
VISION
TRUCKEE MEADOWS
ZERO
ACTION PLAN • 2022 UPDATE
ZERO FATALITIES BY 2030

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MEMBERS OF THE COMMUNITY:

We are working to make our roads safer for everyone. Over the last 10 years, 327 people have died while walking, biking, or driving in our community. These are our friends, our families and our neighbors. The number of fatalities in our community has been on the rise recently and we are taking action to bring the number of traffic fatalities and serious injuries to zero by the year 2030 by implementing Vision Zero Truckee Meadows. The only acceptable number of traffic deaths in our community is zero.

The Vision Zero Truckee Meadows task force was established to take equitable, data-driven and transparent actions to improve safety throughout our community. By working together to make roads and sidewalks safer for pedestrians, we will make our roads safer for everyone. Our community is made stronger by increasing safety and connectivity for our residents and visitors.

Now, more than ever, we must make our streets safe for everyone, no matter where they go, or how they get there. Safety must be our most important consideration and highest priority moving forward.

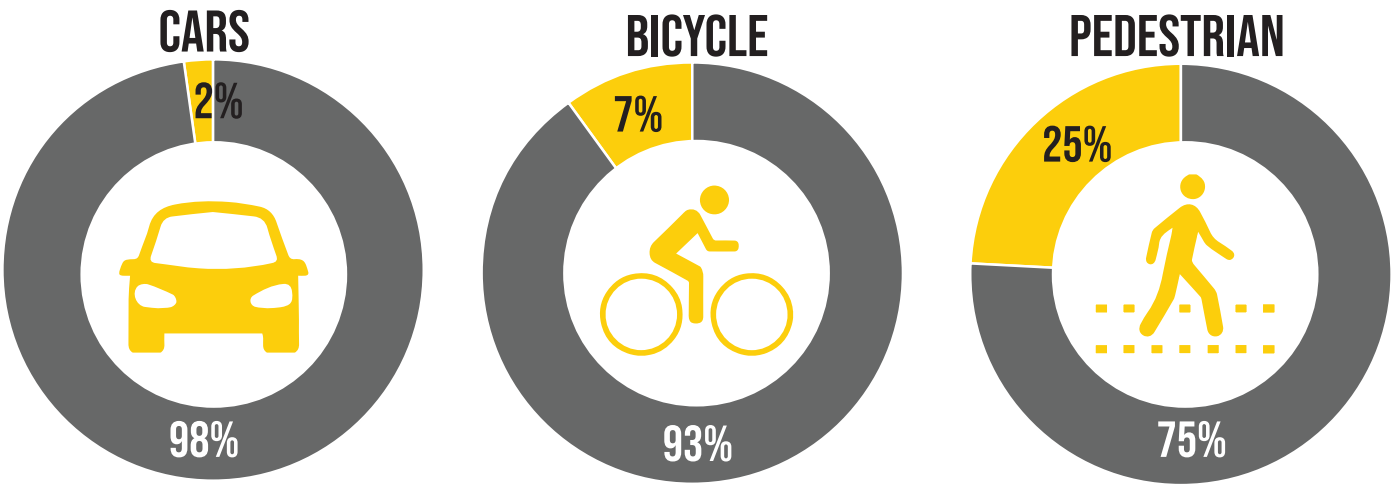
The Vision Zero Truckee Meadows task force is currently comprised of members from the City of Reno, City of Sparks, Washoe County, the Regional Transportation Commission of Washoe County, Washoe County Health District, the Federal Highway Administration, the Nevada Department of Transportation, Office of Traffic Safety, Reno Bike Project, The Chamber, Renown Health, the University of Nevada, Las Vegas, the University of Nevada, Reno, the Washoe County School District and members of the community who have been impacted by traffic fatalities. Through our shared regional commitment to safety, we are committed to changing the rising trend of traffic deaths in our community.

The task force has created an action plan to bring the number of traffic fatalities to zero. We cannot achieve this goal alone. This plan unites us around this common goal as we work together to make our community a stronger and safer place for everyone. We are hoping you will be interested in joining us after reading this plan.

VISION ZERO TRUCKEE MEADOWS GOAL:
ZERO PEDESTRIAN FATALATIES BY 2030

The Vision Zero Truckee Meadows will reach the goal of zero roadway fatalities by 2030 and reduce critical and fatal crashes overall. Vision Zero uses a unique data-driven approach to eliminate all traffic fatalities and serious injuries. This approach focuses on pedestrians as the most vulnerable road users and as the users most disproportionately impacted by crashes. From 2014 – 2018, of all road users involved in a crash, pedestrians were far more likely to be killed or seriously injured compared to other user types, as shown in the graphic below. Additionally, pedestrians represent nearly 30% of traffic fatalities despite the fact that they consistently represent less than 5% of the mode share in the Truckee Meadows.

SHARE OF VICTIMS WHO WERE KILLED OR SERIOUSLY INJURED BY MODE BETWEEN 2014 - 2018



VISION ZERO TRUCKEE MEADOWS TASK FORCE MEMBERS

- City of Reno
  - Neighborhood Services
  - Public Works/Traffic Engineering
  - Reno Police Department (RPD)
- City of Sparks
  - Community Relations
  - Public Works
  - Sparks Police Department
- Federal Highway Administration (FHWA Nevada Division)
- Nevada Department of Transportation (NDOT)
  - Bicycle and Pedestrian Division
  - Traffic Safety Division
  - Zero Fatalities
- Nevada Highway Patrol (NHP)
- Office of Traffic Safety (OTS)
- Regional Transportation Commission of Washoe County (RTC)
  - Communications and Public Affairs
  - Engineering
  - Metropolitan Planning
  - Public Transportation Operations
- Reno Bike Project
- Regional Emergency Medical Services Authority (REMSA)
- Renown Hospital, Trauma Center
- Safe Kids Coalition
- University of Nevada, Reno
  - Department of Engineering
  - Police Department
- University of Nevada, Las Vegas
  - Surgery Division
  - Vulnerable Road Users Project
- Washoe County
  - Community Development
  - Washoe County Health District, Air Quality Management Division
- Washoe County School District
  - Safe Routes to School
- Washoe County Sheriff's Office
- Members of the Public

VISION ZERO TRUCKEE MEADOWS TASK FORCE

The concept of establishing a Vision Zero effort within the Truckee Meadows was conceived during the Nevada Transportation Conference in 2017, when a group of professionals identified an urgent need to improve traffic safety. The multidisciplinary group began meeting later that year and soon established a formal task force. Once formed, the Vision Zero Truckee Meadows (VZTM) Task Force set a goal to reach zero roadway fatalities within the region by the year 2030 and developed the VZTM Action Plan as a means of achieving this goal.

Based on the premise that even one fatality is too many, the foundation of the Task Force is to employ creative solutions in order to eliminate all roadway fatalities. This foundation follows the notion that roads made safer for pedestrians—the most vulnerable road users—will be made safer for everyone. The Task Force, with the support of local leaders, has made a commitment to change the culture related to traffic safety in the Truckee Meadows. The Task Force will continue to monitor, update, and implement this Action Plan until the ultimate goal has been reached.

VISION STATEMENT

Northern Nevadans working together to keep everyone safe on our roads.

MISSION STATEMENT

Northern Nevadans, with the support of elected leaders, have made a commitment to take action to bring the number of fatalities on our roadways to zero. We will make equitable, data-driven, and transparent decisions to improve safety throughout our community. By partnering together to make roads and sidewalks safe for pedestrians, we make our roads safer for everyone. We will actively implement measures proven to reduce serious injuries and fatalities. Through collaboration we will make our community a safe and healthy place, no matter where you go or how you get there.

CREATING A CULTURE OF SAFETY

Traditional traffic safety strategies cannot achieve the target of zero traffic fatalities and serious injuries alone. To achieve a target of zero traffic fatalities and serious injuries, there must be a shift in culture of road users and traffic safety stakeholders.

