Install Wrong Way Driving Countermeasures: Signing, Pavement markings, Geometric Modifications, and ITS Technologies (seeTable 3.1 in Wrong-Way Driving Analysis and Recommendations Final Report)	All	All	20	Unsignalized	Urban or Rural	20%: for 2 Countermeasures from List 30%: for 3 Countermeasures from List 40%: for 4 (or more) Countermeasures from List	20% - 40%	oregon.gov/ODOT/Engineering/Docs _TrafficEng/Wrong-Way-Driver-Report.pdf		
Intersection Systemic	I33	Curb Extensions	All	All	20	Signalized or Unsignalized	Urban	30	30%	Michigan intersection crash reduction factors - https://www.michigan.gov/document s/mdot/mdot_Crash_Reduction_Factors 303744 7.pdf		Likely
Bike/Ped Systemic	BP1	Install Pedestrian Countdown Timer(s)	Pedestrian	All	20	Signalized	Urban or Rural	70	0 - 70%	CMF Clearinghouse (CMF ID: 5272)		
Bike/Ped Systemic	BP2	Provide Intersection Lighting (Bike & Ped)	P & B Night	All Injury (Excludes PDO's)	20	Signalized or Unsignalized	Urban or Rural	42	42%	HSM, CMF Clearinghouse (CMF ID: 436)		Likely
Bike/Ped Systemic	BP3	Install Urban Leading Pedestrian or Bicycle Interval at Signalized Intersection	P & B	All	10	Signalized	Urban	37	37 - 45%	CMF Clearinghouse, Safety Effectiveness of Leading Pedestrian Intervals Using Empirical Bayes Method (https://trid.trb.org/view/881112)	Y- Leading Pedestrian Intervals	
Bike/Ped Systemic	BP4	Install No Pedestrian Phase Feature with Flashing Yellow Arrow	Pedestrian	All	20	Signalized	Urban or Rural	43	43%	Accident Analysis & Prevention, FHWA-HRT-18-044 (https://www.fhwa.dot.gov/publications/research/safety/18044/18044.pdf)		
Bike/Ped Systemic	BP5	Reduce Right Turn Permissive Conflicts (right turn arrow)	P & B	All	20	Signalized	Urban or Rural	20	20%	Engineering Judgement		
Bike/Ped Systemic	BP6	Install Urban Green Bike Lanes at Conflict Points	Bicycle	All	10	Signalized or Unsignalized	Urban	39	39%	CMF Clearinghouse (CMF ID: 3258)		
Bike/Ped Systemic	BP7	Install Bike Box at Conflict Points	Bicycle	All	10	Signalized	Urban or Rural	35	35%	Signalized Intersections: An informational guide FHWA-SA-13-027 (2013)		
Bike/Ped Systemic	BP8	Install Pedestrian Refuge Island	Pedestrian	All	20	None - Roadway	Urban or Rural	31	26 - 31%	CMF Clearinghouse (CMF ID: 8799), NCHRP 841	Y- Medians and Pedestrian Crossing Islands in Urban and Suburban Areas	Likely
Bike/Ped Systemic	BP9	Install Rectangular Rapid Flashing Beacon (2-Lane Road)	Pedestrian	All	20	None - Roadway	Urban or Rural	10	10 - 56%	ODOT Engineering Judgement / NCHRP 841		
Bike/Ped Systemic	BP10	Install Pedestrian Activated Beacon at Intersection	P & B	All	20	None - Roadway	Urban	10	10%	ODOT Engineering Judgement / NCHRP 841		
Bike/Ped Systemic	BP11	Install Rectangular Rapid Flashing Beacon without Median (3-Lane or More Roadway)	Pedestrian	All	20	None - Roadway	Urban or Rural	10	10 - 56%	ODOT Engineering Judgement / NCHRP 841		

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Hotspot or Systemic Application Type	Countermeasure Number	Countermeasure	Crash Type	Injury, PDO or All	Service Life (Years)	Existing Intersection Traffic Control	Urban or Rural	CRF %	Range of CRF	Reference	Proven Safety Countermeasure	ADA Trigger
Bike/Ped Systemic	BP12	Install Rectangular Rapid Flashing Beacon with Median (3-Lane or More Roadway)	Pedestrian	All	20	None - Roadway	Urban or Rural	56	10 - 56%	ODOT Engineering Judgement / NCHRP 841	Y- Medians and Pedestrian Crossing Islands in Urban and Suburban Areas	
Bike/Ped Systemic	BP13	Install Pedestrian Activated Beacon Midblock	P & B	All	20	None - Roadway	Urban	10	10%	ODOT Engineering Judgement / NCHRP 841		
Bike/Ped Systemic	BP14	Install Pedestrian Activated Beacon (flashing Beacon in conjunction with median and stop bar)	P & B	All	20	None - Roadway	Urban	56	56%	ODOT Engineering Judgement / NCHRP 841	Y- Medians and Pedestrian Crossing Islands in Urban and Suburban Areas	
Bike/Ped Systemic	BP15	Install Continental Crosswalk Markings and Advance Pedestrian Warning Signs at Uncontrolled Locations	Pedestrian	All	10	None - Roadway	Urban or Rural	15	15%	FHWA Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections		
Bike/Ped Systemic	BP16	Install Curb Ramps and Extensions with a Marked Crosswalk and Pedestrian Warning Signs	Pedestrian	All	20	None - Roadway	Urban or Rural	37	37%	FHWA Desktop Reference for Crash Reductions Factors		
Bike/Ped Systemic	BP17	Install Advance Pedestrian or Bicycle Warning Signs	P & B	All	10	None - Roadway	Urban or Rural	5	5 - 15%	FHWA Desktop Reference for Crash Reductions Factors		
Bike/Ped Systemic	BP18	Install Pedestrian Signal	P & B	All	20	None - Roadway	Urban or Rural	55	15 - 69%	FHWA Desktop Reference for Crash Reductions Factors		Likely
Bike/Ped Systemic	BP19	Install Pedestrian Hybrid Beacon	P & B	All	20	None - Roadway	Urban	55	55 - 69%	CMF Clearinghouse (CMF ID: 2922, 9020), NCHRP 926 (2020), FHWA Proven Safety Countermeasure (https://safety.fhwa.dot.gov/provenco/untermeasures/ped_hybrid_beacon/)	Y- Pedestrian Hybrid Beacons	Likely
Bike/Ped Systemic	BP20	Convert 4-Lane Roadway to 3-Lane Roadway with Center Turn Lane (Road Diet)	All	All	20	None - Roadway	Urban	29	29%	HSM, NCHRP 926	Y- Road Diets (Roadway Reconfiguration)	Likely
Bike/Ped Systemic	BP21	Install Bike Signal	Bicycle	All	20	Signalized	Urban or Rural	45	45%	FHWA MUTCD Interim Approval for Optional Use of a Bicycle Signal Face (IA-16)		
Bike/Ped Systemic	BP22	Install Bike Lanes	Bicycle	All	20	None - Roadway	Urban or Rural	36	0 - 53%	FHWA Desktop Reference for Crash Reductions Factors		
Bike/Ped Systemic	BP23	Install Cycle Tracks	Bicycle	All Injury (Excludes PDO's)	20	None - Roadway	Urban	59	59 - 74%	CMF Clearinghouse (CMF ID: 4102, 4097)		Likely
Bike/Ped Systemic	BP24	Install Buffered Bike Lanes	Bicycle	All Injury (Excludes PDO's)	20	None - Roadway	Urban	47	N/A	ODOT Engineering Judgement		
Bike/Ped Systemic	BP25	Prohibit Right-Turn-On-Red	P & B	All	10	Signalized	Urban or Rural	41	26 - 44%	HSM		

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Hotspot or Systemic Application Type	Countermeasure Number	Countermeasure	Crash Type	Injury, PDO or All	Service Life (Years)	Existing Intersection Traffic Control	Urban or Rural	CRF %	Range of CRF	Reference	Proven Safety Countermeasure	ADA Trigger
Bike/Ped Systemic	BP26	Advanced Yield and Stop Markings & Signs	P & B	All	10	None - Roadway	Urban or Rural	25	25%	CMF Clearinghouse (CMF ID: 9017)		
Bike/Ped Systemic	BP27	Install Bicycle Boulevard	P & B	All	10	None - Roadway	Urban or Rural	63	63%	CMF Clearinghouse (CMF ID: 3092)		
Bike/Ped Systemic	BP28	Install Raised Crosswalk	P & B	All	20	Signalized or Unsignalized	Urban	30	30%	Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes FHWA-SA-014 (https://safety.fhwa.dot.gov/ped_bike/tools_solve/ped_tctpepc/)		Likely
Bike/Ped Systemic	BP29	Sidewalk	destrian - walking alo	All	20	None - Roadway	Urban or Rural	20	20%	Engineering Judgement	Y- Walkways	Likely
Bike/Ped Systemic	BP30	Install Speed Humps/Table (not on state highways)	P & B	All	20	None - Roadway	Urban	15	15%	CMF Clearinghouse (CMF ID: 145)		
Bike/Ped Systemic	BP31	Street Tree's (supports blueprint for Urban Design)	All	All	20	None - Roadway	Urban	10	10%	ODOT Engineering Judgement		Likely
Roadway Departure Systemic	RD1	Increase Distance to Rural Roadside Obstacle from 3 ft. (1 m) to 16 ft. (5 m)	All	All	20	None - Roadway	Rural	22	22 - 44%	HSM, CMF Clearinghouse (CMF ID: 35)	Y- Roadside Design Improvements at Curves	
Roadway Departure Systemic	RD2	Increase Distance to Rural Roadside Obstacle from 16 ft. (5 m) to 30 ft. (9 m)	All	All	20	None - Roadway	Rural	44	22 - 44%	HSM, CMF Clearinghouse (CMF ID: 36)	Y- Roadside Design Improvements at Curves	
Roadway Departure Systemic	RD3	Flatten Rural Side Slopes	All	All	20	None - Roadway	Rural	See table	3 - 15%	HSM	Y- Roadside Design Improvements at Curves	
Roadway Departure Systemic	RD4	Increase Pavement Friction by Installing High Friction Surface Treatment - Intersection or Segment Application	Wet Road	All	10	None - Roadway	Urban or Rural	57	20 - 68%	CMF Clearinghouse (CMF ID: 195)	Y- Roadside Design Improvements at Curves	
Roadway Departure Systemic	RD5	Provide Safety Edge for Rural Pavement Edge Drop-Off	All	All	10	None - Roadway	Rural	6	5-15%	CMF Clearinghouse	Y- SafetyEdgeSM	
Roadway Departure Systemic	RD6	Install RECOMMENDED Chevron Signs on Rural Horizontal Curves	Run Off The Road	All Injury (Excludes PDO's)	10	None - Roadway	Rural	16	4 - 25%	CMF Clearinghouse (CMF ID: 2438)	Y- Enhanced Delineation and Friction for Horizontal Curves	
Roadway Departure Systemic	RD7	Install REQUIRED Chevron Signs on Rural Horizontal Curves (Ballbanking and Revised Speed Riders Included)	Run Off The Road	All Injury (Excludes PDO's)	10	None - Roadway	Rural	16	16%	ODOT Engineering Judgement	Y- Enhanced Delineation and Friction for Horizontal Curves	
Roadway Departure Systemic	RD8	Install Oversized, Doubled Up and/or Fluorescent Yellow Sheeting for Advance Curve Warning Signs	Run Off The Road	All	10	None - Roadway	Urban or Rural	20	20%	ODOT Engineering Judgement	Y- Enhanced Delineation and Friction for Horizontal Curves	

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Hotspot or Systemic Application Type	Countermeasure Number	Countermeasure	Crash Type	Injury, PDO or All	Service Life (Years)	Existing Intersection Traffic Control	Urban or Rural	CRF %	Range of CRF	Reference	Proven Safety Countermeasure	ADA Trigger
Roadway Departure Systemic	RD9	Provide Static Combination Horizontal Alignment/Advisory Curve Warning Sign	All	All Injury (Excludes PDO's)	10	None - Roadway	Urban or Rural	13	13 - 29%	HSM, CMF Clearinghouse (CMF ID: 73)	Y- Enhanced Delineation and Friction for Horizontal Curves	
Roadway Departure Systemic	RD10	Install Advance Curve Warning Flashers (Curve Warning Signs Exist)	Curve Crashes	All	10	None - Roadway	Urban or Rural	10	10%	Engineering Judgement	Y- Enhanced Delineation and Friction for Horizontal Curves	
Roadway Departure Systemic	RD11	Install Dynamic Speed Feedback Sign for Curves	All	All	10	None - Roadway	Rural	5	5%	CMF Clearinghouse (CMF ID: 6885)	Y- Enhanced Delineation and Friction for Horizontal Curves	
Roadway Departure Systemic	RD12	Install Speed Feedback Sign	All	All	5	None - Roadway	Urban or Rural	10	10%	Engineering Judgement		
Roadway Departure Systemic	RD13	Install Raised or Recessed Pavement Markers	Night	All	10	None - Roadway	Urban or Rural	15	15%	https://www.oregon.gov/ODOT/Engineering/Docs_TrafficEng/Departure-Implementation-Plan.pdf		
Roadway Departure Systemic	RD14	Install Post-Mounted Delineators (Curve Application)	Curve crashes at Night	All	10	None - Roadway	Urban or Rural	30	0 - 30%	FHWA Desktop Reference for Crash Reductions Factors	Y- Enhanced Delineation and Friction for Horizontal Curves	
Roadway Departure Systemic	RD15	Install Edgeline Striping (Tangent and/or Curve Application)	Run off the Road	All	10	None - Roadway	Rural	11	11 - 13%	CMF Clearinghouse (CMF ID: 1943, 1946)	Y- Enhanced Delineation and Friction for Horizontal Curves	
Roadway Departure Systemic	RD16	Install Centerline Rumble Strips	All	All Injury (Excludes PDO's)	10	None - Roadway	Rural	12	9 - 45%	CMF Clearinghouse (CMF ID: 3362, 3350)	Y- Longitudinal Rumble Strips and Stripes	
Roadway Departure Systemic	RD17	Install Centerline Rumble Strips	Head On & Sideswipe Meeting	All Injury (Excludes PDO's)	10	None - Roadway	Rural	45	45%	CMF Clearinghouse (CMF ID: 3360)	Y- Longitudinal Rumble Strips and Stripes	
Roadway Departure Systemic	RD18	Install Shoulder Rumble Strips	Run off the Road	All	10	None - Roadway	Urban or Rural	22	16 - 42%	CMF Clearinghouse (CMF ID: 2423)	Y- Longitudinal Rumble Strips and Stripes	
Roadway Departure Systemic	RD19	Install Profiled Line Pavement Markings	Night & Wet Road	All	5	None - Roadway	Urban or Rural	9	0 - 9%	CMF Clearinghouse (CMF ID: 9803 (2018 4-star study)), FHWA-HRT-17- 075		
Roadway Departure Systemic	RD20	Install Widen Paved Shoulder by 1 ft.	All	All	20	None - Roadway	Urban or Rural	6	3 - 6%	CMF Clearinghouse (CMF ID: 5277)	Y- Roadside Design Improvements at Curves	
Roadway Departure Systemic	RD21	Install Widen Paved Shoulder by 2 ft.	All	All	20	None - Roadway	Urban or Rural	13	5 - 13%	CMF Clearinghouse (CMF ID: 5279)	Y- Roadside Design Improvements at Curves	
Roadway Departure Systemic	RD22	Install Widen Paved Shoulder by 3 ft.	All	All	20	None - Roadway	Urban or Rural	18	6 - 18%	CMF Clearinghouse (CMF ID: 5281)	Y- Roadside Design Improvements at Curves	

			Green = Crash Specific				Blue = Area Type Specific					
Hotspot or Systemic Application Type	Countermeasure Number	Countermeasure	Crash Type	Injury, PDO or All	Service Life (Years)	Existing Intersection Traffic Control	Urban or Rural	CRF %	Range of CRF	Reference	Proven Safety Countermeasure	ADA Trigger
Roadway Departure Systemic	RD23	Upgrade existing markings to wet-reflective pavement markings	Wet Road	All	10	None - Roadway	Urban or Rural	14	14%	CMF Clearinghouse (CMF ID: 8137)		
Roadway Departure Systemic	RD24	Install wider edgelines (4 in. to 6 in.)	All	All	10	None - Roadway	Rural	14	17%	CMF Clearinghouse (CMF ID: 4736, 3-star 2019 study CMF ID: 10128)	Y- Enhanced Delineation and Friction for Horizontal Curves	
Roadway Departure Systemic	RD25	Install Any Type of Median Barrier	All	All Injury (Excludes PDO's)	20	None - Roadway	Urban or Rural	30	30%	HSM, CMF Clearinghouse (CMF ID: 43)	Y- Median Barriers	
Roadway Departure Systemic	RD26	Install New Guardrail (Not Median Barrier Application)	Run off the Road	All Injury (Excludes PDO's)	20	None - Roadway	Urban or Rural	47	47%	CMF Clearinghouse (CMF ID: 38)	Y- Roadside Design Improvements at Curves	
Roadway Departure Systemic	RD27	Install Seasonal Wildlife Warning Signs	All	All	20	None - Roadway	Rural	26	26%	http://cem.uaf.edu/media/131602/20150506-huijser-warning-signs-final-2.pdf		
Roadway Departure Systemic	RD28	Install Wildlife Detection System	Wildlife only	All	20	None - Roadway	Rural	87	87%	FHWA publication: https://www.fhwa.dot.gov/publications/publicroads/09septoct/03.cfm		

H1: Median U-Turn Intersection Treatment

Description: Can be J turns, loons or jug handle turns. Median U-Turn treatments are characterized by eliminating the direct left turn movement at an intersection. Depending on the type of median U-turn treatment, there could be further restrictions of directional movements at the intersection. The median U-turn treatment accommodates these movements by requiring drivers to turn right onto the main road and then make a U-turn maneuver at a one-way median opening.



Image from FHWA

Applications: Can be implemented for signalized or unsignalized intersections. Median U-turn intersection treatments are typically implemented as part of a corridor treatment; however, they can be used at isolated intersections. Unsignalized median U-turn intersections preserve corridor capacity and can be installed without the adverse effects of signal control. Scenarios where J-turn intersections are most applicable include the following:

- Relatively low to medium side-street through volumes and heavy left turn volumes from the major road.
- The minor road total volume to total intersection volume ratio is typically less than or equal to 0.20.

ODOT CRF Value:

30%

Reduction in **All Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

30%

Safety Effects:

It reduces the number of conflict points at the intersection and preserves corridor capacity.

References:

[Synthesis of the Median U-turn Intersection Treatment \(FHWA-HRT-07-033\)](#)

[FHWA Proven Safety Countermeasure \(FHWA-SA-17-054\)](#)

FHWA Proven Safety Countermeasure

- Areas where median widths are greater than 40 feet. For narrower medians, loons or bulb-outs on the shoulders need to be constructed.

For intersections with very high left turn and through volumes from the side road approaches, the J-turn intersection design is not the optimal choice.

Considerations: Requires a substantial amount of right of way which could be costly and have significant environmental and/or drainage impacts too.

Special Conditions: This countermeasure shall be paired with turning restrictions at the intersection.

H2: Right Turn Lane on Single Major Road

Approach: Unsignalized Intersection (3- or 4-leg)

Description: A right turn lane is an auxiliary lane for storage and to accommodate the decreasing speed of right turn vehicles as they approach an intersection.



Image from ODOT

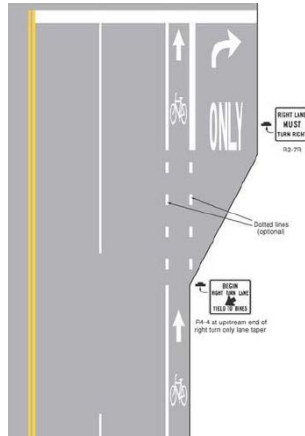


Image from FHWA

Applications: At intersections with a high frequency of rear end crashes resulting from conflicts between a) vehicles turning right and following vehicles and b) vehicles turning right and through vehicles coming from the left on the cross street.

Considerations: This countermeasure may require a significant amount of right of way. Turns lane(s) shall be of adequate storage length so vehicles will not be stopped in the travel lanes. For rural applications, using a buffered right turn lane may improve safety by allowing drivers to see approaching vehicles behind the right turning vehicles.

Special Conditions: This countermeasure CRF value can only be used for installation of a right turn lane on ONE major road approach at a 3-leg or 4-leg UNSIGNALIZED intersection.

ODOT CRF Value:

14%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

14% - 26%

Safety Effects:

Providing a right turn lane at an intersection can reduce rear-end crashes by allowing vehicles to proceed through the intersection without having to stop or slow down for vehicles making a right turn.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 285\)](#)

[Safety Effectiveness of Intersection Left- and Right-Turn Lanes \(FHWA-RD-02-089\)](#)

FHWA Proven Safety Countermeasure

H3: Right Turn Lane on Both Major Road Approaches: Unsignalized Intersection (3- or 4-leg)

Description: A right turn lane is an auxiliary lane for storage and to accommodate the decreasing speed of right turn vehicles as they approach an intersection.



Image from Google

Applications: At intersections with a high frequency of rear end crashes resulting from conflicts between a) vehicles turning right and following vehicles and b) vehicles turning right and through vehicles coming from the left on the cross street.

Considerations: This countermeasure may require a significant amount of right of way. Turns lane(s) shall be of adequate storage length so vehicles will not be stopped in the travel lanes. For rural applications, using a buffered right turn lane may improve safety by allowing drivers to see approaching vehicles behind the right turning vehicles.

Special Conditions: This countermeasure CRF value can only be used for installation of right turn lanes on BOTH major road approaches at a 4-leg UNSIGNALIZED intersection.

ODOT CRF Value:

26%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

14% - 26%

Safety Effects:

Providing a right turn lane at an intersection can reduce rear-end crashes by allowing vehicles to proceed through the intersection without having to stop or slow down for vehicles making a right turn.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 289\)](#)

[Safety Effectiveness of Intersection Left- and Right-Turn Lanes \(FHWA-RD-02-089\)](#)

FHWA Proven Safety Countermeasure

H4: Right Turn Lane on Single Major Road Approaches: Signalized Intersection (3- or 4-leg)

Description: A right turn lane is an auxiliary lane for storage and to accommodate the decreasing speed of right turn vehicles as they approach an intersection.



Image from Google

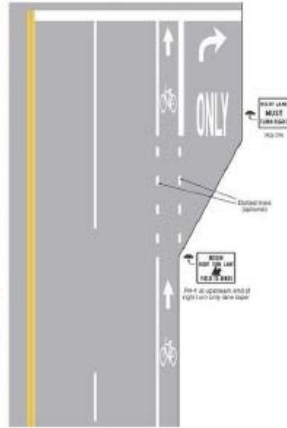


Image from FHWA

Applications: At intersections with a high frequency of rear end crashes resulting from conflicts between a) vehicles turning right and following vehicles and b) vehicles turning right and through vehicles coming from the left on the cross street.

Considerations: This countermeasure may require a significant amount of right of way. Turns lane(s) shall be of adequate storage length so vehicles will not be stopped in the travel lanes.

Special Conditions: This countermeasure CRF value can only be used for installation of a right turn lane on ONE major road approach at a 3-leg or 4-leg SIGNALIZED intersection.

ODOT CRF Value:

4%

**Reduction in All Crashes
at All Severities
(Including PDO's)**

Range of Effectiveness:

4% - 9%

Safety Effects:

Providing a right turn lane at an intersection can reduce rear-end crashes by allowing vehicles to proceed through the intersection without having to stop or slow down for vehicles making a right turn.

References:

Highway Safety Manual

[Crash Modification Factors](#)
[Clearinghouse \(CMF ID: 286\)](#)

Desktop Reference for Crash
Reduction Factors (FHWA-
SA-08-011)

H5: Right Turn Lane on Both Major Road Approaches: Signalized Intersection (3- or 4-leg)

Description: A right turn lane is an auxiliary lane for storage and to accommodate the decreasing speed of right turn vehicles as they approach an intersection.



Image from Google

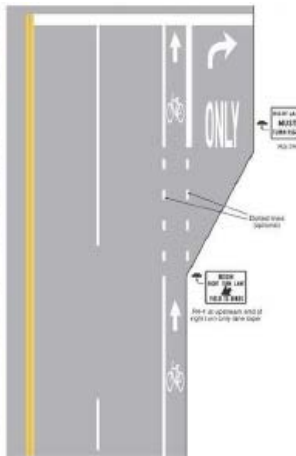


Image from FHWA

Applications: At intersections with a high frequency of rear end crashes resulting from conflicts between a) vehicles turning right and following vehicles and b) vehicles turning right and through vehicles coming from the left on the cross street.

Considerations: This countermeasure may require a significant amount of right of way. Turns lane(s) shall be of adequate storage length so vehicles will not be stopped in the travel lanes. Providing a right turn lane can also increase the crossing time needed for pedestrians, increasing their exposure to vehicle traffic.

Special Conditions: This countermeasure CRF value can only be used for installation of a right turn lane on ONE major road approach at a 3-leg or 4-leg SIGNALIZED intersection.

ODOT CRF Value:

8%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

4% - 9%

Safety Effects:

Providing a right turn lane at an intersection could reduce rear-end crashes by allowing through vehicles to proceed across the intersection without having to stop or slow down for vehicles making a right turn.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 290\)](#)

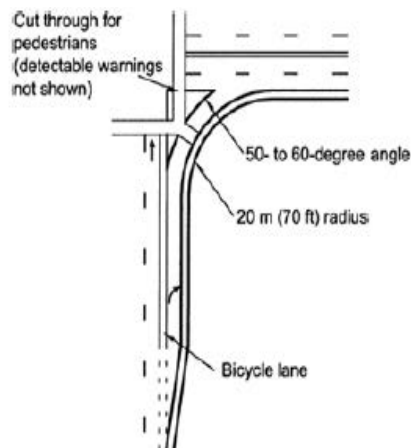
[Safety Effectiveness of Intersection Left- and Right-Turn Lanes \(FHWA-RD-02-089\)](#)

H6: Channelized Right Turn Lane with Raised Median

Description: A right turn lane separated from the through and left turn lanes on the approach by a raised island and has separate traffic control from the primary intersection. The channelized right turn lane may or may not have a deceleration lane entering it and it may have a merge or an auxiliary lane at the existing end.



Image from Google



Applications: Where you want to minimize the number of potential turning conflicts at an intersection, where you want to shorten pedestrian crossing distances and/or where you need a larger turning radius.

Considerations: Creates a wider intersection footprint and may require additional right of way.

Special Conditions: This countermeasure CRF applies to BOTH signalized and unsignalized intersections. This countermeasure requires a concrete/raised island, it does NOT apply to painted islands.

ODOT CRF Value:

35%

Reduction in **All Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

25% - 50%

Safety Effects:

This countermeasure can provide better clarity to the minor street traffic of which vehicles are in the through lanes on the major street and minimizes the number of conflict points within an intersection. It can create a pedestrian refuge for two stage crossings and it minimizes lane encroachment.

References:

[Desktop Reference for Crash Reduction Factors \(FHWA-SA-08-011\)](#)

H7: Left Turn Lane on Single Major Road

Approach: Urban, Unsignalized Intersection (3-leg)

Description: A left turn lane is an auxiliary lane for storage and to accommodate the decreasing speed of left turn vehicles as they approach an intersection. This countermeasure is also known as a channelized left turn lane.



Image from FHWA

Applications: Use this countermeasure where you have a higher frequency of rear end crashes resulting from the conflicts between vehicles turning left and following vehicles. Crash frequencies between vehicles turning left and opposing through vehicles are also candidates for the installation of left turn lanes - drivers feel less pressure to take insufficient gaps when they have their own lane to wait in.

Considerations: Turns lane(s) shall be of adequate storage length so vehicles will not be stopped in the travel lanes.

Special Conditions: This countermeasure CRF value can only be used for installation of a left turn lane on ONE major road approach at an URBAN 3-leg UNSIGNALIZED intersection.

ODOT CRF Value:

33%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

33% - 55%

Safety Effects:

Left turn lanes allow vehicles to proceed through the intersection without having to stop or slow down for vehicles waiting to make a left turn.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 254\)](#)

[Safety Effectiveness of Intersection Left- and Right-Turn Lanes \(FHWA-RD-02-089\)](#)

FHWA Proven Safety Countermeasure

H8: Left Turn Lane on Both Major Road

Approaches: Urban, Unsignalized Intersection (4-leg)

Description: A left turn lane is an auxiliary lane for storage and to accommodate the decreasing speed of left turn vehicles as they approach an intersection. This countermeasure is also known as a channelized left turn lane.



Image from Google

Applications: Use this countermeasure where you have a higher frequency of rear end crashes resulting from the conflicts between vehicles turning left and following vehicles. Crash frequencies between vehicles turning left and opposing through vehicles are also candidates for the installation of left turn lanes - drivers feel less pressure to take insufficient gaps when they have their own lane to wait in.

Considerations: Turns lane(s) shall be of adequate storage length so vehicles will not be stopped in the travel lanes.

Special Conditions: This countermeasure CRF value can only be used for installation of left turn lanes on BOTH major road approaches at an URBAN 4-leg UNSIGNALIZED intersection.

ODOT CRF Value:

47%

**Reduction in All Crashes
at All Severities
(Including PDO's)**

Range of Effectiveness:

47% - 58%

Safety Effects:

Left turn lanes allow vehicles to proceed through the intersection without having to stop or slow down for vehicles waiting to make a left turn.

References:

Highway Safety Manual

[Crash Modification Factors
Clearinghouse \(CMF ID: 269\)](#)

[Safety Effectiveness of
Intersection Left- and Right-
Turn Lanes \(FHWA-RD-02-
089\)](#)

**FHWA Proven Safety
Countermeasure**

H9: Left Turn Lane on Single Major Road

Approach: Rural, Unsignalized Intersection (3-leg)

Description: A left turn lane is an auxiliary lane for storage and to accommodate the decreasing speed of left turn vehicles as they approach an intersection. This countermeasure is also known as a channelized left turn lane.



Image from FHWA

Applications: Use this countermeasure where you have a higher frequency of rear end crashes resulting from the conflicts between vehicles turning left and following vehicles. Crash frequencies between vehicles turning left and opposing through vehicles are also candidates for the installation of left turn lanes - drivers feel less pressure to take insufficient gaps when they have their own lane to wait in.

Considerations: Turns lane(s) shall be of adequate storage length so vehicles will not be stopped in the travel lanes.

Special Conditions: This countermeasure CRF value can only be used for installation of a left turn lane on ONE major road approach at a RURAL 3-leg UNSIGNALIZED intersection.

