

# SIGNALIZED INTERSECTION SAFETY STRATEGIES



## CATEGORY A: REDUCE FREQUENCY AND SEVERITY OF INTERSECTION CONFLICTS THROUGH TRAFFIC CONTROL AND OPERATIONAL IMPROVEMENTS

**A1 – Replace permissive left turns with protected left turns**  
Where to use - Signalized intersections with a high frequency of angle crashes involving left turning and opposing through vehicles. A properly timed protected left-turn phase can also help reduce rear-end and sideswipe crashes between left-turning vehicles and the through vehicles behind them.  
**Keywords:** protected, permissive, signal phasing **SIG**

**A2 – Optimize change and clearance intervals**  
Where to use - Signalized intersections with a high frequency of crashes related to change interval lengths that are possibly too short. These crashes include angle crashes between vehicles continuing through the intersection after one phase has ended and the vehicles entering the intersection on the following phase. Rear-end crashes may also be a symptom of short change intervals.  
**Keywords:** change interval, signal phasing, signal timing **SIG**

**A3 – Restrict or eliminate turning maneuvers**  
Where to use - Signalized intersections with a high frequency of crashes related to turning maneuvers. For right turn on red (RTOR), the target of this strategy is right-turning vehicles that are involved in rear-end or angle crashes with cross-street vehicles approaching from the left or vehicles turning left from the opposing approach, and crashes involving pedestrians.  
**Keywords:** right turn on red **PED SIG**

**A4 – Employ signal coordination**  
Where to use - Signalized intersections with a high frequency of crashes involving major street left-turning and minor street right-turning vehicles where adequate safe gaps in opposing traffic are not available. Major road rear-end crashes associated with speed changes can also be reduced by re-timing signals to promote platooning.  
**Keywords:** signal coordination, signal timing, cycles **PED**

**A5 – Employ emergency vehicle preemption**  
Where to use - Signalized intersections where normal traffic operations impede emergency vehicles and where traffic conditions create a potential for conflicts between emergency and non-emergency vehicles.  
**Keywords:** emergency vehicle preemption, signal timing **PED**

**A6 – Remove unwarranted signal**  
Where to use - Signalized intersections where the traffic volumes and safety record do not warrant a traffic signal.  
**Keywords:** unwarranted, remove signal **PED**

**A7 – Change green signal to flashing yellow arrow for permissive left turns**  
Where to use - Signalized intersections with high frequency of angle crashes involving left-turning and opposing through vehicles. The flashing yellow arrow (FYA) can be used in place of the simple circular green light and other signals to help convey the message that left-turning drivers need to yield to on-coming traffic.  
**Keywords:** FYA, flashing yellow arrow, phasing, left turn, protected, permissive **SIG**

**A8 – Install/implement pedestrian signal improvements**  
Where to use - Signalized intersections with conflicts between vehicles and pedestrians crossing at the intersection, high volume of crossing pedestrians or bicyclists, vehicles not yielding to pedestrians in crosswalk, and high pedestrian delay due to few available gaps in traffic. Measures can include increasing pedestrian clearance intervals (or increasing the cycle length for pedestrian crossing), implementing leading pedestrian interval and installing pedestrian pushbuttons and pedestrian countdown signals.  
**Keywords:** pedestrian, crossing, cycle length, signal phasing, pedestrian interval, countdown **PED**

**A9 – Install bicycle signal**  
Where to use - Signalized intersections with conflicts between vehicles and bicycles crossing at the intersection, high volume of bicyclists, vehicles not yielding to bicyclists.  
**Keywords:** bicycle, signal **BIKE PED**

## CATEGORY B: REDUCE INTERSECTION CONFLICTS THROUGH GEOMETRIC IMPROVEMENTS

**B1 – Provide/improve turn lane channelization**  
Where to use - Signalized intersections with a high frequency of rear-end collisions resulting from conflicts between: (1) vehicles turning and following vehicles; and (2) vehicles from downstream intersection crossing traffic lanes to enter turn lane. The channelization can also provide a pedestrian refuge area and reduce pedestrian crossing distance.  
**Keywords:** channelization, right turn, left turn, turn lane, raised curb **PED**

**B2 – Improve geometry of pedestrian and bicycle facilities**  
Where to use - Signalized intersections with high frequencies of pedestrian and/or bicycle crashes and on routes serving schools or other generators of pedestrian and bicycle traffic. Measures can include curb radius reduction, curb extension, pedestrian refuge/raised median, and raised intersections.  
**Keywords:** pedestrian, widen sidewalk at intersection, raised intersection **SIG BIKE PED P**

**B3 – Utilize innovative intersection geometry**  
Where to use - Signalized intersections with high levels of crashes on a leg where other low-cost strategies have not been successful or are not considered appropriate.  
**Keywords:** innovative intersection geometry **P E**

**B4 – Corridor access management - implement median closures**  
Where to use - Signalized intersections with patterns of crashes related to particular turning maneuvers where drivers have difficulties finding an acceptable gap in traffic.  
**Keywords:** access points, access management **SIG P**