Traffic safety culture can be defined as the shared belief system of a group of people that influences road user behaviors and stakeholder actions that impact traffic safety. A strong safety culture demonstrates a commitment to safety over competing goals and demands. Among road users, this can be manifest through a higher likelihood to voluntarily use safety devices (e.g. seat belts, child safety seats, helmets, etc.), obey traffic laws, limit distractions, and refrain from using the roads when impaired. Organizations in the transportation industry may integrate safety in all aspects of programs and projects: employees have safety in mind when planning, scoping, designing, and constructing a road; employees regularly communicate the importance of road safety with colleagues, customers, and contractors; and executive leaders are vocal supporters of safety and empower employees to seek innovative approaches to improving safety even if safety is not explicitly part of everyone's job title.

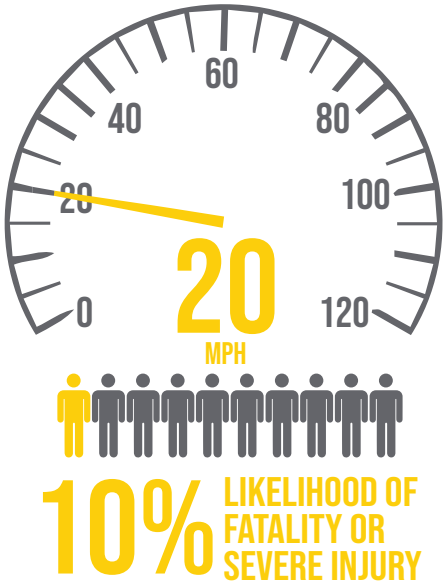
In the context of Vision Zero, a culture of safety is more than a public information campaign—it is a factor in every transportation decision. It aligns efforts across the social environment, leveraging the work of stakeholders at all levels to support traffic safety. Achieving zero fatalities requires leadership and commitment from city and county agencies, elected officials, community stakeholders, and the public and private sectors to find the right solutions for the Truckee Meadows. As the first step in this direction, many of the Task Force agencies signed resolutions in support of the VZTM goal to eliminate fatalities by 2030. These resolutions are supported by an enhanced level of energy and commitment to teamwork for addressing road safety issues.

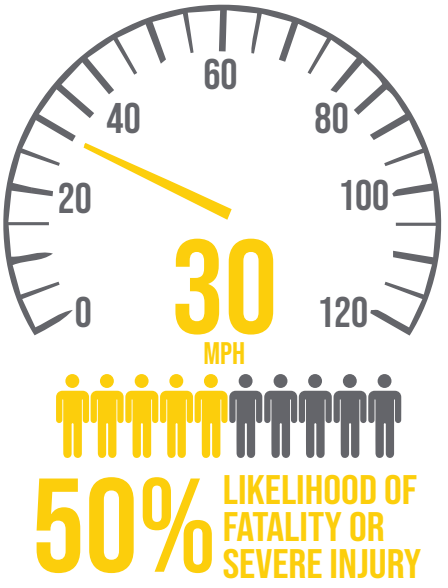
Other Task Force members function as technical experts and resources with more of a grass roots perspective, whose innovations and ideas are incorporated into activities listed as "Action Items" within this Plan. The mix of VZTM Task Force members is important for sustaining the safety culture established within the Truckee Meadows .

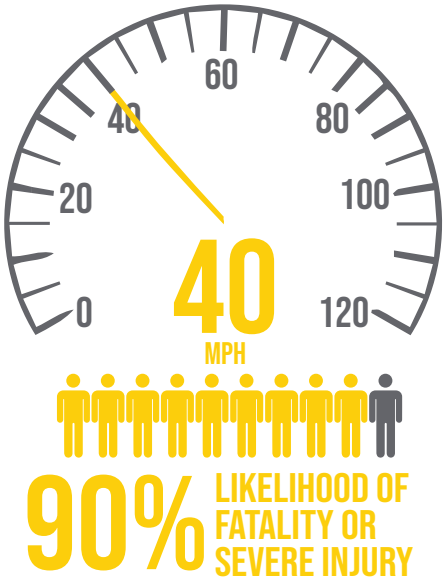
WHAT IS VISION ZERO?

Started in Sweden in the late 1990s, Vision Zero soon spread across Europe and can now be found in many countries worldwide. Implemented as traffic safety policy, it takes an ethical approach toward achieving safety for all road users. Since its inception, Swedish fatalities for all road users has dropped by more than 50 percent! While Sweden has not yet achieved zero fatalities, the fatality rate has dropped by more than half, even while traffic volumes have increased. Similar results have also occurred across other European Vision Zero countries and has begun to manifest in the United States as well.

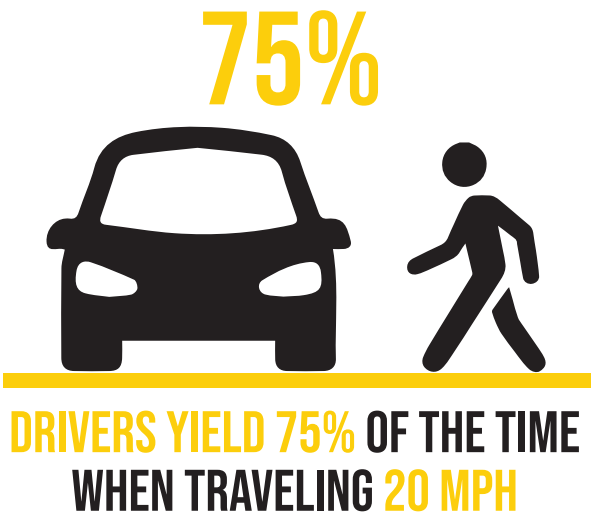
Vision Zero differs from traditional notions of roadway safety, but simply stated, is a concept that all road users can coexist on the street network without losing their lives. It is a concept than can be achieved through a commitment to identifying and addressing the shortcomings of the transportation system itself, including the built environment, policies, and technologies that influence behavior. Vision Zero views traffic crashes as opportunities to fix potential safety risks. The process does not involve an assignment of blame, and instead takes the approach of analyzing the crash from the

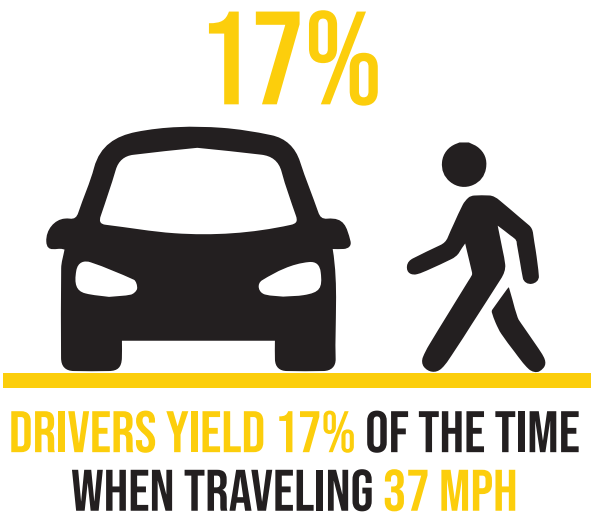






perspective that a mitigation exists or that a better design could have prevented or lessened the severity of the crash. Although system designers—transportation planners and engineers, policymakers, police, etc.—are tasked with the highest level of responsibility for creating a solution, the concept still maintains that individuals have the responsibility to abide by the systems, laws, and policies set by the system designers. If problems persist, the responsibility comes back to the system designers to take further measures to ensure safety.





WHY VISION ZERO?