ODOT CRF Value:

44%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

33% - 55%

Safety Effects:

Left turn lanes allow vehicles to proceed through the intersection without having to stop or slow down for vehicles waiting to make a left turn.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 253\)](#)

[Safety Effectiveness of Intersection Left- and Right-Turn Lanes \(FHWA-RD-02-089\)](#)

FHWA Proven Safety Countermeasure

H10: Left Turn Lane on Both Major Road Approaches: Rural, Unsignalized Intersection (4-leg)

Description: A left turn lane is an auxiliary lane for storage and to accommodate the decreasing speed of left turn vehicles as they approach an intersection. This countermeasure is also known as a channelized left turn lane.



Image from FHWA

Applications: Use this countermeasure where you have a higher frequency of rear end crashes resulting from the conflicts between vehicles turning left and following vehicles. Crash frequencies between vehicles turning left and opposing through vehicles are also candidates for the installation of left turn lanes - drivers feel less pressure to take insufficient gaps when they have their own lane to wait in.

Considerations: Turns lane(s) shall be of adequate storage length so vehicles will not be stopped in the travel lanes.

Special Conditions: This countermeasure CRF value can only be used for installation of left turn lanes on BOTH major road approaches at a RURAL 4-leg UNSIGNALIZED intersection.

ODOT CRF Value:

48%

**Reduction in All Crashes
at All Severities
(Including PDO's)**

Range of Effectiveness:

47% - 58%

Safety Effects:

Left turn lanes allow vehicles to proceed through the intersection without having to stop or slow down for vehicles waiting to make a left turn.

References:

Highway Safety Manual

[Crash Modification Factors
Clearinghouse \(CMF ID: 268\)](#)

[Safety Effectiveness of
Intersection Left- and Right-
Turn Lanes \(FHWA-RD-02-
089\)](#)

**FHWA Proven Safety
Countermeasure**

H11: Left Turn Lane on Single Major Road

Approach: Urban, Signalized Intersection (3-leg)

Description: A left turn lane is an auxiliary lane for storage and to accommodate the decreasing speed of left turn vehicles as they approach an intersection. This countermeasure is also known as a channelized left turn lane.



Image from Google

Applications: Use this countermeasure where you have a higher frequency of rear end crashes resulting from the conflicts between vehicles turning left and following vehicles. Crash frequencies between vehicles turning left and opposing through vehicles are also candidates for the installation of left turn lanes - drivers feel less pressure to take insufficient gaps when they have their own lane to wait in.

Considerations: Turns lane(s) shall be of adequate storage length so vehicles will not be stopped in the travel lanes. Installing turn lanes after a signal has been in place may result in the need to relocate signal poles in order to accommodate the standard width of the turn lane. Pedestrian safety should also be considered. Depending on left turn volume, creating a permissive left turn would protect the adjacent pedestrian movements.

Special Conditions: This countermeasure CRF value can only be used for installation of a left turn lane on ONE major road approach at an URBAN 3-leg SIGNALIZED intersection.

ODOT CRF Value:

7%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

7% - 15%

Safety Effects:

Left turn lanes could allow through vehicles to proceed across the intersection without having to stop or slow down for vehicles waiting to make a left turn.

References:

Highway Safety Manual

[Safety Effectiveness of Intersection Left- and Right-Turn Lanes \(FHWA-RD-02-089\)](#)

H12: Left Turn Lane on Single Major Road

Approach: Urban, Signalized Intersection (4-leg)

Description: A left turn lane is an auxiliary lane for storage and to accommodate the decreasing speed of left turn vehicles as they approach an intersection. This countermeasure is also known as a channelized left turn lane.



Image from FHWA

Applications: Use this countermeasure where you have a higher frequency of rear end crashes resulting from the conflicts between vehicles turning left and following vehicles. Crash frequencies between vehicles turning left and opposing through vehicles are also candidates for the installation of left turn lanes - drivers feel less pressure to take insufficient gaps when they have their own lane to wait in.

Considerations: Turns lane(s) shall be of adequate storage length so vehicles will not be stopped in the travel lanes. Installing turn lanes after a signal has been in place may result in the need to relocate signal poles in order to accommodate the standard width of the turn lane. Protecting adjacent pedestrian movements should also be considered depending on how the left turn operates. Even if the left turn is permissive only, consideration of a FYA with not-ped could protect the conflict between vehicles and pedestrians.

Special Conditions: This countermeasure CRF value can only be used for installation of a left turn lane on ONE major road approach at an URBAN 4-leg SIGNALIZED intersection.

ODOT CRF Value:

10%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

10%

Safety Effects:

Left turn lanes could allow through vehicles to proceed across the intersection without having to stop or slow down for vehicles waiting to make a left turn.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 262\)](#)

[Safety Effectiveness of Intersection Left- and Right-Turn Lanes \(FHWA-RD-02-089\)](#)

H13: Left Turn Lane on Both Major Road Approaches: Urban, Signalized Intersection (4-leg)

Description: A left turn lane is an auxiliary lane for storage and to accommodate the decreasing speed of left turn vehicles as they approach an intersection. This countermeasure is also known as a channelized left turn lane.



Image from FHWA

Applications: Use this countermeasure where you have a higher frequency of rear end crashes resulting from the conflicts between vehicles turning left and following vehicles. Crash frequencies between vehicles turning left and opposing through vehicles are also candidates for the installation of left turn lanes - drivers feel less pressure to take insufficient gaps when they have their own lane to wait in.

Considerations: Turns lane(s) shall be of adequate storage length so vehicles will not be stopped in the travel lanes. Installing turn lanes after a signal has been in place may result in the need to relocate signal poles in order to accommodate the standard width of the turn lane. Protecting adjacent pedestrian movements should also be considered depending on how the left turn operates. Even if the left turn is permissive only, consideration of a FYA with not-ped could protect the conflict between vehicles and pedestrians.

Special Conditions: This countermeasure CRF value can only be used for installation of left turn lanes on BOTH major road approaches at a URBAN 4-leg SIGNALIZED intersection.

ODOT CRF Value:

19%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

17% - 48%

Safety Effects:

Left turn lanes could allow through vehicles to proceed across the intersection without having to stop or slow down for vehicles waiting to make a left turn.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 270\)](#)

[Safety Effectiveness of Intersection Left- and Right-Turn Lanes \(FHWA-RD-02-089\)](#)

H14: Left Turn Lane on Single Major Road

Approach: Rural, Signalized Intersection (3-leg)

Description: A left turn lane is an auxiliary lane for storage and to accommodate the decreasing speed of left turn vehicles as they approach an intersection. This countermeasure is also known as a channelized left turn lane.



Image from Google

Applications: Use this countermeasure where you have a higher frequency of rear end crashes resulting from the conflicts between vehicles turning left and following vehicles. Crash frequencies between vehicles turning left and opposing through vehicles are also candidates for the installation of left turn lanes - drivers feel less pressure to take insufficient gaps when they have their own lane to wait in.

Considerations: Turns lane(s) shall be of adequate storage length so vehicles will not be stopped in the travel lanes. Installing turn lanes after a signal has been in place may result in the need to relocate signal poles in order to accommodate the standard width of the turn lane.

Special Conditions: This countermeasure CRF value can only be used for installation of a left turn lane on ONE major road approach at an RURAL 3-leg SIGNALIZED intersection.

ODOT CRF Value:

15%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

7% - 15%

Safety Effects:

Left turn lanes could allow through vehicles to proceed across the intersection without having to stop or slow down for vehicles waiting to make a left turn.

References:

Highway Safety Manual

[Safety Effectiveness of Intersection Left- and Right-Turn Lanes \(FHWA-RD-02-089\)](#)

H15: Left Turn Lane on Single Major Road

Approach: Rural, Signalized Intersection (4-leg)

Description: A left turn lane is an auxiliary lane for storage and to accommodate the decreasing speed of left turn vehicles as they approach an intersection. This countermeasure is also known as a channelized left turn lane.



Image from Google

Applications: Use this countermeasure where you have a higher frequency of rear end crashes resulting from the conflicts between vehicles turning left and following vehicles. Crash frequencies between vehicles turning left and opposing through vehicles are also candidates for the installation of left turn lanes - drivers feel less pressure to take insufficient gaps when they have their own lane to wait in.

Considerations: Turns lane(s) shall be of adequate storage length so vehicles will not be stopped in the travel lanes. Installing turn lanes after a signal has been in place may result in the need to relocate signal poles in order to accommodate the standard width of the turn lane.

Special Conditions: This countermeasure CRF value can only be used for installation of a left turn lane on ONE major road approach at an RURAL 4-leg SIGNALIZED intersection.

ODOT CRF Value:

18%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

18%

Safety Effects:

Left turn lanes could allow through vehicles to proceed across the intersection without having to stop or slow down for vehicles waiting to make a left turn.

References:

Highway Safety Manual

H16: Left Turn Lane on Both Major Road Approaches: Rural, Signalized Intersection (4-leg)

Description: A left turn lane is an auxiliary lane for storage and to accommodate the decreasing speed of left turn vehicles as they approach an intersection. This countermeasure is also known as a channelized left turn lane.



Image from Google

Applications: Use this countermeasure where you have a higher frequency of rear end crashes resulting from the conflicts between vehicles turning left and following vehicles. Crash frequencies between vehicles turning left and opposing through vehicles are also candidates for the installation of left turn lanes - drivers feel less pressure to take insufficient gaps when they have their own lane to wait in.

Considerations: Turns lane(s) shall be of adequate storage length so vehicles will not be stopped in the travel lanes. Installing turn lanes after a signal has been in place may result in the need to relocate signal poles in order to accommodate the standard width of the turn lane.

Special Conditions: This countermeasure CRF value can only be used for installation of left turn lanes on BOTH major road approaches at a RURAL 4-leg SIGNALIZED intersection.

ODOT CRF Value:

33%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

17% - 48%

Safety Effects:

Left turn lanes could allow through vehicles to proceed across the intersection without having to stop or slow down for vehicles waiting to make a left turn.

References:

Highway Safety Manual

[Safety Effectiveness of Intersection Left- and Right-Turn Lanes \(FHWA-RD-02-089\)](#)

H17: Channelized Left Turn Lane with Raised Median on All Approaches (3- or 4-leg)

Description: Channelized left turn lanes provide a median separation between the designated left turn lane and opposing through lanes at an intersection. This treatment is a basic curb separator that can also include a positive offset where sufficient median widths exist.



Image from Google

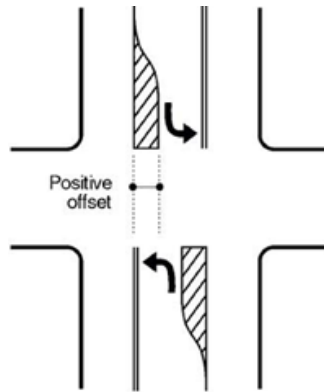


Image from FHWA

Applications: This countermeasure applies to locations where a) there is a high frequency of intersection crashes between vehicles turning left and opposing through vehicles and/or b) there is a higher than expected frequency of turning movements from adjacent business accesses conflicting with intersection movements.

Considerations: Having sufficient pavement width and the potential impacts to restricting business accesses.

Special Conditions: This countermeasure CRF can be applied to signalized and unsignalized intersections. This countermeasure requires a concrete/raised median, it does NOT apply to painted medians.

ODOT CRF Value:

27%

Reduction in **All Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

4% - 27%

Safety Effects:

Channelized left turn lanes provide the left turning motorist a line of sight to opposing through vehicles, allowing them to clearly see oncoming traffic. This countermeasure can also serve to protect the designated left turn lane from vehicles turning into and out of adjacent business accesses.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 249\)](#)

H18: Install Roundabout from Minor Road Stop Control

Description: A modern roundabout is a type of circular intersection defined by the basic operational principle that entering traffic yields to vehicles on the circular roadway.



Image from FHWA

Applications: Roundabouts should be considered for all existing unsignalized intersections that have been identified as needing major safety or operational improvements. Typical crash patterns that could be resolved with a roundabout are higher than expected speed related, angle and/or turning crashes.

Considerations: Roundabouts require a significant amount of public outreach and education in addition to requiring a larger geometric footprint than a typical intersection.

Special Conditions: Map-21 Legislation declares a National focus to reduce Fatalities and Severe (Injury A) crashes on our roadways. Roundabouts are one of the primary tools we can use to reduce severity of crashes and meet this National goal.

ODOT CRF Value:

82%

Reduction in **All Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

19% - 82%

Safety Effects:

Roundabout intersections eliminate a number of vehicle conflict points (up to 75%) typically associated with traditional intersections. They also enhance safety by reducing vehicle speeds (more typical in rural settings) both in and through the intersection and by changing the crash type from angle to sideswipe, which typically results in less severe crashes.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 228\)](#)

**FHWA Proven Safety
Countermeasure**

H19: Install Roundabout from Signalized Intersection

Description: A modern roundabout is a type of circular intersection defined by the basic operational principle that entering traffic yields to vehicles on the circular roadway.



Image from FHWA

Applications: Roundabouts should be considered for all existing signalized intersections that have been identified as needing major safety or operational improvements that cannot be resolved by signalized intersection modifications. Typical crash patterns that could be resolved with a roundabout are higher than expected speed related, angle and/or turning crashes.

Considerations: Roundabouts require a significant amount of public outreach and education in addition to requiring a larger geometric footprint than a typical signalized intersection.

Special Conditions: Map-21 Legislation declares a National focus to reduce Fatalities and Severe (Injury A) crashes on our roadways. Roundabouts are one of the primary tools we can use to reduce severity of crashes and meet this National goal.

ODOT CRF Value:

78%

Reduction in **All Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

48% - 78%

Safety Effects:

Roundabout intersections eliminate a number of vehicle conflict points (up to 75%) typically associated with traditional intersections. They also enhance safety by reducing vehicle speeds (more typical in rural settings) both in and through the intersection and by changing the crash type from angle to sideswipe, which typically results in less severe crashes.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 226\)](#)

FHWA Proven Safety Countermeasure

H20: Convert to All-Way Stop Control (From Urban 2-Way or Yield Control)

Description: Modifying an intersection with minor road stop or yield control intersection to an intersection where the major legs have to stop in addition to the minor legs.



Image from FHWA

Applications: Unsignalized 2-Way Stop or Yield controlled intersections with a pattern of right-angle and turning crashes and relatively balanced volumes on the intersection approaches.

Considerations: Identify moderate volume situations where all-way stop control will operate efficiently without substantially more delay than a signalized intersection. Not every two-way stop-controlled intersection should be considered as a candidate for all-stop control. This strategy should be used selectively, recognizing traffic volumes and patterns and potentially adverse reaction by the driving population to being stopped for no apparent reason. If drivers encounter substantial delays, they may become impatient and act irrationally, which can lead to crash patterns of the type that the strategy is intended to correct.

Special Conditions: This CRF value is for URBAN intersections.

The MUTCD lists guidance for the placement of All-Way (Multi-Way) Stop Sign applications, which should be reviewed as installation of this treatment is considered.

ODOT CRF Value:

75%

Reduction in **Angle Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

18% - 75%

Safety Effects:

All-way stop control can reduce right-angle and turning collisions at unsignalized intersections by providing more orderly movement at an intersection, reducing through and turning speeds, and minimizing the safety effect of any sight distance restrictions that may be present.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 310\)](#)

[The Safety Effect of Conversion to All-Way Stop Control \(TRR 1068\)](#)

H21: Convert to All-Way Stop Control (From Rural 2-Way or Yield Control)

Description: Modifying an intersection with minor road stop or yield control intersection to an intersection where the major legs have to stop in addition to the minor legs.



Image from FHWA

Applications: Unsignalized 2-Way Stop or Yield controlled intersections with a pattern of right-angle and turning crashes and relatively balanced volumes on the intersection approaches.

Considerations: Identify moderate volume situations where all-way stop control will operate efficiently without substantially more delay than a signalized intersection. Not every two-way stop-controlled intersection should be considered as a candidate for all-stop control. This strategy should be used selectively, recognizing traffic volumes and patterns and potentially adverse reaction by the driving population to being stopped for no apparent reason. If drivers encounter substantial delays, they may become impatient and act irrationally, which can lead to crash patterns of the type that the strategy is intended to correct.

Special Conditions: This CRF value is for RURAL intersections.

The MUTCD lists guidance for the placement of All-Way (Multi-Way) Stop Sign applications, which should be reviewed as installation of this treatment is considered.

ODOT CRF Value:

48%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

18% - 75%

Safety Effects:

All-way stop control can reduce right-angle and turning collisions at unsignalized intersections by providing more orderly movement at an intersection, reducing through and turning speeds, and minimizing the safety effect of any sight distance restrictions that may be present.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 315\)](#)

[The Safety Effect of Conversion to All-Way Stop Control \(TRR 1068\)](#)

H22, H23: Install Urban Traffic Signal

Description: Traffic Signals are a traffic control device positioned on roadways to efficiently control and manage competing flows of traffic (vehicles, pedestrians and/or bicycles).



Image from Google

Applications: Where an intersection is experiencing a higher than expected frequency of right angle crashes with adequate sight distance to that intersection from all approaches.

Considerations: It is important that the existing intersection crash patterns are related to failing to yield to right of way as opposed to failing to yield to slowing traffic as a signal installation will likely increase the latter.

Special Conditions: While signals decrease the potential for angle crashes, simultaneously they increase the potential for rear end crashes. It is also important to note that rear end crashes in high speed corridors typically result in more severe crashes than in lower speed corridors. Benefit/Cost Analysis using this countermeasure shall include BOTH CRF values listed below, one for decreasing angle crashes and the other for increasing rear end crashes, to best represent the expected changes in safety with installation.

The MUTCD lists nine warrants for the placement of traffic signals, which should be reviewed as installation of this treatment is considered. State Traffic Engineer Approval and warrant analysis is REQUIRED for all potential signal installations on the State Highway.

ODOT CRF Value:

67% (Angle)

-143% (Rear End)

Reduction in **Angle & Rear End Crashes** at All Severities (Including PDO's)

Range of Effectiveness:

-143% - 77%

Safety Effects:

Traffic signals help to assign right of way to traffic movements which helps to reduce right angle crashes at intersections.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 323\)](#)

[Crash Modification Factors Clearinghouse \(CMF ID: 324\)](#)

H24, H25: Install Rural Traffic Signal

Description: Traffic Signals are a traffic control device positioned on roadways to efficiently control and manage competing flows of traffic (vehicles, pedestrians and/or bicycles).



Image from Google

Applications: Where an intersection is experiencing a higher than expected frequency of right angle crashes with adequate sight distance to that intersection from all approaches.

Considerations: It is important that the existing intersection crash patterns are related to failing to yield to right of way as opposed to failing to yield to slowing traffic as a signal installation will likely increase the latter.

Special Conditions: While signals decrease the potential for angle crashes, simultaneously they increase the potential for rear end crashes. It is also important to note that rear end crashes in high speed corridors typically result in more severe crashes than in lower speed corridors. Benefit/Cost Analysis using this countermeasure shall include BOTH CRF values listed below, one for decreasing angle crashes and the other for increasing rear end crashes, to best represent the expected changes in safety with installation.

The MUTCD lists nine warrants for the placement of traffic signals, which should be reviewed as installation of this treatment is considered. State Traffic Engineer Approval and warrant analysis is REQUIRED for all potential signal installations on the State Highway.

ODOT CRF Value:

77% (Angle)

-58% (Rear End)

**Reduction in Angle & Rear
End Crashes at All
Severities (Including PDO's)**

Range of Effectiveness:

-58% - 77%

Safety Effects:

Traffic signals help to assign right of way to traffic movements which helps to reduce right angle crashes at intersections.

References:

Highway Safety Manual

[Crash Modification Factors
Clearinghouse \(CMF ID: 326\)](#)

[Crash Modification Factors
Clearinghouse \(CMF ID: 328\)](#)

H26: Convert 4-Leg Intersection to Two 3-Leg Intersections (Minor St. AADT is 15%-30% of Total Entering Volume)

Description: Realignment of a 4-leg intersection to two 3-leg intersections in an appreciable distance along the major street.



Image from FHWA

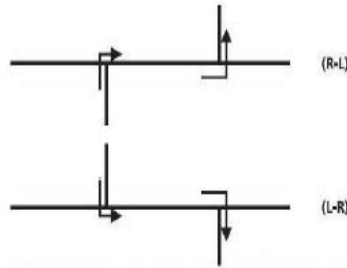


Image from HSM

Applications: Where an intersection is experiencing a higher than expected frequency and/or severity of right angle and/or turning crashes and the minor street volumes are relatively low compared to the major street. This countermeasure should be considered in areas where a signal or roundabout is not feasible.

Considerations: If the intersections are not spaced far enough apart, two problems can occur. First, there may not be enough storage length for the left turning vehicles between the intersections. Second, the operations of the intersections may interfere with one another. In addition, this countermeasure usually requires a significant amount of right of way as you are building an entire new roadbed.

Special Conditions: Per HSM Guidance, this countermeasure is specifically for minor street ADT that is 15-30% of the total entering traffic. The two intersections can be right-left staggered (R-L image seen above) or left-right staggered (L-R image seen above).

ODOT CRF Value:

25%

Reduction in **All Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

10% - 33%

Safety Effects:

By creating two 3-leg intersections you create two intersections with fewer conflict points than at a single, 4-leg intersection.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 201\)](#)

H27: Convert 4-Leg Intersection to Two 3-Leg Intersections (Minor St ADT is 30% + of Total Entering Traffic)

Description: Realignment of a 4-leg intersection to two 3-leg intersections in an appreciable distance along the major street.



Image from FHWA

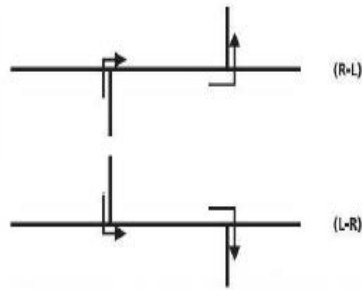


Image from HSM

Applications: Where an intersection is experiencing a higher than expected frequency and/or severity of right angle and/or turning crashes and the minor street volumes are relatively low compared to the major street. This countermeasure should be considered in areas where a signal or roundabout is not feasible.

Considerations: If the intersections are not spaced far enough apart, two problems can occur. First, there may not be enough storage length for the left turning vehicles between the intersections. Second, the operations of the intersections may interfere with one another. In addition, this countermeasure usually requires a significant amount of right of way as you are building an entire new roadbed.

Special Conditions: Per HSM Guidance, this countermeasure is specifically for minor street ADT that is 30% of the total entering traffic. The two intersections can be right-left staggered (R-L image seen above) or left-right staggered (L-R image seen above).

ODOT CRF Value:

33%

**Reduction in All Crashes
at All Injury Severities
(Excludes PDO's)**

Range of Effectiveness:

10% - 33%

Safety Effects:

By creating two 3-leg intersections you create two intersections with fewer conflict points than at a single, 4-leg intersection.

References:

Highway Safety Manual

[Crash Modification Factors
Clearinghouse \(CMF ID: 202\)](#)

H28: Install Rural Median Acceleration Lane

Description: A left turn auxiliary or speed change lane that allows vehicles to accelerate to highway speeds before entering the through traffic lanes of a roadway.



Image from Google

Applications: At unsignalized intersections that are experiencing a high proportion of crashes related to speed differential caused by vehicles turning left onto the highway. They may also be used where intersection sight distance is inadequate or where there are high volumes of trucks entering from the minor road onto the major road. Typically they are used on divided roadways but have also seen success on undivided roadways when paired with concrete lane separators.

Considerations: Acceleration lanes should be of sufficient length to permit adjustments in speeds of both through and entering vehicles so that the driver of the entering vehicle can safely maneuver into a gap before reaching the end of the acceleration lane. Acceleration lanes can establish an add lane that does not require merging, when feasible. In addition, if a left-turn acceleration lane is excessively long or poorly marked, through drivers may mistake it for an additional through lane.

Special Conditions: This countermeasure can only be applied to rural areas. Verify that acceleration lanes are operationally warranted by relatively high left turn volumes. Design the median opening area to minimize conflicts between vehicles entering the left turn acceleration lane and other and turning vehicles using the median opening.

ODOT CRF Value:

45%

Reduction in **All Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

20% - 79%

Safety Effects:

Drivers turning onto a roadway accelerate until the desired highway speed is reached. When acceleration by entering traffic takes place directly on the traveled way, it may disrupt the flow of through traffic and create potential conflicts. Median acceleration lanes can help to minimize this operational problem at rural intersections.

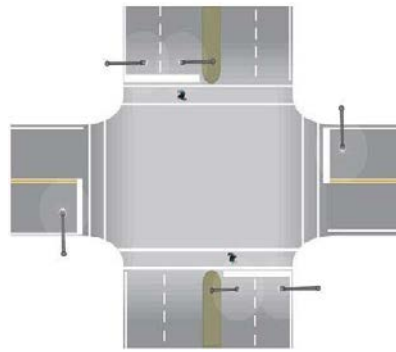
References:

[Crash Modification Factors Clearinghouse \(CMF ID: 2755\)](#)

[Median Intersection Design for Rural High-Speed Divided Highways \(NCHRP Report 650\)](#)

H29: Install Lighting at Intersection

Description: A permanent source of artificial light installed at an intersection that provides greater visibility of the intersection.



Images from FHWA

Applications: Intersections that are experiencing a high instance of dark or nighttime crashes. Particularly for unsignalized intersections, rear-end, right-angle, or turning crashes on the major road approaches may indicate that approaching drivers are unaware of the presence of the intersection.

Considerations: In rural areas it may be difficult to locate a power source. In addition, it is important to determine, upfront, the jurisdiction responsible for paying the ongoing utility costs.

Special Conditions: This countermeasure is for new lighting only, not to replace existing, substandard lighting. This CRF value can be applied to signalized and unsignalized intersections. For ODOT Highways, please refer to the ODOT Lighting Policy and Guidelines for further guidance on lighting warrants.

ODOT CRF Value:

38%

Reduction in **Night Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

31% - 38%

Safety Effects:

Intersection lighting allows for greater visibility of the intersection, making signs and markings more visible and helping drivers determine a safe path through the intersection. This can be especially helpful at rural intersections where the only source of lighting for the roadway is often provided by vehicle headlights.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 433\)](#)

H30: Install Lighting on a Roadway Segment

Description: A permanent source of artificial light installed on a segment of roadway that provides greater visibility of the roadway.



Image from American Electric Lighting



Image from Google

Applications: Segments of roadway that are experiencing a high instance of dark or nighttime crashes, particularly crashes related to missed visual roadway queues.

Considerations: In rural areas it may be difficult to locate a power source. In addition, it is important to determine, upfront, the jurisdiction responsible for paying the ongoing utility costs.

Special Conditions: This countermeasure is for new lighting, not to replace existing, substandard lighting. This CRF value applies to roadway segments only. For ODOT Highways, please refer to the ODOT Lighting Policy and Guidelines for further guidance on lighting warrants.

ODOT CRF Value:

28%

Reduction in **Night Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

17% - 29%

Safety Effects:

Segment lighting allows for greater visibility of the roadway and the visual cues that help drivers determine a safe path along the roadway. This can be especially helpful in rural areas where the only source of lighting for the roadway is often provided by vehicle headlights.

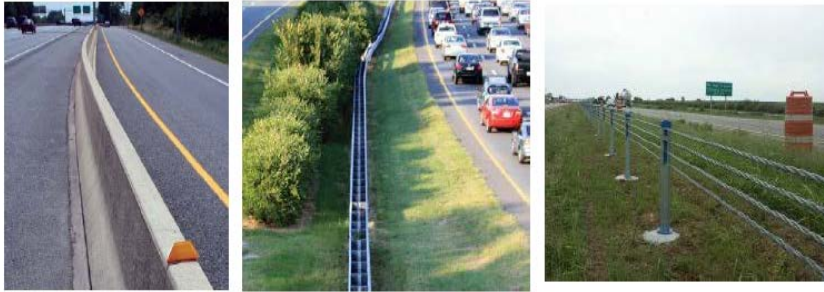
References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 192\)](#)

H31: Install Any Type of Median Barrier

Description: Median barriers are longitudinal barriers most commonly used to separate opposing directions of traffic on a divided highway.



Images from FHWA

Applications: On divided highways with high speeds and high volumes and/or on divided highways with a high frequency of fatal or serious injury median crossover crashes.

Considerations: Ease and costs of maintenance and repair for these barrier systems is an important consideration.

Special Conditions: There are three basic categories of median barriers that each have their own set of pros and cons. Consideration of vehicle types, roadway geometry and potential severity of median crossover crashes must be considered when choosing a median barrier type. The three types are rigid barrier systems (i.e. concrete barrier), semi-rigid barrier systems (i.e. guardrail) and flexible barrier systems (i.e. cable barrier). Rigid barriers have a high installation cost but a low life-cycle cost. They are associated with more severe injury crashes relative to other barrier types but are proven highly effective in locations with heavy truck traffic and insufficient median widths for the other barrier types. Semi-Rigid barriers are most suitable for use in traversable medians having no or little change in grade and cross slope. Initial cost is lower than rigid barriers but it generally has a higher life cycle cost due to repair needs. Typical installation of semi-rigid median barrier is on divided roadways with 20,000 ADT or more and medians less than 50 feet wide. Flexible barriers are the most forgiving barrier systems available for reducing the severity of median crossover crashes. They generally have a lower installation cost than rigid and semi-rigid barriers but typically have a higher life cycle cost due to repair needs. Typical installations of flexible median barriers are in medians less than 50 feet wide.

ODOT CRF Value:

30%

Reduction in **All Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

-24% - 43%

Safety Effects:

While these systems may not reduce the frequency of crashes due to roadway departure, they do help prevent a median crash from becoming a median crossover head-on collision which has a high chance of resulting in a fatality or severe injury.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 43\)](#)

**FHWA Proven Safety
Countermeasure**

H32: Install New Guardrail (Not Median Barrier Application)

Description: A semi-rigid barrier typically consisting of connected segments of metal railing supported by posts and blocks.



Images from FHWA

Applications: Guardrails should be installed where there is evidence (i.e. crash history) of the need to shield motorists from a roadside hazard that has a higher risk for fatal or serious injury crashes than the guardrail itself. Potential roadside hazards could be point hazards (such as a bridge pier or utility pole), medium-sized hazards (such as roadside culverts), and long hazards (such as steep roadside slopes).

Considerations: Guardrails themselves are a roadside obstacle that a motorist can potentially strike (subsequently creating a lot of potential maintenance costs as well) so it is important to minimize guardrail installation to locations where you are protecting a motorist from roadside hazards that have a higher risk for fatal or serious injury crashes.

Special Conditions: For more guidance on installation of guardrails please see NCHRP Report 638.

