PEDESTRIAN & BICYCLE SAFETY STRATEGIES

Category A: Improvements Along the Roadway
A1 - Provide sidewalks, walkways, and paved shoulders
A2 - Provide street furniture and a secure walking environment
A3 - Fill sidewalk gaps
A4 - Add shared use paths
A5 - Install speed feedback signs
A6 - Install speed limit pavement markings
A7 - Provide dedicated pedestrian, bicycle and/or transit lanes

Category B: Geometric Improvements at Crossing Locations
B1 - Install marked crosswalks or enhance existing crosswalks*
B2 - Provide bulb-out curbs*
B3 - Provide crossing islands*
B4 - Provide raised crossings for pedestrians and cyclists*
B5 - Restrict on-street parking near crossing locations*
B6 - Install a pedestrian overpass or underpass
B7 - Extend median nose past crosswalk
B8 - Relocate crosswalk to improve visibility of pedestrians
B9 - Reduce corner radii to encourage lower turning speeds
B10 - Modify curb corners to provide each crosswalk its own ramp
B11 - Install a hardened centerline at intersections
B12 - Reduce width of driveways
B13 - Provide adequate crossing facilities at existing roundabout entries

Category C: Transit-Related Improvements
C1 - Transit stop improvements
C2 - Increase access to transit services

Category D: Bicycle Facilities
D1 - Install marked bicycle lanes or enhance existing bicycle lanes
D2 - Increase bicycle lane width
D3 - Pave shoulders
D4 - Install colored bicycle lanes at signalized intersections
D5 - Provide separated bicycle facilities
D6 - Provide bicycle boxes at intersections
D7 - Install in-road bike lanes
D8 - Implement a protected intersection
D9 - Implement keyhole bike lanes
D10 - Provide bike lanes, cycle track, or grade-separated bike path at roundabouts

Category E: Sign and Signal Improvements
E1 - Install traffic signals
E2 - Install or enhance pedestrian signals
E3 - Improve pedestrian signal timing
E4 - Restrict right-turns-on-red
E5 - Install a Pedestrian Hybrid Beacon (PHB)*
E6 - Install Rectangular Rapid Flashing Beacons (RRFBs)*
E7 - Install a Pedestrian User Friendly Intelligent Intersection (PUFFIN) Crossing
E8 - Install advance pedestrian warning signs*
E9 - Install in-street pedestrian crossing signs*
E10 - Install in-crosswalk lighting
E11 - Install LED flashing signs
E12 - Install automated pedestrian detection
E13 - Implement a Leading Pedestrian Interval (LPI)
E14 - Replace a 5-section signal head with a 4-section signal head
E15 - Provide an accessible pedestrian signal
E16 - Install “Yield To Peds” or “Turning Vehicles Yield/Stop for Peds” signs
E17 - Install “Bikes May Use Full Lane” and fluorescent yellow-green ped/bike signs
E18 - Install “Begin Right Turn Lane Yield To Bikes” signs
E19 - Install RRFBs in advance of crossing RRFBs
E20 - Install advance yield or stop lines*
E21 - Implement a Barnes Dance (Pedestrian Scramble)
E22 - Install “PED XING” pavement markings

Category F: Improve Pedestrian and Bicycle Safety through Other Measures
F1 - Install or enhance school zone features
F2 - On-street parking enhancements
F3 - Pedestrian and driver education programs
F4 - Implement a shared street
F5 - Provide pedestrian streets or malls
F6 - Enhanced railroad crossing safety
F7 - Provide adequate lighting*
F8 - Manage or restrict turning movements
F9 - Consider relevant ADA requirements
F10 - Provide pedestrian fencing
F11 - Provide pedestrian railings

* Please refer to Table 1 in the Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations (Page 16) which provides guidance on application of the specific countermeasure relative to facility types (number of lanes, speed limits, etc.)

E5 - Install a Pedestrian Hybrid Beacon (PHB) Where to use - Unguided pedestrian crossings across high-speed of high-volume roads. Should be installed with a marked crossing, countermotor signals at pedestrian heads, appropriate pedestrian detectors, overhead beacon lights, and appropriate “CROSSWALK STOP ON RED PROCEED ON FLASHING RED WHEN CLEAR” overhead signs with advisory pedestrian with diagonal downward pointing arrows signs located at the top bar.

E6 - Install Rectangular Rapid Flashing Beacons (RRFB) Where to use - Uncontrolled marked crossings, particularly multilane crossings with speeds limit less than 40 MPH. RRFBs should be used in conjunction with pedestrian crossing signals and appropriate advance yield or stop pavement markings and signs.

E7 - Install a Pedestrian Island (PI) Where to use - Where crosswalks are long, the pedestrian volumes are high, or where there are any pedestrian hazards to be avoided. Safety improvements include:

- Improvements include:
- Installing an island, or curbs, or a combination of both, to separate crossing areas.
- Installing a curb or wall to define the pedestrian island.
- Installing a barrier to protect pedestrians.
- Installing a raised median to reduce vehicle speeds.