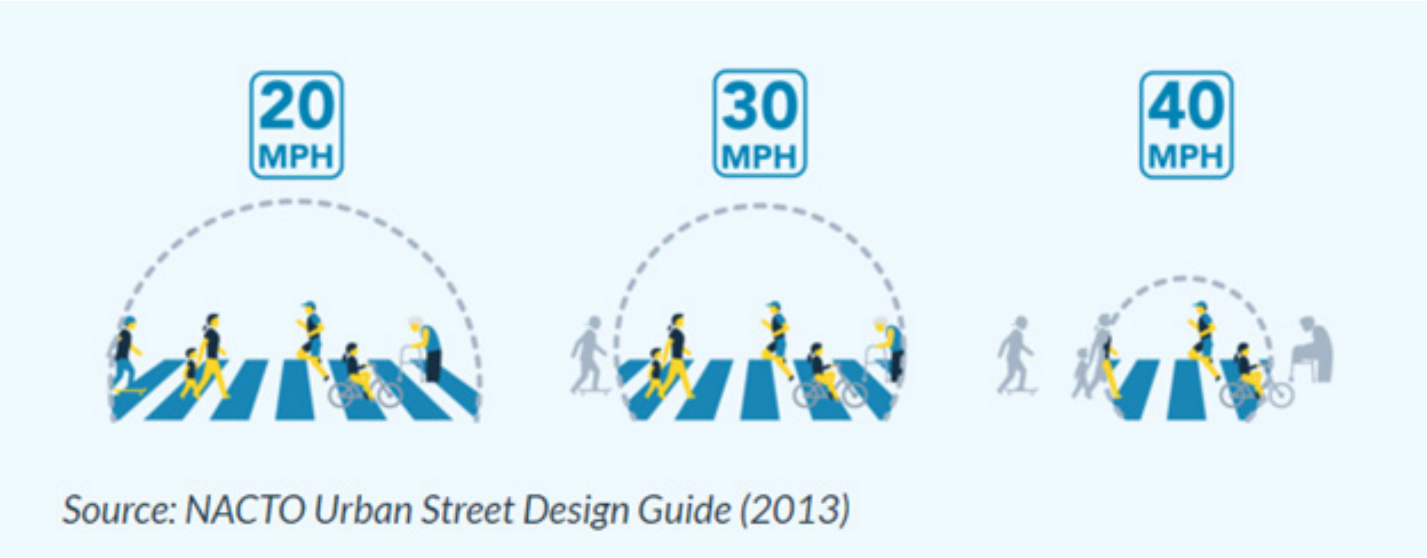
Road safety is truly a matter of life and death. To get the best result—zero deaths—communities must work together to identify and implement solutions for safer roads. Achieving a future with zero traffic deaths requires shifting how communities think about road safety and how investments are prioritized. Vision Zero welcomes new ideas and non-traditional approaches to assuring roads are safer for all, by focusing on making roads safer for the most vulnerable user. As members of the Vision Zero Task Force and/or as members of the community, road safety is in our hands. We have the power to achieve a community where nobody has to die from vehicle crashes.

Roadway safety is also a quality-of-life issue—communities cannot truly thrive without the people that use them feeling safe to do so. Many parents are uncomfortable with allowing their children to walk where non-motorist facilities are not adequate or not present. Even with sidewalks and bike lanes, the level of stress that traffic can create is enough to make people—adults included—decide against using a particular roadway, oftentimes going out of their way to maintain the desired level of comfort for their trip. Many businesses depend on foot traffic, which tends to lead to higher sales and revenue numbers. A roadway project that enhances safety for all users will make that corridor more enticing for bicyclists and pedestrians, thereby increasing foot traffic, upon which businesses place such high value.

Speed is a key contributor to the level of traffic stress (LTS) perceived by non-motorists and is even more critical when considering the impact to pedestrians involved in crashes. Even when traveling at posted speed limits, speed can be a factor in crashes although it may not be reported as such. Bodies without the

benefit of seat belts, air bags, and 3,000 pounds of steel protecting them do not fare well when involved in a crash. The likelihood a pedestrian will survive drops dramatically with an increase of speed from 20 to 40 MPH. Higher speeds not only impact the survival rate but also reduce drivers' field of vision. This leads to longer reaction times and increases required stopping distance making it less likely a crash with other roadway users will be avoided.

Approaches to managing speed include building or modifying roads to include traffic calming features such as roundabouts, bulb-outs and raised medians; establishing speed limits to the function of each road; enforcing speed limits; installing in-vehicle technologies such as intelligent speed assistance; and raising awareness about the dangers of speeding through campaigns and other community outreach.



Source: NACTO Urban Street Design Guide (2013)

IDENTIFYING THE PROBLEM

There is much to be encouraged about considering recent crash statistics in Washoe County relative to the rest of the state and country. Pedestrian fatalities have been declining every year since Vision Zero Truckee Meadows was implemented. The share of pedestrian fatalities in Washoe County has gone down 16% during this same time. In the past 10 years, pedestrian fatalities have gone up 55% in Nevada and 52% nationwide, while Washoe County experienced an 11% increase over that same span. Task Force efforts have resulted in a Pedestrian Safety Zone being established, the unveiling of multiple safety campaigns, installation of several speed feedback signs and other safety improvements, and strengthened partnerships among local stakeholders in a collaborative movement toward zero fatalities.

But the work is not done. The goal of zero fatalities and serious injuries has not yet been attained. Through evaluation of data, implementation of capital projects, and outreach and collaboration, the Task Force will continue its progress toward zero. Upon further inspection of the available safety data, a few contributing factors stand out.

From 2015 to 2020, the time period for which the most current detailed data is available, 62% of fatal crashes in Washoe County occurred at night or under less than ideal lighting conditions, 52% of fatalities involved impairment as a factor, and 23% of fatalities involved speeding as a factor. Additionally, angle and rear end crashes were the most common crash types, by a wide margin. For these and other contributing factors, proven safety countermeasures exist that will be utilized by the Task Force in implementing action items included within this plan.

Data on pedestrians reveals much more alarming statistics. From 2014 – 2018, pedestrians represented 27.3% of the region's total fatalities. This shows the huge disparity—seven times the share of total trips—in impact crashes have on pedestrians versus other road users. Over 60% of total crashes resulting in a fatality or serious injury were in underserved areas of the Truckee Meadows (see map on page 15), despite these areas representing less than one-third of the total population. It is because of these and equally disparate statistics that many VZTM projects will be located in underserved areas and designed and carried out with pedestrians as the primary focus.

These issues and others are further defined by the High-Injury Network (HIN) that was developed as part of this update to take the place of the previously used "focus areas." This HIN, as discussed in more detail later in this plan, was derived from a data-driven safety analysis to help identify problem areas within the region. This process of identifying the problem and applying appropriate solutions is further supported by a more defined focus on the concept of a safe system approach.

27% **OF TRAFFIC FATALITIES BETWEEN 2014-2018 WERE PEDESTRIAN FATALITIES**

VISION ZERO AND THE SAFE SYSTEM APPROACH

Many agencies across the country have started on their own journey toward eliminating fatalities through implementation of a Safe System Approach. The vision of eliminating fatalities and serious injuries on the Nation's roads are shared through such parallel initiatives as Vision Zero, Toward Zero Deaths, and Road to Zero. All three efforts acknowledge the importance of implementing the Safe System Approach in different contexts. Vision Zero applies the Safe System Approach with a focus on safe mobility for all road users, especially those in the undeserved communities. This is because in many road safety-sociodemographic data correlations, higher risks of crash deaths are concentrated in lower-income neighborhoods where exposure to traffic may be higher and past investments in safety programs and infrastructure may be lower.

TRADITIONAL APPROACH	SAFE SYSTEM APPROACH
• Reduce crashes • Speed management • Safety "Four E's" • Apply countermeasures at high crash locations • Examine crash records to identify causes or "deficiencies" • "Balance" safety vs. mobility	• Eliminate fatalities and serious injuries • Kinetic energy management • Five Safe System elements • Proactively apply countermeasures in a "systemic" approach • Strengthen all elements to reduce "system failures" • Only "safe mobility"

The Safe System Approach starts with a mindset that it is unacceptable to allow deaths and serious injuries to occur on the roads. It also acknowledges that road users are human beings and that humans will inevitably make mistakes. On the roads, those mistakes may lead to crashes. The goal of "zero" is to eliminate fatal and serious injuries, not to eliminate crashes. This is a very important distinction for understanding how the road safety problem is viewed under the Safe System Approach. To achieve zero deaths and serious injuries, crashes must be managed so that the kinetic energy exchange on the human body is kept below the tolerable limits for serious harm to occur. This important principle is at the core of applying a Safe System Approach in designing and operating the road system. Human error is to be expected so the road infrastructure and vehicle technology must be designed and operated so that deaths and serious injuries are engineered out. This may be achieved first by reducing the risk of error occurring and secondly by keeping collision forces on the human body within tolerable levels by managing speed and crash angles, so that when crashes do occur, injury severity is kept to a minimum.

IMPLEMENTING THE SAFE SYSTEM APPROACH

The Safe System Approach is an overall guiding vision. There are six Safe System principles, which are the fundamental tenets of a Safe System. There are also five Safe System elements, which are avenues for implementing a Safe System.