**B5 – Provide right-turn lanes at intersections**  
Where to use - Signalized intersections with conflicts between right-turning vehicles and following vehicles, and significant right-turn volume along major road.  
**Keywords:** access points **SIG P**

## CATEGORY C: IMPROVE SIGHT DISTANCE AT SIGNALIZED INTERSECTIONS

**C1 – Clear sight triangles**  
Where to use - Signalized intersections where there is a high frequency of crashes between vehicles turning right on red from one street and through vehicles on the other street or crashes involving left turning traffic where landscaped medians are present.  
**Keywords:** triangle sight distance **SIG BIKE PED**

**C2 – Increase positive turn lane offset**  
Where to use - Signalized intersections where there is a high number of crashes due to turning vehicles limiting the sight distance. Left-turning vehicles can limit the sight distance of left turning vehicles and opposing through vehicles. Right-turning vehicles can limit the sight distance of right-turning cross street traffic.  
**Keywords:** turn lane, offset, positive offset, left-turn lane, right-turn lane **SIG BIKE PED**

## CATEGORY D: IMPROVE DRIVER AWARENESS OF INTERSECTIONS AND SIGNAL CONTROL

**D1 – Improve visibility of intersections on approach(es)**  
Where to use - Signalized intersections with a high frequency of crashes attributed to drivers being unaware of the presence of the intersection.  
**Keywords:** signal visibility **SIG**

**D2 – Improve visibility of signals and signs at intersections**  
Where to use - Signalized intersections with a high frequency of right-angle and rear-end crashes occurring because drivers are unable to see traffic signals and signs sufficiently in advance to safely negotiate the intersection being approached.  
**Keywords:** signal visibility **SIG**

**D3 – Install/add one signal head per lane**  
Where to use - Signalized intersections with a high frequency of crashes caused by driver indecision in lane assignment.  
**Keywords:** add signal, signal head **SIG**

**D4 – Install larger 12" signal heads**  
Where to use - Signalized intersections with a crash history or observed conflicts involving lack of awareness of the intersection or traffic control and observed speeding on approaches to the intersection.  
**Keywords:** signal lense, signal head **SIG**

**D5 – Install signal backplate/retroreflective backplates**  
Where to use - Signalized intersections with poor visibility of the intersection from approaches, a crash history or observed conflicts involving lack of awareness of the intersection or traffic control, and observed speeding on approaches to the intersection.  
**Keywords:** retroreflective, backplate **P**

**D6 – Install intersection warning devices**  
Where to use - Signalized intersections with poor visibility of the intersection from approaches, conflicts involving lack of awareness of the intersection or traffic control, and observed speeding on approaches to the intersection. Intersection warning devices can include warning signs, beacons, and transverse rumble strips.  
**Keywords:** advance warning sign, positive guidance **BIKE PED**

**D7 – Convert pole mounted to overhead signals**  
Where to use - Signalized intersections with poor visibility of the intersection from approaches, a crash history or observed conflicts involving lack of awareness of the intersection or traffic control, and observed speeding on approaches to the intersection.  
**Keywords:** convert signal, pedestal mounted, mast arm **P**

**D8 – Install supplemental pole-mounted signal on near-side approach**  
Where to use - Signalized intersections with poor visibility of the intersection from approaches, a crash history or observed conflicts involving lack of awareness of the intersection or traffic control, and observed speeding on approaches to the intersection.  
**Keywords:** add signal, signal head **SIG**

## CATEGORY E: IMPROVE DRIVER COMPLIANCE WITH TRAFFIC CONTROL DEVICES

**E1 – Provide public information and education**  
Where to use - Signalized intersections with a high frequency of crashes related to drivers either being unaware of (or refusing to obey) traffic laws and regulations that impact traffic safety (especially red-light running, speeding, and not yielding to pedestrians).  
**Keywords:** public information, education **BIKE PED**

**E2 – Provide targeted conventional enforcement of traffic laws**  
Where to use - Signalized intersections with a high frequency of crashes related to drivers either being unaware of (or refusing to obey) traffic laws and regulations that impact traffic safety.  
**Keywords:** targeted enforcement, traffic laws **BIKE PED SIG**

**E3 – Post reasonable, safe, and consistent speed limits on intersection approaches**  
Where to use - Signalized intersections with a high frequency of crashes attributed to drivers who intentionally disobey posted approach speed limits.  
**Keywords:** speed, speed management **P**

## CATEGORY F: IMPROVE ACCESS MANAGEMENT NEAR SIGNALIZED INTERSECTIONS

**F1 – Modify driveway access**  
Where to use - Signalized intersections with high crash frequencies related to driveways adjacent to the intersection. Generally, driveways within 250 feet of the intersection are the greatest concern.  
**Keywords:** relocation, driveway, closure **P**

**F2 – Corridor access management - implement median closures**  
Where to use - Approaches to signalized intersections with a high frequency of crashes involving drivers making turns across medians.  
**Keywords:** open median, closed median **P**

## CATEGORY G: IMPROVE SAFETY THROUGH OTHER INFRASTRUCTURE TREATMENTS

**G1 – Improve drainage in intersection and on approaches**  
Where to use - Signalized intersections with a high frequency of crashes that are related to wet pavement from poor drainage. Such crashes involve vehicles that hydroplane and, hence, are not able to stop when required.  
**Keywords:** drainage, wet pavement **P**