E8 - Install advance pedestrian warning signs Where to use - Crossings where pedestrian volumes may not be expected by motorists.

E9 - Install in-street pedestrian crossing signs Where to use - Unguided marked crossings requiring enhancements of preferred pedestrian stop or yield locations.

E10 - Install in-crosswalk lighting Where to use - Marked crossings requiring improvement of preferred pedestrian locations and preferred stop or yield locations for vehicles. These signs include “STATE LAW Stop For Pedestrians In Crosswalk” signs.

E11 - Install LED Flashing signs Where to use - Uncontrolled marked crossings, particularly multilane crossings, with speeds limit less than 40 MPH. LED flashing signs should be used in conjunction with appropriate advance yield or stop pavement markings and signs.

E12 - Install automated pedestrian detectors Where to use - Pedestrian crossings with button-activated signals, particularly where a high frequency of users are disregarding the pushbutton or are visually impaired.

E13 - Install a Leading Pedestrian Interval (LPI) Where to use - Crossings where pedestrian volumes move simultaneously to a conflicting turn phase. 15% to 3 to 7 seconds help establish pedestrian within crosswalks and improves vehicle compliance with yielding to pedestrians within the crosswalk.

E14 - Replace a 5-section signal head with a 4-section signal head Where to use - Turn lanes controlled by a 5-section signal head where permissive turn phases with pedestrian conflicts, limiting the time available for pedestrians to cross the conflicting pedestrian walk cycle.

E15 - Install an accessible pedestrian signal Where to use - Crossings where accommodations are required for pedestrians with special needs, such as visual impairment.

E16 - Install “ Yield To Peds” or “ Turning Vehicles Yield/Stop For Peds” signs Where to use - Where signalized intersections are long, pedestrian movements may conflict with a crossing pedestrian phase. Improvements include static and blank-out variants of “Yield to Peds” signs.

E17 - Install “Bikes May Use Full Lane” and fluorescent yellow-green ped/bike signs Where to use - Where to use - Where roads where no bicycle lanes or adjacent shoulders are present and where travel lanes are too narrow for bicyclists and vehicles to operate side by side.

E18 - Install “Begin Right Turn Lane Yield To Bikes” signs Where to use - Where to use - Where vehicles enter an exclusive right-turn lane and must cross a bicycle lane.

E19 - Install RRFBs in advance of crossing RRFBs Where to use - Where to use - Midblock crossings where high-speeds in conflict with pedestrian movements. This may be due to lack of compliance and/or conflicts between conflicting pedestrian walk cycles.

E20 - Install advance yield or stop lines Where to use - Uncontrolled mid-block crossings. Yield or stop lines placed 20 to 50 feet in advance of the crosswalk improve driver visibility of crossing pedestrians.

E21 - Implement a Barnes Dance (Pedestrian Scramble) Where to use - Where to use - Signalized intersections with a high frequency of pedestrian and vehicle conflicts, and a dedicated pedestrian signal phase.

E22 - Install “PED XING” pavement markings Where to use - In Advance of crosswalks where the appropriate advance warning sign.

CATEGORIE B: IMPROVE PEDESTRIAN AND BICYCLE SAFETY THROUGH OTHER MEASURES

F1 - Install or enhance school zone features Where to use - School zones where drivers are speeding or not yielding to children in crosswalks. Improvements include:

- Police enforcement or well-trained adult crossing guards
- Slow parking prohibited
- Install or enhance school zone signs and markings.

F2 - On-street parking enhancements Where to use - Busy streets where motorists drive at excessive high speeds and volumes.

- Parking or on-street parking restrictions
- Where to use - Additional on-street parking creates an effective buffer between sidewalks and travel ways, and can serve as a traffic calming measure, reducing vehicle speeds and making drivers move slower.

F3 - Pedestrian warning pavement markings Where to use - Communities may wish to consider installing pedestrian warning pavement markings.

F4 - Implement a shared street Where to use - Streets with very low vehicle volume (approximately 100 or fewer vehicles per hour) and a balance of pedestrian, vehicle, and bicycle use. Shared streets should prioritize low-speed vehicle traffic balanced with pedestrian access and safety.

F5 - Provide pedestrian education programs Where to use - Where to use - Pedestrians are the most vulnerable to injuries and fatalities. High visibility and redundancy are key to success.

F6 - Enhanced road railroad safety Where to use - Railroad crossings lack adequate facilities to assure adequate visibility, sound, or a combination thereof for pedestrians. Additional pedestrian crossing signals may be required. Rail crossing improvements may include:.

- Pedestrian signals with accompanying alarms or announcements indicating an approaching train;
- Guard arms, swing gates, and tactile mats;
- Grade-separated crossing structures (overpass/underpass);
- And, where feasible, a combination of the above.