ODOT CRF Value:

47%

Reduction in
Run off the Road Crashes
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

44% - 47%

Safety Effects:

Because guardrail systems are designed to absorb energy during a crash, and the entire assembly is designed to move or deflect during an impact, guardrail systems usually minimize potential injuries in run off the road or roadway departure crashes.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 38\)](#)

FHWA Proven Safety Countermeasure

H33: Install Two Way Left Turn Lane on 2-Lane Road

Description: A type of traversable median reserved for the exclusive use of vehicles turning left from both directions.



Image from FHWA

Applications: On two-lane roadways where you have frequent accesses and a high frequency of rear end crashes related to vehicles turning left.

Considerations: If the pavement width doesn't already exist, this countermeasure could have significant costs associated with adding more impervious surface. Typical examples are right of way acquisition, drainage impacts and environmental mitigation.

Special Conditions: On arterials with higher volumes (above 20,000 ADT) and frequent access, it may be advantageous to consider a non-traversable (curbed) median, rather than a TWLTL. On higher volume or higher speed roadways, the TWLTL loses much of its safety advantage, which the non-traversable medians retain.

ODOT CRF Value:

39%

Reduction in **Rear End Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

-5% - 53.1%

Safety Effects:

Reduces the need for vehicles to slow down for vehicles waiting to turn left by separating the left turning vehicles from the through lanes. In areas with frequent accesses, this countermeasure could significantly reduce these potential conflicts along an entire corridor in addition to increasing capacity of the facility. This countermeasure can also provide vehicles with the ability to make two-stage turning maneuvers from accesses.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 2351\)](#)

H34: Reduce Urban Driveways from 48 to 26 - 48 per mile

Description: Driveways can be defined as private roads that provide access between public ways and activities or buildings on abutting land. Reducing the number of driveways intersecting public roadways is an access management technique - the method of control of entry and exit points along a roadway.



Images from FHWA

Applications: Where you have a high frequency of driveway related crashes on an urban corridor.

Considerations: It can be difficult to get public support and can be costly to retrofit an existing road with this access management technique.

Special Conditions: This CRF value can only be applied to reducing driveway from 48 to 26 - 48 per mile. Successful access management seeks to simultaneously provide accessibility while enhancing safety, preserving capacity and providing for pedestrian and bicycle needs. For more guidance, please refer to the Highway Safety Manual.

ODOT CRF Value:

29%

Reduction in **All Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

25% - 31%

Safety Effects:

Reducing driveways manages the frequency and magnitude of conflict points at driveways by altering access patterns.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 177\)](#)

FHWA Proven Safety Countermeasure

H35: Reduce Urban Driveways from 26 - 48 to 10 - 24 per mile

Description: Driveways can be defined as private roads that provide access between public ways and activities or buildings on abutting land. Reducing the number of driveways intersecting public roadways is an access management technique - the method of control of entry and exit points along a roadway.



Images from FHWA

Applications: Where you have a high frequency of driveway related crashes on an urban corridor.

Considerations: It can be difficult to get public support and can be costly to retrofit an existing road with this access management technique.

Special Conditions: This CRF value can only be applied to reducing driveway from 26 - 48 to 10 - 24 per mile. Successful access management seeks to simultaneously provide accessibility while enhancing safety, preserving capacity and providing for pedestrian and bicycle needs. For more guidance, please refer to the Highway Safety Manual.

ODOT CRF Value:

31%

Reduction in **All Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

25% - 31%

Safety Effects:

Reducing driveways manages the frequency and magnitude of conflict points at driveways by altering access patterns.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 178\)](#)

FHWA Proven Safety Countermeasure

H36: Reduce Urban Driveways from 10 - 24 to less than 10 per mile

Description: Driveways can be defined as private roads that provide access between public ways and activities or buildings on abutting land. Reducing the number of driveways intersecting public roadways is an access management technique - the method of control of entry and exit points along a roadway.



Images from FHWA

Applications: Where you have a high frequency of driveway related crashes on an urban corridor.

Considerations: It can be difficult to get public support and can be costly to retrofit an existing road with this access management technique.

Special Conditions: This CRF value can only be applied to reducing driveway from 10 - 24 to less than 10 per mile. Successful access management seeks to simultaneously provide accessibility while enhancing safety, preserving capacity and providing for pedestrian and bicycle needs. For more guidance, please refer to the Highway Safety Manual.

ODOT CRF Value:

25%

Reduction in **All Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

25% - 31%

Safety Effects:

Reducing driveways manages the frequency and magnitude of conflict points at driveways by altering access patterns.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 179\)](#)

FHWA Proven Safety Countermeasure

H37: Provide a Raised Median, Urban 2-Lane Road

Description: A concrete median separation between opposing through lanes on a segment of roadway. This countermeasure can include periodic pedestrian refuges and/or designated left turn lanes at major driveways or intersections.



Image from PedBikeSafe

Applications: On roadways with higher traffic volumes and driveway densities with a history of access related crashes.

Considerations: On 2-Lane facilities, if the pavement width doesn't already exist, this countermeasure could have significant costs associated with adding more impervious surface. Typical examples are right of way acquisition, drainage impacts and environmental mitigation. In addition, raised medians limit property accesses which can be perceived by business owners as deterrence to potential customers and to residents as an inconvenience. It is important to involve stakeholders as soon as possible if you plan to implement this countermeasure. Raised medians also concentrate left turns and can increase the frequency of U-turns. It is important to accommodate and/or manage these potential movements accordingly. Lastly, medians create "pinch points" in the roadway that could prevent certain heavy vehicles from traveling through the facility. It is important that appropriate considerations are made for the types of heavy vehicles using the facility in order to provide them the maximum lane widths they need.

Special Conditions: This CRF value is specifically for 2-Lane Urban facilities. Two additional advantages of raised medians, they can prevent head-on or sideswipe.

ODOT CRF Value:

39%

Reduction in **All Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

39%

Safety Effects:

The primary function of raised medians is to manage the frequency and magnitude of conflict points at driveways and intersections by altering access patterns. Additionally they can protect pedestrians by providing a refuge area and shorter exposed crossing distances and can include designated left turn lanes to allow vehicles to proceed through the intersection without having to stop or slow down for vehicles waiting to make a left turn.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 21\)](#)

H38: Provide a Raised Median, Urban Multi-Lane Road

Description: A concrete median separation between opposing through lanes on a segment of roadway. This countermeasure can include pedestrian refuges and/or designated left turn lanes at major driveways or intersections.



Images from FHWA



Applications: On roadways with higher traffic volumes and driveway densities with a history of access related crashes.

Considerations: Raised medians limit property accesses which can be perceived by business owners as deterrence to potential customers and to residents as an inconvenience. It is important to involve stakeholders as soon as possible if you plan to implement this countermeasure. Raised medians also concentrate left turns and can increase the frequency of U-turns. It is important to accommodate and/or manage these potential movements accordingly. In addition, medians create "pinch points" in the roadway that could prevent certain heavy vehicles from traveling through the facility. It is important that appropriate considerations are made for the types of heavy vehicles using the facility in order to provide them the maximum lane widths they need.

Special Conditions: This CRF value is specifically for Multi-Lane Urban facilities. Two additional advantages of raised medians, they can prevent head-on or sideswipe meeting crashes and can provide space for landscaping and other aesthetic treatments.

ODOT CRF Value:

22%

Reduction in **All Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

0% - 22%

Safety Effects:

The primary function of raised medians is to manage the frequency and magnitude of conflict points at driveways and intersections by altering access patterns. Additionally they can protect pedestrians by providing a refuge area and shorter exposed crossing distances and can include designated left turn lanes to allow vehicles to proceed through the intersection without having to stop or slow down for vehicles waiting to make a left turn.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 22\)](#)

H39: Provide a Raised Median, Rural Multi-Lane Road

Description: A concrete median separation between opposing through lanes on a segment of roadway. This countermeasure can include pedestrian refuges and/or designated left turn lanes at major driveways or intersections.



Image from Google



Image from FHWA

Applications: On roadways with higher traffic volumes and driveway densities with a history of access related crashes.

Considerations: Raised medians limit property accesses which can be perceived by business owners as deterrence to potential customers and to residents as an inconvenience. It is important to involve stakeholders as soon as possible if you plan to implement this countermeasure. Raised medians also concentrate left turns and can increase the frequency of U-turns. It is important to accommodate and/or manage these potential movements accordingly. In addition, medians create "pinch points" in the roadway that could prevent certain heavy vehicles from traveling through the facility. It is important that appropriate considerations are made for the types of heavy vehicles using the facility in order to provide them the maximum lane widths they need.

Special Conditions: This CRF value is specifically for Multi-Lane Rural facilities. Two additional advantages of raised medians, they can prevent head-on or sideswipe meeting crashes and can provide space for landscaping and other aesthetic treatments.

ODOT CRF Value:

12%

Reduction in **All Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

0% - 22%

Safety Effects:

The primary function of raised medians is to manage the frequency and magnitude of conflict points at driveways and intersections by altering access patterns. Additionally they can protect pedestrians by providing a refuge area and shorter exposed crossing distances and can include designated left turn lanes to allow vehicles to proceed through the intersection without having to stop or slow down for vehicles waiting to make a left turn.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 24\)](#)

H40: Install Traversable Median (4 ft. or more)

Description: Traversable medians provide separation between opposing flows of traffic and where wide enough, are striped to prohibit its use as a Two Way Left Turn Lane. Traversable medians are delineated by pavement markings ONLY.



Image from East
Arlington
Livable Streets
Coalition



Images from Google

Applications: They can be used as an access management tool to prohibit turning movements into and out of accesses where you have a high frequency of access related crashes and are unable to place a raised median. They can also be used as a buffer zone or recovery area where you have a high frequency of head on or sideswipe meeting crashes and can be supplemented with centerline rumble strips in rural areas.

Considerations: If the pavement width doesn't already exist, this countermeasure could have significant costs associated with adding more impervious surface. Typical examples are right of way acquisition, drainage impacts and environmental mitigation.

Special Conditions: This CRF value can be used for urban and rural areas. Compared to non-traversable medians, safety benefits of traversable medians for access management have less research available to prove their effectiveness. In addition, vehicle compliance of traversable medians is expected to be significantly less than non-traversable medians because of the lack of physical restriction. If a traversable median contains cross-hatching stripes then it restricts left turns. The traversable median is now a highway divider as per PRS 811.430.

ODOT CRF Value:

12%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

12% - 30%

Safety Effects:

For access management, traversable medians manage the frequency and magnitude of conflict points at driveways and intersections by altering access patterns. For head-on and side-swipe meeting crashes, traversable medians create a larger recovery area for errant vehicles.

References:

Engineering Judgement

H41: Install Passing Lane on Rural, 2-Lane Roadway

Description: An auxiliary lane provided in a short segment to accommodate the passage of single-directional traffic.



Image from FHWA



Image from MODOT

Applications: This countermeasure should be provided in a segment location where head-on collisions occur as a result of passing vehicles or locations where there are crashes related to slow moving traffic.

Considerations: It is important to provide optimum passing lane lengths to ensure that vehicles have enough distance to make a safe passing maneuver. There could also be significant costs associated with adding more impervious surface. Typical examples are right of way acquisition, drainage impacts and environmental mitigation.

Special Conditions: This countermeasure also improves overall traffic operations by breaking up traffic platoons and by reducing delays caused by inadequate passing opportunities over substantial lengths of roadway.

ODOT CRF Value:

25%

Reduction in **All Crashes**
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

25% - 35%

Safety Effects:

Providing passing opportunities with a climbing lane reduces the probability of risky passing maneuvers that could lead to various lane departure crashes.

References:

Highway Safety Manual

H42: Widen Rural Paved Lane Width by 1 foot

Description: Increasing the paved width of the travel lanes.



Image from FHWA

Applications: Where you have a high frequency of run off the road crashes.

Considerations: There could be significant costs associated with adding more impervious surface. Typical examples are right of way acquisition, drainage impacts and environmental mitigation.

Special Conditions: This treatment should be used at locations where the width of the travel lane is less than 12 feet.

ODOT CRF Value:

5%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

5%

Safety Effects:

Wider lane widths provide more recovery area for errant vehicles drifting in their lane.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 3\)](#)

FHWA Proven Safety Countermeasure

H43: Flatten Horizontal Curve (Increase Radius)

Description: Increasing the radius of the horizontal curvature of the roadway.



Image from FHWA

Applications: On curves where you have a high frequency of run off the road crashes like head-on or fixed object crashes.

Considerations: Many locations have minimum curve radii because of geometric restrictions like rock cliffs and/or steep slopes. Removing areas of rock and filling slopes can be costly in order to accommodate a realigned horizontal curve with an increased radius. Since this treatment could potentially be costly, it is important to make sure all other potential countermeasures for curve crashes have been considered, tried or proven ineffective before considering this countermeasure.

Special Conditions: Use the table below to select your crash reduction factor ("percent reduction in total" column) based on existing and proposed radii.

Original Degree of Curve	New Degree of Curve	Percent Reduction in Total
30	25	15
	20	31
	15	46
	10	61
	5	78
25	20	17
	15	35
	10	53
	5	72
20	15	20
	10	41
	5	64
15	10	24
	5	50
	3	63
10	5	28
	3	42

ODOT CRF Value:

See Table

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

15% - 78%

Safety Effects:

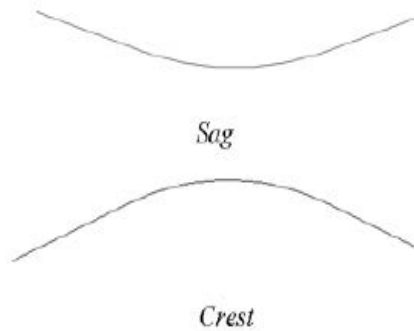
Increased radii means an increase in sight distance, providing a more complete visual to drivers of the upcoming alignment of the roadway. Increased radii also decreases the speed differential between the approach tangent and the horizontal curve, subsequently reducing crash risk.

References:

Crash Modification Factors
Clearinghouse

H44: Flatten Crest Vertical Curve

Description: Reducing the vertical curvature of the roadway either by flattening a crest curve or reducing the grade of a sag curve.



Images from FHWA

Applications: Where you have a high frequency of crashes related to limited sight distance or speed related crashes on steep grades.

Considerations: Flattening crest curves could significantly impact driveway or intersection approaches to the roadway. This treatment could potentially be very costly. It is important to make sure all other potential countermeasures for vertical curve crashes have been considered, tried or proven ineffective before considering this countermeasure.

Special Conditions: This countermeasure can also be applied to unsignalized intersections with restricted sight distance due to vertical geometry and with patterns of crashes related to that lack of sight distance that cannot be ameliorated by less expensive methods.

ODOT CRF Value:

20%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

20% - 51%

Safety Effects:

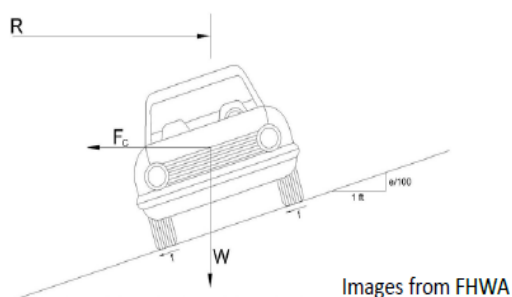
Flattening a crest vertical curve provides a more complete visual to drivers of the upcoming alignment of the roadway and subsequently more stopping sight distance. In addition, when vehicles are behind slow moving vehicles ascending or descending a grade, there could be rear-end conflicts and in some cases risky passing maneuvers leading to head-on crashes. In a sag vertical curve, there is the risk of vehicles descending a grade at speeds too fast for conditions, increasing the risk of high speed rear-end crashes and potentially run off the road crashes.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 721\)](#)

H45: Improve Superelevation Variance (SV) on Rural Curves (Between 0.01 and 0.02)

Description: Superelevation is the rotation of the pavement on the approach to and through a horizontal curve. It is intended to assist the driver in negotiating the curve by counteracting the lateral acceleration produced by tracking.



$$0.01e + f = \frac{V^2}{15R} \quad (\text{Equation 2})$$

Where:

e = rate of superelevation, percent;
f = side friction (demand factor);
V = vehicle speed, mph;
R = radius of curve, ft.

Applications: Use at a curve where you have a higher than expected number of vehicle or truck crashes at a curve that could be attributed to inadequate superelevation. Inadequate superelevation can cause vehicles to skid as they travel through a curve, potentially resulting in a run-off-road crash. Trucks and other large vehicles with high centers of mass are more likely to roll over at curves with inadequate superelevation.

Considerations: This treatment could potentially be very costly. It is important to make sure all other potential countermeasures for curve crashes have been considered, tried or proven ineffective before considering this superelevation countermeasure.

Special Conditions: The base condition is an SV value that is less than 0.01 and the proposed reconstructed SV will fall between 0.01 and 0.02. Superelevation is expressed as a decimal representing the ratio of the pavement slope to width ranging from 0 - 0.12. Typical maximum superelevations range from 0.04 to 0.12 and determined by individual State's. Selection of a maximum superelevation rate is based on several variables such as climate, terrain, highway location (urban vs. rural) and frequency of very slow moving vehicles.

ODOT CRF Value:

CRF = -600 (SV - 0.01)

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

N/A

Safety Effects:

Superelevation offsets the horizontal sideways momentum of the approaching vehicle, minimizing the risk a vehicle of running off the road around a curve.

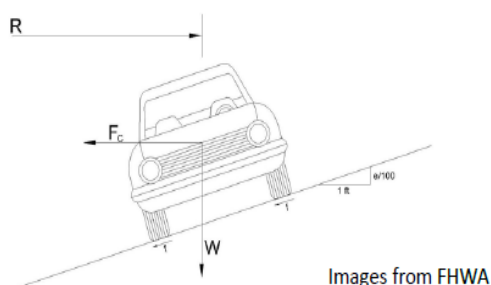
References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 5183\)](#)

H46: Improve Superelevation Variance (SV) on Rural Curves (More than 0.02)

Description: Superelevation is the rotation of the pavement on the approach to and through a horizontal curve. It is intended to assist the driver in negotiating the curve by counteracting the lateral acceleration produced by tracking.



$$0.01e + f = \frac{V^2}{15R} \quad (\text{Equation 2})$$

Where:

e = rate of superelevation, percent;
f = side friction (demand factor);
V = vehicle speed, mph;
R = radius of curve, ft.

Applications: Use at a curve where you have a higher than expected number of vehicle or truck crashes at a curve that could be attributed to inadequate superelevation. Inadequate superelevation can cause vehicles to skid as they travel through a curve, potentially resulting in a run-off-road crash. Trucks and other large vehicles with high centers of mass are more likely to roll over at curves with inadequate superelevation.

Considerations: This treatment could potentially be very costly. It is important to make sure all other potential countermeasures for curve crashes have been considered, tried or proven ineffective before considering this superelevation countermeasure.

Special Conditions: The base condition is an SV value that is less than 0.01 and the proposed reconstructed SV will fall between 0.01 and 0.02. Superelevation is expressed as a decimal representing the ratio of the pavement slope to width ranging from 0 - 0.12. Typical maximum superelevations range from 0.04 to 0.12 and determined by individual State's. Selection of a maximum superelevation rate is based on several variables such as climate, terrain, highway location (urban vs. rural) and frequency of very slow moving vehicles.

ODOT CRF Value:

$$\text{CRF} = -300 * \text{SV}$$

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

N/A

Safety Effects:

Superelevation offsets the horizontal sideways momentum of the approaching vehicle, minimizing the risk a vehicle of running off the road around a curve.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 5184\)](#)

H47: Convert from Urban Two-Way to One-Way Traffic

Description: A segment of roadway that restricts vehicles to one direction travel.

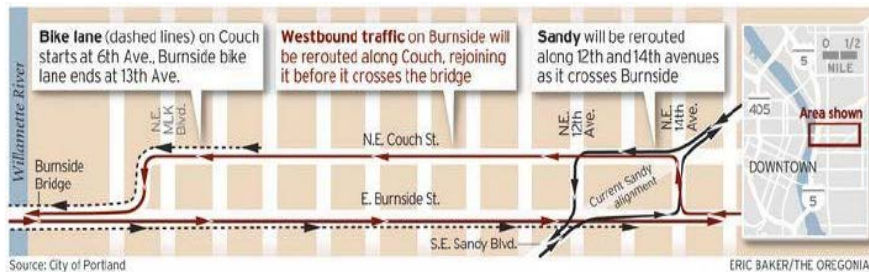


Image from City of Portland

Applications: Preferably in a grid street system where you have a high frequency of intersection crashes along an urban segment and/or crashes related to capacity limitations.

Considerations: A one-way street system often forces drivers to take out-of-direction routes to their destinations.

Special Conditions: One-way streets allow for a less number of signal phases potentially increasing capacity and minimizing delay of various intersections along a segment of roadway. There are benefits to pedestrians with one-way streets too, they only need to look for traffic in one direction and there are often more gaps in traffic due to platooning.

ODOT CRF Value:

47%

**Reduction in All Crashes
at All Severities
(Including PDO's)**

Range of Effectiveness:

47%

Safety Effects:

Reduces the number of potential conflicts at an intersection.

References:

Crash Modification Factors
Clearinghouse

H48: Increase Pavement Friction by Installing High Friction Surface Treatment – Curves Application

Description: Pavement surfacing systems with exceptional skid-resistant properties not typically provided by conventional materials.



Images from FHWA

Applications: In locations where you have frequent crashes where insufficient friction is a contributing factor (i.e. wet weather). These are generally locations where drivers are braking excessively; for example, when going around curves or ramps, down hills or steep grades, or when approaching an intersection. The road surface can become prematurely polished, reducing the pavement friction and allowing vehicles to skid or hydroplane.

Considerations: It is costly to install and could be costly to maintain so it's important to reserve this treatment for the most needed locations. It is important to closely follow the manufacturer's installation instructions in order to reduce any chances of product failure. For more information on High Friction Surface Treatment, please refer to the FHWA website. They have provided many informational materials on the subject.

Special Conditions: There is some concern over the effect of the treatment on motorcyclists if they were to crash so use caution if you have a history of motorcycle crashes at the location you are looking to install the treatment. This treatment can be an intersection or segment application.

ODOT CRF Value:

52%

Reduction in **Wet Road Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

20% - 68%

Safety Effects:

It uses aggregates that are both polish- and wear-resistant and develop channels to prevent water buildup on wet surfaces creating an exceptionally durable surface capable of withstanding extreme roadway friction demands.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 7901\)](#)

[Evaluation of Pavement Safety Performance \(FHWA-HRT-14-065\)](#)

FHWA Proven Safety Countermeasure

H49: Increase Pavement Friction by Installing High Friction Surface Treatment - Ramps Application

Description: Pavement surfacing systems with exceptional skid-resistant properties not typically provided by conventional materials.



Image from MnDOT

Applications: In locations where you have frequent crashes where insufficient friction is a contributing factor (i.e. wet weather). These are generally locations where drivers are braking excessively; for example, when going around curves or ramps, down hills or steep grades, or when approaching an intersection. The road surface can become prematurely polished, reducing the pavement friction and allowing vehicles to skid or hydroplane.

Considerations: It is costly to install and could be costly to maintain so it's important to reserve this treatment for the most needed locations. It is important to closely follow the manufacturer's installation instructions in order to reduce any chances of product failure. For more information on High Friction Surface Treatment, please refer to the FHWA website. They have provided many informational materials on the subject.

Special Conditions: There is some concern over the effect of the treatment on motorcyclists if they were to crash so use caution if you have a history of motorcycle crashes at the location you are looking to install the treatment. This treatment is for a ramp application.

ODOT CRF Value:

86%

Reduction in **Wet Road Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

86%

Safety Effects:

It uses aggregates that are both polish- and wear-resistant and develop channels to prevent water buildup on wet surfaces creating an exceptionally durable surface capable of withstanding extreme roadway friction demands.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 7899\)](#)

[Evaluation of Pavement Safety Performance \(FHWA-HRT-14-065\)](#)

FHWA Proven Safety Countermeasure

H50: Install Urban Variable Speed Limit Signs

Description: Speed limits that change based on road, traffic, and/or weather conditions.

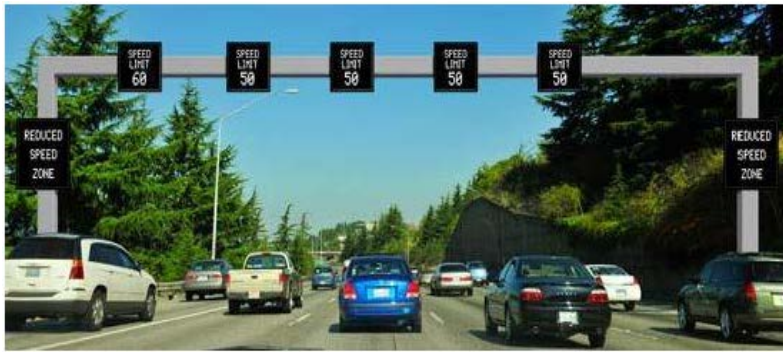


Image from WSDOT



Applications: In locations where you have a high frequency of crashes related to weather conditions or congestion (peak hour or incident related).

Considerations: Could be costly depending on the length of the corridor you are applying this countermeasure to due to the real time data collection and communication expenses.

Special Conditions: There is still ongoing research being done to evaluate the effectiveness of variable speed limits through work zones. Black on white variable speed limit signs shall only be installed in combination with agreement with law enforcement to actively enforce the speed limit(s). Otherwise the signs should be black on yellow advisory speeds.

ODOT CRF Value:

8%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

8%

Safety Effects:

Improves safety by decreasing the risks associated with traveling at speeds that are higher than appropriate for the conditions. Variable Speed Limits can take into account traffic volume, operating speeds, weather information, sight distance, and roadway surface condition when posting speed limits.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 3340\)](#)

H51: Install Urban Variable Speed Limit Signs with Queue/Weather Warning System

Description: Speed limits that change based on road, traffic, and/or weather conditions.



Image from Google

Applications: In locations where you have a high frequency of crashes related to weather conditions or congestion (peak hour or incident related).

Considerations: Could be costly depending on the length of the corridor you are applying this countermeasure to due to the real time data collection and communication expenses.

Special Conditions: There is still ongoing research being done to evaluate the effectiveness of variable speed limits through work zones. Black on white variable speed limit signs shall only be installed in combination with agreement with law enforcement to actively enforce the speed limit(s). Otherwise the signs should be black on yellow advisory speeds.

ODOT CRF Value:

14%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

14%

Safety Effects:

Improves safety by decreasing the risks associated with traveling at speeds that are higher than appropriate for the conditions. Variable Speed Limits can take into account traffic volume, operating speeds, weather information, sight distance, and roadway surface condition when posting speed limits.

References:

Engineering Judgement

H52: Install Rural Variable Speed Limit Signs

Description: Speed limits that change based on road, traffic, and/or weather conditions.



Image from Google

Applications: In locations where you have a high frequency of crashes related to weather conditions or congestion (peak hour or incident related).

Considerations: Could be costly depending on the length of the corridor you are applying this countermeasure to due to the real time data collection and communication expenses.

Special Conditions: There is still ongoing research being done to evaluate the effectiveness of variable speed limits through work zones. Black on white variable speed limit signs shall only be installed in combination with agreement with law enforcement to actively enforce the speed limit(s). Otherwise the signs should be black on yellow.

ODOT CRF Value:

20%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

20% - 30%

Safety Effects:

Improves safety by decreasing the risks associated with traveling at speeds that are higher than appropriate for the conditions. Variable Speed Limits can take into account traffic volume, operating speeds, weather information, sight distance, and roadway surface condition when posting speed limits.

References:

Engineering Judgement

H53: Convert 4-Lane Roadway to 3-Lane Roadway with Center Turn Lane (Road Diet)

Description: A road diet involves converting an undivided four-lane roadway into three lanes consisting of two through lanes and a center two-way left turn lane (TWLTL).



Road Before

Road After

Image from FHWA

Applications: Where you have a high frequency of the following crash types: rear-end crashes from left turns, sideswipe overtaking, left turning crashes, and multiple-threat pedestrian crashes from a vehicle stopped for a pedestrian, blocking the view of the driver in the adjacent lane. Typical candidate four-lane roadways have 20,000 ADT or less.

Considerations: The most common concern with proposed road diets is the potential increase in traffic delays during peak periods. It is important to involve stakeholders during the very early stages of a road diet discussion to ensure the best solution for all users.

Special Conditions: The reduction of lanes in a road diet allows for the roadway to be reallocated for other uses such as bike lanes, pedestrian crossing islands and/or parking. Road diets can be low cost if planned in conjunction with reconstruction or simple overlay projects since a road diet mostly consists of restriping.

ODOT CRF Value:

29%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

29%

Safety Effects:

Reducing the number of through lanes and providing a TWLTL addresses crashes by (1) separating left-turning traffic from through traffic, (2) reducing the number of oncoming lanes through which a left-turning driver must search for a gap, and (3) removing the multiple-threat situation because there is no longer an adjacent lane. Road diets can decrease other incidents by providing designated spaces -- sidewalks and bicycle lanes -- that reduce opportunities for conflicts between motor vehicles and other road users.

References:

Highway Safety Manual

[CMF Clearinghouse ID:199](#)

**FHWA Proven Safety
Countermeasure**

H54: Install Truck Escape Ramp

Description: An emergency area located adjacent to a downgrade roadway to provide a location for out-of-control vehicles to slow and stop away from other vehicles on the road. They are generally located near the middle or the end of long, steep downgrades. The two most common types of truck escape ramps are: gravity ramps built with an upgrade to use the forces of gravity to slow a runaway vehicle and aggregate arrestor bed ramps using special sized rock in a gravel bed to slow a runaway vehicle. These ramps may have either an upward or downward grade.



Image from FHWA

Applications: Where you have a high frequency of speed related truck crashes on steep grades.

Considerations: Potentially a very costly countermeasure as you need significant amount of extra surface area to accommodate the truck escape ramp.

Special Conditions: This countermeasure is most appropriate in mountainous areas. The guidance listed is partially provided by Nevada DOT.

ODOT CRF Value:

20%

Reduction in **Truck Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

33% - 75%

Safety Effects:

Truck escape ramps enable vehicles that are having braking issues to safely stop, avoiding potential run off the road and rear end crashes.

References:

[Desktop Reference for Crash Reduction Factors \(FHWA-SA-08-011\)](#)

H55: Install Guide Signs

Description: Guide signs provide directional and mileage information to specific destinations. Types of roadway guide signs include: interstate, US route, state, and county markers, highway mile markers, national forest route markers, hurricane evacuation route signs, and exit signs.



Images from MUTCD

Applications: Along roadways where crashes occur due to drivers making errors while trying to read signs, change lanes, and decelerate as they are driving toward their destination.

Considerations: Sight distance and maintenance of signs should be considered to ensure traffic safety. Guide signs should be illuminated or retroreflective so that they can be easily read during the day, night, and in poor conditions.

