Appendix F

Countermeasure Toolkit

MEMORANDUM

June 20, 2024

To: Mike Ulrich

Organization: Spokane Regional Transportation Council (SRTC)

From: Michael Hintze, AICP; Alex DuVall, PE; Allison Phillips; Maimoona Rahim; Michael Houston, PE, AICP (Toole Design)

Project: SRTC Regional Safety Action Plan (RSAP)

Re: Technical Memo 4.1: Strategy Development Toolkit

Toolkit Summary

The Toolkit presents design tools known to reduce crashes involving people driving, bicycling, walking, or rolling, and outlines how each tool addresses safety and the expected reduction in crashes. The Toolkit also describes the applicable locations for each tool and the relative estimated cost for implementation.

Categories

Countermeasures are organized into five categories below based on the safety objective:

- **Systemic**

  Tools that are systemic that can be implemented universally across the SRTC region that proactively address road user safety.

- **Active Mode Facilities**
  Create spaces that separate people walking, bicycling, or rolling from motorists.

- **Crossings and Signals**
  Separate users in time to improve spaces where different road users' paths cross.

- **Speed Management**
  Encourage motorists to travel at safe speeds.

- **Other Road Design**
  Additional tools that are more systemic and cover multiple objectives.

Note, within each category the tools are listed and presented in this document alphabetically.

Effectiveness

The level of effectiveness is presented as a crash reduction factor (CRF), which is the estimated percent reduction in crashes. See Appendix C for more information on effectiveness and crash reduction factors.

Implementation Guidance

Specific implementation guidance may be included for countermeasures, particularly related to emergency service access considerations for post-crash care.

Location

Some tools are generally applied along segments, while others improve safety at intersections. The Toolkit indicates the type of location most appropriate to apply each countermeasure. Most countermeasures can be applied to several different types of locations. Based on the Safe System principle that *redundancy is critical*, it is important to consider implementing multiple countermeasures at one location.

Locations for applying the countermeasures in the Toolkit are categorized as follows:

- Along Corridor
- Midblock Crossing
- Signalized Intersection
- Unsignalized Intersection

Countermeasures will be selected for specific locations in the region, only after an evaluation of

the appropriateness of the countermeasure for the location's context.

Crash Types Addressed

Each countermeasure will include which crash type(s) the countermeasure is intended to address.

- Run Off Road
- Pedestrian Crash
- Motorcycle Crash
- Angle
- Bicyclist Crash
- Head-On
- Opposite Direction Left Turn Across Path
- Sideswipe
- Opposite Direction Other
- Rear End

Appendix B describes each of these crash types and how prevalent they are in Spokane County.

Context

Roadways throughout the region have different characteristics based on the number of lanes, vehicles per day, travel speeds, adjacent land use, and other factors. Therefore, different safety tools may be appropriate on different roadways.

The level of appropriateness for urban/suburban or small town/rural contexts for each countermeasure is indicated using following symbols:

- Small Town/Rural
- Urban/Suburban

Opportunity Project Type

There are two types of projects that are flagged in this toolkit. The first are roadway safety countermeasures that could be applicable for SS4A Demonstration Grant funding.[1] The second are roadway safety countermeasures that can be built using quick-build materials, before evaluating whether a permanent installation would be beneficial.

These project types are indicated using following symbols:

- Demonstration Grant (SS4A)
- Quick Build

Cost

The cost ranges are listed for each countermeasure to indicate cost estimates for planning, engineering, and installation of the tool at a single typical location. If the countermeasure is linear, the cost assumes cost per mile. The assumptions on cost for each countermeasure are general and are not specific to a single location or community.

The cost categories and symbols used in the Toolkit are as follows:

$	Low – typically $5,000 or less
$$	Medium – typically $5,000 to $100,000
$$$	Moderate – typically $100,000 to $300,000
$$$$	High – typically $300,000 or more

[1] #3: Eligible Demonstration Activities, https://www.transportation.gov/grants/ss4a/planning-and-demonstration-activities#eligible-demonstration-activities

Summary Matrix

Tool	Location				Context		
	Along Corridors	Midblock Crossing	Signalized Intersection	Unsignalized Intersection	Small Town/Rural	Urban/Suburban	Effectiveness
Systemic							
Accessible Pedestrian Signals			X		X	X	9-70%
Automated Speed Safety Cameras	X				X	X	23-90%
Coordinated Signals			X			X	21-58%
High Visibility Crosswalks		X	X	X	X	X	40%
Leading Pedestrian Intervals (LPIs)			X		X	X	9-59%
Retroreflective Traffic Signal Backplates			X		X	X	15%
Sidewalks	X				X	X	65-89%
Active Mode Facilities							
Bicycle Boulevard/Shared Streets	X				X	X	63%
Buffered Bicycle Lanes	X				X	X	30-49%
Separated Bicycle Facilities	X				X	X	40-66%
Crossings and Signals							
Curb Extensions and Bulb Outs		X	X	X	X	X	N/A
Parking Restrictions at Crossings/Daylighting		X	X	X	X	X	30%
Protected Pedestrian Phases			X			X	35%
Protected Turn Phases			X		X	X	31-100%
Raised Intersections/Crossings		X	X	X	X	X	46%
Raised Refuge Islands		X	X	X	X	X	46-56%
Rectangular Rapid Flashing Beacons (RRFBs)		X		X	X	X	47-73%
Pedestrian Hybrid Beacon		X		X	X	X	29-55%
Signal Clearance			X			X	3-20%
Stop Sign Controls		X		X	X	X	10-27%
Traffic Signals				X	X	X	30-77%
Speed Management							
Edge Lines	X				X	X	22-37%
Speed Feedback Indicator Signs	X					X	N/A
Transverse Rumble Strips	X	X		X	X	X	6-78%

Tool	Location				Context		
	Along Corridors	Midblock Crossing	Signalized Intersection	Unsignalized Intersection	Small Town/Rural	Urban/Suburban	Effectiveness
Other Road Design							
Access Control/Diverters			X	X	X	X	25%
Access Management	X				X	X	5-31%
Chevron Signs on Horizontal Curves	X				X		15-60%
Lighting	X		X	X	X	X	28-38%
Median Barrier	X				X		8%
Pedestrian Lighting	X	X				X	42%
Raised Medians	X				X	X	46%
Relocate/Remove Fixed Objects Outside Clear Zone	X		X	X	X	X	97%
Road/Lane Diets	X				X	X	19-47%
Rumble Strips (Edge line or Centerline)	X				X		13-64%
Wet-Reflective Pavement Markings	X				X	X	3-46%

Guidance on how to use this Toolkit is outlined in **Appendix A.**

Systemic

The Systemic category presents design tools that are appropriate to apply throughout the SRTC region to proactively address safety for all road users.