F7 - Provide adequate lighting Where to use - Crossings with inadequate or unequal street lighting around pedestrian facilities. Pedestrians should be lit from the traffic-approach side on both sides of the road to avoid collisions.

F8 - Manage or restrict turning movements Where to use - Locations where specific turn movements cause excessive conflict with pedestrian traffic and alternative vehicular turns or routing opportunities can be implemented.

F9 - Consider relevant ADA requirements Where to use - Contextually relevant locations where ADA requirements are insufficient for expected users of pedestrian and bicycle facilities.

F10 - Provide pedestrian fencing Where to use - Uncontrolled pedestrian pathways, including roadway sidewalks, to encourage pedestrians and cyclists to cross desired locations.

F11 - Reduce pedestrian railings Where to use - Sidewalks and pathways where adjacent side railings are greater than 11".

- Low-Cost Countermeasure
- Moderate-Cost Countermeasure
- High-Cost Countermeasure
LANE DEPARTURE SAFETY STRATEGIES

CATEGORY 1: KEEP VEHICLES FROM DEPARTING THE ROADSIDE

CATEGORY 1A: CURVE SAFETY

1A 1 - Add spiral transitions to curve - Where to use - High-speed curve locations where standard arc transitions cause driver discomfort.

1A 2 - Increase curve radius - Where to use - Curve locations where curve radii are insufficient to safely or comfortably navigate the curve.

1A 3 - In-lane curve warning pavement markings - Where to use - Curve locations with curve warning signs in place continuing to experience lane departures.

1A 4 - Static curve warning signs - Where to use - Curve locations without adequate curve warning signs to warn drivers of upcoming curve conditions, including curve speed advisory signs.

1A 5 - Fluorescent curve warning signs - Where to use - Curve locations where curve warning signs require increased daytime conspicuity against background environments.

1A 6 - Changeable curve warning signs - Where to use - Curve locations requiring additional supplemental messaging, such as vehicles traveling too fast for the upcoming curve or where hazardous road conditions regularly occur.

1A 7 - Flashing curve warning signs - Where to use - Curve locations with curve warning signs in place continuing to experience lane departures.

1A 8 - Sequential flashing beacons - Where to use - Curve locations requiring additional emphasis and guidance for the upcoming change in horizontal alignment.

1A 9 - Standard chevron signs - Where to use - Curve locations requiring additional emphasis and guidance for the upcoming change in horizontal alignment.

1A x - Oversized chevron signs - Where to use - Curve locations requiring chevron signs with greater conspicuity or where lane departures continue to occur.

1A xi - Improve superelevation - Where to use - Curve locations where the existing superelevation is insufficient to adequately support the speed of travel.

1A xii - Install "Share The Road" signs - Where to use - Roads where no bicycle lanes or adjacent shoulders are present and where travel lanes are too narrow for bicyclists and vehicles to operate side by side. These signs are especially useful for high speed, high volume, or narrow lane roads.

1A xiii - Install "Bicycles May Use Full Lane" signs - Where to use - Roads where no bicycle lanes or adjacent shoulders are too narrow for bicyclists and vehicles to operate side by side. These signs are especially useful for high speed, high volume, or narrow lane roads and are shown to have a higher compliance rate than "Share The Road" signs due to their clearer messaging.

1A xiv - Install optical speed bars and/or chevrons - Where to use - Curve locations where vehicle speeds exceed the speed recommended for the design superelevation.

1B 1 - Resurfacing - Where to use - Locations where pavement condition is poor. Consideration should be given to the proximity to future resurfacing projects.

1B 2 - Friction course application - Where to use - Locations, particularly curves or high-speed roads, where friction course application is preferable to geometric changes to the roadway. Friction course treatments include cold application, complex blend, warm mix, and other horizontal reductions.

1B 3 - Pavement grinding patterns - Where to use - Locations, particularly curves or high-speed roads, where pavement grinding is preferable to geometric changes to the roadway. Pavement grinding patterns include but are not limited to diamond grinding and grooving.

CATEGORY 1C: ACOUSTIC PAVEMENT MARKINGS

1C 1 - Football-shaped centers - Where to use - Locations where vehicles are crossing the centerlines. Football-shaped rumble strips produce more noise but less vibration compared to rectangular rumble strips.

1C 2 - Rectangular centers - Where to use - Locations where vehicles are crossing the centerlines. Rectangular rumble strips produce more vibration but less noise compared to football-shaped rumble strips.

1C 3 - Edgeline rumble strips - Where to use - Locations where vehicles are crossing the edgeline due to driver inattentiveness. Edgeline rumble strips provide greater nighttime visibility, particularly in wet-weather conditions, compared to shoulder rumble strips.

1C 4 - Shoulder rumble strips - Where to use - Locations where vehicles are crossing the edgeline due to driver inattentiveness. Shoulder rumble strips may be installed on existing shoulders without damaging existing edgeline pavement markings.