Special Conditions: Refer to the MUTCD for additional guidance and standards.

ODOT CRF Value:

15%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

15%

Safety Effects:

Guide signs are essential along roadways and provide drivers with information that will help them reach their destinations safely. These signs provide efficient navigation and can reduce driver slowing, stopping, and making abrupt turns or erratic maneuvers that would occur due to the absence of these signs.

References:

[Desktop Reference for Crash Reduction Factors \(FHWA-SA-08-011\)](#)

H56: Provide an Auxiliary Lane between an Entrance Ramp and Exit Ramp (Freeway Interchange)

Description: A designated lane between entrance and exit ramps used to allow traffic to speed up and slow down.

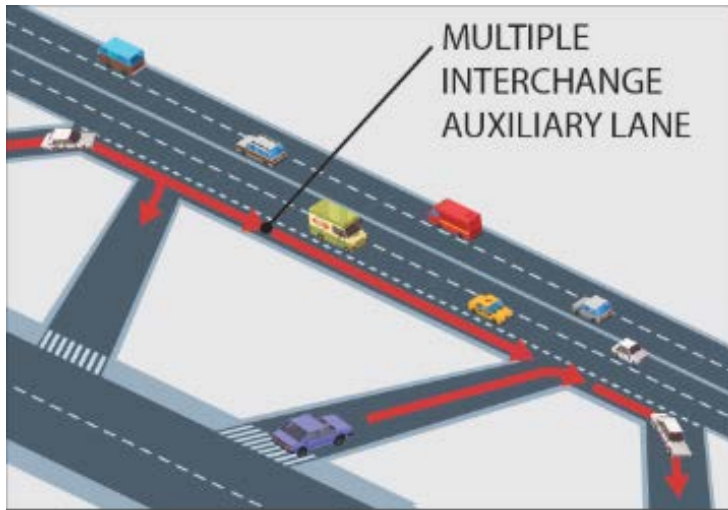


Image from ODOT - Image not to scale

Applications: Where entrance and exit ramps are short, requiring entering traffic to merge quickly and exiting traffic to slow before exiting the main traffic lane.

Considerations: Auxiliary lanes should be of sufficient length to permit adjustments in speeds of both through and entering vehicles so that the driver of the entering vehicle can safely maneuver into a gap before reaching the end of the auxiliary lane.

Special Conditions: This countermeasure CRF is specific to providing an auxiliary lane on freeway interchanges between entrance and exit ramps.

ODOT CRF Value:

20%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

20%

Safety Effects:

Reduces the conflict between exiting and entering traffic on the main lanes. Allows for efficient traffic flow at interchanges.

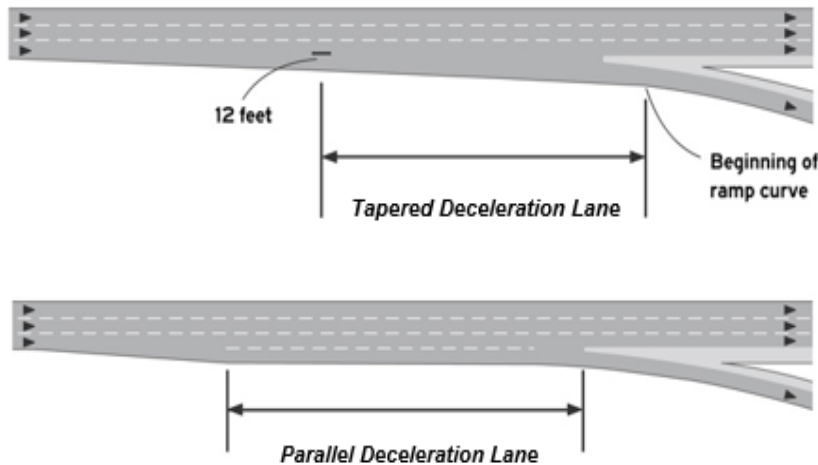
References:

[Crash Modification Factors Clearinghouse \(CMF ID: 3898\)](#)

[Determining Guidelines for Ramp and Interchange Spacing \(NCHRP 169\)](#)

H57: Extend Deceleration Lane by Approximately 100 ft. (Freeway Interchange)

Description: A deceleration lane, also known as an auxiliary or speed-change lane, allows vehicles to slow down in a designated space not used by high-speed through traffic.



Images from FHWA

Applications: At freeway off-ramps that are short, requiring exiting traffic to slow quickly before exiting the main traffic lane.

Considerations: Lane space should be considered when extending deceleration lanes. Converting current roadway shoulders to useable lanes may require widening and strengthening of the existing roadway pavement, leading to higher costs due to construction.

Special Conditions: This countermeasure CRF is specific to extending deceleration lanes on freeway interchanges.

ODOT CRF Value:

7%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

7%

Safety Effects:

Deceleration lanes allow traffic exiting a freeway to slow down to a safer speed without affecting the main flow of traffic. Increases safety by reducing the number of conflicts between vehicles traveling at different speeds.

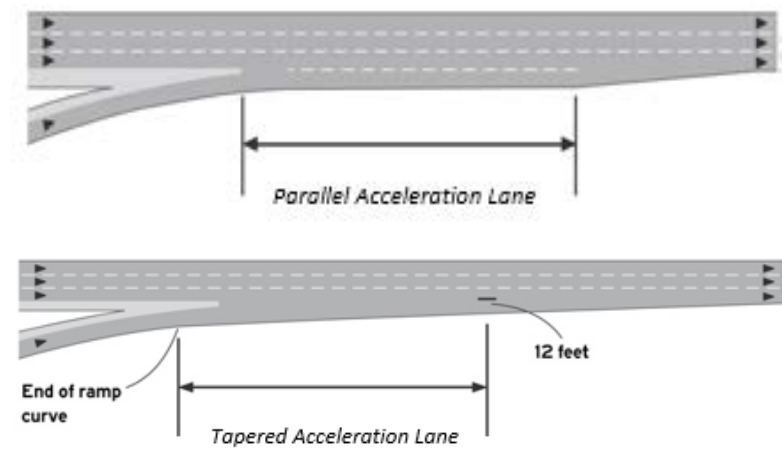
References:

Highway Safety Manual

[Crash Modification Factors
Clearinghouse \(CMF ID:
475\)](#)

H58: Extend Acceleration Lane by Approximately 100 ft. (Freeway Interchange)

Description: An acceleration lane, also known as an auxiliary or speed-change lane, allows vehicles the opportunity to accelerate to freeway speeds in a designated space not used by high-speed through traffic.



Images from FHWA

Applications: At freeway on-ramps that are relatively short, requiring entering traffic to merge quickly with main traffic lanes.

Considerations: Lane space should be considered when extending acceleration lanes. Converting current roadway shoulders to useable lanes may require widening and strengthening of the existing roadway pavement, leading to higher costs due to construction.

Special Conditions: This countermeasure CRF is specific to extending acceleration lanes on freeway interchanges.

ODOT CRF Value:

11%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

11%

Safety Effects:

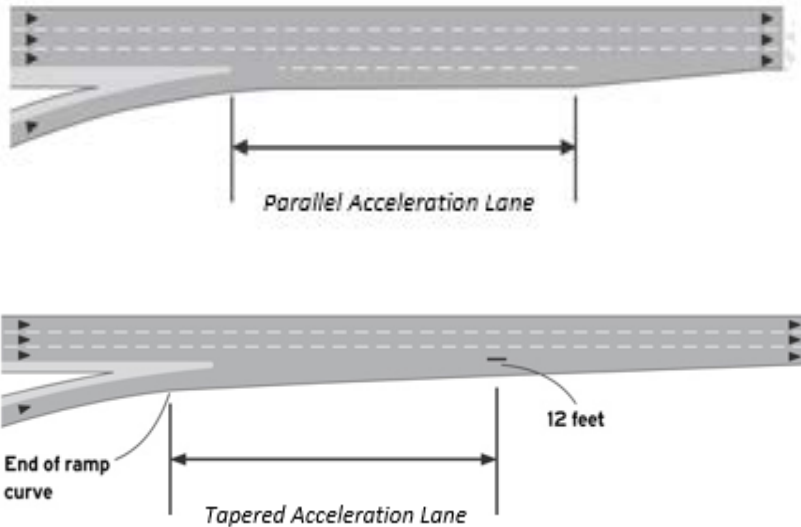
Acceleration lanes increase safety by reducing freeway congestion by creating designated areas for merging traffic to adjust to the proper speed before entering main traffic lanes.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 474\)](#)

H59: Add Acceleration Lane (Interchange)

Description: An acceleration lane, also known as an auxiliary or speed-change lane, allows vehicles the opportunity to accelerate to freeway speeds in a designated space not used by high-speed through traffic.



Images from FHWA

Applications: At freeway on-ramps with a high proportion of crashes related to speed differential caused by vehicles merging with through traffic.

Considerations: Acceleration lanes should be of sufficient length to permit adjustments in speeds of both through and entering vehicles so that the driver of the entering vehicle can safely maneuver into a gap before reaching the end of the acceleration lane.

Special Conditions: This countermeasure CRF is specific to adding acceleration lanes at interchanges.

ODOT CRF Value:

$$CRF=100*(1-e(-2.59*L))$$

Where, L = Length of
Acceleration Lane (in miles)

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

N/A

Safety Effects:

Acceleration lanes increase safety by reducing freeway congestion by creating designated areas for merging traffic to adjust to the proper speed before entering main traffic lanes.

References:

Highway Safety Manual

H60: Reduce Intersection Skew Angle (Minor Street Stop-Controlled Intersections Only) on 3-Leg intersection

Description: A skewed intersection has an angle of less than 90 degrees between intersecting streets.



Road Before



Road After

Images from PedBikeSafe

Applications: At intersections where there are patterns of crashes related to limited sight distance (where the driver must turn their head and neck to view approaching vehicles).

Considerations: Intersection skew angles should provide sufficient sight distance for drivers. High costs may be associated with the realignment and reduction of intersection skew angles.

Special Conditions: This countermeasure CRF is specific to reducing intersection skew angles on minor street stop-controlled 3-Leg intersections in rural areas.

ODOT CRF Value:

CRF =

**$100 * (e^{0.0040 * \text{SkewAngle}})$
existing
 $(e^{0.0040 * \text{SkewAngle}})$
proposed**

**Reduction in All Crashes
at All Severities
(Including PDO's)**

Range of Effectiveness:

N/A

Safety Effects:

Reducing the intersection skew angle results in increased sight distance for drivers and is particularly beneficial to older drivers. Drivers are therefore better able to judge gaps in crossing traffic and stay within their designated lane. Fewer conflicts between vehicles and pedestrians by reducing crossing distances.

References:

Highway Safety Manual

H61: Reduce Intersection Skew Angle (Minor Street Stop-Controlled Intersections Only) on 4-Leg intersection

Description: A skewed intersection has an angle of less than 90 degrees between intersecting streets.



Image from FHWA

Applications: At intersections where there are patterns of crashes related to limited sight distance (where the driver must turn their head and neck to view approaching vehicles).

Considerations: Intersection skew angles should provide sufficient sight distance for drivers. High costs may be associated with the realignment and reduction of intersection skew angles.

Special Conditions: This countermeasure CRF is specific to reducing intersection skew angles on minor street stop-controlled 4-Leg intersections in rural areas.

ODOT CRF Value:

CRF =

$$100 \cdot (1 - e^{0.0054 \cdot \Delta \text{SkewAngle}})$$

Where,

$\Delta \text{SkewAngle} = (\text{Proposed Skew Angle} - \text{Existing Skew Angle})$

**Reduction in All Crashes
at All Severities
(Including PDO's)**

Range of Effectiveness:

N/A

Safety Effects:

Reducing the intersection skew angle results in increased sight distance for drivers and is particularly beneficial to older drivers. Drivers are therefore better able to judge gaps in crossing traffic and stay within their designated lane. Fewer conflicts between vehicles and pedestrians by reducing crossing distances.

References:

Highway Safety Manual

H62: Truck Priority System (Detection)

Description: A priority detection system that uses radar to measure incoming speeds and differentiate between trucks and cars. The system then provides an appropriate signal phase by extending the green interval for the truck within the dilemma zone (the portion of the approach where a driver must decide whether to stop safely or proceed through the intersection when faced with a yellow indication).

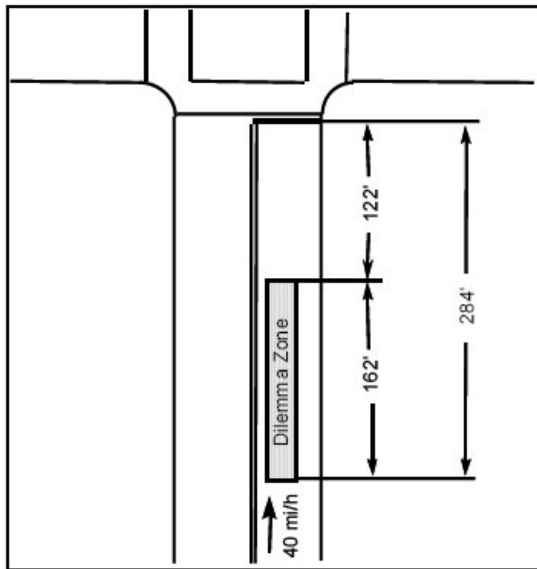


Image from FHWA

Applications: At signalized intersections with a high frequency of crashes (angle and rear end crashes) and red-light violations associated with traffic signal phase changes. Locations with higher than normal truck traffic.

Considerations: These systems are intended for use on higher speed roadways (major road approach with a posted speed limit of 45 mph or higher). It is important to consider stopping distances when implementing this countermeasure.

Special Conditions: Additional benefits of this treatment include reducing delay and stop frequency on the major road and maintaining or reducing overall intersection delay. In the past, loops were used to provide dilemma zone protection for this type of system, but are no longer installed unless under special circumstances.

ODOT CRF Value:

9%

Reduction in **Angle and Rear End Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

9%

Safety Effects:

A priority detection system improves safety by modifying traffic control signal phasing, providing sufficient time for trucks to pass through a signalized intersection. This may reduce rear-end crashes associated with unsafe stopping and angle crashes due to red light violations.

References:

[Field Evaluation of Detection-Control System \(FHWA-HRT-14-058\)](#)

H63: Dual/Double Left Turn Lanes

Description: Two lanes that can be used to make a turn left at a signalized intersection.



Image from Google

Applications: Used at intersections with high left-turn volumes where a single left-turn lane is not sufficient.

Considerations: Consider dual left-turn lanes when volumes exceed 300 vehicles per hour (assuming moderate levels of opposing through traffic and adjacent street traffic). For double left-turn lanes, the following should be considered:

- Widths of receiving lanes and intersection
- Clearance between opposing left-turn movements during concurrent maneuvers.
- Pavement marking and signing visibility.
- Placement of stop lines for left-turning and through vehicles.
- Weaving movements downstream of turn.
- Potential for pedestrian conflict.

Special Conditions: Benefits of dual/double left turn lanes may include a reduced delay to left turning vehicles, improved intersection capacity, and extra green time that can be allocated to other movements or removed to decrease cycle length. Providing positive guidance (pavement markings) along with the implementation of dual/double left turn lanes could help guide drivers through their designated turn lane and reduce sideswipe crashes.

ODOT CRF Value:

29%

Reduction in **All Crashes**
at **All Injury Severities**
(Excluding PDO's)

Range of Effectiveness:

29%

Safety Effects:

Dual/Double left turn lanes provide additional capacity at an intersection and improves intersection operation by reducing the time allocated to the signal phase for the left-turn movement.

References:

[Signalized Intersections Informational Guide \(FHWA-SA-13-027\)](#)

H64: Convert Two-Way Left-Turn Lane to Raised Median

Description: Implementing a raised median in place of a two-way left-turn lane. A two-way left-turn lane (TWLTL) is a designated lane between opposing lanes of traffic, allowing traffic to make left turns from both directions. A physical barrier separates the opposing traffic lanes when a TWLTL is replaced with a raised median.



Image from FHWA

Applications: Along roadway segments where a high frequency of crashes are occurring due to vehicles using two-way left-turn lanes.

Considerations: There is a potential for crashes to occur at median openings which involve vehicles turning left and making U-turns, vehicles directly hitting the median curb, and median crossover crashes.

Special Conditions: Implementing raised medians can provide pedestrian refuge islands at intersections and midblock locations, allowing for two-stage crossing. Raised medians can also prevent head-on or sideswipe crashes and provide space for landscaping and other aesthetic benefits.

ODOT CRF Value:

47%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

47%

Safety Effects:

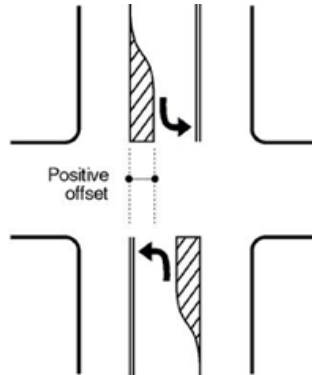
Converting two-way left-turn lanes to raised medians can reduce head-on crashes between vehicles traveling in opposing directions. Raised medians can also provide a pedestrian refuge area and increase safety in locations where pedestrians need to cross the roadway.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 7771\)](#)

H65: Install Offset (buffered) Right Turn Lane

Description: A right turn lane that is offset by moving the lane laterally so that vehicles in right turn lanes no longer obstruct the view of the driver on the minor road approach.



Images from FHWA

Applications: At locations where right-turn vehicles block drivers' views of approaching traffic and where there is a pattern of collisions between minor-road vehicles and major-road vehicles with existing right turn lanes.

Considerations: After installing offset right turn lanes, drivers initially may be confused by the change in traffic patterns, particularly in areas where offset right turn lanes have not been used. This can be minimized by effective use of guide signs and pavement markings. Installation of offset right turn lanes increase the width of the roadway, which creates a longer crossing distance for pedestrians. A possible solution would be to provide a pedestrian refuge island between the offset right turn lane and through travel lanes.

Special Conditions: This countermeasure CRF applies to rural areas.

ODOT CRF Value:

69%

Reduction in **Angle and Turning Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

69%

Safety Effects:

Offset right turn lanes can remove the sight distance obstruction created by traditional right turn lanes and reduce the potential for crashes between vehicles turning left, turning right, or crossing from the minor road and through vehicles on the major road.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 2777\)](#)

[Median Intersection Design for Rural High-Speed Divided Highways \(NCHRP Report 650\)](#)

H66: Install Speed Humps/Table (Not on State Highways)

Description: A speed hump is a raised area (normally 3 to 4 inches in height) in the roadway pavement surface extending transversely across the roadway.



Image from NACTO

Applications: In residential areas or on low-speed local streets where speeding carries a heightened risk for crashes.

Considerations: Adequate signing and marking of each speed hump is essential to warn drivers of the presence of approaching speed humps.

Special Conditions: This countermeasure CRF is specific to installing speed humps on low-speed urban roadways.

ODOT CRF Value:

50%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

50%

Safety Effects:

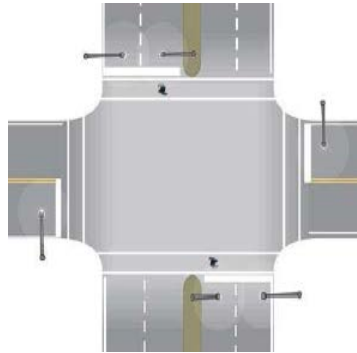
Speed humps are effective at reducing traffic speeds by forcing drivers to slow down and increase driver awareness.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 134\)](#)

I1: Install Lighting at an Intersection

Description: A permanent source of artificial lighting installed at an intersection that provides greater visibility of the intersection.



Images from FHWA

Applications: At intersections with a high frequency of dark or nighttime crashes. Particularly for unsignalized intersections, rear-end, right-angle, or turning crashes on the major road approaches may indicate that approaching drivers are unaware of the presence of the intersection.

Considerations: In rural areas it may be difficult to locate a power source. In addition, it is important to determine, upfront, the jurisdiction responsible for paying the ongoing utility costs. For signalized intersections, retrofitting illumination onto existing signal poles could result in an entire signal rebuild.

Special Conditions: This countermeasure CRF value is for new lighting only on all corners (i.e. no lighting currently exists) and can be applied to signalized and unsignalized intersections (both rural and urban). If the existing intersection is partially lit or partial lighting will be installed at an intersection, refer to the special situation below to calculate CRF value.

For state highways, refer to the [ODOT Lighting Policy and Guidelines](#) for further guidance on lighting warrants.

ODOT CRF Value:

38%

Reduction in **Night Crashes**
at **All Injury Severities**
(Excluding PDO's)

Range of Effectiveness:

31% - 38%

Safety Effects:

Intersection lighting allows for greater visibility of the intersection, making signs and markings more visible, and helping drivers determine a safe path through the intersection. This can be especially helpful at rural intersections where the only source of lighting for the roadway is often provided by vehicle headlights.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 433\)](#)

I2: Improve Signal Hardware: Lenses, Reflectorized Back plates, Size, and Number

Description: This countermeasure includes a set of proven, low-cost countermeasures that can be implemented at signals along a corridor. These countermeasures include the following options:

- Twelve-inch signal lenses
- LED lenses on all signal heads
- Reflectorized back plates on all signal heads
- Supplemental signal heads (recommended a minimum of one traffic signal head per approach lane)
- Elimination of any late night flashing operations
- Traffic signal yellow change interval and all red interval timing adjusted to be in accordance with the Institute of Transportation Engineers (ITE) timing standards
- Addition of a signal head for the right turn lane to reduce right-turn permissive conflicts



Images from FHWA

Applications: On signalized corridors with a higher than expected frequency of intersection crashes, particularly angle and turning crashes related to red light running.

Considerations: It is highly recommended that these treatments be applied systemically. Structural analysis should be done to verify existing signal poles can withstand loading from additional signal heads. Switching out to 12" signal heads could create vehicle height restrictions.

Special Conditions: FHWA recommends these countermeasures to be used as a package so it is important to include as many of the listed countermeasures as possible. FHWA estimated the crash reduction factor for the combined basic countermeasures as 30% reduction in all crashes. This estimate was developed by an expert intersection safety panel using past

ODOT CRF Value:

20%

(2 Countermeasures from List)

25%

(3-4 Countermeasures from List)

30%

(5-6 Countermeasures from List)

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

0% - 46%

Safety Effects:

All of the listed treatments are proven countermeasures that reduce intersection crashes and increase visibility of the signal and its operations.

References:

Engineering Judgement

FHWA Proven Safety Countermeasure

effectiveness research findings for individual countermeasures combined with engineering judgment. ODOT is aware that it may not be possible to install all six countermeasures so we have used engineering judgment to adjust the crash reduction for installing less than all six countermeasures.

I3: Add 3-inch Yellow Retroreflective Sheeting to Signal Backplates

Description: A strip of yellow retroreflective sheeting placed along the perimeter edges of a backplate, providing a “frame” for the signal face.



Images from FHWA

Applications: On signalized corridors with a higher than expected frequency of intersection crashes, particularly angle and turning crashes related to red light running.

Considerations: Low cost safety treatment. The retroreflective sheeting may be added to the signal head if it is in decent shape. However, the full signal head may need to be replaced. Transportation agencies should consider backplates with retroreflective borders as a standard treatment for improving safety at signalized intersections.

Special Conditions: Backplates with retroreflective borders enhance signal visibility, conspicuity, and benefits both older and color vision impaired drivers. This treatment reduces human error as it was designed with respect to human characteristics and limitations.

ODOT CRF Value:

15%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

15%

Safety Effects:

Adding Retroreflective sheeting to signals enhances the visibility of the signal during daytime and nighttime conditions. May also alert drivers to signalized intersections during periods of power outages when non-reflective signal heads and backplates would not be visible.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 1410\)](#)

[FHWA Proven Safety Countermeasure \(FHWA-SA-17-051\)](#)

FHWA Proven Safety Countermeasure

I4: Replace 8-inch Red Signal Heads with 12-inch

Description: An existing 8-inch signal head replaced with a larger 12-inch head.



Figure 3-11. Comparison of Signal Heads Using 8-in. and 12-in. Lenses.

Image from FHWA

Applications: On signalized corridors with a higher than expected frequency of intersection crashes, particularly angle and turning crashes related to red light running.

Considerations: As specified in the MUTCD, 12-in. signal lens shall be used under the following conditions:

- For signal indications for approaches where road users view both traffic control and lane use control signal heads simultaneously.
- If the nearest signal face is between 120 ft. and 150 ft. beyond the stop line, unless a supplemental near-side signal face is provided.
- For signal faces located more than 150 ft. from the stop line.
- For approaches to all signalized locations for which the minimum sight distance (specified in MUTCD) cannot be met.
- For arrow-signal indications.

Special Conditions: This treatment may be particularly beneficial to older drivers. Additionally, MUTCD recommends the use of a 12 in. signal lens on approaches with 85th percentile speeds exceeding 40 mph and where a traffic signal might be unexpected.

ODOT CRF Value:

42%

Reduction in **Angle Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

42%

Safety Effects:

Increasing the size of the signal head improves the visibility of the signal from a longer distance. Treatments that improve signal visibility help drivers make decisions at the intersection and alert them to the presence of a signalized intersection.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 2333\)](#)

I5: Increase Signal Head Quantity: Additional Primary Head

Description: An additional primary head placed on a traffic signal mast arm.



Image from FHWA

Applications: Signalized intersections with a higher than expected frequency of crashes, particularly angle and turning crashes related to red light running.

Considerations: Consider at high speed intersections with fewer signal heads than approach lanes. The cost of adding an additional signal head may be high if a new mast arm and pole are required. Additionally, MUTCD requirements for signal head placement need to be considered. This requirement states that “a minimum of two signal faces shall be provided for the major movement on the approach, even if the major movement is a turning movement.” An additional primary head can be added only if the MUTCD requirement isn’t already met.

Special Conditions: This countermeasure CRF applies to urban areas.

ODOT CRF Value:

28%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

28%

Safety Effects:

Adding an additional signal head improves the visibility of the signal. Treatments that improve signal visibility help drivers make decisions at the intersection and alert them to the presence of a signalized intersection.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 1414\)](#)

[Signalized Intersections Information Guide \(FHWA-SA-13-027\)](#)

I6: Replace Incandescent Traffic Signal Bulbs with Light Emitting Diodes (LEDs)

Description: Traffic signal bulbs are replaced with light emitting diodes (LEDs), which improve signal visibility, reduce energy consumption, and are expected to last much longer than conventional incandescent light bulbs in traffic signals.



Image from FHWA

Applications: On signalized corridors with a higher than expected frequency of intersection crashes, particularly angle and turning crashes related to red light running.

Considerations: It is important to note that studies have revealed potential problems with LEDs, including their inability to melt snow and issues related to visual discomfort caused by glare at night.

Special Conditions: This countermeasure CRF applies to urban areas.

ODOT CRF Value:

17%

Reduction in **Rear End Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

17%

Safety Effects:

Light emitting diodes (LEDs) improve signal visibility which helps drivers make decisions at the intersection and alert them to the presence of a signalized intersection.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 4901\)](#)

[Signalized Intersections Information Guide \(FHWA-SA-13-027\)](#)

I7: Replace Night-Time Flash with Steady Operation

Description: Removal of nighttime flash operations, consisting of traffic signals with red-red or red-yellow operations, to a normal steady (stop-and-go) operation. Night-time flash is activated during nighttime and early morning conditions.



Intersection where the traffic signals were converted from a night-time flash mode to a normal steady operation

Image from FHWA

Applications: On signalized corridors with a higher than expected frequency of intersection crashes, particularly angle and turning crashes.

Considerations: If removal of the flashing operation is not fully actuated and responsive to traffic demand, increases in red light running and/or complaints of long wait times at red signals may occur. Enforcement and temporary signing may be needed for a period of time after converting to the normal phasing operation.

Special Conditions: Refer to the MUTCD for additional guidance on the transition out of flash mode to steady (stop-and-go) mode.

ODOT CRF Value:

48%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

48% - 57%

Safety Effects:

Removing a night-time flash operation would give vehicles more time to see, respond, and yield to pedestrians and other vehicles because they would be required to stop during the red phase.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 4887\)](#)

[Safety Evaluation of Discontinuing Late Night Flash Operations at Signalized Intersections \(FHWA-HRT-13-069\)](#)

I8: Replace Doghouse with Flashing Yellow Arrow Signal Heads

Description: Replacing the 5-Section "doghouse" protected/permissive left turn signal head with a 4- or 3- Section flashing yellow arrow protected/permissive left turn signal.



Doghouse Signal



Flashing Yellow Arrow

Applications: Where you have doghouse signal heads and a high frequency of left turning crashes.

Considerations: Signal software may need to be changed in order to be compatible with the flashing yellow arrow. If you are using a 4-Section flashing yellow arrow head, structural limitations and height restrictions will need to be considered.

Special Conditions: This countermeasure does not apply to doghouse signal heads for right turns. In addition, please consider that the 3-Section head for the flashing yellow arrow only has interim approval from FHWA. The flashing yellow arrow is a protected-permissive left turn phase that can allow for more flexibility of left turn phasing throughout peak and non-peak periods.

ODOT CRF Value:

25%

Reduction in **Left Turning Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

25%

Safety Effects:

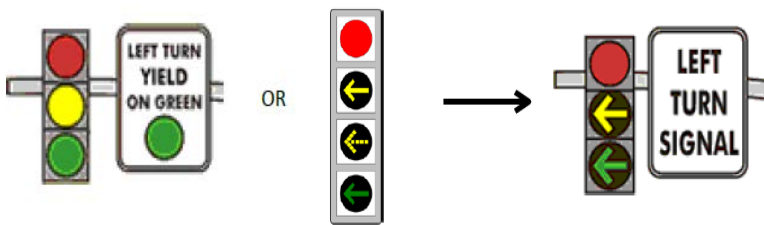
Previous NCHRP studies (493 and Web-Only Document 123) have proven that the flashing yellow arrow is more intuitive with fewer "false positive" reactions as compared to the green ball indication on the doghouse signal head, resulting in a reduction of left turn crashes.

References:

[Safety Effectiveness of Flashing Yellow Arrow: Evaluation of 222 Signalized Intersections in North Carolina](#)

I9: Replace Urban Permissive or Protected/Permissive Left Turns to Protected Only

Description: In a "permissive" mode, a green signal permits vehicles to turn left when an appropriate gap becomes available. In a "protected/permissive" mode, the permissive left-turn phase is immediately followed by an exclusive, protected left-turn phase, initiated by a green arrow signal indication. This countermeasure removes the permissive left-turn phase and provides the exclusive protected left-turn phase only.



Images from FHWA and Becuo

Applications: Where you have a high frequency of left turning crashes.

Considerations: Protected-only left-turn phases may reduce delay for turning vehicles but are likely to increase overall intersection delay. If your signal is within a coordinated system, it is recommended that proper analysis and timing adjustments are made to accommodate the potential impact to the corridor's capacity by implementing this countermeasure.