**G2 – Provide high friction surface treatment in intersection and on approaches**  
Where to use - Signalized intersection approaches where skidding is determined to be a problem, especially in wet conditions.  
**Keywords:** pavement, friction, condition, skid resistance **SIG**

**G3 – Coordinate closely spaced signals near at-grade railroad crossings**  
Where to use - Signalized intersections in close proximity to at-grade railroad crossings with a high frequency of crashes. This situation presents a significant potential for vehicle-train crashes, but vehicle-vehicle crashes could also occur if drivers try to speed through an intersection to avoid waiting in a queue near the railroad crossing.  
**Keywords:** railroad crossing, signal coordination **PED**

**G4 – Relocate signal hardware out of clear zone**  
Where to use - Signalized intersections where signal hardware is located within the clear zone or is a sight obstruction (particularly on high-speed approaches).  
**Keywords:** fixed objects, clear zone **P**

**G5 – Restrict or eliminate parking on intersection approaches**  
Where to use - Signalized intersections with permitted parking on the approaches that may present a safety hazard either by blocking sight distance or due to parking maneuvers.  
**Keywords:** on-street parking **BIKE PED**

## 2013 INTERSECTION FATALITIES



Source: FARS, National Highway Traffic Safety Administration (2013). Available: [http://safety.fhwa.dot.gov/intersection/resources/intsafetratbro/intersection\\_guide12.pdf](http://safety.fhwa.dot.gov/intersection/resources/intsafetratbro/intersection_guide12.pdf)

SAFETY CONCERN	SIGNALIZED COST		
	Low	Moderate	High
<b>High frequency of right-angle crashes attributed to:</b>			
nearby driveways		F2	F1
traffic from cross street	A2, A3	E2	
skewed intersection			
poor sight distance	A1, C1, G5	C2, G4	B3
drivers misjudging gaps	A1		
not enough gaps for drivers	A1	A4, B4	
driver unaware of intersection	D1, D2, D5, D6	C2	B4
nighttime conditions	D1, D2, D5		
right turning vehicles hit from side	A3, C1, G5	B1, G4	
<b>High frequency of rear-end crashes attributed to:</b>			
left turning vehicles hit from behind	A1	B1	B3
left opposing vehicles hit from behind		B1	B3
right turning vehicles hit from behind	A3	B1, B5	
standing water on roadway		G1	
vehicles unable to stop safely (skidding)		G2	
driver unaware of intersection	D1, D2, D5	D3, D4, D8	D7
nighttime conditions	D1, D2, D5	D4	D7
speed differentials of vehicles		A4, E3	
sudden stops	A2, A3	A4, D3	
<b>High frequency of left-turn crashes attributed to:</b>			
left turn vehicles hit by opposing traffic	A1, A3, A7, C1	B1, B4	B3
nighttime conditions	D1, D2, D5		
<b>High frequency of sideswipe crashes attributed to:</b>			
vehicles within intersection	A1	B1	
<b>High frequency of pedestrian/bicycle crashes:</b>			
on school routes or near generators of ped/bike traffic	A8	B2, E2	
vehicle/bicycle sideswipes on approaches		A9, G1	
with left turning vehicles	A1, A3	A9	
<b>Address overall safety issues:</b>			
violation of traffic laws	E1	A9, E2	
intersection near railroad crossing		G3	
intersection near fire station		A5	
excessive delay	A6		
disobedience of traffic signal	A6	A9, D3, D8	

### Key to the Brochure

**Costs:** Costs will also vary considerably and are affected by local conditions. Costs are ranked as: low, moderate, moderate to high, and high. The scale is meant to reflect costs relative to the other strategies described in the category (signalized or unsignalized).

● Low Cost Measure ● Moderate Cost Measure ● High Cost Measure

**P FHWA Proven Safety Countermeasure:** More information about FHWA Proven Safety Countermeasures can be found at: <http://safety.fhwa.dot.gov/provencountermeasures/>

**E FHWA Everyday Counts:** Every Day Counts (EDC) is an effort led by FHWA in cooperation with American Association of State and Highway and Transportation Officials (AASHTO) to identify and rapidly deploy proven but underutilized innovations to shorten the project delivery process, enhance roadway safety, reduce congestion and improve environmental sustainability. See <http://www.fhwa.dot.gov/everydaycounts/> for additional information.