Adopters of a Safe System Approach will utilize the five elements of a safe transportation system—safe road users, safe vehicles, safe speeds, safe roads, and post-crash care—in an integrated and holistic manner. Achieving zero traffic deaths and serious injuries requires strengthening all five elements. A Safe System cannot be achieved without all five elements working in synergy. Within a Safe System Approach, weaknesses in one element may be compensated for with solutions in other areas. A true Safe System approach involves optimizing across all the elements to create layers of protection against harm on the roads. These elements of action can be summarized as follows:

- **Safe Road Users –** The safety of all road users is equitably addressed, including those who walk, bike, drive, ride transit, or travel by other modes.
- **Safe Vehicles –** Vehicles are designed and regulated to minimize the frequency and severity of collisions using safety measures that incorporate the latest technology.
- **Safe Speeds –** Humans are less likely to survive high-speed crashes. Reducing speeds can accommodate human-injury tolerances in three ways: reducing impact forces, providing additional

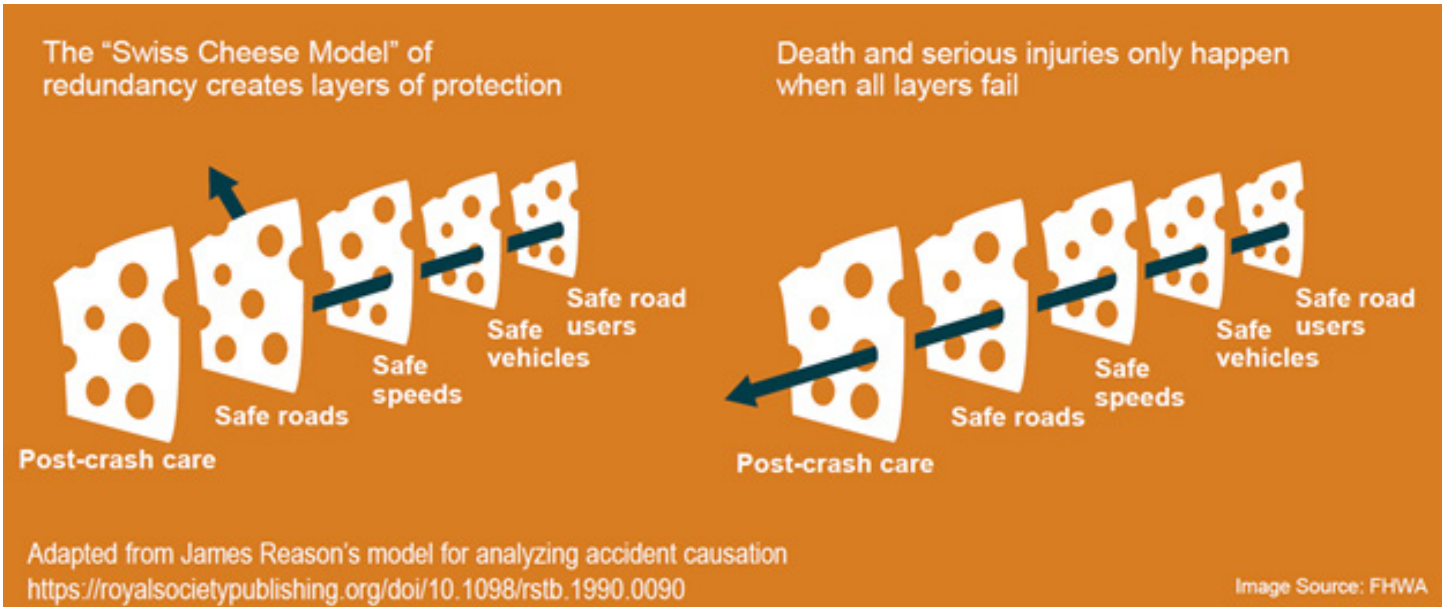
time for drivers to stop, and improving visibility.

- **Safe Roads –** Designing transportation infrastructure to accommodate human mistakes and injury tolerances can greatly reduce the severity of crashes that do occur. Examples include physically separating people traveling at different speeds or via different modes, providing dedicated times for different users to move through a space, and alerting users to hazards and other road users.
- **Post-Crash Care –** People who are injured in collisions rely on emergency first responders to quickly locate and stabilize their injuries and transport them to medical facilities. Post-crash care also includes forensic analysis at the crash site, traffic incident management, and other activities.

Source: FHWA.

The six Safe System "principles," shown around the outside ring of the graphic to the left, are the fundamental beliefs that the Safe System Approach is built on. They establish the goal of the Safe System Approach, acknowledge human limitations, and set expectations for how to act. A successful Safe System Approach weaves together all six principles:

- **Deaths and serious injuries are unacceptable** While no crashes are desirable, the Safe System Approach emphasizes a focus on crashes that result in death and serious injuries. Regardless of road users' socio-economic backgrounds, their abilities, and the modes they use, no one should experience deaths or serious injuries when using the transportation system.
- Humans make mistakes – Road users will inevitably make mistakes, and those mistakes can lead to crashes. The Safe System Approach expects that the road system be planned, designed, and operated to be forgiving of inevitable human mistakes, so that serious injury outcomes are unlikely to occur.
- **Humans are vulnerable** – Humans have limited ability to tolerate crash impacts before harm occurs. Although the exchange of kinetic energy in collisions among vehicles, objects, and road users has multiple determinants, applying the Safe System Approach involves managing the kinetic energy of crashes to avoid serious injury outcomes.
- **Responsibility is shared** – All stakeholders (transportation system users and managers, vehicle manufacturers, etc.) must work collaboratively to ensure that crashes don't lead to fatal or serious injuries.
- **Safety is proactive** – Transportation agencies should use proactive and data-driven tools to identify and mitigate latent risks in the system, rather than waiting for crashes to occur and reacting afterwards.
- **Redundancy is crucial** – Reducing the risk of severe crash outcomes requires all parts of the system to be strengthened, so that if one element fails, the others still protect road users.



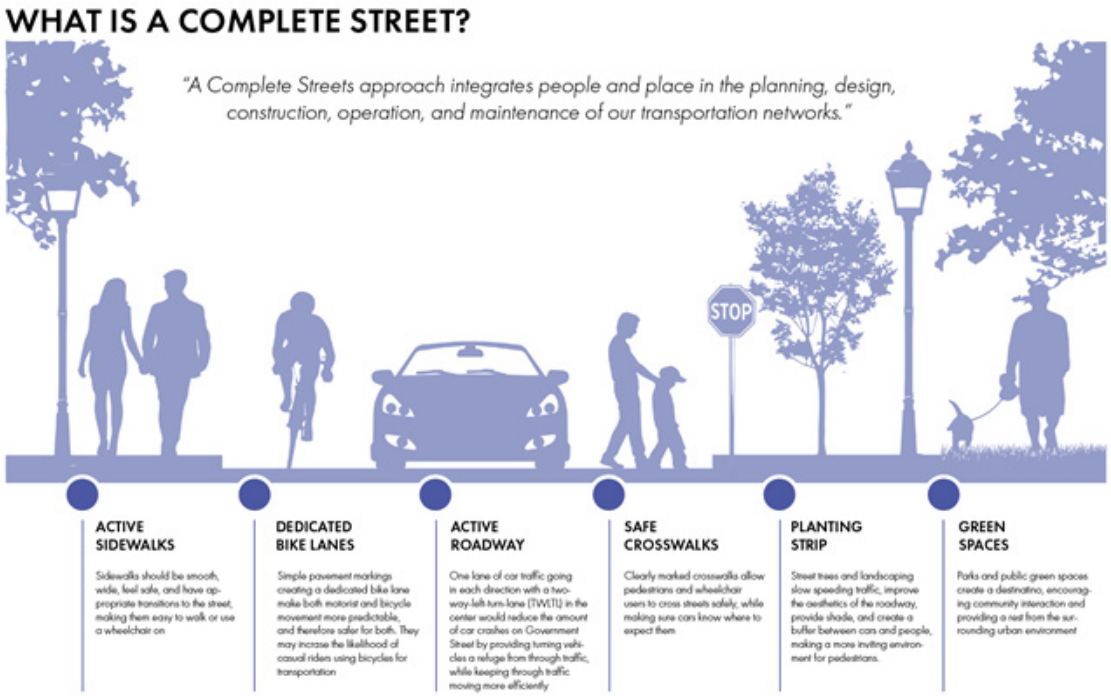
Communities that have implemented the Safe System Approach – including interventions to ensure safer speeds – are those which have made the most progress in saving lives on their roads. How these concepts will be implemented within the Truckee Meadows, through increased use of data, are discussed below.