The tools in this category are:

- Accessible Pedestrian Signals (APS)
- Automated Speed Safety Cameras
- Coordinated Signals
- High Visibility Crosswalks
- Leading Pedestrian Intervals (LPIs)
- Retroreflective Traffic Signal Backplates
- Sidewalks

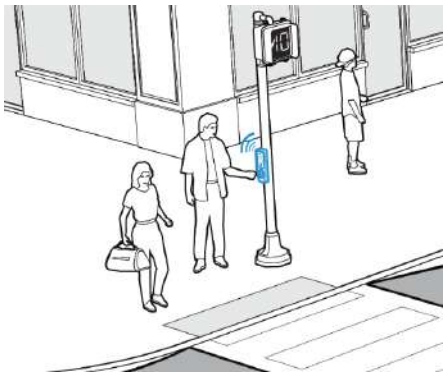
Accessible Pedestrian Signals (APS)

Type
Systemic

Description
Devices that communicate information about the WALK and DON'T WALK intervals at signalized intersections in non-visual formats for people who are walking that are blind or have reduced vision. The devices can include audible tones, speech messages, and/or vibrating surfaces.

Implementation Guidance
Install in conjunction with LPIs.

Crash Type(s) Addressed
Pedestrian Crash, Rear End



Opportunity Project Type
- Demonstration Grant (SS4A)

Cost

$ $$ $$$ $$$$

Applicable Locations
- Signalized intersections

Effectiveness

9-70%

Context
- Small Town/Rural
- Urban/Suburban

Automated Speed Safety Cameras

Type
Systemic

Description
A type of automated enforcement technology that detects and records images of drivers traveling faster than the posted speed limit. The footage is then reviewed by local police departments to issue a warning or violation.

Implementation Guidance
Equitable, data driven approach to identify locations. Locations must meet line of sight requirements. Prioritize for locations on the HIN, school zones, and work zones. Remove when roadway engineering changes are implemented that are proven to reduce operating speeds. Refer to strategies section.

Crash Type(s) Addressed
Run Off Road, Pedestrian Crash, Motorcycle Crash, Angle

Cost

$ $$ **$$$** $$$$

Effectiveness

23-90%

Opportunity Project Type
- Demonstration Grant (SS4A)

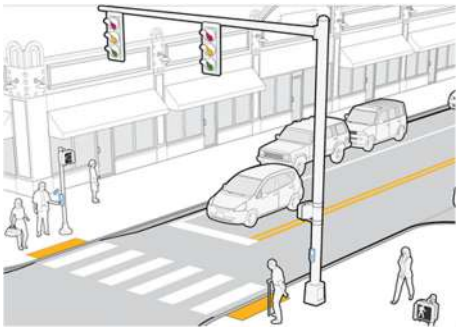
Applicable Locations
- Along corridors

Context
- Small Town/Rural
- Urban/Suburban

Coordinated Signals

Type
Systemic

Description
Coordinated signal timing synchronizes traffic movements and manages the progression of drivers. Signals can be timed to a target speed limit to encourage drivers to drive at safer speeds.



Implementation Guidance

Crash Type(s) Addressed
Motorcycle Crash, Angle, Opposite Direction Left Turn Across Path, Sideswipe, Rear End

Cost

$ **$$** $$$ $$$$

Effectiveness

21% to 58%

Opportunity Project Type
-

Applicable Locations
- Signalized intersections

Context
- Urban/Suburban

High Visibility Crosswalks

Type
Systemic

Description
Continental style that are visible to both the driver and pedestrian from farther away as compared to traditional transverse line crosswalks.

Implementation Guidance
Install high visibility, continental style crosswalks, with Americans with Disabilities (ADA) compliant curb ramps.

Crash Type(s) Addressed
Pedestrian Crash, Bicyclist Crash, Opposite Direction Left Turn Across Path, Rear End

Opportunity Project Type
- Demonstration Grant (SS4A)

Cost
$ $$ $$$ $$$$

Applicable Locations
- Midblock crossings
- Signalized intersections
- Unsignalized intersections

Effectiveness
40%

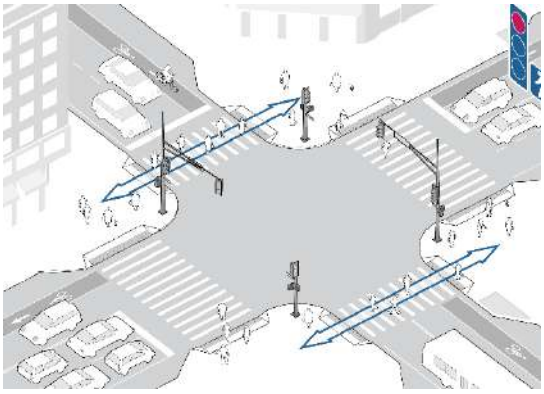
Context
- Small Town/Rural
- Urban/Suburban

Leading Pedestrian Intervals (LPIs)

Type
Systemic

Description
Programmed traffic signals that give people a 3-7 second head start to enter crosswalks.

Implementation Guidance
Install in conjunction with APS. If bicycle signal heads are installed, consider programming leading bicycle intervals (LBIs).



Crash Type(s) Addressed
Pedestrian Crash, Bicyclist Crash

Opportunity Project Type
-

Cost
$ **$$** $$$ $$$$

Applicable Locations
- Signalized intersections

Effectiveness
9-59%

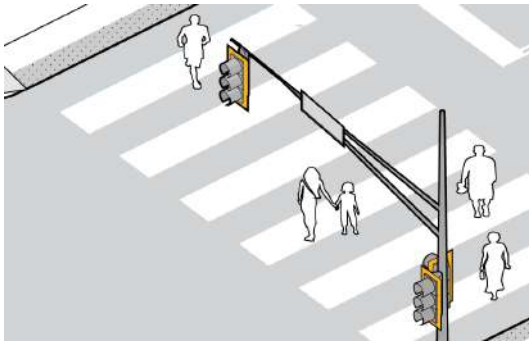
Context
- Small Town/Rural
- Urban/Suburban

Retroreflective Traffic Signal Backplates

Type
Crossings and Signals

Description
Traffic signals are framed with a 1 to 3-inch wide retroreflective border. Improve the visibility of the illuminated face of the traffic signal in both day and nighttime conditions.