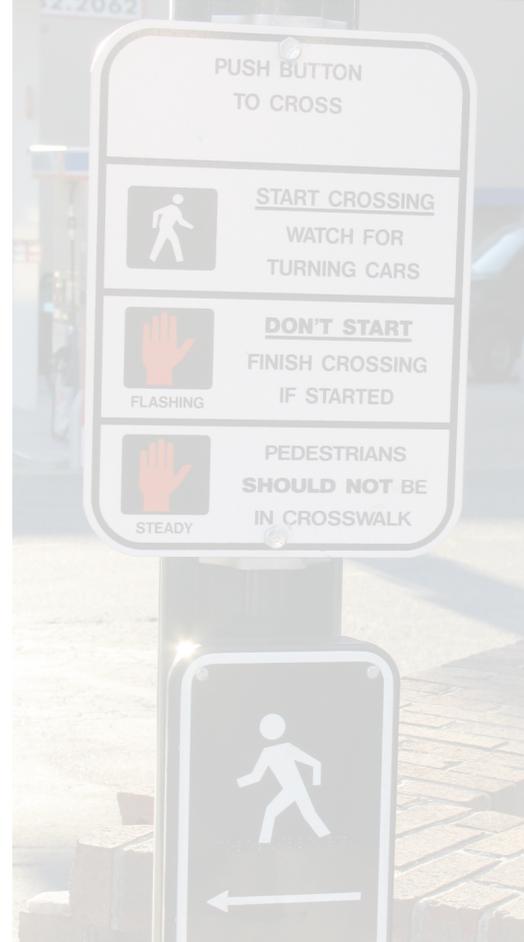
**Keywords:** Keywords have been provided for those countermeasures with a crash modification factor in the CMF Clearinghouse (<http://www.cmfclearinghouse.org/>). Some countermeasures may be found using a variety of search terms and the keywords provided are examples of those terms. For those countermeasures without keywords listed, their effectiveness may not have been studied or submitted to the CMF clearinghouse.

**SIG** FHWA Signalized Intersections: An Informational Guide (2nd Edition): <http://safety.fhwa.dot.gov/intersection/signalized/13027/fhwa13027.pdf>

**UNSIG** Unsignalized Intersection Improvement Guide (NCHRP 03-104)

**BIKE** BIKESAFE 2014- Bicycle Safety Guide and Countermeasure Selection System [http://pedbikesafe.org/BIKESAFE/guide\\_background.cfm](http://pedbikesafe.org/BIKESAFE/guide_background.cfm)

**PED** PEDSAFE 2013- Pedestrian Safety Guide and Countermeasure Selection System [http://pedbikesafe.org/PEDSAFE/guide\\_background.cfm](http://pedbikesafe.org/PEDSAFE/guide_background.cfm)



# Intersection Safety Strategies

Second Edition

The original version of this brochure (FHWA-SA-08-008) was originally produced as a quick reference to all the strategies listed in NCHRP Report 500, Volume 5 (Unsignalized) and Volume 12 (Signalized). This second edition has been revised and updated to reflect more timely information and experience available through the Crash Modification Factor (CMF) Clearinghouse.

**For more information, please visit:**  
<http://safety.fhwa.dot.gov>

# UNSIGNALIZED INTERSECTION SAFETY STRATEGIES



## CATEGORY A: IMPROVE MANAGEMENT OF ACCESS

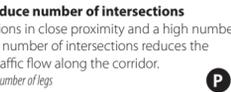
**A1 – Corridor access management - reduce driveway conflicts**  
Where to use - Unsignalized intersections with high crash frequencies related to driveways adjacent to the intersection. Generally, driveways within 250 feet of the intersection are the greatest concern.  
**Keywords:** driveway closure, driveway relocation, access management, reduce driveways



**A2 – Corridor access management - modify driveway access**  
Where to use - Driveways located near unsignalized intersections that experience high crash frequencies but that cannot practically be closed or relocated.  
**Keywords:** access management, turn prohibitions, prohibit left-turns



**A3 – Corridor access management - reduce number of intersections**  
Where to use - Corridors with many intersections in close proximity and a high number of intersection related crashes. Reducing the number of intersections reduces the number of conflict points and can improve traffic flow along the corridor.  
**Keywords:** intersection spacing, access management, change number of legs



**A4 – Corridor access management - implement median closures**  
Where to use - Unsignalized intersections that have observed conflicts with left-turning vehicles from the major or minor road, finding acceptable gaps from minor road, and where driveway access causes delay and/or collisions.  
**Keywords:** closed median, convert open medians



## CATEGORY B: REDUCE CONFLICTS THROUGH GEOMETRIC DESIGN IMPROVEMENTS

**B1 – Provide left-turn lanes at intersections**  
Where to use - Unsignalized intersections with a high frequency of crashes resulting from the conflict between (1) vehicles turning left and following vehicles and (2) vehicles turning left and opposing through vehicles.  
**Keywords:** provide left turn lane



**B2 – Provide provide zero or positive offset left-turn lanes at intersections**  
Where to use - Unsignalized intersections with a high frequency of crashes between vehicles turning left and opposing through vehicles, as well as rear-end crashes between through vehicles on the opposing approach. Also at intersections on divided highways with medians wide enough to provide the appropriate offset but can be implemented on approaches without medians if sufficient width exists.  
**Keywords:** positive offset turn lane

**B3 – Provide left or right-turn bypass lanes on shoulders at T-intersections**  
Where to use - At three-legged unsignalized intersections on two-lane highways with moderate through and turning volumes, especially intersections that have a pattern of rear-end collisions involving vehicles waiting to turn left from the highway.  
**Keywords:** by-pass lane