SAFETY IN NUMBERS

Vision Zero uses a data-driven approach to identify and implement solutions that are objective, equitable, transparent, and, most importantly, to eliminate traffic fatalities and serious injuries. It also shifts the focus of safety projects from being reactive to proactive. Because the Safe System Approach acknowledges that humans will make errors and that crashes will occur, data is needed to identify locations and roadway features that may be more prone to higher crash rates, and to engineer customized solutions to address these potential problems.

SYSTEMIC APPROACH

While taking a proactive approach to traffic safety may help prevent crashes before they happen, reconstructing the entire road network may not be feasible. The systematic application of treatments to all high-risk locations may be limited by available resources. Ultimately, it is desirable to address all potential safety risks, but applying a systemic approach will make progress toward this goal while remaining within the confines of available resources. A systemic approach to safety involves widely implemented improvements based on prioritization of locations with high-risk roadway features correlated with specific severe crash types. This approach broadens traffic safety efforts without overextending an agency's ability to do so. Current projects will simply apply complete streets concepts systemically while future projects will look to address specific high-risk roadway features and employ complete streets design elements.

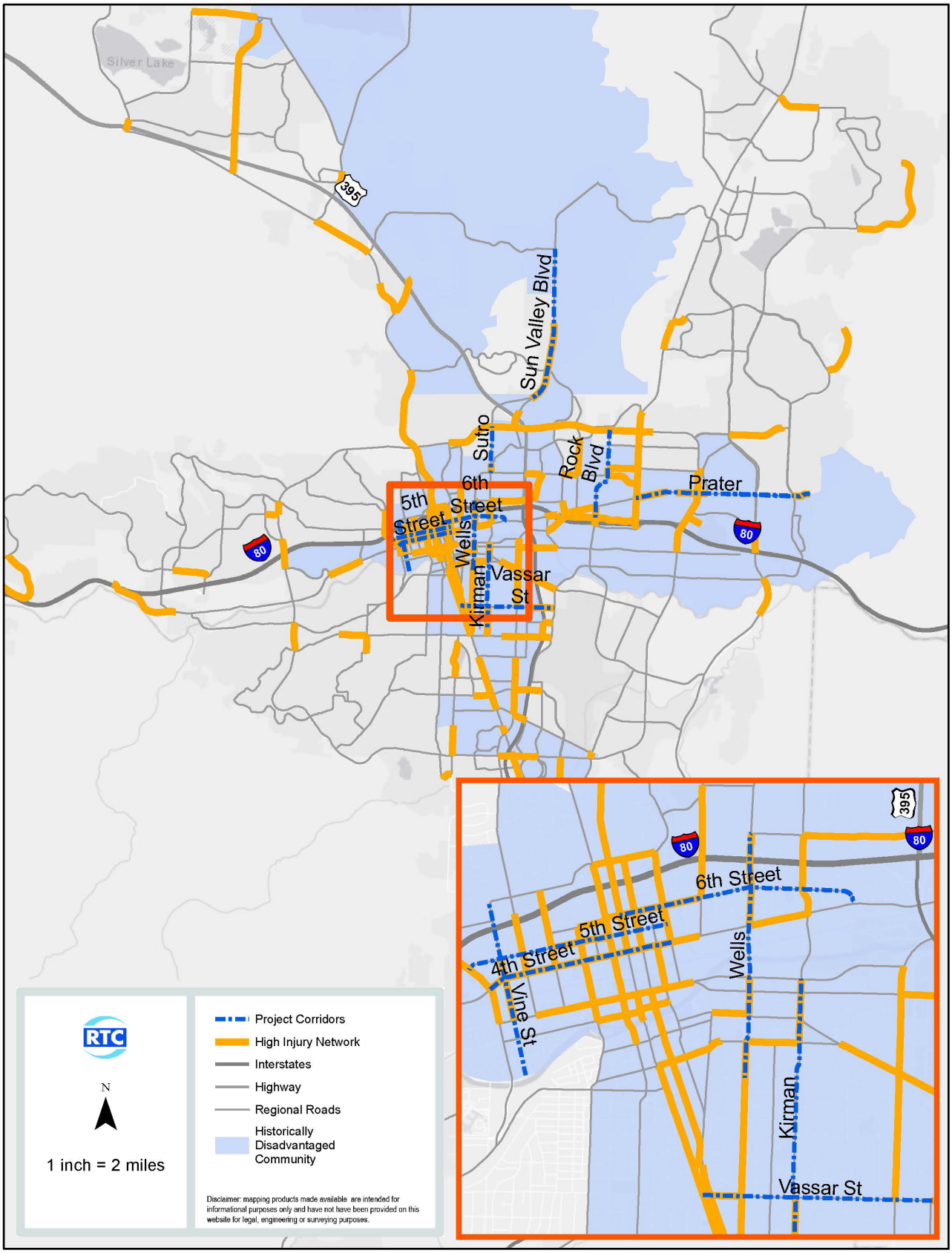


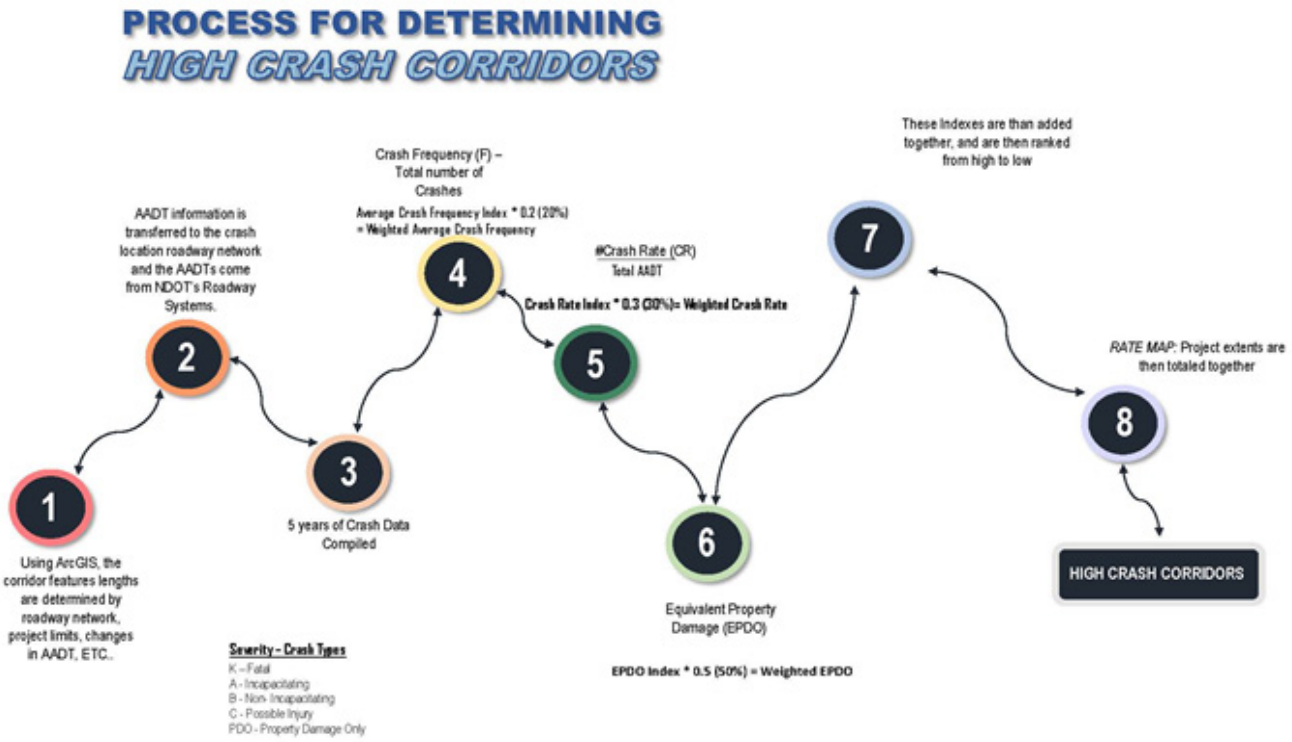
HIGH-INJURY NETWORK

The original VZTM Action Plan included four "focus areas" that were identified as areas of the region that were prioritized as needing safety enhancements. A mix of crash, survey, and anecdotal data was used to define the boundaries and the specific safety needs of each area. As part of this update, a High-Injury Network (HIN) was developed as a means of becoming more data-driven and to better assist with project selection by focusing safety improvements on priority corridors where the most serious crashes happen with the most frequency. The HIN involves a safety analysis that identifies the corridors with the highest levels of fatal and serious crashes for pedestrians, bicyclists, and motorists. It refines the entirety of the Truckee Meadows roadway network into a subset of corridors and intersections where crashes are most concentrated. The process accounts for frequency, crash rate, and severity rating. Frequency is based on the total number of crashes over the entire length of the corridor and normalized by distance, resulting in a crash per mile. Crash rate is a function of crashes per average annual daily traffic (AADT) per mile. Severity rating analyzes the average severity of crashes over the entire length of a given corridor. The three metrics are then combined (weighted as 20% frequency, 30% crash rate, and 50% severity) to produce an overall safety need score, shown as top 10% and top 25%. An enhanced safety analysis resulting in an updated HIN is expected with the next iteration of the VZTM Action Plan. This cannot be completed without the aid of additional data.

40% OF THE FATALITIES AND SERIOUS INJURIES OCCUR ON 10% OF THE ROADS

TRUCKEE MEADOWS HIGH-INJURY NETWORK





MIRE FDE

The FHWA's Model Inventory of Roadway Elements (MIRE) is a recommended listing of roadway characteristic and traffic inventory elements critical to safety management. MIRE is a guide to help transportation agencies improve their roadway and traffic data inventories, developed to support advanced safety analyses. A subset of this data, MIRE Fundamental Data Elements (FDE) provide enough data to enable jurisdictions to analyze crash experience on their roadway networks relative to the expected average crash frequency given the roadway and traffic characteristics at each location (see Appendix 1 for table of MIRE FDE elements). While states are not required to maintain a complete collection of this data for all public roads until 2026, access to this data for all roads within the Truckee Meadows is being catalogued locally and should be available by early 2023.

APPLICATION OF DATA

Vision Zero Truckee Meadows is working toward a holistic approach to safety, but needs data to get there. With access to the necessary MIRE FDE and up-to-date crash data expected in the near future, this version of the VZTM Action Plan will be utilized in the present term, allowing for implementation of a fully transparent and data-driven systemic approach to safety. Projects identified in the Action Items section of the next update will be identified and prioritized based on this data. Additionally, appropriate solutions will be engineered with the guidance of several sources, such as the FHWA's Proven Safety Countermeasures (see Appendix 2), the RTC's Reno Sparks Bicycle & Pedestrian Plan – Design Best Practices and the Crash Modification Factors Clearinghouse. The combination of systemic roadway data, current crash data, and reputable sources on countermeasures and other safety design considerations will be used to appropriately identify and address safety issues. This information will be instrumental in developing action items for inclusion in future iterations of this plan. Ultimately, each project—current or future—will be designed with features that reflect the context and character of the corridor.