Implementation Guidance



Crash Type(s) Addressed
Motorcycle Crash, Angle, Opposite Direction Left Turn Across Path, Sideswipe, Read End

Cost
$ $$ $$$ $$$$

Effectiveness
15%

Opportunity Project Type
-

Applicable Locations
- Signalized intersections

Context
- Small Town/Rural
- Urban/Suburban

Sidewalks

Type
Systemic

Description
Sidewalks provide space along a street for pedestrian travel that is separated from moving vehicles.

Implementation Guidance
Sidewalks require high-quality construction and maintenance that avoids pavement cracking and buckling. A quick-build alternative is to install a curb-protected walkway. Install ADA compliant curb ramps.

Crash Type(s) Addressed
Pedestrian Crash, Run Off Road, Bicyclist Crash

Cost
$ $$ $$$ **$$$$**

Effectiveness
65-89%

Opportunity Project Type
-

Applicable Locations
- Along corridors

Context
- Small Town/Rural
- Urban/Suburban

Active Mode Facilities

The Active Mode Facilities category presents design tools known to create spaces that separate people walking, bicycling, or rolling from drivers.

The tools in this category are:

- Bicycle Boulevards/Shared Streets
- Buffered Bicycle Lanes
- Separated Bicycle Facilities

Bicycle Boulevards/Shared Streets

Type
Active Mode Facilities

Description
Bicycle Boulevards, Neighborhood Bike Routes, or Shared Streets are streets intentionally designed for low motor traffic volumes and speeds to prioritize people bicycling. Signs, pavement markings, and speed and volume management measures discourage through by motorists.

Implementation Guidance
Appropriate for lower speed, lower volume roads.

Crash Type(s) Addressed
Bicyclist Crash

Cost

$ **$$** **$$$** $$$$

Effectiveness

63%

Opportunity Project Type
- Quick Build

Applicable Locations
- Along corridors

Context
- Small Town/Rural
- Urban/Suburban

Buffered Bicycle Lanes

Type
Active Mode Facilities

Description
Bicycle lanes that include a buffered space to separate people biking from vehicular traffic or parking. The buffer is provided through hashed or parallel pavement markings between the bicycle lanes and the general travel lanes, typically providing an additional 1–3 feet of space at the edge of the bike lane and the travel lane.

Implementation Guidance
Appropriate for lower speed, higher volume roads.

Crash Type(s) Addressed
Bicyclist Crash

Cost
$ **$$** $$$ $$$$

Effectiveness
30-49%

Opportunity Project Type
- Demonstration Grant (SS4A)
- Quick Build

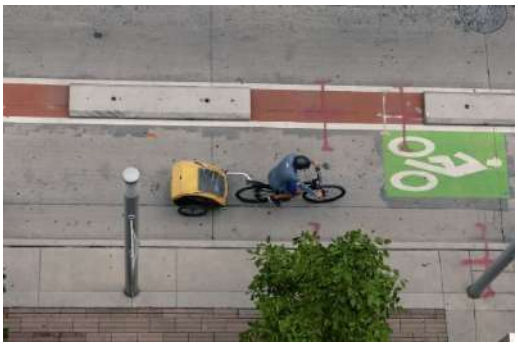
Applicable Locations
- Along corridors

Context
- Small Town/Rural
- Urban/Suburban

Separated Bicycle Facilities

Type
Active Mode Facilities

Description
Separated bicycle lanes provide physical separation between bicyclists and drivers using objects like flex posts, parking stops, planters, or concrete barriers. These lanes are generally located along corridors with few driveways or conflict points.



Implementation Guidance
Appropriate for higher speed and higher volume roads. Flex posts may be used for quick-build, but vertical elements that provide protection for bicyclists are preferred for permanent construction (e.g., jersey barriers or concrete curbs).

Crash Type(s) Addressed
Bicyclist Crash

Cost
$ $$ **$$$** $$$$

Effectiveness
40-66%

Opportunity Project Type
- Demonstration Grant (SS4A)
- Quick Build

Applicable Locations
- Along corridors

Context
- Small Town/Rural
- Urban/Suburban

Crossings and Signals

The Crossings and Signals category presents design tools that address issues with different road users' paths crossing by separating users in space and time.

The tools in this category are:

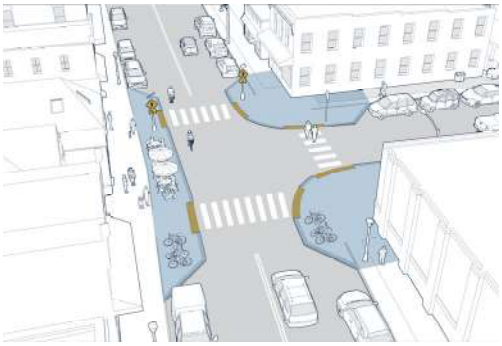
- Curb Extensions and Bulb Outs
- Parking Restrictions at Crossings (Daylighting)
- Protected Phasing
- Raised Intersections/Crossings
- Raised Refuge Islands
- Rectangular Rapid Flashing Beacons (RRFBs)
- Pedestrian Hybrid Beacon (PHB)
- Signal Clearances
- Stop Sign Controls
- Traffic Signals

Curb Extensions and Bulb Outs

Type
Crossings and Signals

Description
Extensions to a section of sidewalk into the roadway at intersections and other crossing locations. Shortens the crossing distance for people walking, reduces turning speeds, and improves sight distance between drivers and people crossing.

Implementation Guidance
Can be installed as permanent curb reconfigurations, or through paint and post bulb-outs.



Crash Type(s) Addressed
Pedestrian Crash

Cost

$ **$$** $$$ $$$$

Effectiveness

A crash reduction rate has not yet been determined.