**B4 – Provide left-turn acceleration lanes in median at divided highway high speed intersections**  
Where to use - Unsignalized intersections with conflicts due to speed differential between entering vehicles and through vehicles, high left-turn volumes onto high-speed major roads, and significant delay for left-turning vehicles waiting for a suitable gap on the major road.  
**Keywords:** provide right turn lane

**B5 – Provide right-turn lanes at intersections**  
Where to use - Unsignalized intersections with a high frequency of rear-end crashes resulting from conflicts between (1) vehicles turning right and following vehicles and (2) vehicles turning right and through vehicles coming from the left on the cross street.  
**Keywords:** provide right turn lane

**B6 – Provide offset right-turn lanes at intersections**  
Where to use - Unsignalized intersections with a high frequency of crashes between vehicles on the minor road that are turning left, turning right, or proceeding straight through, and vehicles on the major road.  
**Keywords:** offset right turn lane

**B7 – Provide full-width paved shoulders in intersection areas**  
Where to use - Unsignalized intersections on divided highways with no shoulder or shoulder widths less than 8 feet that experience a high proportion of run-off-road crashes as a result of avoidance maneuvers or a high proportion of rear-end crashes that could have been avoided had a full-width paved shoulder been provided.  
**Keywords:** shoulder width, 12 feet shoulder, pave full-width shoulder

**B8 – Modify allowed turning maneuvers through geometric improvements**  
Where to use - Unsignalized intersections with patterns of crashes related to particular turning maneuvers where it is impractical to reduce that pattern of crashes by improving sight distance or providing a left-turn or shoulder bypass lane. Also, at locations where it is possible to restrict or eliminate turning maneuvers by providing channelization or by closing the median opening. (Replace direct left-turn with right-turn/U-turn).  
**Keywords:** replace direct left with right turn / u turn

**B9 – Convert four-legged intersections to offset T-intersections**  
Where to use - Unsignalized four-legged intersections with very low through volumes on the cross street.  
**Keywords:** convert four-leg to two three-leg

**B10 – Convert offset T-intersections to four-legged intersections**  
Where to use - Unsignalized offset T-intersections where through volumes on the cross street are very high.

**B11 – Realign intersection approaches to reduce or eliminate intersection skew**  
Where to use - Unsignalized intersections with a high frequency of crashes resulting from insufficient intersection sight distance and awkward sight lines at a skewed intersection.  
**Keywords:** change skew angle

**B12 – Reduce or extend curb radius**  
Where to use - Unsignalized intersections with observed vehicles making right-turn movements at high speeds, high pedestrian traffic, poor visibility of on-coming traffic for pedestrians waiting to cross the road, and a crash history or observed conflicts between bicyclists and/or pedestrians and right-turning vehicles.  
**Keywords:** widen sidewalk

**B13 – Install medians and pedestrian crossing islands**  
Where to use - Unsignalized intersections with crossings that span multiple lanes and observed difficulty of pedestrians finding safe gaps in traffic to cross.  
**Keywords:** raised median

**B14 – Install roundabout or mini-roundabout**  
Where to use - Unsignalized intersections with a crash history or observed conflicts related to speeding through the intersection.  
**Keywords:** roundabout

## CATEGORY C: IMPROVE SIGHT DISTANCE

**C1 – Clear sight triangles on stop- or yield-controlled approaches to intersections or in the medians of divided highways near intersections**  
Where to use - Unsignalized intersections or medians with restricted sight distance and patterns of crashes related to lack of sight distance, where sight distance can be improved by clearing roadside or median obstructions without major construction.  
**Keywords:** increase triangle sight distance



**C2 – Change horizontal and/or vertical alignment of approaches to provide more sight distance**  
Where to use - Unsignalized intersections with restricted sight distance due to horizontal and/or vertical geometry and with patterns of crashes related to that lack of sight distance that cannot be ameliorated by less expensive methods.  
**Keywords:**

**C3 – Eliminate parking that restricts sight distance**  
Where to use - Unsignalized intersections with restricted sight distance due to parking.  
**Keywords:** prohibit on-street parking

## CATEGORY D: IMPROVE AVAILABILITY OF GAPS AND ASSIST DRIVERS IN JUDGING GAPS

**D1 – Install an intersection conflict warning system (ICWS)**  
Where to use - Unsignalized intersections with a crash history involving vehicles entering or crossing the major road, difficulty among drivers in determining appropriate gaps in traffic, and awareness of the intersection is lacking.  
**Keywords:** install dynamic advance intersection warning system



**D2 – Re-time adjacent signals to create gaps at stop-controlled intersections**  
Where to use - Unsignalized intersections (between signalized intersections) with a high frequency of right-angle or turning related crashes due to a lack of sufficient gaps in through traffic on the major road.

## CATEGORY E: IMPROVE DRIVER AWARENESS

**E1 – Improve visibility of intersections by providing enhanced signing and delineation**  
Where to use - Unsignalized intersections that are not clearly visible to approaching motorists, particularly approaching motorists on the major road. The strategy is particularly appropriate for intersections with patterns of rear-end, right-angle, or turning crashes related to lack of driver awareness of the presence of the intersection. Measures can include installing larger or supplementary regulatory and warning signs at intersections or providing dashed markings (extended left edge-lines) for major-road continuity across the median opening at divided highway intersection.