Special Conditions: Other factors that may warrant the use of protected-only left-turn phases include delay, visibility and distance of the intersection.

ODOT CRF Value:

99%

Reduction in Left Turning Crashes at All Severities
(Including PDO's)

Range of Effectiveness:

6% - 99%

Safety Effects:

"Protected-only" phasing consists of providing a separate phase for left-turning traffic and allowing left turns to be made only on a green left arrow signal indication, with no pedestrian movement or vehicular traffic conflicting with the left turn. As a result, left-turn movements with "protected-only" phasing have fewer potential conflicts than those with "permissive-only" or "protected/permissive" phasing.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 333\)](#)

I10: Protected Left Turn: Split Side Street Signal Phasing

Description: Split phasing is the assignment of right-of-way to all movements of one approach, followed by all movements of the opposing approach.

Applications: Where you have a high frequency of crashes related to left turning vehicles.

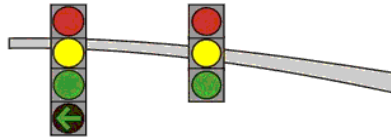


Image from FHWA

Considerations: It is important to consider pedestrian crossing phases. One problem related to split phasing with protected left turn displays is the potential impact on coordinated signal systems. This would either require a longer cycle length to accommodate the pedestrians or would result in frequent signal out-of-coordination. Additionally, split signal phasing creates additional intersection delay and is generally less efficient than other signal phasing options. Split phasing should only be used in unusual situations, determined by an engineer with signal timing expertise (see ODOT Traffic Signal Policy and Guidelines).

Special Conditions: Some additional conditions where split phasing might be considered:

- Need to accommodate multiple turn lanes on one approach, where a shared through left turn lane is required due to inadequate width space to provide separate lanes.
- Left-turn volumes on opposing approaches are approximately equal to through traffic volumes and total approach volumes are different for opposing approaches.
- Offset approaches where opposing left turns could not proceed simultaneously or permissive left turns could not be expected to yield to opposing through traffic.
- Angle of intersection creates paths of opposing left turns that could cause conflict.
- Opposing approaches that each only have a single lane to accommodate all movements and where left turn volumes require a protected phase.
- One of the opposing approaches has a heavy demand while the other approach has a minimal demand.

ODOT CRF Value:

70%

Reduction in **Left Turning Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

70%

Safety Effects:

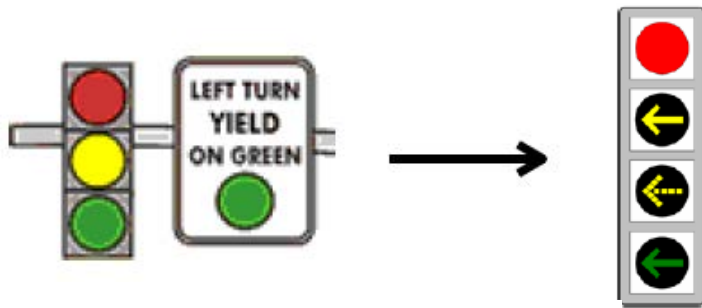
Split phasing avoids the conflict of opposing left turn vehicle paths by controlling the traffic on opposing approaches to move in separate sequences. Reduces conflicts between left turning vehicles and pedestrians.

References:

[NCDOT Research - Project Development Crash Reduction Factors](#)

I11: Replace Urban Permissive Left Turns to Protected/Permissive

Description: In a "permissive" mode, a green signal permits vehicles to turn left only when an appropriate gap becomes available. In a "protected/permissive" mode, the permissive left-turn phase is immediately followed by an exclusive, protected left-turn phase, initiated by a green arrow signal indication.



Images from FHWA and Becuo

Applications: Where you have a high frequency of left turning crashes and protected-only phasing is not justified.

Considerations: Considerations should be made to driver expectations and if your signal is within a coordinated system. It is recommended that proper analysis and timing adjustments are made to accommodate the potential impact to the corridor's capacity by implementing this countermeasure.

Special Conditions: Some additional benefits to providing protected/permissive left turn phasing:

- Average delay per left-turn vehicle is reduced.
- Protected green arrow time is reduced.
- There is potential to omit or provide an exclusive protected left-turn phase.
- Arterial progression can be improved, particularly when special signal head treatments are used to allow lead-lag phasing.

ODOT CRF Value:

16%

Reduction in **Left Turning Crashes at All Injury Severities**
(Excluding PDO's)

Range of Effectiveness:

6% - 99%

Safety Effects:

While permissive-only left turn operations may reduce delay for the intersection, it may adversely affect intersection safety as it requires motorists to choose acceptable gaps.

Protected/permissive left turn phasing provides an exclusive phase for left turning vehicles that reduces the number of potential left turning conflicts. Protected-permissive left turn phases can offer a good compromise between safety and efficiency and allows for more flexibility of left turn phasing throughout peak and non-peak periods.

References:

Highway Safety Manual

[CMF Clearinghouse ID: 4578](#)

I12: Change from Permissive Only to FYA - Permissive Only

Description: Replacing a circular green indication with a flashing yellow arrow. FYA – permissive only signals have three sections: a steady red arrow, a steady yellow arrow, and a flashing yellow arrow. They are used on approaches where an exclusive left turn phase is not present.

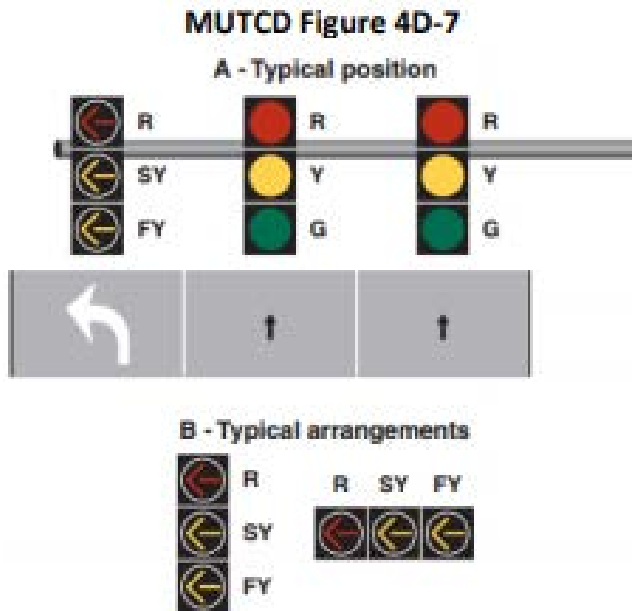


Image from MUTCD

Applications: Where there is a high frequency of left turn crashes at signalized intersections.

Considerations: Considerations should be made to driver expectations and if the signal is within a coordinated system. It is recommended that proper analysis and timing adjustments are made to accommodate the potential impact to the corridor's capacity by implementing this countermeasure.

ODOT CRF Value:

50%

Reduction in **Left Turning Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

50%

Safety Effects:

Where a circular green permissive indication is present, drivers might mistake that signal as implying they have the right-of-way over opposing traffic.

Replacing this signal indication with a flashing yellow arrow could help eliminate confusion, and reduce collisions from left-turning movements.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 7700\)](#)

I13: Install Coordination or Adaptive Signal Timing of Urban Traffic Signals

Description: Coordination is the ability to synchronize multiple intersections to enhance the operation of one or more directional movements in a system. Adaptive Signal Timing is coordination that adjusts the timing of red, yellow and green lights to accommodate changing traffic patterns in real time and ease traffic congestion.

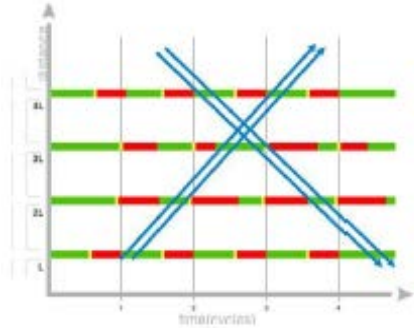


Image from FHWA

Applications: Signalized intersections located close to each other where traffic volumes between the adjacent intersections are large. It should also be considered on corridors with a high frequency of rear end crashes and red light running crashes.

Considerations: Signals too close together can present problems related to drivers focusing on a downstream signal and not noticing the signal they are approaching, or proceeding through a green signal and not being able to stop for a queue at an immediate downstream signal. Dispersion of platoons can occur if signals are spaced too far apart, resulting in inefficient use of the signal coordination. Achieving a coordinated system along a corridor may be complicated by signal requirements associated with crossing facilities, any of which may also require signal coordination. The need for long signal cycles associated with multiphase operation and long clearance intervals will dictate the cycle length on which progression will be based. Such a cycle length may produce additional delays for pedestrians and side street traffic.

Special Conditions: Signals up to 3/4 mile of each other should be considered for coordination. Factors that should be considered include geographic boundaries, volume/capacity ratios, and characteristics of traffic flow. This countermeasure includes controllers, detection and communications. It is important to note that adaptive signal systems typically require additional detection beyond the standard.

FHWA requires, for all federally funded projects, an Engineering Systems Document for ITS devices such as adaptive signal timing.

ODOT CRF Value:

17%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

17%

Safety Effects:

Coordinated signals produce platoons of vehicles that can proceed without stopping at multiple intersections.

Reducing the number and frequency of required stops and maintaining constant speeds for all vehicles reduce rear-end conflicts. In addition, signal coordination can improve the operation of turning movements. Drivers may have difficulty making permitted turning maneuvers because of a lack of gaps in through traffic. Crashes may occur when drivers become impatient and accept a gap that is smaller than needed.

Such crashes could be reduced if longer gaps were made available.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 6856\)](#)

I14: Install Actuated Advance Warning Dilemma Zone Protection System at High Speed Signals (Microwave Detection)

Description: The dilemma zone is that portion of the approach where a driver suddenly facing a yellow indication must make a decision whether to stop safely or to proceed through the intersection. This countermeasure provides microwave radar that detects the speed and distance of a vehicle from the intersection and extends the green interval if the vehicle is within the dilemma zone.

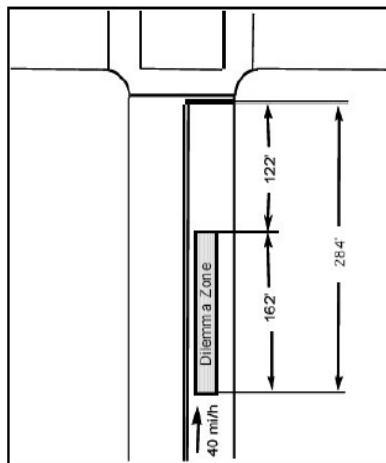


Image from FHWA

Applications: At locations with a high frequency of crashes associated with the traffic signal phase change (e.g., rear-end and angle crashes) and high frequencies of red-light violations. This countermeasure should also be considered at high speed signalized intersections.

Considerations: On older signals there may be conduit capacity issues and structural issues related to where you need to mount the detection system.

Special Conditions: This countermeasure is recommended and encouraged for use on higher speed facilities (45 mph +). In the past, dilemma zone protection has been provided through loop and/or camera detection. Microwave radar is a newer technology that more easily incorporates individual vehicle speeds in the dilemma zone detection. Additional benefits of this treatment include reducing delay and stop frequency on the major road and maintaining or reducing overall intersection delay. It is important to consider both truck and passenger vehicle stopping distances when implementing this countermeasure.

ODOT CRF Value:

8%

**Reduction in All Crashes
at All Severities
(Including PDO's)**

Range of Effectiveness:

0% - 43.6%

Safety Effects:

The Advance Dilemma-Zone Detection system enhances safety at signalized intersections by modifying traffic control signal timing to reduce the number of drivers that may have difficulty deciding whether to stop or proceed during a yellow phase. This may reduce rear-end crashes associated with unsafe stopping and angle crashes due to illegally continuing into the intersection during the red phase.

References:

[Crash Modification Factors
Clearinghouse \(CMF ID:
4857\)](#)

I15: Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)

Description: A flashing beacon installed on a signal ahead or intersection ahead warning sign. This feature flashes at all times.



Image from Google

Applications: At intersections with patterns of right-angle or turning crashes related to lack of driver awareness of the upcoming intersection (e.g. first signal upon entering an urban area or intersection with limited sight distance).

Considerations: In rural areas, it may be difficult to find a source of power for the beacon(s).

Special Conditions: This countermeasure can include a single flashing beacon or dual flashing beacons that flash alternately ("wig-wag").

ODOT CRF Value:

13%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

10.2% - 13.3%

Safety Effects:

It helps to bring more awareness to drivers of an upcoming intersection where it might not be expected. For example, where there may be long stretches between intersections or locations where intersection visibility is an issue (e.g. limited sight distance or during nighttime conditions).

References:

[FHWA Desktop Reference
for Crash Reductions Factors
\(FHWA-SA-08-011\)](#)

I16: Install Actuated/Coordinated Flashing Beacons as Advance Warning for Signalized Intersections

Description: A flashing beacon on an advance warning sign for a signalized intersection that activates at a predetermined time before the end of the green interval.



Image from Shari Lewis

Applications: At locations with a high frequency of crashes associated with the traffic signal phase change (e.g., rear-end and angle crashes) and high frequencies of red-light violations. This countermeasure could also be used at locations with a high frequency of crashes related to limited sight distance.

Considerations: Some studies have shown that this countermeasure could inadvertently encourage some drivers to accelerate in order to make it through the green interval so use this countermeasure with caution.

Special Conditions: Additional potential benefits of this treatment include reducing delay and stop frequency on the major road and maintaining or reducing overall intersection delay.

ODOT CRF Value:

36%

Reduction in **Rear End Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

36% - 62%

Safety Effects:

It notifies drivers that the green interval is about to end in order to help reduce indecision and volatility in driver behavior during the yellow interval.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 1672\)](#)

[FHWA Desktop Reference for Crash Reductions Factors \(FHWA-SA-08-011\)](#)

I17: Increase Triangle Sight Distance

Description: Removal of sight distance restrictions (e.g., vegetation, parked vehicles, signs, buildings) from the sight triangles at an intersection.

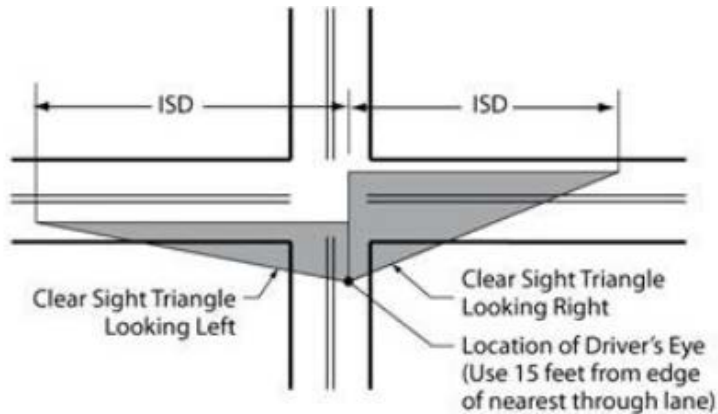


Image from FHWA

Applications: At intersections with restricted sight distance and patterns of crashes related to lack of sight distance where sight distance can be improved by clearing roadside obstructions without major construction.

Considerations: Removing or relocating obstacles can often be restricted and/or costly. Removing parking needs to have local community support.

Special Conditions: While countermeasure can be applied to signalized or unsignalized intersections, it is more likely to make a significant impact at unsignalized intersections as there is more driver response needed to judge gap sizes before deciding whether to initiate a roadway entry or a turning maneuver.

ODOT CRF Value:

48%

Reduction in **All Crashes**
at **All Injury Severities**
(Excluding PDO's)

Range of Effectiveness:

11% - 56%

Safety Effects:

Drivers will be able see approaching vehicles on the main line without obstruction and therefore make better decisions about entering the intersection safely.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 307\)](#)

I18: Increase Pavement Friction by Installing High Friction Surface Treatment - Intersection or Segment Application

Description: Pavement surfacing systems with exceptional skid-resistant properties not typically provided by conventional materials.



Images from FHWA

Applications: In locations where you have frequent crashes where insufficient friction is a contributing factor (i.e. wet weather). These are generally locations where drivers are braking excessively; for example, when going around curves or ramps, down hills or steep grades, or when approaching an intersection. The road surface can become prematurely polished, reducing the pavement friction and allowing vehicles to skid or hydroplane.

Considerations: It is costly to install and could be costly to maintain so it's important to reserve this treatment for the most needed locations. It is important to closely follow the manufacturer's installation instructions in order to reduce any chances of product failure. For more information on High Friction Surface Treatment, please refer to the FHWA website. They have provided many informational materials on the subject.

Special Conditions: There is some concern over the effect of the treatment on motorcyclists if they were to crash so use caution if you have a history of motorcycle crashes at the location you are looking to install the treatment. This treatment can be an intersection or segment application.

ODOT CRF Value:

57%

Reduction in **Wet Road Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

17% - 57%

Safety Effects:

It uses aggregates that are both polish- and wear-resistant and develop channels to prevent water buildup on wet surfaces creating an exceptionally durable surface capable of withstanding extreme roadway friction demands.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 195\)](#)

[Evaluation of Pavement Safety Performance \(FHWA-HRT-14-065\)](#)

I19, I20: Left Turn Traffic Calming Treatments, Posted Speeds < 35 MPH (Hardened Centerline and Left Turn Wedge)

Description: Left turn traffic calming treatments:

- Hardened Centerline: consists of rubber speed bumps and bollards anchored to a yellow centerline.
- Left Turn Wedge: consists of a marked wedge box with rubber speed bumps or plastic flexible posts.

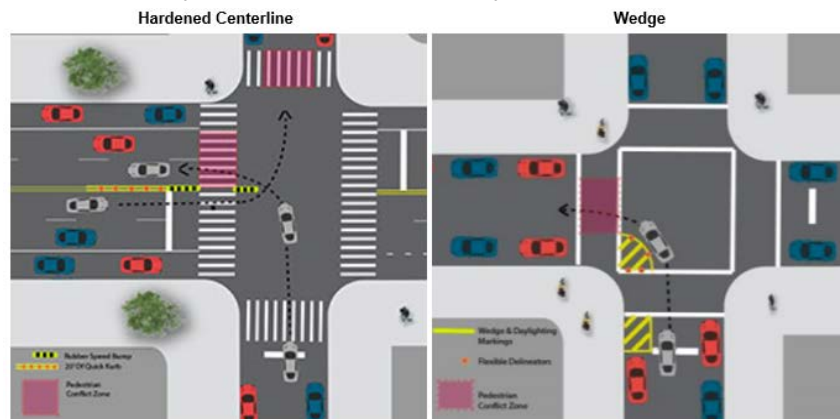


Image from PBOT

Applications: At intersections with a high frequency of left turning crashes, where vehicles are failing to yield to pedestrians.

Considerations: Left turn traffic calming treatments are low cost and require minimal installation time.

Special Conditions: This countermeasure CRF is specific to urban areas. Hardened centerlines are installed where a one-way or two-way road meets a two-way road. Left turn wedges are installed where a one-way meets another one-way.



Images from NYC DOT

ODOT CRF Value:

10%

Reduction in **Left Turning Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

10%

Safety Effects:

Left turn traffic calming treatments improve intersection safety by forcing vehicles to make a more 90-degree turn, slowing left turn speeds. These treatments prevent corner cutting and increase crosswalk visibility, which can reduce conflicts between vehicles and pedestrians.

References:

Engineering Judgment

I21: Improve Intersection Warning: Stop Ahead Pavement Markings, Stop Ahead Signs, Larger Signs, Additional Stop Signs and/or Other Intersection Warning or Regulatory Signs

Description: FHWA has compiled a list of proven low cost countermeasures that can be implemented at unsignalized intersections. They are listed below:

- Doubled up (left and right), oversize advance intersection warning signs, with street name sign plaques on the through approach
- Doubled up (left and right), oversize advance "Stop Ahead" intersection warning signs
- Doubled up (left and right), oversize STOP signs
- Installation of a minimum 6 ft. wide raised splitter island on the stop approach (if no pavement widening is required)
- Properly placed stop bar
- Removal of any foliage or parking that limits sight distance
- Double arrow warning sign at stem of T-intersections



Images from FHWA

Applications: At unsignalized intersections with a high frequency of angle or turning crashes.

Considerations: If the width is not already available to place a splitter island, this countermeasure will require widening and the appropriate accommodations for adding impervious surface.

Special Conditions: FHWA recommends these countermeasures to be used as a package so it is important to include as many of the listed countermeasures as possible. FHWA estimated the crash reduction factor for the combined basic countermeasures as 30% reduction in all crashes. ODOT is aware that it may not be possible to install all seven countermeasures so we have used engineering judgment to adjust the crash reduction for installing less than all seven countermeasures.

ODOT CRF Value:

20%

(1-2 Countermeasures from List)

25%

(3-4 Countermeasures from List)

30%

(5-7 Countermeasures from List)

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

11% - 55%

Safety Effects:

These countermeasures can be used to increase drivers' alertness to the presence of an unsignalized intersection and reduce potential conflicts with other entering vehicles.

References:

Engineering Judgment

**FHWA Proven Safety
Countermeasure**

I22: Install Advance Warning Signs (Signal Ahead)

Description: Warning signs placed before a signalized intersection to inform drivers of an approaching signal.



Image from Google

Applications: At signalized intersections with patterns of angle crashes related to lack of driver awareness of the approaching signalized intersection.

Considerations: Placement of warning signs should be considered to provide adequate perception-reaction time for drivers. A sign placed at the wrong location may result in it being seen too late by drivers to react safely. MUTCD requires advanced warning signs when “the primary traffic-control device is not visible from a sufficient distance to permit the road user to respond to the device.”

Special Conditions: This countermeasure is specific to urban areas. Refer to the MUTCD for additional guidance on placement of these signs.

ODOT CRF Value:

35%

Reduction in **Angle Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

35%

Safety Effects:

Advanced warning signs inform drivers of upcoming traffic signals and reduce potential conflicts with other vehicles present at signalized intersections.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 1684\)](#)

I23: Increase Retro-reflectivity of Stop Signs (reflective strips on sign post optional)

Description: A material applied to a stop sign that reflects a large portion of light directly back to the source. When applied to a sign, retroreflective sheeting will redirect light from the driver's headlights back to the driver's eyes making the sign more visible, which is especially during nighttime or other reduced visibility conditions.



Retroreflective stop sign in daylight and nighttime conditions
Image from FHWA

Applications: At unsignalized intersections with patterns of right-angle crashes related to lack of driver awareness of the stop sign.

Considerations: Maintenance is an important consideration to ensure the sign continues to serve its intended safety purpose. Service life of a retroreflective sign depends upon the type and quality of the sheeting chosen.

Special Conditions: MUTCD has requirements for minimum required retro-reflectivity levels. A sign will need to be replaced if it falls below the MUTCD required levels.

ODOT CRF Value:

7%

Reduction in **Angle Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

7%

Safety Effects:

Increasing the retroreflectivity increases visibility and conspicuity of the stop sign and reduces the frequency of crashes related to driver unawareness of stop controlled intersections.

They may also improve safety at locations where there is a lack of nighttime visibility of intersections.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 6048\)](#)

FHWA Proven Safety Countermeasure

I24: Provide Flashing Beacons at All-Way Stop Controlled Intersections

Description: Red flashing beacons placed on the top of the stop signs at an all-way stop controlled intersection.



Image from FHWA

Applications: At unsignalized intersections with patterns of right-angle crashes related to lack of driver awareness of the Stop sign on a stop-controlled approach.

Considerations: In rural areas, it may be difficult to find a source of power for the beacons.

Special Conditions: This countermeasure only applies to all-way stop controlled intersections.

ODOT CRF Value:

28%

Reduction in **Angle Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

5% - 58%

Safety Effects:

Flashing beacons provide a visible signal indicating the presence of an intersection and can be very effective in rural areas where there may be long stretches between intersections. They may also improve safety at locations where nighttime visibility of intersections is an issue.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 454\)](#)

I25: Provide Flashing Beacons at Minor Road Stop Controlled Intersections

Description: At minor road stop controlled intersections, red flashing beacons installed on top of Stop signs on the minor, controlled road and/or yellow flashing beacons installed on top of Advance Intersection Warning Signs on the major, uncontrolled road.



Image from Sebastian Chavez

Applications: At unsignalized intersections with patterns of right-angle crashes related to lack of driver awareness of the Stop sign on a stop-controlled approach.

Considerations: In rural areas, it may be difficult to find a source of power for the beacons.

Special Conditions: This countermeasure only applies to minor road stop controlled intersections. You can choose to place flashing beacons on the major road, minor road or on all approaches.

ODOT CRF Value:

13%

Reduction in **Angle Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

5% - 58%

Safety Effects:

Flashing beacons provide a visible signal indicating the presence of an intersection and can be very effective in rural areas where there may be long stretches between intersections. They may also improve safety at locations where nighttime visibility of intersections is an issue.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 449\)](#)

I26: Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections

Description: Flashing beacons that only flash when a sensor detects a vehicle approaching the intersection. ODOT encourages the installation of the type of actuated beacon that provides enhanced warning to the through driver that there is a vehicle on a cross road stop approach that may enter the intersection. Research has shown that this actuated beacon has seen the most effectiveness.



Image from Kevin Hass

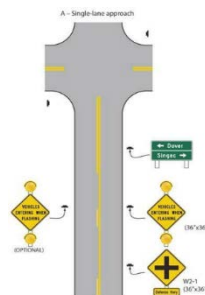


Image from FHWA

Applications: At unsignalized intersections that experience severe intersection-related crashes due to speed, low visibility, or insufficient gaps. This countermeasure should be used where other signing enhancements have been shown to be ineffective.

Considerations: In rural areas, it may be difficult to find a source of power for the beacons. Consider potential maintenance costs/impacts when deciding between camera, loop, and radar detection. For loop detection, turning vehicles may trigger the loops if over tracking occurs. If the delay is set too high, vehicles that need to be detected won't get picked up. Loops although cheaper, should be a last resort with these systems.

Special Conditions: This countermeasure only applies to unsignalized intersections. For more information please refer to the following two FHWA publications; (1) Stop-Controlled Intersection Safety: Through Route Activated Warning Systems (FHWA-SA-11-015) or (2) Safety Evaluation of Flashing Beacons at STOP-Controlled Intersections (FHWA-HRT-08-044)

***FHWA requires, for all federally funded projects, an Engineering Systems Document for ITS devices such as intersection conflict warning systems.**

ODOT CRF Value:

27%

**Reduction in All Crashes
at All Severities
(Including PDO's)**

Range of Effectiveness:

27%

Safety Effects:

These systems provide enhanced safety warning information for approaching drivers, making them aware that vehicles are or may be entering the intersection.

References:

[Crash Modification Factors
Clearinghouse \(CMF ID:
8441\)](#)

[Safety Evaluation of
Intersection Conflict Warning
Systems \(FHWA-HRT-15-
076\)](#)

I27: Install Transverse Rumble Strips on Stop Controlled Approach(es)

Description: Rumble strips that are milled-in or rolled-in patterns placed across the roadway that provide both an audible warning (rumbling sound) and physical vibration to alert drivers of an upcoming intersection.



Image from Google

Applications: Where you have a high frequency of crashes as a result of vehicles failing to stop at a stop sign (e.g. limited visibility of an approaching intersection) and where other signing enhancements have been shown to be ineffective.

Considerations: Considerations should be made to existing pavement quality and potential noise impacts to neighboring residents.

Special Conditions: Transverse rumble strips are typically installed at rural, unsignalized intersections. This feature should be considered when a splitter island cannot be installed.

ODOT CRF Value:

25%

Reduction in **All Crashes** at
Fatal & Injury A Severities

Range of Effectiveness:

-36% - 33%

Safety Effects:

Transverse rumble strips have been proven to be effective at reducing the number of vehicles disregarding a stop sign by using an audible alert as they are approaching an intersection.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 2705\)](#)

[Safety Evaluation of Transverse Rumble Strips on Approaches to Stop-Controlled Intersections in Rural Areas \(FHWA-HRT-12-047\)](#)

I28: Install 6 ft. or greater Raised Divider on Stop Approach (Splitter Island)

Description: A channelizing island that separates traffic in opposing directions of travel at a stop approach of an unsignalized intersection and contains a left side, supplemental Stop sign.



Image from FHWA

Applications: Where you have a high frequency of crashes as a result of vehicles failing to stop at a stop sign (e.g. limited visibility of an approaching intersection) and where other signing enhancements have been shown to be ineffective. The strategy is particularly appropriate for intersections where the speeds on the minor road are high and/or on approaches to skewed intersections.

Considerations: If the width is not already available to place a splitter island, this countermeasure will require widening and the appropriate accommodations for adding impervious surface.

Special Conditions: This feature should be considered when transverse rumble strips cannot be installed.

ODOT CRF Value:

15%

Reduction in **All Crashes** at
All Severities
(Including PDO's)

Range of Effectiveness:

15%

Safety Effects:

The installation of splitter islands allows for the addition of a stop sign in the median to make the intersection more conspicuous.

References:

[Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections \(FHWA-SA-09-020\)](#)

I29: Prohibit Right-Turn-On-Red

Description: A sign indicating that a vehicle should not make a right turn when the signal is red.



Image from Google

Applications: At signalized intersections with a high frequency of crashes as a result of vehicles turning right and where there are high pedestrian volumes and inadequate sight distances.

Considerations: Low cost treatment. Prohibiting right-turn-on-red may lead to higher right-turn-on green conflicts when there are concurrent signals. Signs should also be clearly visible to drivers. May require structural analysis to assess wind loading created by the addition of the sign to the signal mast arm.

Special Conditions: At intersections experiencing high pedestrian volumes, prohibiting right-turn-on-red along with a leading pedestrian interval could provide additional safety benefits for pedestrians. Where a right-turn-on-red restriction is needed during certain times of the day, a part-time or variable message no-turn-on-red sign could be used.

ODOT CRF Value:

9%

Reduction in **All Crashes** at
All Severities
(Including PDO's)

Range of Effectiveness:

9%

Safety Effects:

Prohibiting vehicles from turning right on red can improve safety at intersections with limited sight distances and could reduce conflicts from right turning vehicles.

References:

Highway Safety Manual

I30: Provide "Stop Ahead" Pavement Markings

Description: Pavement markings on a roadway surface that inform drivers of an approaching unsignalized intersection.



Image from FHWA

Applications: Where you have a high frequency of crashes due to lack of driver awareness of upcoming, unexpected, or partially concealed stop-controlled intersections.

Considerations: Size and placement of the pavement markings should be considered.

Special Conditions: This countermeasure is especially useful in rural areas at unsignalized intersections with patterns of crashes which suggest that drivers may not be aware of the presence of the intersection.