1C 5 - Transverse rumble strips - Where to use - Locations where drivers need to be alerted to changing conditions not anticipated by the inductive driver, such as the need to slow down approaching a curve.

1C 6 - Profiled thermoplastic pavement markings - Where to use - Locations where a low-cost alternative to rumble strips is desired. Profiled thermoplastic performs especially well at night and in wet-weather conditions compared to standard thermoplastic pavement markings.

1C 7 - Preferred rumble strips - Where to use - Locations where a low-cost alternative is preferred to traditional transverse rumble strips.

CATEGORY 1D: NIGHTTIME VISIBILITY

1D 1 - Increase pavement marking retroreflectivity - Where to use - Locations where pavement markings are characterized by poor visibility at night or are worn and in need of refreshing.

1D 2 - Install flashing beacons as advance warning - Where to use - Locations where roadway conditions or features require greater driver attention due to nighttime visibility limitations.

1D 3 - Provide new highway lighting - Where to use - Locations without highway lighting which meet AASHTO and TAC requirements.

1D 4 - Improve existing highway lighting - Where to use - Locations where existing lighting is insufficient for present road conditions.

1D 5 - Provide wider edgelines (8") - Where to use - Locations requiring greater edgeline conspicuity, such as at alignment changes.

1D 6 - Post-mounted delineators - Where to use - Short stretches featuring changes in horizontal alignment such as curves or lane-reduction transitions. Can be used in conjunction with oversized chevron signs.

1D 7 - Improve sign retroreflectivity - Where to use - Locations where existing signs are damaged, worn, or otherwise insufficiently retroreflective to provide adequate nighttime visibility.

1D 8 - Install retroreflective strips on sign poles - Where to use - Signs requiring additional conspicuity, particularly at night, especially curve warning signs, cue delineators, and WARNING WAY signs.

1D 9 - Install or refurbish existing pavement edgelines and Reflective Pavement Markers - Where to use - Locations where pavement edgelines or Reflective Pavement Markers are either missing or sufficiently worn as to negatively impact driver awareness and visibility of the pavement edge.

CATEGORY 1E: SPEED MANAGEMENT

1E 1 - Decrease speed limit - Where to use - Locations exhibiting large number of speed-related run-off-the-road crashes.

1E 2 - Install changeable speed warning signs - Where to use - Locations exhibiting large number of speed-related run-off-the-road crashes where the speed limit is deemed appropriate.

CATEGORY 1F: OTHER MEASURES

1F 1 - Increase lane width - Where to use - Locations where narrow lanes are found to contribute to lane departure type crash trends.

1F 2 - Add median or increase existing median width - Where to use - Locations with high frequency of head-on crashes caused by vehicles traveling the median, including a Two-Way Left Turn Lane. Medians taking the place of a Two-Way Left Turn Lane should include median openings where appropriate.

1F 3 - Add shoulders or increase existing shoulder width - Where to use - Locations where narrow shoulders are found to contribute to lane departure crash trend.

1F 4 - Provide wider edgelines (8") - Where to use - Locations where shoulders are non-existent or comprised of grass, gravel or other composite material.

1F 5 - Install advance warning signs - Where to use - Unexpected road features or conditions requiring driver action or awareness.

1F vi - Limited sight distance signs - Where to use - In the vicinity of roadway alignment, foliage, or other natural vegetation which may obstruct the view.

1F vii - "Lane Ends" signs - Where to use - Locations where a reduction in the number of lanes is imminent and drivers must merge from the upcoming dropped lane.

CATEGORY 2: PROVIDE FOR SAFE RECOVERY AFTER ROADSIDE DEPARTURE

CATEGORY 2A: CLEAR ZONE MODIFICATION

2A 1 - Change clear zone width - Where to use - Locations where clear zone widths do not meet FDM criteria or are otherwise excessively narrow.

2A 2 - Relocate fixed objects outside of clear zone - Where to use - Locations where fixed objects, such as trees, sign posts, and light posts, are located within the Clear Zone or otherwise do not meet roadway safety criteria in the FDM.

CATEGORY 2B: VEHICULAR CONTROL

2B 1 - SafetyEdge® - Where to use - Locations with narrow paved shoulders or grass shoulders where pavement-edge-related crashes occur. Additional testing may be needed to qualify the application of Safety Edge.

2B 2 - Flatten side slopes - Where to use - Locations where clear zone side slopes do not meet FDM criteria or are otherwise excessively tall.

CATEGORY 3: REDUCE CRASH SEVERITY WHEN RECOVERY IS NOT POSSIBLE

CATEGORY 3A: LONGTIDUAL BARRIERS

3A 1 - Cable barrier - Where to use - Locations where roadside barriers are desired to arrest vehicles departing the roadway, preventing them from deflecting back into traffic or from reaching oncoming traffic lanes or other hazardous roadside conditions.