**E2 – Improve visibility of the intersection by providing lighting**  
Where to use - Unsignalized, unlit intersections with substantial patterns of nighttime crashes. In particular, patterns of rear-end, right-angle, or turning crashes on the major-road approaches to an unsignalized intersection may indicate that approaching drivers are unaware of the presence of the intersection.  
**Keywords:** illumination, lighting

**E3 – Install splitter islands on the minor-road approach to an intersection**  
Where to use - Minor road approaches to unsignalized intersections where the presence of the intersection or the stop sign is not readily visible to approaching motorists. The strategy is particularly appropriate for intersections where the speeds on the minor road are high.  
**Keywords:** channelizing separator islands, splitter island

**E4 – Provide a stop line on minor-road approaches**  
Where to use - Approaches to unsignalized intersections having traffic control devices that are not currently being recognized by some approaching motorists. Locations should be identified by patterns of crashes related to lack of driver recognition of the traffic control device (e.g., right-angle crashes related to stop sign violations).  
**Keywords:** centerline, stop bar, stop sign

**E5 – Install transverse rumble strips on intersection approaches**  
Where to use - Approaches to unsignalized intersections with traffic control devices that are not currently being recognized by some approaching motorists. Locations should be identified by patterns of crashes related to lack of driver recognition of the traffic control device (e.g., right-angle crashes related to stop sign violations). Rumble strips should be considered after an adequate trial of less intrusive treatments.  
**Keywords:** transverse rumble strips, stop controlled approach

**E6 – Provide supplementary stop signs mounted over the roadway**  
Where to use - Unsignalized intersections with patterns of right-angle crashes related to lack of driver awareness of the presence of the intersection. In particular, it might be appropriate to use this strategy at the first stop-controlled approach (possibly of a series) located on a long stretch of highway without any required stops, or at an intersection located after a sharp horizontal curve.

**E7 – Provide pavement markings with supplementary messages, such as STOP AHEAD**  
Where to use - Unsignalized intersections with patterns of rear-end, right-angle, or turning crashes related to lack of driver awareness of the presence of the intersection.  
**Keywords:** STOP AHEAD, pavement marking

**E8 – Provide improved maintenance and retroreflectivity of stop signs**  
Where to use - All stop-controlled intersections.  
**Keywords:** retroreflectivity, stop sign

**E9 – Install flashing beacons at stop-controlled intersections**  
Where to use - Unsignalized intersections with patterns of right-angle crashes related to lack of driver awareness of the intersection on an uncontrolled approach and lack of driver awareness of the stop sign on a stop-controlled approach.  
**Keywords:** flashing beacon, stop controlled

**E10 – Add a warning beacon to an existing regulatory or warning sign (Provide flashing beacons at stop controlled intersections)**  
Where to use - Unsignalized intersections with a crash history or observed vehicle conflicts caused by non-compliance with a traffic control device or lack of awareness of intersection traffic control and where the existing sign is not conspicuous in its surroundings.

**E11 – Provide intersection warning signs**  
Where to use - Unsignalized intersections with poor visibility of the intersection from approaches, a crash history or observed conflicts involving lack of awareness of the intersection or traffic control, and observed speeding on approaches to the intersection.

**E12 – Provide Advance Traffic Control Warning signs (Install advance warning signs (positive guidance))**  
Where to use - Unsignalized intersections with poor visibility of the intersection traffic control from one or more approaches.

**E13 – Install post-mounted reflective delineators at the intersection**  
Where to use - Unsignalized intersections with a history of nighttime crashes, remote stretches in which intersections may not be conspicuous to drivers along the major road, and poor nighttime visibility of the intersection.

**E14 – Install reflective strips on sign posts**  
Where to use - Unsignalized intersections with observed poor conspicuity of existing signs, particularly at night, crash history or observed conflicts due to lack of awareness of the intersection or intersection traffic control, especially at night, and observations of non-compliance with traffic control.  
**Keywords:** enhance regulatory

**E15 – Provide a yield line on yield-controlled approaches**  
Where to use - Unsignalized intersections with a crash history or observed conflicts related to failure to yield to the right-of-way.

**E16 – Replace standard stop sign with flashing LED enhanced stop sign**  
Where to use - Unsignalized intersections with a crash history or observed vehicle conflicts caused by non-compliance with traffic control device or lack of awareness of intersection traffic control, an existing sign that is not conspicuous in its current surroundings, and poor sign visibility during low-light conditions.  
**Keywords:** enhance warning

**E17 – Install red or orange flags with a regulatory or warning sign**  
Where to use - Unsignalized intersections with conflicts caused by non-compliance with traffic control device or lack of awareness of intersection traffic control, an existing sign that is not conspicuous in its surroundings, and a recent change in traffic control or traffic regulation.

**E18 – Enhance pedestrian signing**  
Where to use - Use such signs as a Pedestrian Warning sign (W11-2), Turning Vehicles Yield to Peds sign (R10-15), Pedestrian Crossing Sign (R1-5, R1-9, R9-2, R9-3), and In-Street Pedestrian Crossing Sign (R1-6) at unsignalized intersections with conflicts between vehicles and pedestrians crossing the roadway, vehicles that are not yielding to pedestrians in existing crosswalk or unmarked crosswalk.