ODOT CRF Value:

31%

Reduction in **All Crashes** at
All Severities
(Including PDO's)

Range of Effectiveness:

31%

Safety Effects:

Stop ahead pavement markings can be used to increase drivers' alertness to the presence of an unsignalized intersection and reduce potential conflicts with other entering vehicles.

References:

Highway Safety Manual

**FHWA Proven Safety
Countermeasure**

I31: Provide Overhead Lane-Use Signs

Description: Intersection lane control signs mounted overhead and placed over the lane to which it applies.



Image from FHWA

Applications: Where you have a high frequency of rear end crashes at signalized intersections.

Considerations: Use of an overhead sign for one approach lane does not require installation of overhead signs for the other lanes of that approach. Sign supports should be considered to minimize potential hazard. Structural analysis will likely be required to address wind loading created by the signs.

Special Conditions: Especially important for treatments involving indirect turning movements that may violate driver expectation.

ODOT CRF Value:

10%

Reduction in **Rear End Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

10%

Safety Effects:

Overhead lane-use signs provide improved visibility and may help reduce rear end and sideswipe crashes due to last-minute lane changes and better prepare drivers to watch for potential conflicts.

References:

[Signalized Intersections Information Guide \(FHWA-SA-13-027\)](#)

I32: Install Wrong Way Driving Countermeasures: Signing, Pavement markings, Geometric Modifications, and ITS Technologies

Description: Countermeasures that can be implemented to reduce wrong-way crashes:

- Signage: wrong-way signs, oversized signs, lower-mounted signs, multiple signs, "Entrance Freeway" Sign at ramps
- Pavement Markings: Wrong-Way Arrows, Red Raised Pavement Markings, Stop Lines, Dotted Lane Line Extensions, Delineations, Turn or Through Lane Arrows, "ONLY" Markings
- Geometric Modifications: Channelizing Islands, Extended Raised Median or Longitudinal Channelizing Devices, Open Sight Distance and Uniform Lighting Levels at Ramp Terminal, widening and narrowing or entrance and exit ramp terminals
- ITS Technologies: Sensors, Traffic Management Center to Inform Law Enforcement and Incident Responders, Dynamic Signs to Warn Drivers: LED/RRFBs Illuminated wrong-way Signs, Changeable Message Signs (CMS), In-Pavement Warning Lights



Image from ODOT

Applications: Where you have a high frequency of crashes due to wrong-way driving.

Considerations: These treatments can be applied systematically.

Special Conditions: Refer to the Wrong Way Driving Analysis and Recommendations Report for further guidance.

ODOT CRF Value:

20%

(2 Countermeasures from List)

30%

(3 Countermeasures from List)

40%

(4 or more Countermeasures from List)

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

20% - 40%

Safety Effects:

These listed treatments can reduce crashes related to wrong-way driving.

References:

[Wrong Way Driving Analysis and Recommendations](#)

I33: Curb Extensions

Description: Curb extensions (also known as bulb-outs), narrow the width of the roadway by extending the curb line or sidewalk out into the parking lane.



Image from SDOT

Applications: At intersections with a higher than expected frequency of crashes that could be reduced by minimizing crossing distances and maximizing the visibility of pedestrians.

Considerations: It is important to provide sufficient pavement width to accommodate the largest size of vehicles expected to travel on the road in question. The new curb line should not extend into the traveled way where bicyclists or motor vehicles may be traveling. Additionally, stormwater drainage may need to be considered as curb extensions often require changing street drainage.

Special Conditions: Curb extensions should typically be used where there is a parking lane and where transit and cyclists will be traveling outside the curb edge for the length of the street.

ODOT CRF Value:

30%

Reduction in **All Crashes** at
All Severities
(Including PDO's)

Range of Effectiveness:

30%

Safety Effects:

Curb extensions significantly improve pedestrian crossings by reducing the pedestrian crossing distance, improving the ability of pedestrians and motorists to see each other, and reducing the time that pedestrians are in the street.

References:

[MDOT Intersection Crash Reduction Factors](#)

BP1: Install Pedestrian Countdown Timer(s)

Description: Pedestrian signal heads are traffic signal indications exclusively intended for controlling pedestrian traffic. They consist of the illuminated symbols of a walking person (symbolizing Walk) and an upraised hand (symbolizing Don't Walk). Pedestrian countdown timers are pedestrian signal heads that include a countdown during the flashing Don't Walk phase that provides pedestrians with the remaining seconds available before the pedestrian phase ends.



Image from FHWA

Applications: Where you have a high frequency of pedestrian crashes at signalized intersections.

Considerations: Depending on the age of the signal, you may need to replace the entire pedestrian signal head as opposed to just the LED module, which could increase installation costs. 90% of the time this will trigger ADA for ODOT to meet reach and landing. This then leads to rebuilding ramps, which could be very costly.

Special Conditions: This type of pedestrian signal head is the 2009 MUTCD standard and shall be installed at all new signal installations if flashing don't walk time is 7 seconds or more. It is encouraged that this countermeasure be applied systemically along a signalized corridor to create consistency for the pedestrians as they travel along the corridor.

This countermeasure may be included in an application for a Signalized Intersection Systemic project.

ODOT CRF Value:

70%

Reduction in **Pedestrian Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

0% - 70%

Safety Effects:

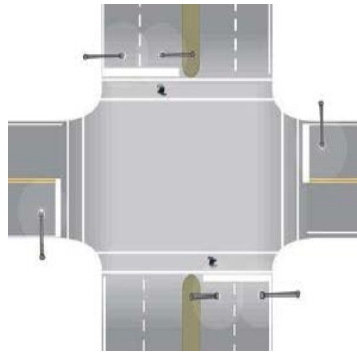
The countdown timer enables pedestrians to make better decisions on when to safely cross the road, effectively reducing the exposure of pedestrians to vehicular traffic at a signalized intersection.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 5272\)](#)

BP2: Provide Intersection Illumination (Bike & Ped)

Description: A permanent source of artificial light installed at an intersection that provides greater visibility of the intersection and its potential multi-modal users.



Images from FHWA

Applications: At intersections where you have a high frequency of bicycle and pedestrian crashes at night.

Considerations: In rural areas it may be difficult to locate a power source. In addition, it is important to determine, upfront, the jurisdiction responsible for paying the ongoing utility costs. For signalized intersections, retrofitting illumination onto existing signal poles could result in an entire signal rebuild.

Special Conditions: This countermeasure may be used at a midblock pedestrian crossing location. This countermeasure is for new lighting only, not to replace existing, substandard lighting. This CRF value can be applied to signalized and unsignalized intersections. For ODOT Highways, please refer to the ODOT Lighting Policy and Guidelines for further guidance on lighting warrants.

ODOT CRF Value:

42%

Reduction in **Nighttime
Pedestrian and Bicycle
Crashes at All Injury
Severities**
(Excluding PDO's)

Range of Effectiveness:

42%

Safety Effects:

Intersection lighting allows for greater visibility of the intersection. Roadway users and features are more visible and help all users determine a safe path through the intersection. This can be especially helpful at rural intersections where the only source of lighting for the roadway is often provided by vehicle headlights.

References:

Highway Safety Manual

[Crash Modification Factors
Clearinghouse \(CMF ID:
436\)](#)

BP3: Install Urban Leading Pedestrian or Bicycle Interval at Signalized Intersections

Description: Leading pedestrian interval (LPI) gives pedestrians and bicycles using the marked crosswalk an advance walk signal before the motorists get a green indication, giving the pedestrian or bicyclist several seconds to start crossing before vehicles start proceeding through the intersection.

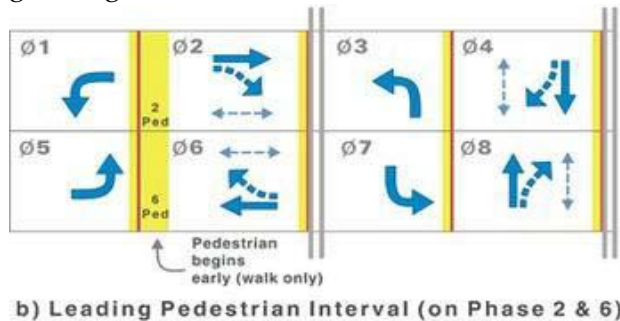


Image from FHWA

Applications: Where you have a high frequency of motorized users failing to yield to the right of way of non-motorized users at a signalized intersection.

Considerations: It is important to consider the potential intersection capacity and delay impacts to implementing this countermeasure. MUTCD recommends audible pedestrian pushbuttons for visually impaired pedestrians when using this feature, as they may miss the start of the walk signal because there isn't the vehicle sound to queue that it has begun early. This feature could also be considered for use by Time of Day to account for specific pedestrian surges such as school or shift releases. Lighting conditions should also be considered specifically in rural or suburban fringe areas where pedestrians may not be expected at all times of the day.

Special Conditions: This treatment could also be beneficial in areas where you have a high number of older pedestrians who tend to be slower to start into the intersection. It could also be particularly effective where there is a dual lane turning movements. If a Leading Pedestrian Interval is implemented on the sidestreet phases 4 & 8 it should reduce left turn and right turn pedestrian crashes from the sidestreet if the left turns are permissive. If the left turns are protected this will only reduce right turning pedestrian crashes from the sidestreet.

*This countermeasure may be included in an application for a Signalized Intersection Systemic project.

ODOT CRF Value:

37%

Reduction in Pedestrian and Bicycle Crashes at All Severities
(Including PDO's)

Range of Effectiveness:

37% - 45%

Safety Effects:

Provides better notice of the presence of pedestrian or bicyclists in the roadway/crosswalk for permissive left-turning or right-turning drivers. It makes non-motorized users more visible to motorized users and motorized users more likely to yield to them.

References:

[Safety Effectiveness of Leading Pedestrian Intervals using Empirical Bayes Method](#)

[Crash Modification Factors Clearinghouse](#)

FHWA Proven Safety Countermeasure

BP4: Install No Pedestrian Phase Feature with Flashing Yellow Arrow

Description: The separation of the pedestrian walk phase from the flashing yellow arrow (permissive) left turn phase. When an intersection has pedestrian pushbutton activation and the pedestrian phase is activated, the flashing yellow arrow indication is not displayed for the duration of the pedestrian walk phase. The flashing yellow arrow is either delayed or suppressed.

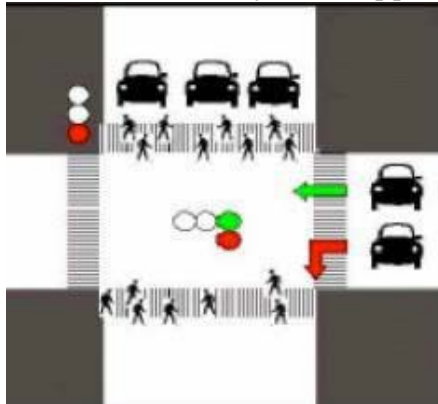


Image from PedBikeSafe

Applications: Where the volume of pedestrians crossing the crosswalk, in conflict with the left turning traffic, is high or where you have a high frequency of left turning vehicles failing to yield to pedestrians during the flashing yellow arrow indication.

Considerations: It is important to consider the potential delay to left turning vehicles by implementing this countermeasure. In order to implement this countermeasure, you will need to verify that your existing signal software will be able to support it.

Special Conditions: You cannot implement this countermeasure without push button activation for pedestrians. If pedestrian push buttons do not already exist, installing them can be included as part of this countermeasure. This countermeasure should include Protected Left Turns which, similar to a Not-Ped Right Turn Overlaps, completely remove the occurrence of permissive left turn conflicts with the pedestrian phase. Cost benefit calculation should only reduce pedestrian crashes for the permissive conflicts it is reducing. Only left turning pedestrian crashes for the modified phases should be included.

*This countermeasure may be included in an application for a Signalized Intersection Systemic project.

ODOT CRF Value:

43%

Reduction in **Pedestrian Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

43%

Safety Effects:

This separation allows the pedestrian to cross the approach entirely before the flashing yellow arrow indication is displayed, thereby reducing potential vehicle to pedestrian conflicts.

References:

Accident Analysis & Prevention (Chen)

[Phasing and Leading Pedestrian Intervals on Pedestrian Safety \(FHWA-HRT-18-044\)](#)

BP5: Reduce Right Turn Permissive Conflicts (Right Turn Arrow)

Description: A leading pedestrian interval for right turn permissive conflicts. Pedestrians using marked crosswalks at intersections are given an advanced walk signal, providing pedestrians with several seconds to start crossing before vehicles receive a flashing yellow right turn arrow. The duration of the pedestrian walk phase is protected.



Applications: Where you have a high frequency of right turning vehicles failing to yield to pedestrians or where conflicts between right turning vehicles and pedestrians is high.

Considerations: It is important to consider the potential delay impacts by implementing this countermeasure. You will also need to verify that your existing signal software will be able to support it. May require additional programming and signal head additions.

Special Conditions: This countermeasure would only reduce right turning pedestrian crashes for the movement it is being installed on and can only be implemented where right turn lanes exist. Cost benefit calculation should only reduce pedestrian crashes for the permissive conflicts it is reducing. Only right turning pedestrian crashes for the modified phases should be included.

ODOT CRF Value:

20%

Reduction in **Pedestrian and Bicycle Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

20%

Safety Effects:

Allows pedestrians to cross the approach entirely before the flashing yellow indication is displayed, thereby reducing potential conflicts between vehicles and pedestrians.

References:

Engineering Judgement

BP6: Install Urban Green Bike Lanes at Conflict Points

Description: Green bike lanes are green-colored pavement placed on the roadway to enhance visibility of a bicycle lane.



Image from BTA Oregon

Applications: In locations that have a high frequency of bicycle to vehicle conflicts where enhanced awareness of the presence of a bicycle lane could decrease the potential number of conflicts.

Considerations: It is important to consider the added maintenance costs to installing this kind of treatment, especially in locations where vehicles may be regularly passing over the markings.

Special Conditions: This countermeasure has limited available research on its effectiveness so it should be used where other more proven countermeasures have shown to not be effective. For additional guidance, please refer to the MUTCD Interim Approval for green bike lanes.

ODOT CRF Value:

39%

Reduction in **Bicycle Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

39%

Safety Effects:

It helps to bring awareness of the presence of potential bicyclists in locations where drivers may not be expecting them.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 3258\)](#)

BP7: Install Bike Box at Conflict Points

Description: The bike box is a designated space for bicyclists at an intersection (often painted green) that allows bicyclists to position themselves ahead of vehicle traffic.



Image from Portland Mercury

Applications: Where you have a high frequency of right turning vehicles failing to yield to through moving bicyclists at an intersection.

Considerations: It is important to consider the added maintenance costs to installing this kind of treatment, especially in locations where vehicles may be regularly passing over the markings.

Special Conditions: This countermeasure has limited available research on its effectiveness so it should be used where other more proven countermeasures have shown to not be effective.

Experimental approval from FHWA is REQUIRED for use of this countermeasure.

ODOT CRF Value:

35%

Reduction in **Bicycle Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

35%

Safety Effects:

Bike boxes make bicyclists more visible to motorists by placing them in their direct line of sight when stopped at an intersection. They alert vehicles to the presence of bicyclists at an intersection and can serve as a reminder to drivers to yield to bicyclists when they are turning right.

References:

[Signalized Intersections: An Information Guide \(FHWA-SA-13-027\)](#)

BP8: Install Pedestrian Refuge Island

Description: Concrete pedestrian refuge islands with crosswalk markings placed on a street at unsignalized intersections or midblock locations to separate crossing pedestrians from motor vehicles and provide pedestrians with the ability to cross one direction of traffic at a time.



Image from FHWA

Applications: Where you have a higher than expected frequency of pedestrian crashes or vehicles crashes caused by pedestrians that could be reduced by minimizing the crossing distance and maximizing the visibility of pedestrians.

Considerations: It is important to provide sufficient pavement width to accommodate the largest size of vehicles expected to travel on the road in question. It is also important to consider the potential impact to turning movements at any nearby accesses as a result of the median island.

Special Conditions: The following is guidance from FHWA on pedestrian raised median islands. Raised medians should be considered on sections of multi-lane roadways in urban and suburban areas, particularly in areas where there are mixtures of significant pedestrian and vehicle traffic (more than 12,000 Average Daily Traffic (ADT)) and intermediate or high travel speeds (40 mph or more). Medians/refuge islands should be at least 4 feet wide (preferably 8 feet wide to accommodate pedestrian comfort and safety) and of adequate length to allow the anticipated number of pedestrians to stand and wait for gaps in traffic before crossing the second half of the street.

On the State Highway System, marked crosswalks at uncontrolled (unsignalized) locations require State Traffic Engineer approval

Note: To accommodate large vehicles on State Highways, the pedestrian median curb may need to have a mountable outside edge. When the outside edge is designed as mountable, additional delineation might be needed to make the median more

ODOT CRF Value:

31%

Reduction in **Pedestrian Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

26% - 31%

Safety Effects:

Pedestrians are able to more safely make a two-stage crossing by having to only look for a gap in one direction of traffic at a time while being protected by a concrete curbed island.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 8799\)](#)

[Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments \(NCHRP 841\)](#)

FHWA Proven Safety Countermeasure

visible. **Refer** to ODOT's Standard Drawings and Details for design guidance and the Traffic Line Manual for guidance on delineation.

BP9: Install Rectangular Rapid Flashing Beacon (2-Lane Road)

Description: Rectangular Rapid Flash Beacons (RRFBs) are user-actuated amber Light Emitting Diodes (LEDs) that supplement warning signs at unsignalized intersections or mid-block crosswalks. The signals rest in the dark phase until activated by a push button and then flash in a rapid stutter flash pattern.



Image from Frank Ockenfels

Applications: On 2-lane roads where crash data indicates a need to provide additional notification to motorists of the presence of crossing pedestrians or where there are insufficient gaps in vehicle traffic to provide a pedestrian a crossing opportunity.

Considerations: It may be important to provide educational outreach to the community on safe use of RRFB's. There are instances where pedestrians have been shown to blindly trust that vehicles will immediately yield to them once they activate the RRFB. Their failure to check for oncoming traffic can result in a pedestrian crash regardless of the presence of an RRFB.

Special Conditions: RRFB's are meant to supplement standard pedestrian crossing warning signs and crosswalk markings. Typically, pedestrian crossing warning signs are placed on the left and right sides of the road at the crossing. Placing advanced stop bars are optional. It is important to remember that RRFB's have limited available research on their effectiveness on crashes so they should be used where other more proven countermeasures have shown to not be effective.

On the State Highway System, RRFB's and marked crosswalks at uncontrolled locations require State Traffic Engineer approval

Note: To accommodate large vehicles on State Highways, the pedestrian median curb may need to have a mountable outside edge. When the outside edge is designed as mountable, additional delineation might be needed to make the median more visible. **Refer** to ODOT's Standard Drawings and Details for design guidance and the Traffic Line Manual for guidance on delineation.

ODOT CRF Value:

10%

Reduction in **Pedestrian Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

10% - 56%

Safety Effects:

RRFB's can enhance safety by reducing crashes between vehicles and pedestrians by increasing driver awareness of potential pedestrian conflicts.

References:

Engineering Judgement

[Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments \(NCHRP Report 841\)](#)

BP10: Install Rectangular Rapid Flashing Beacon without Median (3-Lane or More Roadway)

Description: Rectangular Rapid Flash Beacons (RRFBs) are user-actuated amber Light Emitting Diodes (LEDs) that supplement warning signs at unsignalized intersections or mid-block crosswalks. The signals rest in the dark phase until activated by a push button and then flash in a rapid stutter flash pattern.



Image from Google

Applications: On multi-lane roads where crash data indicates a need to provide additional notification to motorists of the presence of crossing pedestrians or where there are insufficient gaps in vehicle traffic to provide a pedestrian a crossing opportunity.

Considerations: It may be important to provide educational outreach to the community on safe use of RRFB's. There are instances where pedestrians have been shown to blindly trust that vehicles will immediately yield to them once they activate the RRFB. Their failure to check for oncoming traffic can result in a pedestrian crash regardless of the presence of an RRFB.

Special Conditions: RRFB's are meant to supplement standard pedestrian crossing warning signs and crosswalk markings. Typically, pedestrian crossing warning signs are placed on the left and right sides of the road at the crossing. Placing advanced stop bars highly recommended on multi-lane facilities. It is important to remember that RRFB's have limited available research on their effectiveness on crashes so they should be used where other more proven countermeasures have shown to not be effective.***On the State Highway System, RRFB's and marked crosswalks at uncontrolled locations require State Traffic Engineer approval***

Note: To accommodate large vehicles on State Highways, the pedestrian median curb may need to have a mountable outside edge. When the outside edge is

ODOT CRF Value:

10%

Reduction in **Pedestrian and Bicycle Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

10%

Safety Effects:

RRFB's can enhance safety by reducing crashes between vehicles and pedestrians by increasing driver awareness of potential pedestrian conflicts.

References:

Engineering Judgement

[Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments \(NCHRP Report 841\)](#)

designed as mountable, additional delineation might be needed to make the median more visible. **Refer** to ODOT's Standard Drawings and Details for design guidance and the Traffic Line Manual for guidance on delineation.

BP11: Install Rectangular Rapid Flashing Beacon with Median (3-Lane or More Roadway)

Description: Rectangular Rapid Flash Beacons (RRFBs) are user-actuated amber Light Emitting Diodes (LEDs) that supplement warning signs at unsignalized intersections or mid-block crosswalks. The signals rest in the dark phase until activated by a push button and then flash in a rapid stutter flash pattern. **This countermeasure includes installation of a pedestrian refuge island in addition to the RRFB.**



Image from Washington County (OR)

Applications: On multi-lane roads where crash data indicates a need to provide additional notification to motorists of the presence of crossing pedestrians or where there are insufficient gaps in vehicle traffic to provide a pedestrian a crossing opportunity.

Considerations: If placed at an intersection with designated left turn lanes, a pedestrian refuge island will impact left turning movements. It may be important to provide educational outreach to the community on safe use of RRFB's. There are instances where pedestrians have been shown to blindly trust that vehicles will immediately yield to them once they activate the RRFB. Their failure to check for oncoming traffic can result in a pedestrian crash regardless of the presence of an RRFB. It is important to provide sufficient pavement width to accommodate the largest size of vehicles expected to travel on the road in question.

Special Conditions: This countermeasure is highly encouraged on higher speed facilities. RRFB's are meant to supplement standard pedestrian crossing warning signs and crosswalk markings. Typically, pedestrian crossing warning signs are placed on the left and right sides of the road at the crossing. Placing an RRFB in the pedestrian refuge island and advanced stop bars are highly recommended on multi-lane facilities. It is important to remember that RRFB's alone have limited available research on their effectiveness on

ODOT CRF Value:

56%

Reduction in **Pedestrian Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

10% - 56%

Safety Effects:

RRFB's with a pedestrian refuge island, allow pedestrians to more safely make a two-stage crossing by having to only look for a gap in one direction of traffic at a time while being protected by a concrete curbed island.

References:

Engineering Judgement

[Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments \(NCHRP Report 841\)](#)

crashes so they should be used where other more proven countermeasures have shown to not be effective or in combination with more proven countermeasures. ***On the State Highway System, RRFB's and marked crosswalks at uncontrolled locations require State Traffic Engineer approval***

Note: To accommodate large vehicles on State Highways, the pedestrian median curb may need to have a mountable outside edge. When the outside edge is designed as mountable, additional delineation might be needed to make the median more visible. **Refer** to ODOT's Standard Drawings and Details for design guidance and the Traffic Line Manual for guidance on delineation.

BP12: Install Pedestrian Activated Beacon at Intersection

Description: A pedestrian activated warning device located at roadside pedestrian intersection crossings. Pedestrian activated beacons are similar to rectangular rapid flashing beacons (RRFBs).



Image from NCHRP

Applications: On multi-lane roads where crash data indicates a need to provide additional notification to motorists of the presence of crossing pedestrians or where there are insufficient gaps in vehicle traffic to provide a pedestrian a crossing opportunity.

Considerations: Educational outreach to the community on safe use of pedestrian activated beacons may be needed. Pedestrians' failure to check for oncoming traffic and blindly trusting that vehicles will yield to them once they activate the beacon can result in a pedestrian crash even in the presence of a pedestrian activated beacon.

Special Conditions: Pedestrian activated beacons have limited available research on their effectiveness on crashes so they should be used where other more proven countermeasures have shown to not be effective or in combination with more proven countermeasures.

Note: To accommodate large vehicles on State Highways, the pedestrian median curb may need to have a mountable outside edge. When the outside edge is designed as mountable, additional delineation might be needed to make the median more visible. **Refer** to ODOT's Standard Drawings and Details for design guidance and the Traffic Line Manual for guidance on delineation.

ODOT CRF Value:

10%

Reduction in **Pedestrian Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

10% - 56%

Safety Effects:

Pedestrian activated beacons at intersections can enhance safety by reducing crashes between vehicles and pedestrians/bicyclists by increasing driver awareness of potential pedestrian conflicts.

References:

Engineering Judgement

[Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments \(NCHRP Report 841\)](#)

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BP13: Install Pedestrian Activated Beacon Midblock

Description: A pedestrian activated warning device located at roadside pedestrian crossings. A flashing beacon that is activated by a pedestrian at midblock locations.



Midblock
pedestrian
crossing - Image
from FHWA

Applications: On multi-lane roads where crash data indicates a need to provide additional notification to motorists of the presence of crossing pedestrians or where there are insufficient gaps in vehicle traffic to provide a pedestrian a crossing opportunity.

Considerations: Educational outreach to the community on safe use of pedestrian activated beacons may be needed. Pedestrians' failure to check for oncoming traffic and blindly trusting that vehicles will yield to them once they activate the beacon can result in a pedestrian crash even in the presence of a pedestrian activated beacon.

Special Conditions: This type of treatment is most commonly used on unsignalized urban streets with heavy traffic, where the gaps available for pedestrians to cross the street are inadequate. Pedestrian activated beacons have limited available research on their effectiveness on crashes so they should be used where other more proven countermeasures have shown to not be effective or in combination with more proven countermeasures.

Note: To accommodate large vehicles on State Highways, the pedestrian median curb may need to have a mountable outside edge. When the outside edge is designed as mountable, additional delineation might be needed to make the median more visible. **Refer** to ODOT's Standard Drawings and Details for design guidance and the Traffic Line Manual for guidance on delineation.

ODOT CRF Value:

10%

Reduction in **Pedestrian and
Bicycle Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

10%

Safety Effects:

Pedestrian activated beacons at a midblock can enhance safety by reducing crashes between vehicles and pedestrians by increasing driver awareness of potential pedestrian conflicts.

References:

Engineering Judgement

[Development of Crash
Modification Factors for
Uncontrolled Pedestrian
Crossing Treatments
\(NCHRP Report 841\)](#)

BP14: Install Pedestrian Activated Beacon (Flashing Beacon in Conjunction with Median and Stop Bar)

Description: A pedestrian activated warning device located at roadside pedestrian crossings. This countermeasure involves a flashing beacon that will flash when activated by the pedestrian, a median located at the crosswalk to provide a pedestrian refuge area, and stop bars provided as white lines on the pavement surface to indicate where a vehicle must stop when the pedestrian beacon is activated.

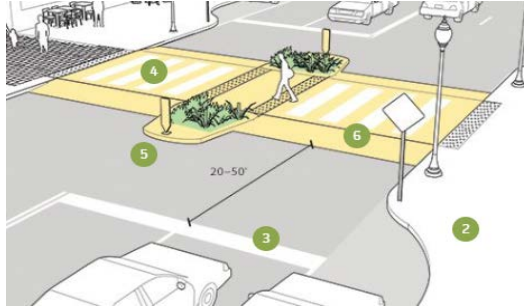


Image from NACTO

Applications: On multi-lane roads where crash data indicates a need to provide additional notification to motorists of the presence of crossing pedestrians or where there are insufficient gaps in vehicle traffic to provide a pedestrian a crossing opportunity.

Considerations: Educational outreach to the community on safe use of pedestrian activated beacons may be needed. Pedestrians' failure to check for oncoming traffic and blindly trusting that vehicles will yield to them once they activate the beacon can result in a pedestrian crash even in the presence of a pedestrian activated beacon.

Special Conditions: Pedestrian activated beacons in conjunction with raised medians and stop bars have limited available research on their effectiveness on crashes so they should be used where other more proven countermeasures have shown to not be effective or in combination with more proven countermeasures.

Note: To accommodate large vehicles on State Highways, the pedestrian median curb may need to have a mountable outside edge. When the outside edge is designed as mountable, additional delineation might be needed to make the median more visible. **Refer** to ODOT's Standard Drawings and Details for design guidance and the Traffic Line Manual for guidance on delineation.

ODOT CRF Value:

56%

**Reduction in Pedestrian and
Bicycle Crashes
at All Severities
(Including PDO's)**

Range of Effectiveness:

56%

Safety Effects:

Pedestrian activated beacons in conjunction with a median and stop bar enhance safety by reducing crashes between vehicles and pedestrians by increasing driver awareness of potential pedestrian conflicts

References:

Engineering Judgement

[Development of Crash
Modification Factors for
Uncontrolled Pedestrian
Crossing Treatments
\(NCHRP Report 841\)](#)

**FHWA Proven Safety
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BP15: Install Continental Crosswalk Markings and Advance Pedestrian Warning Signs at Uncontrolled Locations

Description: A crosswalk is a location where the pedestrian leaves the sidewalk and enters the roadway and the pedestrian's path of travel crosses the motorist's path of travel. Marked crosswalks use pavement markings to indicate optimal or preferred locations for pedestrians to cross and help designate right-of-way for motorists to yield to pedestrians.



Image from Google

Applications: Where you have a higher than expected frequency of pedestrian crashes or vehicles crashes caused by pedestrians.

Considerations: Pedestrians are sensitive to out-of-the-way travel, and reasonable accommodation should be made to make crossings both convenient and safe at locations with adequate visibility. Too many and unnecessary marked crosswalks on a segment of road has a high potential to result in driver complacency and reduced yielding compliance.

Special Conditions: This countermeasure can be applied at intersections or midblock locations. It is important to remember that all intersections are legal pedestrian crossings in Oregon, regardless if they are marked or not. Advanced stop bars are REQUIRED in multi-lane sections. Consider marking a crosswalk at non-signalized locations where engineering judgment dictates that the number of motor vehicle lanes, pedestrian exposure, average daily traffic (ADT), posted speed limit, and geometry of the location would make the use of specially designated crosswalks desirable for traffic/pedestrian safety and mobility. Marked crosswalks alone (i.e., without traffic-calming treatments, traffic signals and pedestrian signals when warranted, or other substantial crossing improvement) are insufficient and should not be used under the following conditions:

ODOT CRF Value:

15%

Reduction in **Pedestrian Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

15%

Safety Effects:

Crosswalks help call attention to pedestrians crossing a road and provide a defined location in which to do so.