3A 2 - Guardrail barrier - Where to use - Locations where roadside barriers are desired to prevent vehicles from deflecting back into traffic or from reaching oncoming traffic lanes or hazardous roadside conditions.

3A 3 - Concrete barrier - Where to use - Locations where roadside barriers are desired to deflect vehicles into the shoulder or use with travel lanes where significant roadside hazards exist, such as at bridges.

3A 4 - Concrete wall - Where to use - Locations where roadside barriers are desired to deflect vehicles into the shoulder or use with travel lanes where significant roadside hazards exist, such as at bridges. Concrete walls assist in noise reduction from roadway traffic to neighboring developments.

3A v - Crash cushions at fixed roadside features - Where to use - Locations where roadside fixed objects such as roadside barriers cannot be relocated outside the roadway or clear zone.

CATEGORY 3B: ROADSIDE FIXED OBJECTS

3B 1 - Increase lateral offset of utility poles - Where to use - Locations where utility poles are located within the Clear Zone or otherwise do not meet roadside safety criteria in the FDM.

3B 2 - Reduce longitudinal density of utility poles - Where to use - Locations where the number or spacing of utility poles poses a greater risk to vehicles departing the roadway.

3B 3 - Increase lateral clearance between the traveled way and objects within clear zone - Where to use - Locations where objects are located within the clear zone but are unable to be relocated based on the FDM criteria.

Cost Countermeasure

= Low-Cost Countermeasure

= Moderate-Cost Countermeasure

= High-Cost Countermeasure

The majority of the countermeasure information was obtained from FHWA’s “Roadway Departure Safety Website.” This information is supplemented with additional countermeasure considerations from the FHWA’s CMF Clearinghouse.
**Category A: Reduce frequency and severity of intersection conflicts through traffic control and operational improvements**

A1 - Replace permissive left turns with protected left turns
A2 - Optimize change and clearance intervals
A3 - Restrict or eliminate turning maneuvers
A4 - Employ signal coordination
A5 - Employ emergency vehicle preemption
A6 - Remove un warrant ed signal
A7 - Change green signal to flashing yellow arrow for permissive left turns
A8 - Implement/implement pedestrian signal improvements
A9 - Install bicycle signal
A10 - Install transit signal priority technology
A11 - Modify night-time flash period (replace with steady operation)
A12 - Change left-turn phase permission (protected/permissive modification)

**Category B: Reduce intersection conflicts through geometric improvements**

B1 - Provide/improve turn lane channelization
B2 - Improve geometry of pedestrian and bicycle facilities
B3 - Utilize innovative intersection geometry
B4 - Corridor access management - implement median closures
B5 - Provide right-turn lanes at intersections
B6 - Convert T intersection to a continuous green T intersection
B7 - Install left-turn lane
B8 - Install acceleration/deceleration lanes
B9 - Change intersection skew angle

**Category C: Improve sight distance at signalized intersections**

C1 - Clear sight triangles
C2 - Increase positive turn lane offset

**Category D: Improve driver awareness of intersections and signal control**

D1 - Improve visibility of intersections and signal control
D2 - Improve visibility of signals and signs at intersections
D3 - Install/add one signal head per lane
D4 - Install larger 12" signal heads
D5 - Install signal backplates/retroreflective backplates
D6 - Install intersection warning devices
D7 - Convert pole mounted to overhead signals
D8 - Install supplemental pole-mounted signal on near-side approach
D9 - Install flashing beacons as advance warning
D10 - Advance street name signs
D11 - Convert signal from diagonal span wire to box span
D12 - Convert signal from span wire to mast arm

**Category E: Improve driver compliance with traffic control devices**

E1 - Provide public information and education
E2 - Provide targeted conventional enforcement of traffic laws
E3 - Post reasonable, safe, and consistent speed limits on intersection approaches
E4 - Install red-light indicator lights
E5 - Install red-light cameras
E6 - Install an actuated advance warning dilemma zone protection system at high-speed signalized intersections

**Category F: Improve access management near signalized intersections**

F1 - Modify driveway access
F2 - Corridor access management - implement median closures

**Category G: Improve safety through other infrastructure treatments**

G1 - Improve drainage in intersection and on approaches
G2 - Provide high friction surface treatment in intersection and on approaches
G3 - Coordinate closely spaced signals near at-grade railroad crossings
G4 - Relocate signal hardware out of clear zone
G5 - Restrict or eliminate parking on intersection approaches
G6 - Convert a conventional signalized intersection to a signalized superstreet
G7 - Resurface pavement
G8 - Improve lighting
G9 - Deactivate red-light camera

**For a more comprehensive list of countermeasures relevant to pedestrians and bicyclists at signalized intersections, please refer to the “Pedestrian & Bicycle Safety Strategies”**

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**SIGNALIZED COST**

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<td>with left turning vehicles</td>
<td>A1, A3, A12</td>
<td>A8, H1</td>
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**Address overall safety issues:**