**E19 – Replace transverse crosswalk markings with high visibility markings**  
Where to use - Unsignalized intersections with conflicts between vehicles and pedestrians crossing the roadway, vehicles that are not yielding to pedestrians in existing crosswalk or unmarked crosswalk.

**E20 – Provide advance yield line**  
Where to use - Unsignalized intersections with conflicts between vehicles and pedestrians crossing the roadway, vehicles that are not yielding to pedestrians in existing crosswalk.

## CATEGORY F: CHOOSE APPROPRIATE INTERSECTION TRAFFIC CONTROL

**F1 – Provide all-way stop-control at appropriate intersections**  
Where to use - Unsignalized intersections with patterns of right-angle and turning crashes and moderate and relatively balanced volumes on the intersection approaches.  
**Keywords:** stop control, all-way stop



**F2 – Provide roundabouts at appropriate locations**  
Where to use - Unsignalized intersections that are experiencing right-angle, rear-end, and turning crashes. Roundabouts are appropriate at most intersections, and at intersections with large traffic delays roundabouts are oftentimes a superior alternative to all-way stop or signalization. Roundabouts can also be very effective at intersections with complex geometry (e.g., more than four approach roads) and intersections with frequent left-turn movements.  
**Keywords:** roundabout, unsignalized



**F3 – Provide pedestrian hybrid beacon**  
Where to use - Unsignalized intersections with conflicts between vehicles and non-motorists crossing at the intersection, high volume of crossing pedestrians or bicyclists, vehicles not yielding to pedestrians in crosswalk, and high pedestrian delay due to few available gaps in traffic.  
**Keywords:** high intensity activated crosswalk, pedestrian activated beacon



**F4 – Provide rectangular rapid flashing beacon**  
Where to use - Unsignalized intersections with conflicts between vehicles and non-motorists crossing at the intersection, high volume of crossing pedestrians or bicyclists, vehicles not yielding to pedestrians in crosswalk, and high pedestrian delay due to few available gaps in traffic.  
**Keywords:** pedestrian delay, bike



**F5 – Convert a unsignalized intersection to an unsignalized restricted crossing U-turn (also known as a J-turn)**  
Where to use - Unsignalized intersections with conflicts involving left-turning vehicles or vehicles attempting to continue on the minor road by crossing the major road, insufficient gaps in major road traffic for left-turn or through movements from minor road, and conflicts involving vehicles in the median.  
**Keywords:** super-street, j-turn, cut



## CATEGORY G: IMPROVE COMPLIANCE WITH TRAFFIC CONTROL DEVICES AND TRAFFIC LAWS

**G1 – Provide targeted enforcement to reduce stop sign violations**  
Where to use - Unsignalized intersections where stop sign violations and patterns of crashes related to stop sign violations have been observed. Crash types potentially related to stop sign violations include right-angle and turning collisions.



**G2 – Provide targeted public information and education on safety problems at specific intersections**  
Where to use - Jurisdictions that have experienced a large number of safety problems at unsignalized intersections.

## CATEGORY H: REDUCE OPERATING SPEEDS

**H1 – Provide targeted speed enforcement**  
Where to use - Unsignalized intersections where speed violations and patterns of crashes related to speed violations are observed. Crash types potentially related to speed violations include right-angle, rear-end, and turning crashes.  
**Keywords:** speed limit, speed limit sign



**H2 – Provide traffic calming on intersection approaches through a combination of geometric and traffic control devices**  
Where to use - Specific approaches to unsignalized intersections that are experiencing crash types potentially related to speed violations, specifically right-angle, rear-end, and turning collisions.  
**Keywords:** speed limit, speed limit sign



**H3 – Post reasonable, safe, and consistent speed limits on intersection approaches**  
Where to use - Unsignalized intersections experiencing a high frequency of speed related violations or crashes.  
**Keywords:** lower posted speed, speed limit

**H4 – Provide speed reduction pavement markings**  
Where to use - Unsignalized intersections with a citation history or observations of speeding on the approach to the intersection and conflicts due to lack of awareness of the intersection.  
**Keywords:** speed limit, speed limit sign



**H5 – Provide a dynamic speed feedback sign**  
Where to use - Unsignalized intersections with a citation history or observations of speeding on approach to intersection, change in speed limit or land use (e.g., change from rural to urban), and changeable speed limit by time and day of the week (e.g., during school hours).  
**Keywords:** changeable speed warning signs



**H6 – Provide smooth lane narrowing**  
Where to use - high-speed, uncontrolled approaches of two-lane two-way stop controlled intersections with low traffic volumes to reduce speeds when approaching such intersections. Lane narrowing can be accomplished through pavement markings or a combination of pavement markings and edge line/shoulder/median rumble strips.  
**Keywords:** lane narrowing, rumble strips, painted median



## CATEGORY I: GUIDE MOTORISTS MORE EFFECTIVELY

**I1 – Provide turn path markings**  
Where to use - Complex unsignalized intersections with a high frequency of crashes related to turning vehicle positioning (e.g., sideswipe crashes).  
**Keywords:** channelization



**I2 – Provide a double yellow centerline on the median opening of a divided highway at intersections**  
Where to use - Unsignalized intersections on divided highways that are experiencing a high degree of crashes caused by side-by-side queuing and angle stopping within the median area.