SAFETY IN ACTION

Since adoption of Vision Zero Truckee Meadows in 2019, much progress has been made toward achieving zero fatalities. This update builds upon the momentum already created, with the intent of increasing the number of completed projects and decreasing the number of fatalities and serious injuries. The Action Items section of this document has been updated with new projects based on evolving needs and information. The table below provides a summary of progress made to date on previously identified Action Plan items. These items will continue to be addressed, as noted, through 2030 and beyond.

2019 VISION ZERO TRUCKEE MEADOWS ACTION ITEMS

Action Item Number	Action Item Description	Progress to Date	Continued Progress
1a	Expand the Vision Zero Truckee Meadows (VZTM) Task Force membership through public/private partnerships with the community and continue to meet every other month. Task Force membership will include government agencies, emergency responders, hospitals and trauma center, planners, engineers, media partners, members of the business community, other agencies, and members of the public.	Task Force created and regular meetings ongoing; new partnerships formed with existing partnerships strengthened	Short-term / ongoing
1b	Convene regular steering committee meetings of executive-level representatives to coordinate the VZTM efforts.	Executive-level participation will need to be enhanced	Mid-term
1c	Continue progress toward the goal of reaching zero roadway fatalities by the year 2030 through implementation of Action Items and other efforts.	Goal has been adopted by Vision Zero Truckee Meadows with multiple Task Force members enacting formal resolutions	Long-term
1d	Maintain and update VZTM website and include maps and information on crash data, near misses, outreach materials, planned projects and links to the Complete Streets Master Plan, Regional Transportation Plan, RTC Bicycle and Pedestrian Master Plan, and safety material.	Website has been launched and is updated with campaigns, meeting agendas and minutes, safety data, etc.	Short-term / ongoing
1e	Integrate goals and objectives of the Nevada Strategic Highway Safety Plan with VZTM and Task Force actions.	NSHSP has incorporated VZTM goals and partnership exists between VZTM and NDOT's Zero Fatalities initiative	Short-term / ongoing

2a	Integrate traffic calming and complete streets measures into roadways projects to improve safety. Work with local, state, and federal partners to update regulatory authority for setting speed limits and for implementing multimodal improvements identified in the Complete Streets Master Plan and other Master Plans.	Many transportation projects identified in RTP are multimodal in nature and consistent with the CSMP and local master plans; funding recently awarded to Task Force agency members for traffic calming projects	Short-term / ongoing
2b	Review jurisdiction policies, plans, codes, and/or standards to identify opportunities to improve transportation safety via implementation of new developments.	Sidewalks on both sides of the street in new developments mandated in at least some cases, and otherwise preferred	Short-term / ongoing
2c	Develop a regional lighting standard and enhance street lighting to improve visibility throughout the Truckee Meadows. Use information from 2021 UNR lighting study as appropriate.	Recent lighting study completed by NDOT and UNR with recommendations for improving visibility; Task Force agencies will need to decide if/how to take action based on results	Short-term / ongoing
2d	Establish collaborative process to ensure that VZTM countermeasure and multimodal transportation options are evaluated and implemented where feasible on projects.	2050 RTP confirmed collaborative process for constructing multimodal transportation projects; VZTM update provides overview of process for reviewing appropriate countermeasures	Short-term / ongoing
2e	Work with local partners to require new development projects to build connectivity of sidewalks and bicycle network through the implementation of sidewalks, bike infrastructure, and roadway improvements identified in local master plans, RTC Bicycle and Pedestrian Master Plan, RTC Complete Streets Master Plan and Regional Transportation Plan. Include evaluation and implementation of new crosswalks within school zones and near transit, park and ride lots, and RTC ACCESS turn-around and parking locations.	Connectivity included as a goal in local master plans; consideration to transit also given	Short-term / ongoing
2f	Update regional signal timing to improve safety for all modes.	All pedestrian signal timing has been updated to meet current MUTCD standards; all signals receive regular reviews and improvements	Short-term / ongoing
2g	Add reflective yellow backplates on signal heads for higher visibility in low-light settings.	Retroreflective backplates being installed regionwide	Short-term / ongoing