References:

[Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections \(FHWA-SA-09-020\)](#)

Oregon Department of Transportation

- Where the speed limit exceeds 40 mph
- On a roadway with four or more lanes without a raised median or crossing island that has (or will soon have) an ADT of 12,000 or greater
- On a roadway with four or more lanes with a raised median or crossing island that has (or soon will have) an ADT of 15,000 or greater

For additional guidance, please refer to FHWA's Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations.

On the State Highway System, marked crosswalks at uncontrolled locations require State Traffic Engineer approval

BP16: Install Curb Ramps and Extensions with a Marked Crosswalk and Pedestrian Warning Signs

Description: Curb extensions (also known as bulb-outs) extend the sidewalk or curb line out into the parking lane, which reduces the effective street width.

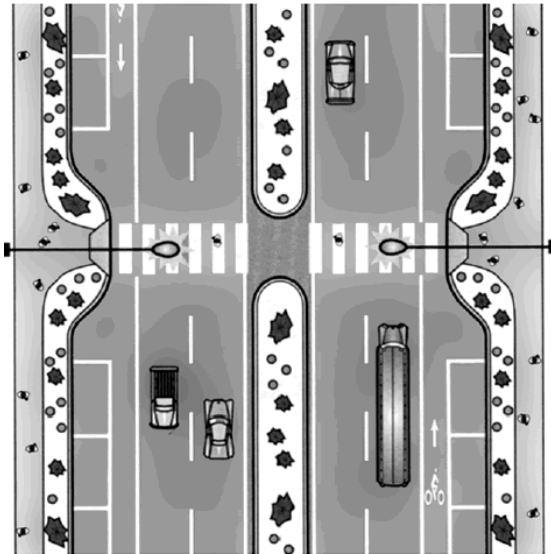


Image from FHWA

Applications: Where you have a higher than expected frequency of pedestrian crashes or vehicles crashes caused by pedestrians that could be reduced by minimizing the crossing distance and maximizing the visibility of pedestrians.

Considerations: It is important to provide sufficient pavement width to accommodate the largest size of vehicles expected to travel on the road in question. The new curb line should not encroach the traveled way where bicyclists or motor vehicles may be traveling either.

Special Conditions: This countermeasure can be used at intersections or midblock locations. Curb extensions should typically be used where there is a parking lane and where transit and cyclists will be traveling outside the curb edge for the length of the street. ***On the State Highway System, marked crosswalks at uncontrolled locations require State Traffic Engineer approval***

ODOT CRF Value:

37%

Reduction in **Pedestrian Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

37%

Safety Effects:

Curb extensions significantly improve pedestrian crossings by reducing the pedestrian crossing distance, improving the ability of pedestrians and motorists to see each other, and reducing the time that pedestrians are in the street.

References:

[Desktop Reference for Crash Reduction Factors \(FHWA-SA-08-011\)](#)

BP17: Install Advance Pedestrian or Bicycle Warning Signs

Description: Yellow warning symbol signs with appropriate supplemental plaques warning of pedestrian and/or bicycles (W11-1, W11-2, W11-15) potentially crossing the road.



Image from Google

Applications: Where crash data indicates a need to provide additional notification to motorists of the presence of crossing pedestrians and/or bicyclists.

Considerations: These signs should be reserved for use in locations that have shown a need through crash data to avoid sign clutter and driver complacency.

Special Conditions: The combined Bicycle/Pedestrian (W11-15) sign may be used where both bicyclists and pedestrians might be crossing the roadway, such as at an intersection with a shared-use path. Please refer to the 2009 MUTCD for additional guidance on placement of these signs and the appropriate supplemental plaques that should be included.

This countermeasure cannot be used with any of the marked crosswalk countermeasures as signs are already included in those countermeasures

ODOT CRF Value:

5%

Reduction in **Pedestrian and Bicycle Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

5% - 15%

Safety Effects:

It warns motorists of locations where unexpected entries into the roadway by pedestrians and/or bicycles might occur.

References:

[Desktop Reference for Crash Reduction Factors \(FHWA-SA-08-011\)](#)

BP18: Install Pedestrian Signal

Description: Traffic Signals are a traffic control device positioned on roadways to efficiently control and manage competing flows of traffic (vehicles, pedestrians and/or bicycles). A Pedestrian Signal controls the flow of traffic and provides sufficient time for safe and efficient pedestrian and/or bicycle crossings.



Image from Google

Applications: Where you have a higher than expected frequency of pedestrian/bicycle crashes or vehicle crashes caused by pedestrians/bicycles and other less aggressive countermeasures have been proven to be ineffective.

Considerations: There should be discussions on which type of pedestrian activated traffic control device is the most appropriate countermeasure for the identified problem. Inappropriate placement of a Pedestrian Signal could result in an increase in vehicle crashes and a decrease in compliance from either vehicles or pedestrians.

Special Conditions: Pedestrian signals are appropriate where it is difficult to find a gap in traffic to make a crossing and there are a significant number of pedestrians wanting to cross at a particular location.

A pedestrian signal is warranted by MUTCD Warrant #4. State Traffic Engineer Approval and warrant analysis is REQUIRED for all potential signal installations on the State Highway.

ODOT CRF Value:

55%

Reduction in Pedestrian and Bicycle Crashes at All Severities (Including PDO's)

Range of Effectiveness:

15% - 69%

Safety Effects:

It warns motorists of locations where unexpected entries into the roadway by pedestrians and/or bicycles might occur.

References:

[Desktop Reference for Crash Reduction Factors \(FHWA-SA-08-011\)](#)

BP19: Install Pedestrian Hybrid Beacon

Description:

The pedestrian hybrid beacon (PHB) - also known as the High intensity Activated crosswalk (or HAWK) - is a pedestrian-activated warning device located on the roadside or on mast arms over midblock pedestrian crossings. The



Image from FHWA

The beacon head consists of two red lenses above a single yellow lens. The beacon head is "dark" until the pedestrian desires to cross the street. When activated it displays a brief flashing and steady yellow intervals followed by a steady red indication to drivers and a "WALK" indication to pedestrians.

Applications: Where you have a higher than expected frequency of pedestrian/bicycle crashes or vehicle crashes caused by pedestrians/bicycles and other less aggressive countermeasures have been proven to be ineffective. This treatment may be used at locations with a high number of pedestrian crashes where additional visibility of pedestrian crossings is needed.

Considerations: There should be discussions on which type of pedestrian activated traffic control device is the most appropriate countermeasure for the identified problem. Inappropriate placement of a PHB could result in an increase in vehicle crashes and a decrease in compliance from either vehicles or pedestrians. Since the pedestrian hybrid beacon is an unfamiliar traffic control device (for many people), effort should be made to perform outreach to the public before implementation so there is no confusion about how the beacon operates and what drivers and pedestrians should do when encountering it.

Special Conditions: In general, PHB's should be used if gaps in traffic are not adequate to permit pedestrians to cross, if vehicle speeds on the major street are too high to permit pedestrians to cross, or if pedestrian delay is excessive. Hybrid beacons may be used at locations with lower volumes than what is required for a pedestrian signal.

ODOT CRF Value:

55%

Reduction in **Pedestrian and Bicycle Crashes at All Severities** (Including PDO's)

Range of Effectiveness:

55% - 69%

Safety Effects:

It displays a red indication to drivers when activated, which creates a gap for pedestrians to cross a major roadway. They provide positive guidance to pedestrians regarding the permitted signal interval to cross a street and prohibit pedestrian crossings when conflicting traffic may impact pedestrian safety.

References:

[CMF Clearinghouse ID: 9020](#)

[NCHRP 926](#)

[Safety Effectiveness of the HAWK Pedestrian Crossing Treatment \(FHWA-HRT-10-042\)](#)

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The MUTCD guidance for the placement of PHB's should be reviewed as installation of this treatment is considered. State Traffic Engineer Approval is REQUIRED for all PHB installations on the State Highway.

BP20: Convert 4-Lane Roadway to 3-Lane Roadway with Center Turn Lane (Road Diet)

Description: A road diet involves converting an undivided four-lane roadway into three lanes consisting of two through lanes and a center two-way left turn lane (TWLTL).



Image from FHWA

Applications: Where you have a high frequency of the following crash types: rear-end crashes from left turns, sideswipe overtaking, left turning crashes, and multiple-threat pedestrian crashes from a vehicle stopped for a pedestrian, blocking the view of the driver in the adjacent lane. Typical candidate four-lane roadways have 20,000 ADT or less.

Considerations: The most common concern with proposed road diets is the potential increase in traffic delays during peak periods. It is important to involve stakeholders during the very early stages of a road diet discussion to ensure the best solution for all users.

Special Conditions: The reduction of lanes in a road diet allows for the roadway to be reallocated for other uses such as bike lanes, pedestrian crossing islands and/or parking. Road diets can be low cost if planned in conjunction with reconstruction or simple overlay projects since a road diet mostly consists of restriping.

ODOT CRF Value:

29%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

29%

Safety Effects:

Reducing the number of through lanes and providing a TWLTL addresses crashes by (1) separating left-turning traffic from through traffic, (2) reducing the number of oncoming lanes through which a left-turning driver must search for a gap, and (3) removing the multiple-threat situation because there is no longer an adjacent lane. Road diets can decrease other incidents by providing designated spaces -- sidewalks and bicycle lanes -- that reduce opportunities for conflicts between motor vehicles and other road users.

References:

Highway Safety Manual
[NCHRP Report 617](#)

**FHWA Proven Safety
Countermeasure**

BP21: Install Bike Signal

Description: A bicycle signal face provided at a signalized intersection exclusively for bicycle use. Steady and flashing red, yellow and green bicycle signal indications shall have the same meanings as described in the 2009 MUTCD for steady and flashing circular red, yellow and green signal indications for motor vehicles.



Image from J. Maus

Attachment IA-16-1 Typical Arrangements of Signal Sections in Bicycle Signal Faces

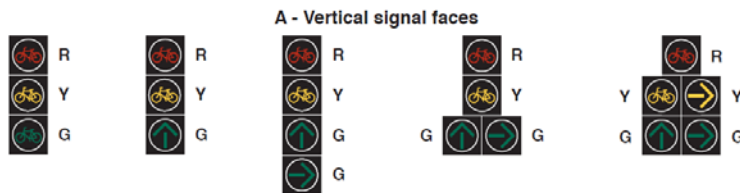


Image from MUTCD

Applications: At a signalized intersection where there is a higher frequency of bicycle crashes that could be mitigated with an exclusive bicycle signal phase.

Considerations: Where passive detection is used, it is important to consider the type of bicycle detection that will be the most appropriate for the location in question. On older signals there may be conduit capacity issues and structural issues related to where you need to mount the signal head(s).

Special Conditions: Bicycle signals are appropriate where conflicts between turning vehicles and bicycles occur enough to warrant exclusive bicycle phasing. Where the potential exists for a conflict between the bicycle phase and vehicles turning right on a red indication, it is required to prohibit right turn vehicle movements on red.

*For more guidance on installing bike signals, please refer to the ODOT Signal Policy and Guidelines and the MUTCD Interim Approval Memo for Bike Signals. The MUTCD interim approval for the placement of bicycle signals should be reviewed as installation of this treatment is considered. State Traffic Engineer Approval and warrant analysis is REQUIRED for all potential signal installations on the State Highway.

ODOT CRF Value:

45%

Reduction in **Bicycle Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

45%

Safety Effects:

A bike signal provides a separate phase for bicycles and minimizes potential vehicle to bicycle right of way conflicts.

References:

[Interim Approval for
Optional Use of a Bicycle
Signal Face \(IA-16\)](#)

BP22: Install Bike Lanes

Description: Bike lanes are defined as a portion of the roadway that has been designated by signing and pavement marking for the preferential or exclusive use by bicyclists. Typically, there is one bike lane provided on each side of the roadway and travels in the same direction as the motorized vehicle lane.



Image from FHWA

Applications: Where you have a high frequency of bicycle crashes particularly where there is a high volume of bicycle traffic along a corridor, such as known or designated bicycle routes.

Considerations: This countermeasure can be costly depending on right of way acquisition needs and drainage impacts. It is important to provide adequate space between the bike lane and parked cars so that open doors do not create a hazard for bicyclists and to avoid termination of bike lanes where bicyclists are left in a vulnerable situation.

Special Conditions: For more guidance on bike lanes and their design standards, please refer to the AASHTO Guide for the Development of Bicycle Facilities, the Oregon Bicycle and Pedestrian Design Guide and Section 9C.04 of the Oregon Supplement to the MUTCD.

ODOT CRF Value:

36%

Reduction in **Bicycle Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

0% - 53%

Safety Effects:

Bicycle lanes make the movements of both motorists and bicyclists more predictable and provide a consistent separation between bicyclists and passing motorists.

References:

[Desktop Reference for Crash Reduction Factors \(FHWA-SA-08-011\)](#)

BP23: Install Cycle Tracks

Description: A bike lane (one- or two-way) with a physical barrier between the bike and motor vehicle travel lanes, such as a curb or parking lanes.



Image from City of Portland

Applications: Where bicycle crash data indicates a need to provide additional separation between bicycles and vehicles (parked or moving).

Considerations: This countermeasure can be costly depending on right of way acquisition needs and drainage impacts. Can also pose a crash risk at intersections where turning vehicles cannot see bicyclists emerging from behind parked cars or standing pedestrians.

Special Conditions: For more guidance, please refer to the Oregon Bicycle and Pedestrian Design Guide and the NACTO Urban Bikeway Design Guide.

ODOT CRF Value:

59%

Reduction in
Bicycle Crashes
at **All Injury Severities**
(Excluding PDO's)

Range of Effectiveness:

59% - 74%

Safety Effects:

Provides a dedicated and protected space for bicyclists from vehicles and reduces the risk of a parked car opening their door in the path of a bicyclist.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 4102\)](#)

BP24: Install Buffered Bike Lanes

Description: A conventional bike lane with an adjacent buffer space (painted median) separating the bicycle lane from the vehicle travel lane and/or adjacent parking lane.

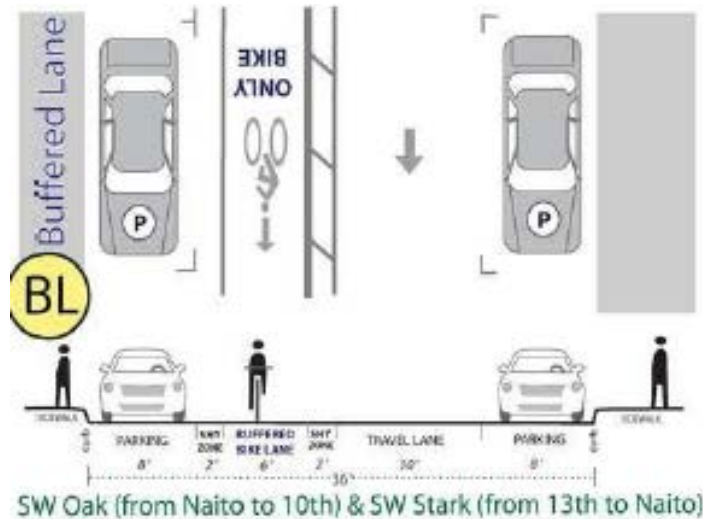


Image from City of Portland

Applications: Where bicycle crash data indicates a need to provide additional separation between bicycles and vehicles (parked or moving).

Considerations: This countermeasure can be costly depending on right of way acquisition needs and drainage impacts.

Special Conditions: For more guidance, please refer to the Oregon Bicycle and Pedestrian Design Guide and the NACTO Urban Bikeway Design Guide.

ODOT CRF Value:

47%

Reduction in **Bicycle Crashes**
at **All Injury Severities**
(Excluding PDO's)

Range of Effectiveness:

N/A

Safety Effects:

Provides a larger separation between bicyclists and motorists in the adjacent travel lane. It also provides more space for bicyclists to maneuver around a parked car with their door open.

References:

Engineering Judgement

BP25: Prohibit Right-Turn-On-Red

Description: A sign indicating that a vehicle should not make a right turn when the signal is red.



Image from Google

Applications: At signalized intersections with a high frequency of crashes as a result of vehicles turning right and where there are high pedestrian volumes and inadequate sight distances.

Considerations: Prohibiting right-turn-on-red may lead to higher right-turn-on green conflicts when there are concurrent signals. Signs should also be clearly visible to drivers. May require structural analysis to assess wind loading created by the addition of the sign to the signal mast arm.

Special Conditions: At intersections experiencing high pedestrian volumes, prohibiting right-turn-on-red along with a leading pedestrian interval could provide additional safety benefits for pedestrians. Where a right-turn-on-red restriction is needed during certain times of the day, a part-time or variable message no-turn-on-red sign could be used.

ODOT CRF Value:

41%

Reduction in **Pedestrian and Bicycle Crashes** at **All Severities** (Including PDO's)

Range of Effectiveness:

26% - 44%

Safety Effects:

Prohibiting vehicles from turning right on red can improve safety at intersections with limited sight distances and could reduce conflicts between right turning vehicles and pedestrians.

References:

Highway Safety Manual

BP26: Advanced Yield and Stop Markings & Signs

Description: Markings and signs placed in advance of marked crosswalks to indicate where vehicles should yield or stop for pedestrians.

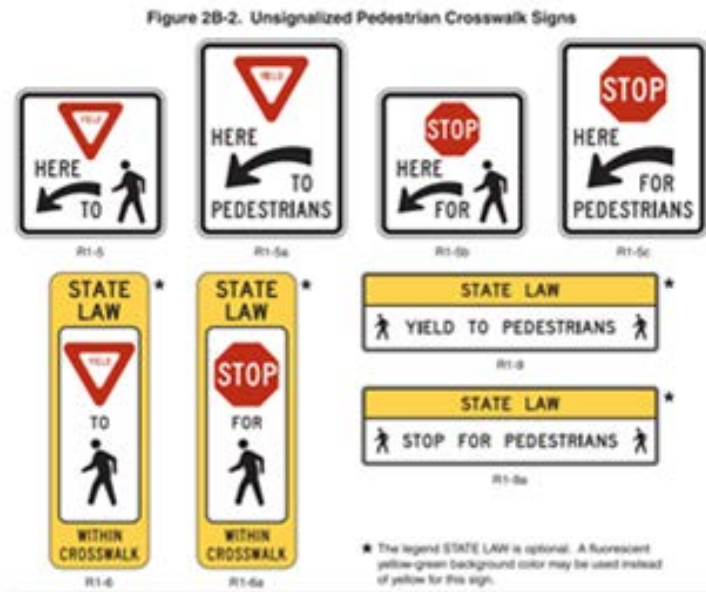


Image from Pedbikesafe

Applications: Where you have a high frequency of vehicle-pedestrian crashes along roadways or at unsignalized intersections.

Considerations: Effectiveness of advanced yield and stop markings & signs depends on motorists' compliance with the markings and signs. Placement location of these marking and signs should be taken into consideration as motorists may ignore them if they are placed too far away from a pedestrian crosswalk.

Special Conditions: This countermeasure can greatly reduce crashes at unsignalized midblock crossings.

ODOT CRF Value:

25%

Reduction in Pedestrian and Bicycle Crashes at All Severities (Including PDO's)

Range of Effectiveness:

25%

Safety Effects:

Advanced yield and stop markings & signs improve the visibility of pedestrians therefore reducing crashes between vehicles and pedestrians. Discourages drivers from stopping too close to crosswalks and blocking other drivers' view of pedestrians. Pedestrians can see if a vehicle is stopping or not to take appropriate action.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 9017\)](#)

BP27: Install Bicycle Boulevard

Description: Bicycle boulevards are designated areas for use by bicyclists. Side streets that are signed and improved.



Image from City of Berkeley

Applications: Where you have a high frequency of vehicle-bicycle crashes along roadways.

Considerations: May require an additional paved surface to provide space for pedestrian sidewalks. Development of bicycle boulevards in rural areas may be difficult due to lack of alternate through roadways and amount of traffic on the roadway.

Special Conditions: For additional guidance, please refer to the Oregon Bicycle and Pedestrian Design Guide and the NACTO Urban Bikeway Design Guide.

ODOT CRF Value:

63%

Reduction in **Pedestrian and Bicycle Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

63%

Safety Effects:

Properly implemented bicycle boulevards provide bicyclists with a safer alternative to riding on arterial streets and reduce vehicle-bicycle collisions.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 3092\)](#)

[Cyclist Safety on Bicycle Boulevards and Parallel Arterial Routes in Berkeley, California](#)

BP28: Install Raised Crosswalk

Description: Raised crosswalks are the same height as the sidewalk they connect with and span the width of the roadway.



Image from FHWA

Applications: Where you have a high frequency of pedestrian and bicycle crashes due to vehicles traveling too fast which causes a decrease in motorists' reaction time.

Considerations: Typically installed on 2-lane or 3-lane roads with low speed limits (less than 30mph) and an average AADT below 9000. Should not be used on arterial streets, truck routes, or emergency routes. With larger vehicles, this countermeasure can cause noise and because of this, public buy-in may be needed. Drainage may also pose problems and should be considered.

Special Conditions: Raised crosswalks are often placed at midblock crossing locations.

ODOT CRF Value:

30%

Reduction in **Pedestrian and Bicycle Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

30%

Safety Effects:

Raised crosswalks provide improved visibility of pedestrians to drivers and reduces vehicle speeds therefore reducing collisions. Raised crosswalks create a safer pedestrian crossing environment.

References:

[Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes \(FHWA-SA-014\)](#)

BP29: Add Sidewalk

Description: A sidewalk is a paved path, located along roadways, designated for use by pedestrians. Sidewalks are usually raised and can be separated from roads by curbs and/or planting strips or swales.



Source: pedbikeimages.org / Burden

Applications: Where there is a higher than expected frequency of pedestrian crashes or vehicle crashes caused by pedestrians walking along a roadway.

Considerations: Consider sidewalks as a treatment for accommodating pedestrians along heavily traveled corridors where frequent pedestrian use is expected. Sidewalk furnishings can also be implemented to provide additional buffering between pedestrians and vehicles. Sidewalk designs should meet and follow ADA guidelines.

Special Conditions: This countermeasure is only applicable to crashes involving pedestrians walking along a roadway, not crossing. For further guidance and standards, refer to the Oregon Bicycle and Pedestrian Design Guide.

ODOT CRF Value:

20%

Reduction in
Pedestrian – walking along
Crashes at All Severities
(Including PDO's)

Range of Effectiveness:

20%

Safety Effects:

Sidewalks provide refuge for pedestrians and create a safer walking environment away from traffic. Sidewalks help improve roadway operations, safety, and mobility.

References:

ODOT Engineering
Judgement

**FHWA Proven Safety
Countermeasure**

BP30: Install Speed Humps/Table (Not on State Highways)

Description: A speed hump is a raised area (normally 3 to 4 inches in height) in the roadway pavement surface extending transversely across the roadway.



Image from NACTO

Applications: In residential areas or on low-speed local streets where speeding carries a heightened risk for crashes.

Considerations: Adequate signing and marking of each speed hump is essential to warn roadway drivers that speed humps are present.

Special Conditions: This countermeasure CRF is specific to installing speed humps on low-speed urban roadways.

ODOT CRF Value:

15%

Reduction in **Pedestrian and Bicycle Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

15%

Safety Effects:

Speed humps are effective at reducing traffic speeds by forcing drivers to slow down and increase driver awareness.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 145\)](#)

BP31: Add Street Tree's (supports blueprint for Urban Design)

Description: The addition of street trees along a roadway commonly placed adjacent to sidewalks, curb edges, or within roadway medians.



Image from Google

Applications: Along roadways with a frequency of crashes related to vehicle speed, where speed is a contributor to pedestrian and bicycle crashes.

Considerations: The placement and spacing of street trees should be considered. Street trees must meet sight distance standards and be carefully placed such that they provide a clear line of sight and do not block street lights or utilities. Proper maintenance of street trees is needed to ensure driver and pedestrian visibility is not obstructed. It is also important to consider crash history. Street trees should not be implemented where there is a history of roadway departure crashes or a potential for these crashes to occur.

Special Conditions: This countermeasure supports ODOT's Blueprint for Urban Design. For further guidance on street tree placement and spacing, refer to the ODOT Highway Design Manual.

ODOT CRF Value:

10%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

10%

Safety Effects:

Street trees provide traffic calming, and when properly placed and spaced, can have a positive influence on safety. Street trees narrow a driver's visual field, providing distinct roadway edges, which help motorists guide their movements and assess their speed. Placement of street trees can also provide separation between motorists and pedestrians, creating a safer walking environment.

References:

Engineering Judgement

RD1: Increase Distance to Rural Roadside Obstacle from 3 ft. (1m) to 16 ft. (5m)

Description: Increasing the clear zone of a roadway by removing obstacles within 16 feet of the roadway.

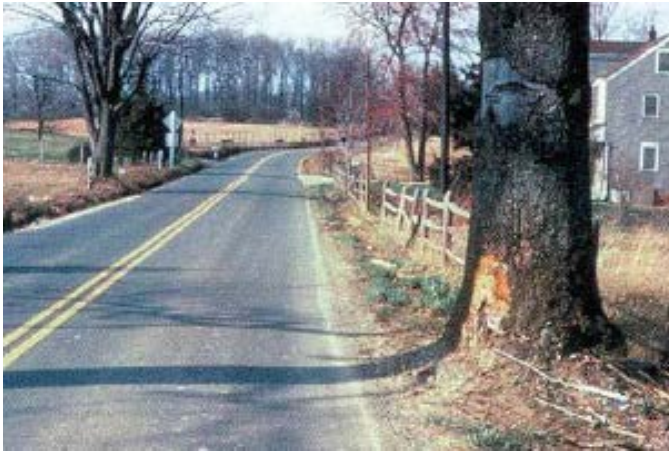


Image from FHWA

Applications: Where you have a high frequency of roadway departure crashes attributed to striking fixed objects, ditches, or other roadside obstacles.

Considerations: Removing objects can be costly and the appropriate easements may be needed to remove objects outside of the agency's right of way.

Special Conditions: This countermeasure only applies to rural areas.

ODOT CRF Value:

22%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

22% - 44%

Safety Effects:

A clear zone is an unobstructed, traversable roadside area that allows a driver to stop safely or regain control of a vehicle that has left the roadway. By increasing the clear zone area, you increase the likelihood that a roadway departure results in a safe recovery rather than a crash.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 35\)](#)

FHWA Proven Safety Countermeasure

RD2: Increase Distance to Rural Roadside Obstacle from 16 ft. (5 m) to 30 ft. (9m)

Description: Increasing the clear zone of a roadway by removing obstacles within 30 feet of the roadway.



Image from FHWA

Applications: Where you have a high frequency of roadway departure crashes attributed to striking fixed objects, ditches, or other roadside obstacles.

Considerations: Removing objects can be costly and the appropriate easements may be needed to remove objects outside of the agency's right of way.

Special Conditions: This countermeasure only applies to rural areas.

ODOT CRF Value:

44%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

22% - 44%

Safety Effects:

A clear zone is an unobstructed, traversable roadside area that allows a driver to stop safely or regain control of a vehicle that has left the roadway. By increasing the clear zone area, you increase the likelihood that a roadway departure results in a safe recovery rather than a crash.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 36\)](#)

FHWA Proven Safety Countermeasure

RD3: Flatten Rural Side Slopes

Description: Flat areas adjacent to the travel way that are sloped to provide drainage and can provide a safe recovery area of vehicles departing their lane.



Image from FHWA

Applications: Where you have a high frequency of overturn crashes that could be mitigated with flattening the side slope (e.g. on the outside of curves with small radii or where the side slope has a slope of greater than 3:1).

Considerations: The provision of flattened side slopes may require erosion mitigation and may have property impacts, requiring extensive right of way acquisition.

Special Conditions: This countermeasure could be applied systemically and could be installed in conjunction with a paving project. This countermeasure could potentially be very costly depending on the type of roadside mitigation needed and the right of way impacts.

Table 13-18. Potential Crash Effects on Total Crashes of Flattening Sideslopes (15)

Treatment	Setting (Road Type)	Traffic Volume	Crash Type (Severity)	CMF			
				Sideslope In Before Condition	Sideslope In After Condition		
					1V:4H	1V:5H	1V:6H
Flatten Sideslopes	Rural (Two-lane road)	Unspecified	All types (Unspecified)	1V:2H	0.94	0.91	0.88
				1V:3H	0.95	0.92	0.89
				1V:4H		0.97	0.93
				1V:5H			0.97
				1V:6H			0.95

Base Condition: Existing sideslope in *before* condition.

NOTE: Standard error of the CMF is unknown.

ODOT CRF Value:

See Table

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

3% - 15%

Safety Effects:

By reducing the amount of road side slope, vehicles are better able to recover after leaving the travel way. The flatter the slope, the more traversable the side slope becomes.

References:

Highway Safety Manual

**FHWA Proven Safety
Countermeasure**

RD4: Increase Pavement Friction by Installing High Friction Surface Treatment - Intersection or Segment Application

Description: Pavement surfacing systems with exceptional skid-resistant properties not typically provided by conventional materials.



Images from FHWA

Applications: In locations where you have frequent crashes where insufficient friction is a contributing factor (i.e. wet weather). These are generally locations where drivers are braking excessively; for example, when going around curves or ramps, down hills or steep grades, or when approaching an intersection. The road surface can become prematurely polished, reducing the pavement friction and allowing vehicles to skid or hydroplane.

Considerations: It is costly to install and could be costly to maintain so it's important to reserve this treatment for the most needed locations. It is important to closely follow the manufacturer's installation instructions in order to reduce any chances of product failure. For more information on High Friction Surface Treatment, please refer to the FHWA website. They have provided many informational materials on the subject.

Special Conditions: There is some concern over the effect of the treatment on motorcyclists if they were to crash so use caution if you have a history of motorcycle crashes at the location you are looking to install the treatment. This treatment can be an intersection or segment application.

ODOT CRF Value:

57%

Reduction in **Wet Road Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

20% - 68%

Safety Effects:

It uses aggregates that are both polish- and wear-resistant and develop channels to prevent water buildup on wet surfaces creating an exceptionally durable surface capable of withstanding extreme roadway friction demands.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 195\)](#)

FHWA Proven Safety Countermeasure

RD5: Provide Safety Edge for Rural Pavement Edge Drop-Off

Description: Safety edge is a pavement edge sloped at an angle (30-35 degrees) to make it easier for a driver to safely reenter the roadway after inadvertently driving onto the shoulder.



Image from FHWA

Applications: It should be installed at locations where there is a high frequency of vehicle pavement edge drop-offs, particularly on rural roads with unpaved shoulders.

Considerations: Installing the Safety Edge during the paving process is critical to achieving a durable pavement edge. Vegetation near the roadbed will need to be cleared for the machine needed to install safety edge.

Special Conditions: This countermeasure can only be applied in combination with a paving project. It should be applied systemically and should be generally considered on all paving projects.