Opportunity Project Type
- Demonstration Grant (SS4A)*
- Quick Build

* quick-build

Applicable Locations
- Midblock crossings
- Signalized intersections
- Unsignalized intersections

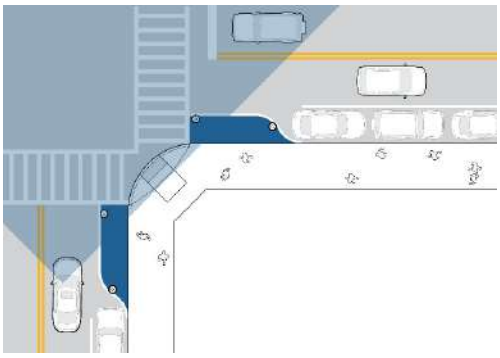
Context
- Small Town/Rural
- Urban/Suburban

Parking Restrictions at Crossings (Daylighting)

Type
Crossings and Signals

Description
Signs, pavement markings, curb extensions, or vertical delineators that restrict on-street parking near a crossing or intersection. Also known as “daylighting.”

Implementation Guidance
Coordinate with parking policies. See strategies section of this memo.



Crash Type(s) Addressed
Pedestrian Crash, Bicyclist Crash

Cost

$ $$ $$$ $$$$

Effectiveness
30%

Opportunity Project Type
- Demonstration Grant (SS4A)*
- Quick Build

*quick-build

Applicable Locations
- Midblock crossings
- Signalized intersections
- Unsignalized intersections

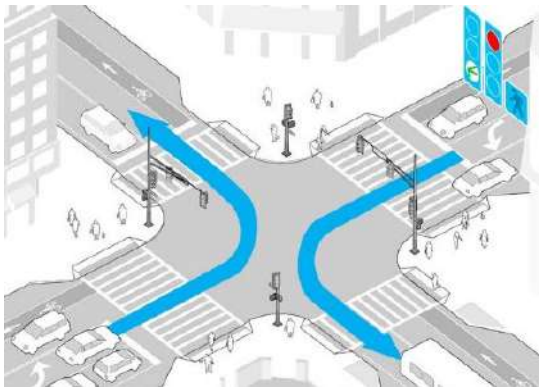
Context
- Small Town/Rural
- Urban/Suburban

Protected Phasing

Type
Crossings and Signals

Description
Adjusting signal phasing so that pedestrian, bicycle, and/or turning movements are independent, separating users in time. This goes beyond an LPI. Reduces conflict points between turning drivers from other drivers and people walking and bicycling.

Implementation Guidance
An example of a protected pedestrian phase at a signal is a “pedestrian scramble.” Coordinate signal timing with bicycle signal heads, where installed.



Crash Type(s) Addressed
Pedestrian Crash

Cost

$ $$ $$$ $$$$

Effectiveness
31-100%

Opportunity Project Type
-

Applicable Locations
- Signalized intersections

Context
- Urban/Suburban

Raised Intersections/Crossings

Type
Crossings and Signals

Description
Raised crosswalks or raised intersections are ramped speed tables spanning the entire width of the roadway or intersection usually at minor locations. Reduce drivers' speeds, increase driver yielding, and improve crossing safety for people walking or bicycling.

Implementation Guidance
Elevate crossings at least three inches above the roadway, and up to the sidewalk level.

Crash Type(s) Addressed
Pedestrian Crash

Opportunity Project Type
-

Cost
$ **$$** $$$ $$$$

Applicable Locations
- Midblock crossings
- Signalized intersections
- Unsignalized intersections

Effectiveness
46%

Context
- Small Town/Rural
- Urban/Suburban

Raised Refuge Islands

Type
Crossings and Signals

Description
Curbed sections in the center of a roadway that separate opposing directions of general purpose lanes. Increases visibility of people crossing. Allows a 2-stage crossing at uncontrolled locations.

Implementation Guidance
At midblock crossings, Raised Refuge Islands may require crossing signals such as RRFB, PHB, etc. Quick-build variations may use "tough curb", or similar bolt down features, and flex-posts.

Crash Type(s) Addressed
Pedestrian Crash, Bicyclist Crash

Project Type
- Quick Build

Cost
$ **$$** $$$ $$$$

Applicable Locations
- Midblock crossings
- Signalized intersections
- Unsignalized intersections

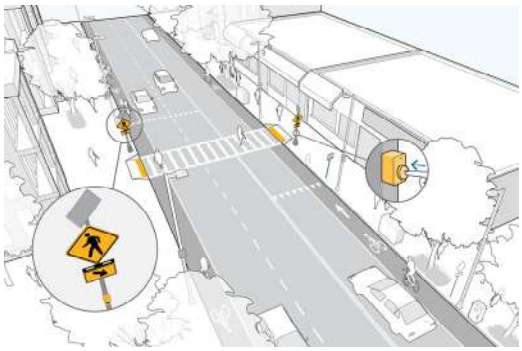
Effectiveness
46-56%

Context
- Small Town/Rural
- Urban/Suburban

Rectangular Rapid Flashing Beacons (RRFBs)

Type
Crossings and Signals

Description
Bright, flashing LEDs, mounted with pedestrian crossing signs that are activated by the person crossing the street. Increases driver yielding to people at uncontrolled crossings. Can be solar powered or hard-wired to the electrical grid.



Implementation Guidance
Install systemic pavement markings and signage at all RRFBs, including advance stop bars. Applicable on arterial streets where there are three or more lanes, where the posted speed limit is at or below 35mph.

Crash Type(s) Addressed
Pedestrian Crash, SSW, REN

Cost

$ **$$** $$$ $$$$

Effectiveness

47-73%

Opportunity Project Type
- Demonstration Grant (SS4A)

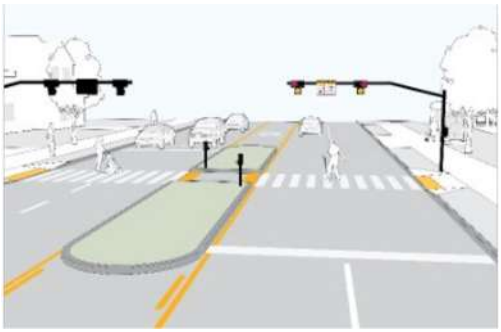
Applicable Locations
- Midblock crossings
- Unsignalized intersections

Context
- Small Town/Rural
- Urban/Suburban

Pedestrian Hybrid Beacon (PHB)

Type
Crossings and Signals

Description
A pushbutton activated beacon-controlled crossing that provides a protected walk phase for pedestrians and/or bicyclists.