**I3 – Provide a double yellow centerline on the minor road approaches**  
Where to use - Unsignalized intersections with conflicts between stopped vehicles and turning or oncoming vehicles and poor vehicle positioning.  
**Keywords:** centerline, stop bar, stop sign



**I4 – Provide dotted edge-line extensions**  
Where to use - Unsignalized intersections with vehicles on the minor approaches not positioning themselves appropriately before entering the major road and vehicles in the median of a divided roadway that are encroaching upon the major road through lane.  
**Keywords:**



## UNSIGNALIZED COST

SAFETY CONCERN	Low	Moderate	High
<b>High frequency of right-angle crashes attributed to:</b>			
nearly driveways	A2, C1, C3	A1, B6, B8	
traffic from minor street	C1, C3, D2, E4	B6, B8, D1	A3, F2
skewed intersection			B11, C2, F2
poor sight distance	C1, C3, H3	D1	C2, F2
drivers misjudging gaps	H3, H6	A4, D1	F2, F5
not enough gaps for drivers	D2, F1	A4	B9, F2, F5
driver unaware of intersection	E1, E4-E14, E16, E17	E3	
nighttime conditions	E8	E2	
failure to yield at stop or yield sign	E1, E4, E20	G1	F2
possible signal location			F2
heavy but balanced traffic flow			F2
speed differentials of vehicles	H3, H6	A4, H1, H2	F2
<b>High frequency of rear-end crashes attributed to:</b>			
left turning vehicles hit from behind	B3	B1, B2, B3	F2
left opposing vehicles hit from behind		B2	F2
trucks and RVs entering divided highway		B4	
speed differential of entering vehicles		B4	F2
right turning vehicles hit from behind		B5, B6	B11, F2
approaching vehicles hit from behind		B7	
no left turn lane and high opposing traffic		B8	
driver unaware of intersection	E1, E5-E14, E16, E17	E3	
nighttime conditions		E2	
speed differentials of vehicles	H3, H4, H6	H1, H2, H5	F2
<b>High frequency of left-turn crashes attributed to:</b>			
left turn vehicles hit by opposing traffic		B1	B10, B14, C2, F2, F5
trucks and/or RVs entering divided highway		B4	
no left turn lane and high opposing traffic		B8	
nighttime conditions	E10	E2	
heavy but balanced traffic flow			F2
Poor sight distance			C2
<b>High frequency of sideswipe crashes attributed to:</b>			
speed differential of entering vehicles	H6		F2
vehicles within intersection	I1, I2	B12	
vehicles approaching intersection	I3		
<b>High frequency of run off road crashes:</b>			
approaching intersection	I4	B7	
<b>High frequency of pedestrian/bicycle crashes:</b>			
	E18-E20	B12-B13, F3-F4, H2	
<b>Address overall safety issues:</b>			
violation of traffic laws	G2	G1	

## Key to the Brochure

**Costs:** Costs will also vary considerably and are affected by local conditions. Costs are ranked as: low, moderate, moderate to high, and high. The scale is meant to reflect costs relative to the other strategies described in the category (signalized or unsignalized).

● Low Cost Measure ● Moderate Cost Measure ● High Cost Measure

**P** FHWA Proven Safety Countermeasure: More information about FHWA Proven Safety Countermeasures can be found at: <http://safety.fhwa.dot.gov/provencountermeasures/>

**E** FHWA Everyday Counts: Every Day Counts (EDC) is an effort led by FHWA in cooperation with American Association of State and Highway and Transportation Officials (AASHTO) to identify and rapidly deploy proven but underutilized innovations to shorten the project delivery process, enhance roadway safety, reduce congestion and improve environmental sustainability. See <http://www.fhwa.dot.gov/everydaycounts/> for additional information.

**Keywords:** Keywords have been provided for those countermeasures with a crash modification factor in the CMF Clearinghouse (<http://www.cmfclearinghouse.org/>). Some countermeasures may be found using a variety of search terms and the keywords provided are examples of those terms. For those countermeasures without keywords listed, their effectiveness may not have been studied or submitted to the CMF Clearinghouse.

**SIG** FHWA Signalized Intersections: An Informational Guide (2nd Edition): <http://safety.fhwa.dot.gov/intersection/signalized/13027/fhwas13027.pdf>

**UNSIG** Unsignalized Intersection Improvement Guide (NCHRP 03-104)

**BIKE** BIKESAFE 2014 - Bicycle Safety Guide and Countermeasure Selection System [http://pedbikesafe.org/BIKESAFE/guide\\_background.cfm](http://pedbikesafe.org/BIKESAFE/guide_background.cfm)

**PED** PEDSAFE 2013 - Pedestrian Safety Guide and Countermeasure Selection System [http://pedbikesafe.org/PEDSAFE/guide\\_background.cfm](http://pedbikesafe.org/PEDSAFE/guide_background.cfm)