ODOT CRF Value:

6%

Reduction in **All Crashes** at
All Severities
(Including PDO's)

Range of Effectiveness:

5-15%

Safety Effects:

It minimizes pavement drop-off crashes by providing a more manageable recovery area for vehicles departing their travel lane.

References:

Crash Modification Factors
Clearinghouse

**FHWA Proven Safety
Countermeasure**

RD6: Install RECOMMENDED Chevron Signs on Rural Horizontal Curves

Description: The chevron alignment sign (W1-8) defines a change in horizontal alignment of a roadway. The signs show the shape and degree of curvature and help to guide drivers through the curve or turn. This countermeasure applies to installing chevrons where the MUTCD only RECOMMENDS their installation.



Images from MUTCD

Applications: Chevrons shall be installed per the MUTCD guidelines. Where chevrons are not required, they should be installed at any curve or turn with a history of roadway departure crashes. They can be installed at locations where no chevrons currently exist, or to supplement chevrons that are already in place.

Considerations: There may not be enough spacing to place a sufficient amount of chevrons around a curve or turn. Where engineering judgment determines the need, large turn arrow(s) can be used in place of chevrons. This is consistent with MUTCD guidance.

Special Conditions: The historic standard of practice for installing a large arrow is limited to locations with sharper curves or turns. One primary benefit of installing chevrons over one large arrow is that if one chevron in a set is displaced in a crash or other event, the other chevrons would still provide guidance around a curve until the chevron could be replaced. The displacement of one large arrow does not provide this benefit.

ODOT CRF Value:

16%

Reduction in **Run of the Road Crashes at All Injury Severities**
(Excluding PDO's)

Range of Effectiveness:

4% - 25%

Safety Effects:

Chevrons help to delineate an upcoming curve, helping drivers to be aware of the presence of an approaching curve and help navigate their path.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 2438\)](#)

FHWA Proven Safety Countermeasure

RD7: Install REQUIRED Chevron Signs on Rural Horizontal Curves (Ballbanking and Revised Speed Riders Included)

Description: The chevron alignment sign (W1-8) defines a change in horizontal alignment of a roadway. The signs show the shape and degree of curvature and help to guide drivers through the curve or turn. This countermeasure applies to installing chevrons where the MUTCD REQUIRES their installation. This countermeasure includes ballbanking to the 2009 MUTCD standard and replacing speed riders where appropriate.



Images from MUTCD

Applications: Chevrons shall be installed per the MUTCD guidelines. They should be installed at any curve or turn with a history of roadway departure crashes. They can be installed at locations where no chevrons currently exist, or to supplement chevrons that are already in place.

Considerations: There may not be enough spacing to place a sufficient amount of chevrons around a curve or turn. Where engineering judgment determines the need, large turn arrow(s) can be used in place of chevrons. This is consistent with MUTCD guidance.

Special Conditions: The historic standard of practice for installing a large arrow is limited to locations with sharper curves or turns. One primary benefit of installing chevrons over one large arrow is that if one chevron in a set is displaced in a crash or other event, the other chevrons would still provide guidance around a curve until the chevron could be replaced. The displacement of one large arrow does not provide this benefit.

ODOT CRF Value:

16%

Reduction in **Run of the Road Crashes at All Injury Severities**
(Excluding PDO's)

Range of Effectiveness:

16%

Safety Effects:

Chevrons help to delineate an upcoming curve, helping drivers to be aware of the presence of an approaching curve and help navigate their path.

References:

Engineering Judgement

FHWA Proven Safety Countermeasure

RD8: Install Oversized, Doubled Up and/or Fluorescent Yellow Sheeting for Advance Curve Warning Signs

Description: “Doubled-up” refers to installing a second, identical sign on the left side of the roadway. Installing oversized signing refers to installing a larger sign than typically required. Fluorescent yellow sheeting is a high-intensity retroreflective sheeting that makes the sign more visible to motorists who can recognize and respond to it earlier.

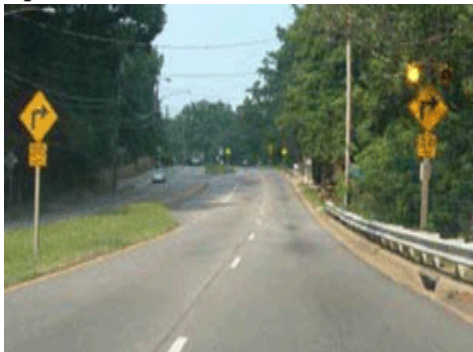


Image from FHWA

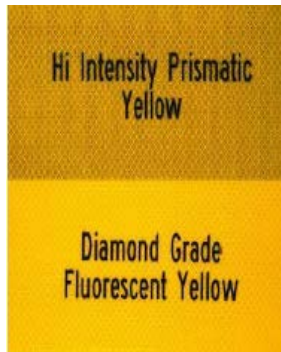


Image from ODOT

Applications: Where you have a higher than expected number of curve crashes.

Considerations: It is encouraged that this countermeasure be used to enhance curves that have a crash history to help highlight the curves that need more driver attention.

Special Conditions: This countermeasure is encouraged to be applied systemically, on the curves with crash histories within a segment of roadway. More than one signing enhancement listed can be installed. The ODOT Roadway Departure Plan can provide guidance on recommended crash thresholds for implementing these countermeasures.

ODOT CRF Value:

20%

Reduction in Run of the Road Crashes at All Severities
(Including PDO's)

Range of Effectiveness:

20%

Safety Effects:

All of these signing enhancements can improve the effectiveness of curve warning and delineation signs by increasing the conspicuity, or prominent visibility, of the sign, especially during dark conditions.

References:

Engineering Judgement

FHWA Proven Safety Countermeasure

RD9: Provide Static Combination Horizontal Alignment/Advisory Curve Warning Signs

Description: A combined Turn (W1-1) sign or the Curve (W1-2) sign with the Advisory Speed (W13-1) plaque to form a combination warning sign that is placed at the beginning of a turn or curve.



Images from MUTCD

Applications: Use it as a supplement to (not a replacement for) the advance Horizontal Alignment sign and Advisory Speed plaque where crash history depicts a need for enhanced curve warning.

Considerations: It is important, for curves with crash histories, to consider all curve warning enhancement options to determine which countermeasure is the most appropriate for the identified crash pattern(s).

Special Conditions: This sign is often used on sequential curves that have different advisory speeds and are spaced too closely to be signed separately with advance Horizontal Alignment signs. The slower curve often needs additional warning. See the 2009 MUTCD for additional guidance.

ODOT CRF Value:

13%

Reduction in **All Crashes**
at **All Injury Severities**
(Excluding PDO's)

Range of Effectiveness:

13% - 29%

Safety Effects:

The sign is intended to remind motorists of the need to slow down as they begin to negotiate the alignment change.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 73\)](#)

FHWA Proven Safety Countermeasure

RD10: Install Advance Curve Warning Flashers (Curve Warning Signs Exist)

Description: A flashing beacon placed on the advance Horizontal Alignment signs for a horizontal curve.



Images from FHWA

Applications: Where you have a curve with a high frequency of roadway departure crashes and other more traditional, low cost treatments have not shown an improvement in safety.

Considerations: In rural areas it may be difficult to find a power source.

Special Conditions: If there are doubled up advance curve warning signs, flashing beacons can be placed on both signs and either flashing alternately or simultaneously.

ODOT CRF Value:

10%

Reduction in **Curve Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

10%

Safety Effects:

Using flashing beacons with a warning sign is another way to gain motorists' attention.

References:

Engineering Judgement

**FHWA Proven Safety
Countermeasure**

RD11: Install Dynamic Speed Feedback Sign for Curves

Description: Supplemental beacons and/or messages that activate when a motorist approaches the curve at a high speed.



Image from FHWA

Applications: Where you have a curve with a high frequency of roadway departure or speed related crashes and other more traditional, low cost treatments have not shown an improvement in safety.

Considerations: In rural areas it may be difficult to find a power source.

Special Conditions: There are many types of dynamic curve warning signs. It is important to do more research on the type of sign that would be most appropriate for the location in question.
FHWA requires, for all federally funded projects, an Engineering Systems Document for ITS devices such as dynamic curve speed warning systems.

ODOT CRF Value:

5%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

5%

Safety Effects:

It measures the speeds of approaching vehicles and provides messages to speeding drivers to slow down to an advisory speed.

The advantage of this treatment is that the device has a much greater effect on high-speed vehicles than a static curve warning sign.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 6855\)](#)

FHWA Proven Safety Countermeasure

RD12: Speed Feedback Signs

Description: Speed feedback signs provide drivers with real-time information about their speed as they pass the sign.



Image from SDOT

Applications: In locations with a high frequency of speed related crashes (potentially related to careless/reckless driving or speed differential).

Considerations: These signs should be appropriately supplemented with police enforcement. It is important to consider setting a maximum speed that's being reported back to the driver to discourage the potential "how fast can you go" driving competition.

Special Conditions: Speed feedback signs should be used along with speed limit signs so that drivers know how their speed compares to the legal limit. Speed feedback signs may be permanent installations or temporary for targeted enforcement efforts.

ODOT CRF Value:

10%

Reduction in **All Crashes** at
All Severities
(Including PDO's)

Range of Effectiveness:

10%

Safety Effects:

When paired with enforcement, it helps to manage driving speeds and reduces the risk of speed related crashes.

References:

Engineering Judgement

RD13: Install Raised or Recessed Pavement Markers

Description: Delineators placed on the roadway adjacent to the longitudinal pavement markings of a road. They are used to supplement the delineation provided by existing pavement markings.

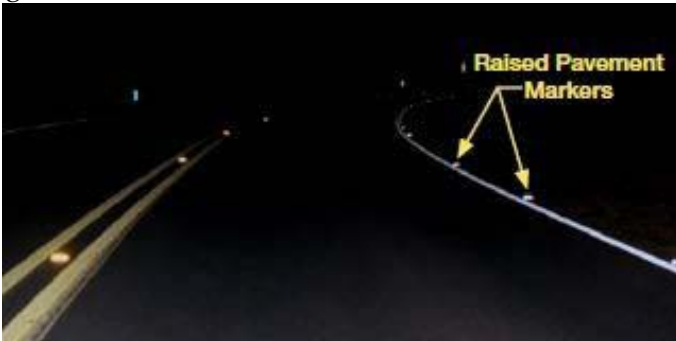


Image from FHWA



Image from Wikipedia

Applications: Where you have a high frequency of roadway departure crashes, particularly during wet and/or nighttime conditions.

Considerations: Raised pavement markers usually don't withstand regular snow plowing.

Special Conditions: Raised or recessed pavement markers should be installed on roads with sufficient pavement quality to hold the devices in place. The decision to place raised or recessed pavement markers is dependent on traffic volume and weather conditions typical of the road in question. The color of the pavement markers shall match the color of the adjacent pavement markings.

ODOT CRF Value:

15%

Reduction in **Night Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

15%

Safety Effects:

By installing raised or recessed pavement markers, the pavement markings are much more prominent in adverse weather conditions, helping a driver to safely navigate the path of the roadway.

References:

[Roadway Departure Implementation Plan](#)

RD14: Install Post-Mounted Delineators (Curve Application)

Description: A flexible fiber or aluminum post retroreflective device mounted above the roadway surface and along the side of the roadway in a series to show roadway alignment.



Image from FHWA

Applications: Delineators should be placed on curves with a history of crashes, particularly at nighttime. For best results, post-mounted delineators are to be installed on each chevron support post and coupled with edge line and center line pavement markings.

Considerations: Depending on the crash history of a curve, they may need to be replaced often.

Special Conditions: The MUTCD requires the color of the delineators to match the color of the adjacent edge line. Adjust spacing of delineators on approaches to and throughout the horizontal curves so that several delineators are always visible to the motorist.

ODOT CRF Value:

30%

Reduction in
Curve Crashes at Night
at **All Severities**
(Including PDO's)

Range of Effectiveness:

0% - 30%

Safety Effects:

Retroreflective material, such as post-mounted delineators, can be a highly effective treatment for delineating curves, especially at nighttime. They improve driver lane position both at the entry to the curve and at its midpoint.

References:

[Desktop Reference for Crash Reduction Factors \(FHWA-SA-08-011\)](#)

FHWA Proven Safety Countermeasure

RD15: Install Rural Edge line Striping (Tangent and/or Curve Application)

Description: Edge line markings separate the travel lane from the shoulder. A standard edge line marking is 4 inches wide.



4" – Lane line dimensions are shown on the striping plans.

Image from FHWA



Image from ODOT

Applications: On rural roadways with a traveled way of 20 ft or more in width where you have a high frequency of roadway departure crashes and edgeline striping is not already in place.

Considerations: Adding in edge line striping where none has previously existed will increase maintenance costs.

Special Conditions: Please refer to the ODOT Traffic Line Manual for more guidance on when to place edge line striping.

ODOT CRF Value:

11%

Reduction in **Run off the Road Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

11% - 13%

Safety Effects:

Edge lines communicate the intended roadway alignment and travel path to the driver. This can be especially beneficial during nighttime or adverse weather conditions.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 1943\)](#)

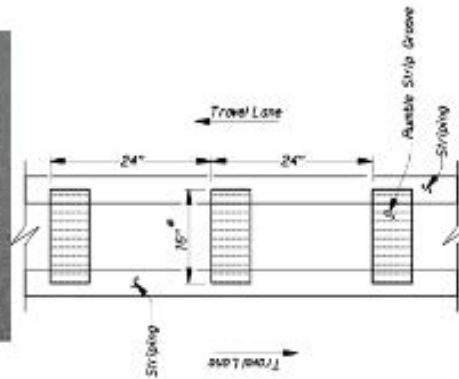
FHWA Proven Safety Countermeasure

RD16, RD17: Install Centerline Rumble Strips

Description: Rumble strips are ground/milled in patterns on the roadway that provide both an audible warning (rumbling sound) and a physical vibration to drivers.



Image from FHWA



Images from ODOT

Applications: Where you have a high frequency of roadway departure crashes, particularly head-on or sideswipe meeting crashes. This countermeasure may be applied to any roadways with rural characteristics.

Considerations: It is important to consider that there is adequate pavement/lane width to minimize the amount of external noise generated by rumble strips. It is also important to consider the potential noise impacts to nearby residential areas. Finally, pavement quality needs to be considered before placing rumble strips to avoid reducing the design life of the pavement.

Special Conditions: This countermeasure shall be applied systemically.

ODOT CRF Value:

12% (All)

45% (Head-on / Sideswipe Meeting)

Reduction in **Head on & Sideswipe Crashes** at **All Injury Severities** (Excluding PDO's)

Range of Effectiveness:

9% - 45%

Safety Effects:

The audible warning and physical vibration inside the car alerts drivers that they are leaving their travel lane, allowing them time to make a safe recovery back into their lane.

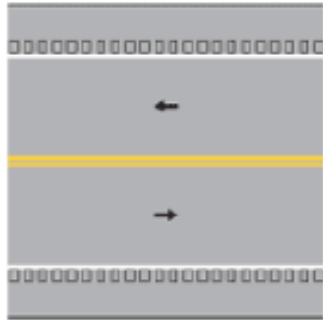
References:

[Crash Modification Factors Clearinghouse \(CMF ID: 3360 & 2423\)](#)

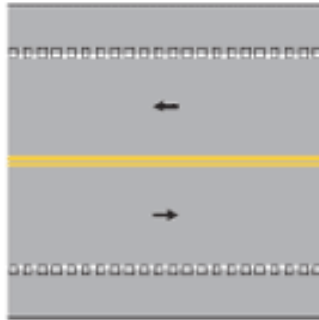
FHWA Proven Safety Countermeasure

RD18: Install Shoulder Rumble Strips

Description: Rumble strips are ground/milled in patterns on the roadway that provide both an audible warning (rumbling sound) and a physical vibration to drivers.



A - Edge line not on rumble strip



B - Edge line on rumble strip



Images from FHWA

Applications: Where you have a high frequency of roadway departure crashes, particularly fixed object and non-collision crashes.

Considerations: It is important to consider that there is adequate pavement/lane width to minimize the amount of external noise generated by rumble strips and provide bicycles with adequate shoulder width to ride on. It is also important to consider the potential noise impacts to nearby residential areas. Finally, pavement quality needs to be considered before placing rumble strips to avoid reducing the design life of the pavement.

Special Conditions: This countermeasure shall be applied systemically. Shoulder rumble strips can be placed on or adjacent to the edge line pavement markings.

ODOT CRF Value:

22%

Reduction in **Run off the Road Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

16% - 42%

Safety Effects:

The audible warning and physical vibration inside the car alerts drivers that they are leaving their travel lane, allowing them time to make a safe recovery back into their lane.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 2423\)](#)

FHWA Proven Safety Countermeasure

RD19: Install Profiled Line Pavement Markings

Description: A type of pavement marking consisting of a base stripe with raised shapes located at regular and predetermined intervals.



Image from Contrafed Publishing Co.

Applications: Where you have a high frequency of roadway departure crashes and are unable to place ground/milled in rumble strips.

Considerations: Profiled line pavement markings do not withstand regular snow plowing. The effectiveness and design life of profiled line is considerably less than ground/milled in rumble strips as the markings are gradually worn down as vehicles travel over them.

Special Conditions: Profiled line pavement markings can be used for centerline or edge line markings.

ODOT CRF Value:

9%

Reduction in **Night and Wet Road Crashes** at **All Severities** (Including PDO's)

Range of Effectiveness:

0% - 9%

Safety Effects:

Profiled line pavement markings produces a rumble effect and in addition to enhancing the visibility of the pavement markings. In addition, they provide better visibility during wet/rainy conditions.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 9803\)](#)

[Safety Evaluation of Profiled Thermoplastic Pavement Markings \(FHWA-HRT-17-075\)](#)

RD20: Widen Paved Shoulder by 1 ft.

Description: Increasing the width of the paved surface adjacent to/outside of the travel lanes by 1 foot.



Image from FHWA

Applications: Where you have a high frequency of roadway departure crashes. The primary roadway departure safety benefit of widening the paved shoulder on a roadway is that it provides a larger stable recovery area for errant drivers leaving their travel lane. Additional benefits to shoulder widening are listed below:

- A place to maneuver to avoid crashes;
- Improves stopping sight distance at horizontal curves by providing an offset to objects such as barrier and bridge piers;
- Improves bicycle accommodations; and
- Provides space for emergency storage of disabled vehicles.

Considerations: This countermeasure could have significant costs associated with adding more impervious surface. Typical examples are right of way acquisition, drainage impacts and environmental mitigation.

Special Conditions: Per FHWA guidance, for narrow pavement widths, it is beneficial to provide narrower lanes with wider shoulders at low AADTs (less than 1,000 vpd), while the configuration with 12-foot lanes and no shoulders appears to be most beneficial for large AADTs (greater than 1,000 vpd).

ODOT CRF Value:

6%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

3% - 6%

Safety Effects:

Provides a larger stable
recovery area for errant
drivers leaving their travel
lane

References:

[Crash Modification Factors
Clearinghouse \(CMF ID:
5277\)](#)

**FHWA Proven Safety
Countermeasure**

RD21: Widen Paved Shoulder by 2 ft.

Description: Increasing the width of the paved surface adjacent to/outside of the travel lanes by 2 feet.



Image from FHWA

Applications: On rural undivided highways where you have a high frequency of roadway departure crashes. The primary roadway departure safety benefit of widening the paved shoulder on a roadway is that it provides a larger stable recovery area for errant drivers leaving their travel lane. Additional benefits to shoulder widening are listed below:

- A place to maneuver to avoid crashes;
- Improves stopping sight distance at horizontal curves by providing an offset to objects such as barrier and bridge piers;
- Improves bicycle accommodations; and
- Provides space for emergency storage of disabled vehicles.

Considerations: This countermeasure could have significant costs associated with adding more impervious surface. Typical examples are right of way acquisition, drainage impacts and environmental mitigation.

Special Conditions: Per FHWA guidance, for narrow pavement widths, it is beneficial to provide narrower lanes with wider shoulders at low AADTs (less than 1,000 vpd), while the configuration with 12-foot lanes and no shoulders appears to be most beneficial for large AADTs (greater than 1,000 vpd).

ODOT CRF Value:

13%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

5% - 13%

Safety Effects:

Provides a larger stable recovery area for errant drivers leaving their travel lane

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 5279\)](#)

[Impact of Shoulder Width and Median Width on Safety \(NCHRP Report 633\)](#)

FHWA Proven Safety Countermeasure

RD22: Widen Paved Shoulder by 3 ft.

Description: Increasing the width of the paved surface adjacent to/outside of the travel lanes by 3 feet.



Image from FHWA

Applications: Where you have a high frequency of roadway departure crashes.

Considerations: This countermeasure could have significant costs associated with adding more impervious surface. Typical examples are right of way acquisition, drainage impacts and environmental mitigation. The primary roadway departure safety benefit of widening the paved shoulder on a roadway is that it provides a larger stable recovery area for errant drivers leaving their travel lane. Additional benefits to shoulder widening are listed below:

- A place to maneuver to avoid crashes;
- Improves stopping sight distance at horizontal curves by providing an offset to objects such as barrier and bridge piers;
- Improves bicycle accommodations; and
- Provides space for emergency storage of disabled vehicles.

Special Conditions: Per FHWA guidance, for narrow pavement widths, it is beneficial to provide narrower lanes with wider shoulders at low AADTs (less than 1,000 vpd), while the configuration with 12-foot lanes and no shoulders appears to be most beneficial for large AADTs (greater than 1,000 vpd).

ODOT CRF Value:

18%

Reduction in **All Crashes**
at **All Severities**
(Including PDO's)

Range of Effectiveness:

6% - 18%

Safety Effects:

Provides a larger stable recovery area for errant drivers leaving their travel lane

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 5281\)](#)

[Impact of Shoulder Width and Median Width on Safety \(NCHRP Report 633\)](#)

FHWA Proven Safety Countermeasure

RD23: Upgrade Existing Markings to Wet/Reflective Pavement Markings

Description: Applied on existing roadway surface edge lines as a paint, tape, or a thermoplastic material. Wet-reflective elements allow a pavement marking to retain its retroreflectivity when covered by water.

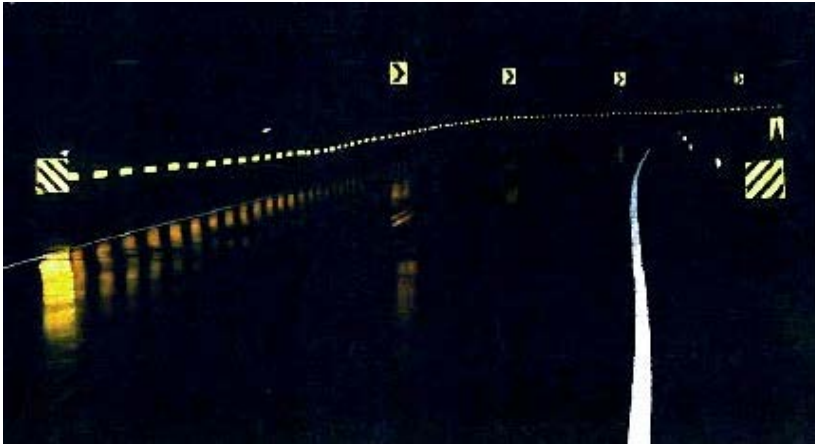


Image from FHWA, 3M

Applications: Where you have a high frequency of roadway crashes in wet weather conditions when non-wet reflective pavement markings tend to disappear, leading to reduced driver visibility.

Considerations: Costs associated with installation and maintenance of wet-reflective pavement markings.

Special Conditions: This countermeasure is helpful in reducing crashes in nighttime wet road conditions and in work zones where drivers encounter unfamiliar traffic patterns.

ODOT CRF Value:

14%

Reduction in **Wet Road Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

14%

Safety Effects:

Wet-Reflective pavement markings increase the retroreflectivity of the edge line markings on roads which improves visibility and helps guide motorists safely along the roadway path.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 8137\)](#)

RD24: Install Wider Edgelines (4 in. to 6 in.)

Description: Widen edgelines from 4 inches to 6 inches.



Image from MnDOT

Applications: Where you have a high frequency of roadway departure crashes.

Considerations: Cost of widening edgelines varies depending on material used.

Special Conditions: Wider edgeline pavement markings have been shown to have a positive effect on the safety of rural two-lane roadways.

ODOT CRF Value:

14%

Reduction in **All Crashes** at
All Severities
(Including PDO's)

Range of Effectiveness:

17%

Safety Effects:

Increasing the width of roadways increases visibility for drivers. Improves safety by keeping drivers in their designated travel lane and allows more time for drivers to focus on critical driving tasks.

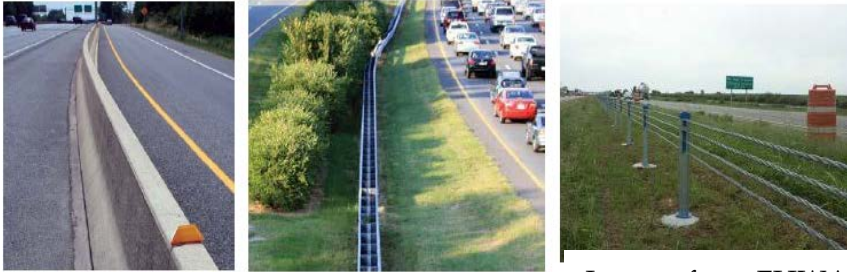
References:

[Crash Modification Factors Clearinghouse \(CMF ID: 4736\)](#)

FHWA Proven Safety Countermeasure

RD25: Install Any Type of Median Barrier

Description: Median barriers are longitudinal barriers most commonly used to separate opposing directions of traffic on a divided highway.



Images from FHWA

Applications: On divided highways with high speeds and high volumes and/or on divided highways with a high frequency of fatal or serious injury median crossover crashes.

Considerations: Ease and costs of maintenance and repair for these barrier systems is an important consideration.

Special Conditions: There are three basic categories of median barriers that each have their own set of pros and cons.

Consideration of vehicle types, roadway geometry and potential severity of median crossover crashes must be considered when choosing a median barrier type. The three types are rigid barrier systems (i.e. concrete barrier), semi-rigid barrier systems (i.e. guardrail) and flexible barrier systems (i.e. cable barrier). Rigid barriers have a high installation cost but a low life-cycle cost. They are associated with more severe injury crashes relative to other barrier types but are proven highly effective in locations with heavy truck traffic and insufficient median widths for the other barrier types. Semi-Rigid barriers are most suitable for use in traversable medians having no or little change in grade and cross slope. Initial cost is lower than rigid barriers but it generally has a higher life cycle cost due to repair needs. Typical installation of semi-rigid median barrier is on divided roadways with 20,000 ADT or more and medians less than 50 feet wide. Flexible barriers are the most forgiving barrier systems available for reducing the severity of median crossover crashes. They generally have a lower installation cost than rigid and semi-rigid barriers but typically have a higher life cycle cost due to repair needs. Typical installations of flexible median barriers are in medians less than 50 feet wide.

ODOT CRF Value:

30%

Reduction in **All Crashes** at
All Injury Severities
(Excludes PDO's)

Range of Effectiveness:

30%

Safety Effects:

While these systems may not reduce the frequency of crashes due to roadway departure, they do help prevent a median crash from becoming a median crossover head-on collision which has a high chance of resulting in a fatality or severe injury.

References:

Highway Safety Manual

[Crash Modification Factors Clearinghouse \(CMF ID: 43\)](#)

FHWA Proven Safety Countermeasure

RD26: Install New Guardrail (Not Median Barrier Application)

Description: A semi-rigid barrier typically consisting of connected segments of metal railing supported by posts and blocks.



Images from FHWA

Applications: Guardrails should be installed where there is evidence (i.e. crash history) of the need to shield motorists from a roadside hazard that has a higher risk for fatal or serious injury crashes than the guardrail itself. Potential roadside hazards could be point hazards (such as a bridge pier or utility pole), medium-sized hazards (such as roadside culverts), and long hazards (such as steep roadside slopes).

Considerations: Guardrails themselves are a roadside obstacle that a motorist can potentially strike (subsequently creating a lot of potential maintenance costs as well) so it is important to minimize guardrail installation to locations where you are protecting a motorist from roadside hazards that have a higher risk for fatal or serious injury crashes.

Special Conditions: For more guidance on installation of guardrails please see NCHRP Report 638.

ODOT CRF Value:

47%

Reduction in
Run off the Road Crashes
at **All Injury Severities**
(Excludes PDO's)

Range of Effectiveness:

47%

Safety Effects:

Because guardrail systems are designed to absorb energy during a crash, and the entire assembly is designed to move or deflect during an impact, guardrail systems usually minimize potential injuries in run off the road or roadway departure crashes.

References:

[Crash Modification Factors Clearinghouse \(CMF ID: 38\)](#)

FHWA Proven Safety Countermeasure

RD27: Install Seasonal Wildlife Warning Signs

Description: Seasonal wildlife warning signs that are only present during certain times of the year when wildlife cross roadway systems most frequently.



Image from FHWA

Applications: Where you have a high frequency of roadway crashes related to crossing wildlife.

Considerations: It may be important to provide educational outreach to the public on the use of seasonal wildlife warning signs as well as give drivers advice on the best actions to take to avoid collisions with wildlife.

Special Conditions: Seasonal wildlife signs are used most frequently in rural areas where wildlife are attracted to roadside vegetation.

ODOT CRF Value:

26%

Reduction in **All Crashes** at
All Severities
(Including PDO's)

Range of Effectiveness:

26%

Safety Effects:

Seasonal wildlife warning signs improves the safety of roadways by alerting drivers to areas where wildlife could be present to help reduce crashes with vehicles.

References:

[Wildlife Warning Signs and Animal Detection Systems](#)

RD28: Install Wildlife Detection System

Description: Wildlife detection systems that utilize sensors to detect large animals.



Image from FHWA

Applications: Where you have a high frequency of roadway crashes related to crossing wildlife.

Considerations: When installing detection systems, the sensors need to be set at the appropriate height for specific species. Sensors that are installed too low to the ground may detect other small species, leading to false wildlife detections. Highway agency should establish a management plan that includes regular checks of the system's basic functions. Other considerations include: system readability, robustness (performance over time and maintenance), length of road the sensors will need to cover, and sign/system placement.

Special Conditions: This countermeasure is specific to wildlife only crashes in rural areas.

ODOT CRF Value:

87%

Reduction in **Wildlife Only Crashes at All Severities**
(Including PDO's)

Range of Effectiveness:

87%

Safety Effects:

Wildlife detection systems, when placed in appropriate locations, can reduce collisions between wildlife and vehicles by informing drivers when wildlife is present.

References:

[Advances in Wildlife Crossing Technologies \(FHWA-HRT-09-006\)](#)