Implementation Guidance
Also called High Intensity Activated Crosswalks (HAWKs). Beacons are preferably placed above the crosswalk, rather than the side of the road. Most effective when vehicle speeds are too high or gaps in traffic are too infrequent for pedestrians to cross safely. PHBs can be used when there is >1 lane per direction and daily traffic volume >9,000.

Crash Type(s) Addressed
Pedestrian Crash, SSW, REN

Cost
$ $$ **$$$** $$$$

Effectiveness
29-55%

Opportunity Project Type
- Demonstration Grant (SS4A)

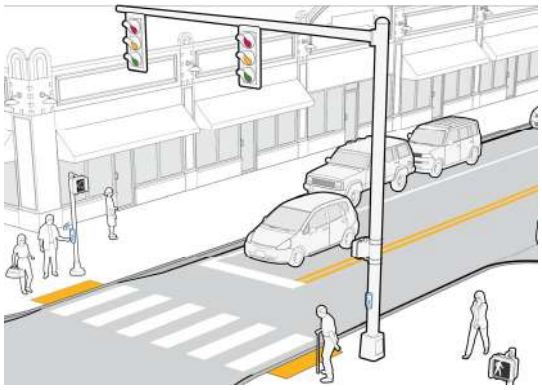
Applicable Locations
- Midblock crossings
- Unsignalized intersections

Context
- Small Town/Rural
- Urban/Suburban

Signal Clearances

Type
Crossings and Signals

Description
Signal clearance is the time between one direction of travel getting the red phase signal and the opposing direction getting the green phase signal. A longer clearance can be achieved by having an all-red phase where all directions rest on red.



Implementation Guidance

Crash Type(s) Addressed
Angle, OLT

Cost
$ $$ $$$ $$$$

Effectiveness
3-20%

Opportunity Project Type
-

Applicable Locations
- Signalized intersections

Context
- Urban/Suburban

Stop Sign Controls

Type
Crossings and Signals

Description
A STOP sign is a regulatory sign that indicates where drivers are required to stop. At stop-controlled intersections, drivers must yield the right of way to people walking, rolling, and bicycling before proceeding.

Implementation Guidance
Implement systemic signing and marking improvements at stop-controlled intersections, including stop bars. Stop signs should be retroreflective and may be accompanied by flashing red signal or have embedded flashing LED lights for improved visibility

Crash Type(s) Addressed
Motorcycle Crash, Angle, OLT, SSW, REN

Cost

$ $$ $$$ $$$$

Effectiveness

10-27%

Opportunity Project Type
- Demonstration Grant (SS4A)

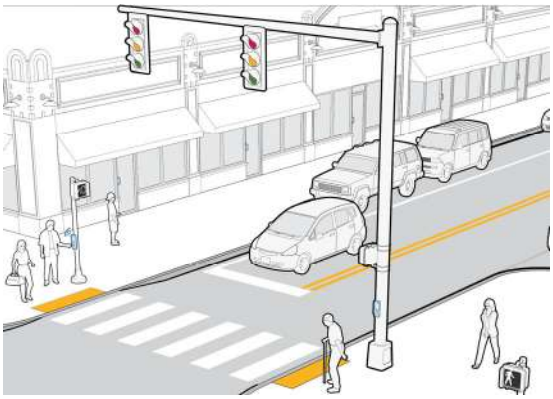
Applicable Locations
- Unsignalized intersections

Context
- Small Town/Rural
- Urban/Suburban

Traffic Signals

Type
Crossings and Signals

Description
Traffic signals are tools that assign right of way to the movements of various users at an intersection including drivers, and people walking or bicycling.



Implementation Guidance
Subject to evaluation of warrants.

Crash Type(s) Addressed
Angle, Opposite Direction Left Turn Across Path, Rear End

Cost

$ $$ $$$ **$$$$**

Effectiveness

30-77%

Opportunity Project Type
- Demonstration Grant (SS4A)

Applicable Locations
- Unsignalized intersections

Context
- Small Town/Rural
- Urban/Suburban

Speed Management

The Speed Management category presents design tools known to create roadways where drivers operate at safe speeds.

The tools in this category are:

- Appropriate Speed Limits for All Road Users
- Edge Lines
- Gateway Entrance Treatments
- Roundabout
- Speed Feedback Indicator Signs
- Transverse Rumble Strips

Tools from other categories are also known to create roadways where drivers operate at safe speeds.

The tools listed in other categories are:

- Systemic
    - Automated Speed Safety Cameras
    - Coordinated Signals
    - Bicycle Boulevards/Shared Streets
    - Buffered Bicycle Lanes
    - Separated Bicycle Facilities
- Crossings and Signals
    - Curb Extensions and Bulb Outs
    - Raised Intersections/Crossings
    - Raised Refuge Islands
- Other Road Design
    - Chevron Signs on Horizontal Curves
    - Raised Medians
    - Road/Lane Diets

Appropriate Speed Limit for All Road Users

Type
Speed Management

Description
Posted speed limits are often the same as the legislative statutory speed limit. Local agencies in WA can establish non-statutory speed limits or designate reduced speed zones based on an engineering study.

Implementation Guidance
FHWA encourages agencies to utilize USLIMITS2, NCHRP 966, and the Safe System Approach when setting posted speed limits. The use of 20mph speed limits in urban core areas have been proven to be beneficial, per FHWA. To achieve desired speeds, agencies will often need to implement other speed strategies, such as those listed in this section.

Crash Type(s) Addressed
Run Off Road, Pedestrian Crash, Motorcycle Crash, Angle, Bicyclist Crash, Head-On, Opposite Direction Left Turn Across Path, Sideswipe, Opposite Direction Other, Rear End

Opportunity Project Type
- Demonstration Grant (SS4A)

Cost

$ $$ $$$ $$$$

Applicable Locations
- Along corridors

Effectiveness

Variable, depending on speed reduction.