2h	Utilize RTC's bicycle, pedestrian and wheelchair count data to support implementation of VZTM action items in order to enhance accessibility and safety opportunities for vulnerable road users.	Count data incorporated into report finalized early in 2022	Short-term / ongoing
2i	Implement ADA and sidewalk improvements through the 3-year RTC Bus Stop Improvement and Connectivity Program.	FTA grants being utlilized to make progress on ADA Transition Plan	Short-term / ongoing
3a	Recommend, pursue and establish Pedestrian Safety Zones.	One Pedestrian Safety Zone established with plans to implement two others	Mid-term / ongoing
3b	Partner with the City of Reno's anti-speeding campaign to encourage drivers to slow down in neighborhoods, and educate residents on how to submit traffic-calming petitions in applicable neighborhoods.	Anti-speeding campaign materials incorporated into VZTM efforts, including information about submitting traffic-calming petitions	Short-term / ongoing
3c	Partner with the Office of Traffic Safety's "Don't Kill A Dream" campaign using media partners to engage the public through TV, print, billboards, and social media, with the goal of creating awareness of pedestrian safety issues.	"Don't Kill a Dream" campaign materials incorporated into VZTM efforts and disseminated through various media outlets	Short-term / ongoing
3d	Develop a workshop and outreach materials for media professionals and first responders on how to best communicate about traffic crashes and roadway safety.	Task Force will need to collaborate on whether/how to implement this item	Mid-term / ongoing
3e	Increase the use of speed feedback signs and other Intelligent Transportation System (ITS) devices to discourage speeding. Implement and maintain Safe Routes to School programs with local jurisdictions.	Funding recently awarded to Task Force agencies for projects--including SRTS programs--aimed at enhancing safety in school zones	Short-term / ongoing
3f	Engage and partner with the Safe Routes to School program and charter schools to support parents, students, and school staff to educate students about safety, and develop a workshop to engage the community and businesses about roadway safety and the goal to reach zero roadway fatalities by 2030.	VZTM partnered with SRTS programs and charter schools to provide education on VZ efforts	Short-term / ongoing

3g	Partner with local stakeholders such as law enforcement, Downtown Ambassadors, Community Assistant Center, HOPES Clinic, Eddy House, Catholic Community Services, Washoe County Senior Center, University of Nevada, Reno, Volunteers of America, and Veteran's Affairs to provide outreach efforts that inform vulnerable populations (homeless, low-income, etc.) about pedestrian safety.	Task Force members obtained safety items and brochures, distributing them among community agencies that support vulnerable populations	Short-term / ongoing

ENHANCING SAFETY IN THE TRUCKEE MEADOWS

Pedestrian safety is a top priority for the Vision Zero Truckee Meadows Task Force. While the number of pedestrian fatalities in Washoe County decreased from 15 to 12 and from 12 to 10 year-over-year (2019 to 2020 and 2020 to 2021, respectively), each one of these fatalities was preventable.

The Vision Zero Truckee Meadows Task Force first took action toward improving safety when it launched a pedestrian safety campaign early in 2019. The campaign aimed to engage the local community and partners with meaningful outreach and messaging and activate everyone to take ownership and participate in preventing traffic fatalities and serious injuries. The initial campaign was developed through the Nevada Office of Traffic Safety and aimed at making pedestrian safety everyone's responsibility. The latest campaign reinforces the notion that all road users can work together to prevent crashes.

In 2021, a pedestrian safety zone was successfully established in one of the original focus areas. Additionally, funding was awarded to enhance safety in school zones through installation of speed feedback signs and pedestrian flashing lights and for the continuation of Safe Routes to School programs.

The Vision Zero Truckee Meadows Task Force will continue to build upon these and other actions undertaken since 2019. Several of the projects identified as part of this initial effort are ongoing, while many others have been added as a result of this continued commitment and through the application of new information and data.

TASK FORCE COORDINATION

Member agencies of the Vision Zero Truckee Meadows Task Force are committed to implementing safety in their respective programs and projects. This commitment is evidenced throughout agency planning documents, development codes, design standards, stated goals and strategies, and other policy documents. The goals and Action Items of VZTM match up well with recently adopted plans and policies regionwide that guide the development of the transportation network in the Truckee Meadows.

The RTC's 2050 Regional Transportation Plan includes guiding principles and goals centered around improving and promoting safety as well as integrating all types of transportation. In implementing roadway projects, the aim is to not only enhance a safe and interconnected multimodal transportation system, but to provide these mobility options while accounting for the context and needs of the areas and people they serve. Projects are coordinated with appropriate Task Force agencies to ensure the highest level of quality and safety. For example, the City of Reno's Master Plan strives to "balance the safety and needs of all transportation modes—driving, bicycling, walking, and taking transit—in day-to-day planning, development review, and decision-making." Both the Master Plan and Municipal Code incorporate and address several elements related to the equitable and sustainable enhancement of multimodal transportation. The City of Sparks maintains guidelines on traffic calming that focus on improving neighborhood safety and livability. This set of recommended standards includes a map of emergency response routes and coincides with the City's Comprehensive Plan. Washoe County maintains a similar document that establishes thresholds for processing and analyzing traffic calming and traffic engineering/operational requests. The County is also in the process of updating its Master Plan and Development Code which prioritizes safety and accessibility. Various other local policies and guidelines align to create a broader vision for the region of achieving a safe and connected transportation network.

Beyond the consistent safety narrative that already exists, Task Force members are working to identify opportunities to improve how processes address safety. Revisions to existing policies, guidelines, and standards are being considered with the intent of improving safety in all areas. Action Item 2b was developed specifically in this regard—others will be identified and added to the Action Item list as appropriate.

EQUITY CONSIDERATIONS

Projects added to the Action Items section have been reviewed and selected to ensure equity. VZTM seeks to align roadway safety improvements with the areas most impacted by traffic deaths and serious injuries—often the most underserved communities in the region. It is therefore important to apply an equitable distribution of projects throughout the Truckee Meadows. It should be noted that the term "underserved," as applied to VZTM, is consistent with the Historically Disadvantaged Community designation, which includes areas defined by the U.S. Census. Between 2014 and 2018, over 60% of total crashes and 54.7% of crashes resulting in a fatality or serious injury were in underserved areas of the Truckee

Meadows. Of the crashes occurring within the HIN, nearly 80% are within underserved areas. Considering underserved areas of the Truckee Meadows represent only 31.7% of the total population and 39.1% of regional roadway miles, these crash statistics affirm that traffic safety efforts focused in these areas are not misguided. Following closely with available data, the Action Item section has been updated to include projects expected to have the biggest impact on reducing crashes, primarily for pedestrians and primarily in underserved areas.

The Task Force will expand its reach by soliciting input from members of the public and groups that represent underserved communities to identify Action Items that can be incorporated to better address safety issues within these communities. This will be done, as it has in the past, through in-person surveys and other outreach activities.

Of the Action Items new to this plan, many are capital projects. Each of these identified projects is located in the underserved areas of the Truckee Meadows. Part of the justification for this is based on the fact that these projects will involve design features geared toward the safety of active transportation users. Much of the underserved population has a high transit propensity, meaning they are more likely to walk, bike and take transit, and would benefit more from such projects. For example, 17% of individuals living within 1/4-mile of project corridors are living in poverty and 52% are living in zero- or one-car households. Appendix 4 provides a more complete picture of the demographics in proximity to project corridors.

VISION ZERO TRUCKEE MEADOWS ACTION ITEMS

As discussed previously, project selection going forward will incorporate a more comprehensive process utilizing data soon to be available. As it stands, project selection already undergoes a rigorous process using several layers of consideration including the HIN, project readiness/need, coordination/input, equity, and geography/existing conditions. Many projects were also vetted through the prioritization process established in the Regional Transportation Plan (see Appendix 3). All projects incorporated into the current, and future iterations, of the VZTM Action Plan involve complete streets elements. The application of these elements is derived from the RTC's Complete Streets Master Plan which considers bikeability, walkability, transit access, roadway characteristics, crash data, employment, population, public facilities, and public transit in corridor evaluation. Complete streets elements will be applied systemically across current and future VZTM Action Plan projects as a means of addressing safety and accessibility.

The Action Items shown in the table below were added as part of this update. Each Action Item is numbered and includes a brief description and estimated implementation timeframe. Progress of each item will continue to be monitored and reported. Specific project updates will be posted, as they occur, to the VZTM website and incorporated into future updates of the VZTM Action Plan. Finally, progress of relevant projects will be measured and reported over time to track successes and other outcomes. Data will be collected and analyzed to determine the impact and effectiveness of each project implemented. Before and after metrics such as frequency and severity of crashes; vehicle speeds; ADT; bicycle and pedestrian counts; near misses; and others will be evaluated at various intervals.