- Violation of traffic laws | E1 | A9, E2 |
- Intersection near railroad crossing | G3 | |
- Intersection near fire station | A5 | |
- Excessive delay | A6 | G6 |
- Disobedience of traffic signal | A6 | A9, D3, D8, E4, E5 |
- Intersection frequented by transit services | A10 | |
CONTROL AND OPERATIONAL IMPROVEMENTS

SECTION A: MODIFY DRIVER AWARENESS OF INTERSECTIONS AND SIGNAL CONTROL

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

- **D6** - Install intersection warning devices Where to use - Signalized intersections with poor visibility of the interaction from approaches, conflicts involving lack of awareness of the interaction or traffic control, and observed speeding on approaches to the interaction. Intersection warning devices can include warning signals, beacons, flashing red light cameras, etc.

- **D7** - Convert pole mounted to overhead signals Where to use - Signalized intersections with poor visibility of the interaction from approaches, a crash history or observed conflicts involving lack of awareness of the interaction or traffic control, and observed speeding on approaches to the interaction.

SECTION B: IMPROVE ACCESS MANAGEMENT NEAR SIGNALIZED INTERSECTIONS

- **E1** - Provide driveway access Where to use - Signalized intersections with high crash frequencies related to driveways adjacent to the intersection. Generally, driveways within 210 feet of the intersection are the greatest concern.

- **E2** - 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.

SECTION C: 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.

- **G2** - Provide high friction surface treatment in intersection and on approaches Where to use - Signalized intersections where skidding is determined to be a problem, especially in wet conditions.

- **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 where appropriate signal modifications also occur if drivers speed through an intersection to avoid waiting in a queue near the railroad crossing.

- **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).

- **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.

- **G6** - Convert a conventional signalized intersection to a signalized superstreet Where to use - Signalized intersections experiencing excessive conflicts or delays, particularly with regard to left and turn traffic.

- **G7** - Resurface pavement Where to use - Signalized intersection approaches where skidding is determined to be a problem, especially in wet conditions.

- **G8** - Improve lighting Where to use - Signalized intersections experiencing a high frequency of nighttime rear end crashes.

- **G9** - Duct tape red-light camera Where to use - Signalized intersections with a high frequency of rear-end crashes caused by driver distraction in lane assignment.

= Low-Cost Countermeasure
= Moderate-Cost Countermeasure
= High-Cost Countermeasure

The majority of the countermeasure information and the format of this information was obtained from a web-based tool or other resource (or rephrasing) with the format 'Safety Strategies'. This information was supplemented with additional countermeasure considerations from FHWA’s CMF Clearinghouse.
UNSIGNALED INTERSECTION SAFETY STRATEGIES

Category A: Improve management of access
A1 - Corridor access management - reduce driveway conflicts
A2 - Corridor access management - modify driveway access
A3 - Corridor access management - reduce number of intersections
A4 - Corridor access management - implement median closures

Category B: Reduce conflicts through geometric design improvements
B1 - Provide left-turn lanes at intersection
B2 - Provide zero or positive offset left-turn lanes at intersections
B3 - Provide left or right-turn bypass lanes on shoulders at T-intersections
B4 - Provide left-turn acceleration lanes in median at divided highway high speed intersections
B5 - Provide right-turn lanes at intersections
B6 - Provide offset right-turn lanes at intersections
B7 - Provide full-width paved shoulders in intersection areas
B8 - Modify allowed turning maneuvers through geometric improvements
B9 - Convert four-legged intersections to offset T-intersections
B10 - Convert offset T-intersections to four-legged intersections
B11 - Realign intersection approaches to reduce or eliminate intersection skew
B12 - Reduce or extend curb radius
B13 - Install medians and pedestrian crossing islands
B14 - Install roundabout or mini 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
C2 - Change horizontal and/or vertical alignment of approaches to provide more sight distance
C3 - Eliminate parking that restricts sight distance
C4 – Install fence instead of wall to provide clear sight distance

Category D: Improve availability of gaps and assist drivers in judging gaps
D1 - Install an intersection conflict warning system (ICWS)
D2 - Re-time adjacent signals to create gaps at stop-controlled intersections

Category E: Improve driver awareness
E1 - Improve visibility of intersections by providing enhanced signing and delineation
E2 - Improve visibility of the intersection by providing lighting
E3 - Install splitter islands on the minor-road approach to an intersection
E4 - Provide a stop line on minor-road approaches
E5 - Install transverse rumble strips on intersection approaches
E6 - Provide supplementary stop signs mounted over the roadway
E7 - Provide pavement markings with supplementary messages (e.g. STOP AHEAD)
E8 - Provide improved maintenance and retroreflectivity of stop signs
E9 - Install flashing beacons at stop-controlled intersections
E10 - Add a warning beacon to an existing regulatory or warning sign (Provide flashing beacons at stop controlled intersections)
E11 - Provide intersection warning signs
E12 - Provide Advance Traffic Control Warning signs (Install advance warning signs (positive guidance))
E13 - Install post-mounted reflective delineators at the intersection
E14 - Install reflective strips on sign posts
E15 - Provide a yield line on yield-controlled approaches
E16 - Replace standard stop sign with flashing LED enhanced stop sign
E17 - Install red or orange flags with a regulatory or warning sign
E18 - Enhance pedestrian signing
E19 - Replace transverse crosswalk markings with high visibility markings
E20 - Provide advance yield line
E21 - Install crosswalk on one minor approach
E22 - Install object maker sign or keep right sign