Context
- Small Town/Rural
- Urban/Suburban

Edge Lines

Type
Speed Management

Description
Solid lines striped along the outer edge of the lane to narrow curb-side lanes. The adjusted travel lane gives drivers the perception of a narrower roadway. The neutral area between the curb and the general purpose lane can be repurposed for uses such as parking or a bikeway.

Implementation Guidance
Can be used in urban/suburban contexts to encourage slower driving speeds by narrowing travel lanes, or in rural contexts for increased visibility.

Crash Type(s) Addressed
Run Off Road, Head-On, Sideswipe

Cost

$ $$ $$$ $$$$

Effectiveness

22-37%

Source: LADOT

Opportunity Project Type
- Demonstration Grant (SS4A)

Applicable Locations
- Along corridors

Context
- Small Town/Rural
- Urban/Suburban

Gateway Entrance Treatments

Type
Speed Management

Description
Alert drivers that the nature of the roadway is changing, such as approaching a rural town from a higher-speed road, and they should reduce speed. Could be a combination of enhanced signage, lane reduction, colored pavements, pavement markings, gateway structures, or traffic calming treatments (i.e., raised intersection/crossing).

Implementation Guidance
Use transitional speed limits, Reduced Speed Limit Ahead warning signs, and Stop for Pedestrian (R1-6a) signs per MUTCD.

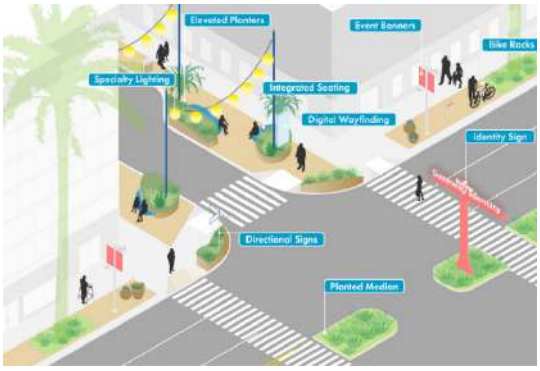
Crash Type(s) Addressed
Pedestrian Crash, Angle, Bicyclist Crash, Opposite Direction Left Turn Across Path

Cost

$ $$ $$$ $$$$

Effectiveness

A crash reduction rate has not yet been determined.



Opportunity Project Type
- Demonstration Grant (SS4A)*

*quick-build

Applicable Locations
- Along corridors

Context
- Small Town/Rural
- Urban/Suburban

Roundabout

Type
Speed Management

Description
Circular intersections controlled by yielding rather than a signal or stop. Safely and efficiently moves traffic. Reduces driver speeds and conflict points at intersections for all modes by eliminating all left turns.

Implementation Guidance
Speeds and geometry should facilitate driver yielding. Entry speed should be about 15 mph. Drivers can be slowed at exit and entry points with horizontal or vertical deflection. Crossing treatments for bicyclists and pedestrians should be installed at least 20 feet from roundabout entries and may be installed with RRFBs.

Crash Type(s) Addressed
Pedestrian Crash, Motorcycle Crash, Angle, Bicyclist Crash, Head-On, Opposite Direction Left Turn Across Path, Sideswipe, Opposite Direction Other, Rear End

Opportunity Project Type
- Demonstration Grant (SS4A)

Cost
$ $$ $$$ **$$$$**

Applicable Locations
- Along corridors

Effectiveness
78-82%

Context
- Small Town/Rural
- Urban/Suburban

Speed Feedback Indicator Signs

Type
Speed Management

Description
A traffic control device that measures speed and displays feedback to drivers going above the posted speed. Numbers typically flash on the screen if the current driver's speed is faster than the speed limit.

Implementation Guidance
Manage driver speeds by comparing the driver's current speed with the speed limit and displaying speeds on electronic signs.

Crash Type(s) Addressed
Run Off Road, Pedestrian Crash, Motorcycle Crash, Bicyclist Crash, Sideswipe

Opportunity Project Type
- Demonstration Grant (SS4A)

Cost
$ **$$** $$$ $$$$

Applicable Locations
- Along corridors

Effectiveness
A crash reduction rate has not yet been determined.

Context
- Urban/Suburban

Transverse Rumble Strips

Type
Speed Management

Description
Transverse rumble strips are textured asphalt or raised thermoplastic pavement markings across a travel lane to alert motorists of reduced speed conditions or a stop ahead.

Implementation Guidance
Transverse rumble strips should be paired with signage alerting drivers to the change ahead.

Crash Type(s) Addressed
Run Off Road, Angle, Rear End

Opportunity Project Type
-

Cost

$ **$$** $$$ $$$$

Applicable Locations
- Along corridors
- Midblock crossings
- Unsignalized intersections

Effectiveness

6-78%

Context
- Small Town/Rural
- Urban/Suburban

Other Road Design

The Other Road Design category presents additional design tools that do not fit in the previous categories.

The tools in this category are:

- Access Control/Diverters
- Access Management
- Chevron Signs on Horizontal Curves
- Lighting
- Median Barrier
- Pedestrian Lighting
- Raised Medians
- Relocate Fixed Objects Outside Clear Zone
- Road/Lane Diets
- Rumble Strips (Edge Line or Centerline)
- Wet-Reflective Pavement Markings

Access Controls/Diverters

Type

Other Road Design

Description

A diverter is an island placed at a neighborhood street intersection that prevents certain through and/or turning movements and decreases the number of drivers entering the street. Diverters still allow access for people walking or riding a bicycle.

Implementation Guidance

Coordinate with emergency service providers to determine necessary access.

Crash Type(s) Addressed

Motorcycle Crash, Angle, Head-On, Opposite Direction Left Turn Across Path, Sideswipe, Rear End

Cost

$ **$$** $$$ $$$$

Effectiveness

25%

Opportunity Project Type

-

Applicable Locations

- Signalized intersections
- Unsignalized intersections

Context

- Small Town/Rural
- Urban/Suburban

Access Management

Type
Other Road Design

Description
Access management refers to the design, application, and control of entry and exit points along a roadway, including intersections and driveways that serve properties.

Implementation Guidance
Reduce driveway density to create fewer conflict points among road users. Install raised, directional c-curb to limit right-in-right-out or left-in-left-out turning movements.