Category F: Choose appropriate intersection traffic control
F1 - Provide all-way stop control at appropriate intersections
F2 - Provide roundabouts at appropriate locations
F3 - Provide pedestrian hybrid beacon
F4 - Provide rectangular rapid flashing beacon
F5 - Convert a unsignalized intersection to an unsignalized restricted crossing U-turn (also known as a J-turn)
F6 - Install a traffic signal
F7 - Install high-emphasis crosswalks

Category G: Improve compliance with traffic control devices and traffic laws
G1 - Provide targeted enforcement to reduce stop sign violations
G2 - Provide targeted public information and education on safety problems at specific intersections
G3 - Install pavement markings PED XING in advance of crossings
G4 - Install STATE LAW STOP FOR PEDS signs in advance of crossings

Category H: Reduce operating speeds
H1 - Provide targeted speed enforcement
H2 - Provide traffic calming on intersection approaches through a combination of geometric and traffic control devices
H3 - Post reasonable, safe, and consistent speed limits on intersection approaches
H4 - Provide speed reduction pavement markings
H5 - Provide a dynamic speed feedback sign
H6 - Provide smooth lane narrowing
H7 - Raised bicycle crossings
H8 - Raised intersections

Category I: Guide motorists more effectively
I1 - Provide turn path markings
I2 - Provide a double yellow centerline on the median opening of a divided highway at intersections
I3 - Provide a double yellow centerline on the minor road approaches
I4 - Provide dotted edge-line extensions

For a more comprehensive list of countermeasures relevant to pedestrians and bicyclists at unsignalized intersections, please refer to the “Pedestrian & Bicycle Safety Strategies”

The majority of the countermeasure information and the format of this information was obtained from FHWA’s “Unsignalized Intersection Safety Strategies”. This information was supplemented with additional countermeasure considerations from FHWA’s CMF Clearinghouse.
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.

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 modified.

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.

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 right and opposing traffic.

B2 – Provide left-turn accommodations at intersections 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.

C1 – Reduce conflicts through geometric design improvements Where to use - Unsignalized intersections or medians with poor visibility of the intersection approaches. High volume of through vehicles, high hourly vehicle volumes, peak hour vehicle volumes, insufficient gaps in major road traffic for crossing the major road, vehicles not yielding to pedestrians in crosswalk or unmarked crosswalk.

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 alleviated by less intrusive treatments or site.

C3 – Eliminate parking that restricts sight distance Where to use - Unsignalized intersections with restricted sight distance due to parking.

C4 – Install fence instead of wall to provide clear sight distance Where to use - Unsignalized intersections with restricted sight distance due to the presence of walls.

C5 – Improve visibility of intersections by providing lighting Where to use - Unsignalized intersections that are not visibly clear to approaching motorists, particularly approaching turning vehicles. Lighting improves visibility of intersections, 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-line) for major road continuity across the median opening at divided highway locations.

C6 – 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.

C8 – Install an intersection control warning system (ICWS) Where to use - Unsignalized intersections with a crash history showing vehicles entering or crossing the major road, difficulty among drivers in determining appropriate gap between turning and following traffic, lack of well-marked 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.

B13 – Install medians and pedestrian crossing islands Where to use - Unsignalized intersections with poor visibility of the intersection approaches. Where to use - Unsignalized intersections with a crash history or observed conflicts 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) on a long stretch of highway without any required stop, or at an intersection located in a rural area.

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

B8 – Provide improved maintenance and retroreflectivity of stop signs Where to use - All stop-controlled intersections.

B9 – 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.

B10 – 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.

B11 – Install warning signs Where to use - Unsignalized intersections with poor visibility of the intersection from approaches or observed conflicts related to lack of awareness of the intersection or traffic control, and observed speeding on approaches to the intersection.

B12 – Provide Advance Traffic Control Warning Signals (Install advance warning signs positive guidance) Where to use - Unsignalized intersections with poor visibility of the intersection traffic control from approaches.

B13 – Install post-mounted reflective delineators at the intersection Where to use - Unsignalized intersections with a history of nighttime crashes, remote streets in which may be inconspicuous to drivers approaching the major road, and poor nighttime visibility of the intersection.

B14 – Install reflective strips on sign posts Where to use - Unsignalized intersections with observed poor visibility of the intersection or observed conflicts due to lack of awareness of the intersection or traffic control, and observed speeding on approaches to the intersection.

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 turning vehicles. Lighting improves visibility of intersections, 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-line) for major road continuity across the median opening at divided highway locations.

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.

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.

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. Measures may include installing a minor road stop line, a visible marking of right-edge of 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.

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. Measures may include installing a transverse rumble strip, a visible marking of right-edge of 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.

E6 – Install a traffic signal Where to use - Unsignalized intersections that satisfy the requirements of the MUTCD Section 4C, including: 8-hour vehicle volumes, 4-hour vehicle volumes, peak hour vehicles, pedestrian volumes, vehicle crossing proximity, the presence of a coordinated signal system or roadway network, or an at-grade rail crossing.

F7 – Install high-emphasis crosswalks Where to use - Unsignalized intersections with pedestrian crossings...
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<thead>
<tr>
<th>CATEGORY H: REDUCE OPERATING SPEEDS</th>
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<td><strong>H1</strong> — Provide targeted speed enforcement</td>
<td>Where to use — Unsignalized intersections where speed violations and patterns of crashes related to speed violations are observed. Crash type potentially related to speed violations include right-angle, rear-end, and turning crashes.</td>
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<td><strong>H2</strong> — Provide traffic calming on intersection approaches through a combination of geometric and traffic control devices</td>
<td>Where to use — Specific approaches to unsignalized intersections that are experiencing high speeds.</td>
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<td><strong>H3</strong> — Provide smooth lane narrowing</td>
<td>Where to use — Unsignalized intersections experiencing a high frequency of speed related violations or crashes.</td>
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<td><strong>H4</strong> — Provide speed reduction pavement markings</td>
<td>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.</td>
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</table>

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<thead>
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<th>CATEGORY I: GUIDE MOTORISTS MORE EFFECTIVELY</th>
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<td><strong>I1</strong> — Provide turn path markings</td>
<td>Where to use — Complex unsignalized intersections with a high frequency of crashes related to turning vehicle positioning (esp. sideswipe crashes).</td>
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<tr>
<td><strong>I2</strong> — Provide a double yellow centerline on the median opening of a divided highway at intersections</td>
<td>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 in the median area.</td>
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<tr>
<td><strong>I3</strong> — Provide a double yellow centerline on the minor road approaches</td>
<td>Where to use — Unsignalized intersections with conflicts between stopped vehicles and turning or oncoming vehicles and poor vehicle positioning.</td>
</tr>
<tr>
<td><strong>I4</strong> — Provide dotted edge-line extensions</td>
<td>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 road that are encroaching upon the major road through lane.</td>
</tr>
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<tr>
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<th>Low</th>
<th>Moderate</th>
<th>High</th>
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<td>High frequency of right-angle crashes attributed to:</td>
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<td>nearby driveways</td>
<td>A2, C1, C3</td>
<td>A1, B6, B8</td>
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<tr>
<td>traffic from cross street</td>
<td>C1, C3, D2, E4</td>
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<tr>
<td>skewed intersection</td>
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<td>poor sight distance</td>
<td>C1, C3, C4, H3</td>
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<td>drivers misjudging gaps</td>
<td>H3, H6</td>
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<td>driver unaware of intersection</td>
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<tr>
<td>speed differentials for vehicles</td>
<td>H3, H6</td>
<td>A4, H1, H2, F2, F6</td>
<td></td>
</tr>
</tbody>
</table>

| High frequency of rear-end crashes attributed to: |  |
| left turning vehicles hit from behind | B3 | B1, B2, B3 |
| left opposing vehicles hit from behind | B2 | F2 |
| trucks and RVs entering divided highway | B4 |
| speed differentials 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 | B6 |
| driver unaware of intersection | E1, E5, E14, E16, E17 | E3, E4, E5 |
| nighttime conditions | E2 |
| speed differentials of vehicles | H3, H4, H6 | H1, H2, H5, F2 |

| High frequency of left-turn crashes attributed to: |  |
| left turning vehicles hit by opposing traffic | E22 | B1, B10, B14, C2, F2, F5, F6 |
| trucks and/or RVs entering divided highway | B4 |
| no left turn lane and high opposing traffic | B8, F6 |
| nighttime conditions | E10, E2 |
| heavy but balanced traffic flow | F2 |
| nighttime conditions | C2 |

| High frequency of sideswipe crashes attributed to: |  |
| speed differential of entering vehicles | H6 | F2 |
| vehicles within intersection | D1, D2 | B12, C8 |
| vehicles approaching intersection | E15, E16 |

| High frequency of run off road crashes: |  |
| approaching intersection | I4 | B7 |

| High frequency of pedestrian/bicycle crashes: |  |
| with approaching vehicles | E18, E20, E21, F7, G3, G4, B10, B13, F3, F4, H2, H7 | F6, F8, F9, H8 |

| Address overall safety issues: |  |
| violation of traffic laws | G2 | G1 |

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