Source: FHWA

Crash Type(s) Addressed
Motorcycle Crash, Opposite Direction Left Turn Across Path, Sideswipe

Cost
$ **$$** $$$ $$$$

Effectiveness
5-31%

Opportunity Project Type
-

Applicable Locations
- Along corridors

Context
- Small Town/Rural
- Urban/Suburban

Chevron Signs on Horizontal Curves

Type
Other Road Design

Description
Chevron curve warning signs are a type of delineation treatment placed on the outside of a curve to warn a driver of an approaching bend in the road.

Implementation Guidance
Review signing policies to ensure consistent implementation. Install retroreflective or fluorescent signs.

Crash Type(s) Addressed
Run Off Road, Head-On, Sideswipe

Cost
$ **$$** $$$ $$$$

Effectiveness
15-60%

Opportunity Project Type
-

Applicable Locations
- Along corridors

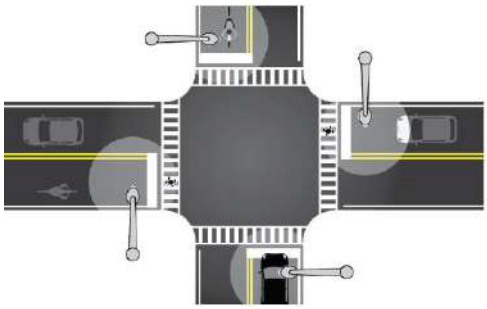
Context
- Small Town/Rural

Lighting

Type
Other Road Design

Description
Overhead lighting to illuminate crossings, signs, and street markings. Increases visibility for all road users, especially at crossings.

Implementation Guidance
Most new lighting installations are made with breakaway features, shielded, or placed far enough from the roadway to reduce the probability and severity of fixed-object crashes. FHWA's EDC7 Nighttime Visibility for Safety recommends installing LED lighting for better visibility.



Source: FHWA

Crash Type(s) Addressed
Angle, Rear End

Cost

$ $$ $$$ **$$$$**

Effectiveness

28-38%

Opportunity Project Type
-

Applicable Locations
- Along corridors
- Signalized intersections
- Unsignalized intersections

Context
- Small Town/Rural
- Urban/Suburban

Median Barrier

Type
Other Road Design

Description
Median barriers are longitudinal barriers that separate opposing traffic, typically on a rural highway. Could be cable barriers, metal-beam guardrails, or concrete barriers.

Implementation Guidance
Coordinate with emergency service providers to determine necessary gaps in the cable median barrier for turnaround ability.

Crash Type(s) Addressed
Head-On

Cost

$ $$ **$$$** $$$$

Effectiveness

8%

Opportunity Project Type
-

Applicable Locations
- Along corridors

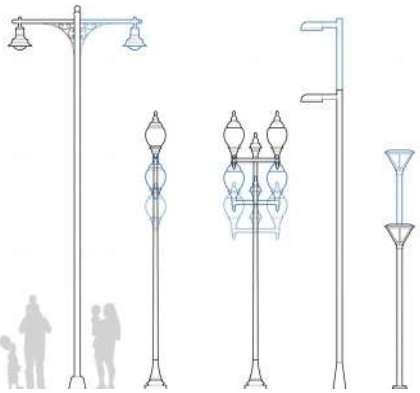
Context
- Small Town/Rural

Pedestrian Lighting

Type
Other Road Design

Description
Pedestrian-scale lighting illuminates sidewalks and crossings where light fixtures are shorter than roadway-scale light fixtures.

Implementation Guidance
Pedestrian crosswalk lighting should illuminate with positive contrast to make it easier for a driver to visually identify a pedestrian. This means placing the luminaires in forward locations in relation to the crossing. FHWA's EDC7 Nighttime Visibility for Safety recommends installing LED pedestrian lighting, which can reduce pedestrian crashes up to 65%.



Crash Type(s) Addressed
Pedestrian Crash

Cost
$ $$ $$$ **$$$$**

Effectiveness
42-65%

Opportunity Project Type
-

Applicable Locations
- Along corridors
- Midblock corridors

Context
- Urban/Suburban

Raised Medians

Type
Other Road Design

Description
Curbed sections of the roadway in the median that separate opposing directions of travel lanes. Restrict motor vehicle turn movements and increase separation between drivers traveling in opposing directions.

Implementation Guidance
Coordinate with emergency service providers to determine necessary gaps in the medians for turnaround ability. May be combined with raised refuge island at crossing locations.

Crash Type(s) Addressed
Head-On

Cost
$ **$$** **$$$** $$$$

Effectiveness
46%

Opportunity Project Type
- Quick Build

Applicable Locations
- Along corridors

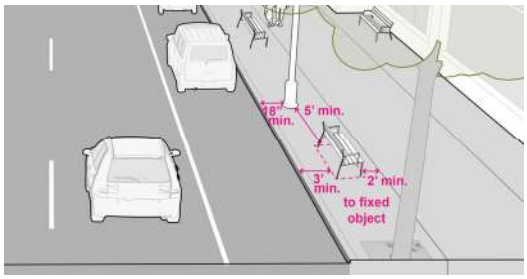
Context
- Small Town/Rural
- Urban/Suburban

Relocate Fixed Objects Outside Clear Zone

Type
Other Road Design

Description
Relocate or remove fixed objects, like utility poles, utility boxes, streetscape amenities, and more, outside the clear zone to reduce fixed object crashes.

Implementation Guidance
Roadside clearances vary by context. Coordinate desired design with policies. It is not always feasible to relocate utilities outside the clear zone.



Crash Type(s) Addressed
Run Off Road

Opportunity Project Type
-

Cost
$ **$$ $$$ $$$$**

Applicable Locations
- Along corridors
- Unsignalized Intersection
- Signalized Intersection

Effectiveness
97%

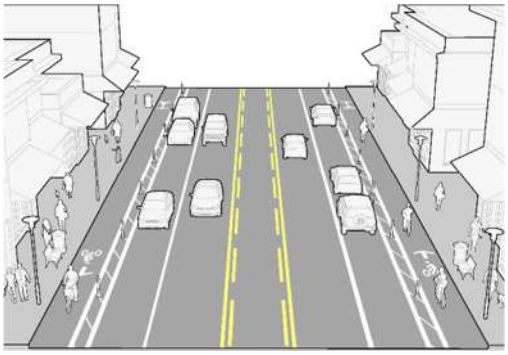
Context
- Small Town/Rural
- Urban/Suburban

Road/Lane Diets

Type
Other Road Design

Description
A reduction in the number of lanes or general purpose lane width in order to reduce driver speeds and/or repurpose roadway space. Roads may be a candidate for a road diet based on the daily traffic volume, posted or target speed limit, and/or planned addition of bicycle facilities.

Implementation Guidance
Eliminating a travel through lane can make room for a bicycle lane, turn lanes, wider sidewalks, median island, curb extensions, on-street parking, landscaping, or other uses.



Crash Type(s) Addressed
Motorcycle Crash, Angle, Sideswipe, Rear End, Bicyclist Crash

Opportunity Project Type
-

Cost
$ $$ **$$$** $$$$

Applicable Locations
- Along corridors

Effectiveness
19% to 47%

Context
- Small Town/Rural
- Urban/Suburban

Rumble Strips (Edge Line or Centerline)

Type
Other Road Design

Description
Rumble strips are milled or raised elements on pavement, placed at the edge line or centerline of a rural roadway to alert drivers that are traveling outside their lane.

Implementation Guidance
If shoulders are available for bicyclists, providing gaps in the rumble strips allows bicyclists to safely access the travel lane.

Crash Type(s) Addressed
Run Off Road, Angle, Head-On, Sideswipe

Opportunity Project Type
-

Cost
$ **$$** $$$ $$$$

Applicable Locations
- Along corridors

Effectiveness
13-64%

Context
- Small Town/Rural

Wet-Reflective Pavement Markings

Type
Other Road Design

Description
Wet-reflective pavement markings are designed to counteract the effects of water and improve visibility in wet, low-light conditions.

Implementation Guidance
Consider establishing a wet-reflective pavement marking specification.

Crash Type(s) Addressed
Run Off Road, Sideswipe

Opportunity Project Type
- Demonstration Grant (SS4A)

Cost
$ $$ **$$$** $$$$

Applicable Locations
- Along corridors

Effectiveness
3-46%

Context
- Small Town/Rural
- Urban/Suburban

APPENDIX A: How to Use the Countermeasure Toolkit

How to use this Toolkit

1. Evaluate crash causation within the project area.
2. Determine which countermeasure(s) will best resolve those crash types based on the information provided in this Toolkit.
3. Determine specific locations and key design details of countermeasure(s).
4. Pull Crash Modification Factors (CMFs) for each countermeasure.
5. Select a Method to Analyze Multiple CMFs.[2]
6. Apply a Method to Analyze Multiple CMFs.[3]
7. Model CMFs to 0 or CRFs to 100%.
8. Engineer safety improvements based on key details in this Toolkit.
9. Build safety improvements.
10. Monitor effectiveness of safety improvements and document actual crash reductions (see Systemic Safety Project Selection and Evaluation section below).
11. Add additional countermeasures or make field adjustments based on actual crash data (see Systemic Safety Project Selection and Evaluation section below).
12. Conduct systemic safety analysis to prioritize projects (see Systemic Safety Project Selection and Evaluation section below).

Systemic Safety Project Selection and Evaluation

Follow the Federal Highway Administration (FHWA) Systemic Safety Project Selection Tool (Selection Tool) for more specific guidance on how to do systemic safety analysis and project prioritization.[4] The Selection Tool outlines how to understand crash types and how roadway context informs selection of systemic safety improvements to conduct project prioritization. The Selection Tool can be used to make system wide improvements (such as leading pedestrian intervals at all signalized intersections) or systemic improvements based on the steps below:

1. Install countermeasures where fatal and serious injury crashes are occurring.
2. Measure the safety improvement of those countermeasures installed.
3. Apply those countermeasures that have worked at reducing and eliminating crashes to similar roadway conditions where crashes could occur.

[2] https://www.youtube.com/watch?v=OPvAjUpT6Dg
[3] https://www.youtube.com/watch?v=48M7TBKTCM0
[4] https://safety.fhwa.dot.gov/systemic/fhwasa13019/sspst.pdf

A period of at least three years is recommended by the Selection Tool to evaluate changes in crashes based on installed countermeasures. After gathering crash data for at least three years, local jurisdictions can determine countermeasure effectiveness that can inform program modifications.

Continuous long-term tracking is also critical for identifying program impacts and useful life. Long-term tracking provides an opportunity for local jurisdictions to direct investments toward effective countermeasures and discontinue funding countermeasures that do not achieve the desired results.

Examples of evaluation of short-term crash data and continuous long-term tracking are included in the Selection Tool.

Appendix C: Effectiveness of Countermeasures

Effectiveness

The level of effectiveness is presented as a crash reduction factor (CRF), which is the estimated percent reduction in crashes. Please note that a crash modification factor (CMF) is the inverse of a CRF. The lower the CMF value, the higher the CRF percentage is (e.g., a CMF of 0.25 is the same as a CRF of 75%).

Although researchers have estimated the reduction in crashes that can be achieved by implementing many road safety tools, crash reduction estimates do not exist for all tools. When research has shown a reduction in crashes for a given tool, it is noted in the Toolkit. This percent is usually presented in a range based on findings from different research or different crash types and contexts. Most of the information on crash reduction is from FHWA's Crash Modification Factors Clearinghouse or FHWA's Proven Safety Countermeasures, unless otherwise noted.[5,6,7] Engineers should confirm the appropriate CRF or CMF value for site-specific factors by using FHWA's Clearinghouse or other proven safety countermeasure sources.

Note: The FHWA cautions that 1) crash reduction estimates should be regarded general effectiveness and are not specific to any road or community, and 2) engineers must exercise judgment and consider site-specific factors when considering which tools to apply.[8]

[5] US DOT. 2023. Crash Modification Factors Clearinghouse. http://www.cmfclearinghouse.org/

[6] FHWA-HRT-23-078. Developing Crash Modification Factors for Separated Bicycle Lanes. https://highways.dot.gov/sites/fhwa.dot.gov/files/FHWA-HRT-23-078.pdf

[7] US DOT. Proven Safety Countermeasures. https://highways.dot.gov/safety/proven-safety-countermeasures

[8] US DOT. 2008. Toolbox of Countermeasures and Their Potential Effectiveness for Roadway Departure Crashes. https://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa18041/