ACTION 1: ENHANCE VISION ZERO TRUCKEE MEADOWS PROGRAM

Action Item Number	Action Item Description	Implementation Time-frame
Action 1f:	Collect and report data on project outcomes to determine level of success of the program, projects, and individual project elements.	Short-term / ongoing

ACTION 2: IMPROVE STREET DESIGN/INFRASTRUCTURE

Action Item Number	Action Item Description	Implementation Time-frame
Action 2j:	Improve data collection on roadway elements to at least MIRE FDE to help identify systemic roadway needs and to enhance decision-making for projects when selecting which treatments to implement in mitigating crash issues.	Mid-term / ongoing
Action 2k:	Construct multimodal capital improvement projects throughout region using HIN, systemic roadway data, and Task Force input as guides to select and prioritize project locations.	Short-term / ongoing
Action 2l:	Construct multimodal capital improvement project on 5th Street from Keystone Avenue to Evans Avenue. Address specific safety issues based on data and Task Force input.	Short-term
Action 2m:	Construct multimodal capital improvement project on 6th Street from Virginia Street to 4th Street. Address specific safety issues based on data and Task Force input.	Short-term
Action 2n:	Construct multimodal capital improvement project on Vassar Street from Holcomb Avenue to Terminal Way. Address specific safety issues based on data and Task Force input.	Mid-term
Action 2o:	Construct multimodal capital improvement project on Kirman Avenue from Kuenzli Street to Casazza Drive. Address specific safety issues based on data and Task Force input.	Mid-term
Action 2p:	Construct multimodal capital improvement project on Rock Boulevard from Victorian Avenue to McCarran Boulevard. Address specific safety issues based on data and Task Force input.	Mid-term
Action 2q:	Construct multimodal capital improvement project on Sutro Street from McCarran Boulevard to Oddie Boulevard. Address specific safety issues based on data and Task Force input.	Mid-term

Action 2r:	Construct multimodal capital improvement project on Sun Valley Boulevard from 7th Avenue to Scottsdale Road. Address specific safety issues based on data and Task Force input.	Mid-term
Action 2s:	Construct multimodal capital improvement project on 4th Street from Keystone Avenue to Evans Avenue. Address specific safety issues based on data and Task Force input.	Mid-term
Action 2t:	Construct multimodal capital improvement project on Keystone Avenue from California Avenue to Interstate 80. Address specific safety issues based on data and Task Force input.	Mid-term
Action 2u:	Construct multimodal capital improvement project on Vine Street from Riverside Drive to University Terrace. Address specific safety issues based on data and Task Force input.	Long-term
Action 2v:	Construct multimodal capital improvement project on Wells Avenue from Moran Street to 9th Street. Address specific safety issues based on data and Task Force input.	Mid-term
Action 2w:	Construct multimodal capital improvement project on Prater Way from Pyramid Way to Pete's Way. Address specific safety issues based on data and Task Force input.	Mid-term

ACTION 3: COMMUNITY ENGAGEMENT/OUTREACH

Action Item Number	Action Item Description	Implementation Time-frame
Action 3h:	Increase public outreach, education, and input opportunities. Reporting and transparency are important for keeping community leaders and the public informed and involved in the action plan updates and project implementation.	Short-term / ongoing
Action 3i:	Implement additional pedestrian surveys using new data and refined survey techniques.	Mid-term / ongoing
Action 3j:	Implement educational campaign tailored to engineers, planners, and members of the public demonstrating the importance of proper utilization of infrastructure and determining appropriate project locations and features that will be more functional in practice (i.e., crosswalks that pedestrians will actually use).	Mid-term

APPENDIX 1: MIRE FDE ELEMENTS

MIRE FDE Data Elements					
		Surface Type			
		Non-Local Paved Roads		Local Paved Roads	Unpaved Roads
Functional Class	Roadway Segment	Segment Identifier			
		Functional Class			
		Type of Governmental Ownership			
		Begin Point Segment Descriptor			
		End Point Segment Descriptor			
		Surface Type			
		Number of Through Lanes			
		Annual Average Daily Traffic (AADT)			
		Rural/Urban Designation			
		Route Number	Route/Street Name		
		Federal Aid/Route Type	Segment Length		
		Direction of Inventory	Median Type		
		Access Control	One/Two-Way Operations		
		AADT Year			
	Intersection	Unique Junction Identifier	Unique Approach Identifier		
		Location Identifier for Road 1 Crossing Point	Location Identifier for Road 2 Crossing Point		
		Intersection/Junction Geometry	Intersection/Junction Traffic Control		
		AADT (for each intersecting road)	AADT Year (for each intersecting road)		
	Interchange / Ramp	Unique Interchange Identifier	Interchange Type		
		Location Identifier for Roadway Beginning Ramp Terminal	Location Identifier for Roadway Ending Ramp Terminal		
		Roadway Type at Beginning Ramp Terminal	Roadway Type at Ending Ramp Terminal		
		Ramp Length	Functional Class		
		Ramp AADT	Year of Ramp AADT		
		Type of Governmental Ownership			

APPENDIX 2: FHWA'S PROVEN SAFETY COUNTERMEASURES BOOKLET

MAKING OUR ROADS SAFER | One Countermeasure at a Time

28 Proven Safety Countermeasures that offer significant and measurable impacts to improving safety

U.S. Department of Transportation
Federal Highway Administration

ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE
https://safety.fhwa.dot.gov/

Technical Report Documentation Page

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15. SUPPLEMENTARY NOTES

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16. ABSTRACT

The Proven Safety Countermeasure Initiative (PSCi) is a collection of 28 countermeasures and strategies effective in reducing roadway fatalities and serious injuries on our Nation's highways. Transportation agencies are strongly encouraged to consider widespread implementation of PSCs to accelerate the achievement of local, State, and National safety goals. This booklet provides 1-page handouts for all 28 PSCs, broken into the focus areas of speed management, roadway departure, intersections, pedestrians/bicyclists, and crosscutting for countermeasures that apply across categories.

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OFFICE OF SAFETY

Proven Safety Countermeasures

SPEED MANAGEMENT

Speed Safety Cameras

Variable Speed Limits

Appropriate Speed Limits for All Road Users

ROADWAY DEPARTURE

Wider Edge Lines

Enhanced Delineation for Horizontal Curves

Longitudinal Rumble Strips and Stripes on Two-Lane Roads

SafetyEdge℠

Roadside Design Improvements at Curves

Median Barriers

INTERSECTIONS

Backplates with Retroreflective Borders

Corridor Access Management

Dedicated Left- and Right-Turn Lanes at Intersections

Reduced Left-Turn Conflict Intersections

Roundabouts

Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections

Yellow Change Intervals

PEDESTRIANS/BICYCLES

Crosswalk Visibility Enhancements

Bicycle Lanes

Rectangular Rapid Flashing Beacons (RRFB)

Leading Pedestrian Interval

Medians and Pedestrian Refuge Islands in Urban and Suburban Areas

Pedestrian Hybrid Beacons

Road Diets (Roadway Reconfiguration)

Walkways

CROSSCUTTING

Pavement Friction Management

Lighting

Local Road Safety Plans

Road Safety Audit

Introduction

Widespread use of the 28 Proven Safety Countermeasures (PSCs) identified in this booklet can offer significant, measurable impacts as part of any agency's approach to improving safety. These strategies are designed for all road users and all kinds of roads—from rural to urban, from high-volume freeways to less traveled two-lane State and county roads, from signalized crossings to horizontal curves, and everything in between. Each countermeasure addresses at least one safety focus area – speed management, intersections, roadway departures, or pedestrians/bicyclists – while others are crosscutting strategies that address multiple safety focus areas.

Between 2016 and 2019, 85 percent[1] of all public highway fatalities occurred on Federal-aid highways, which represent 25 percent[2] of the entire public highway network. FHWA's partner agencies have invested in highway safety through the Highway Safety Improvement Program (HSIP), which provides targeted safety funding that is eligible for use on all public roads. However, this dedicated funding source represents only about 6 percent of the total Federal-aid program.[3] Every transportation project, whether or not the specific project purpose is safety related, is a new opportunity to save lives on our roadways. The FHWA's Proven Safety Countermeasures are eligible under most Federal-aid highway funding programs, and can support state, local, and tribal agency efforts to effectively accomplish goals to reduce fatalities and serious injuries. These countermeasures should serve as the basis for what agencies consider and implement when designing any highway project to improve safety.

To assist practitioners with determining the most appropriate PSC for their location of interest, the PSC webpage includes a filter tool that allows users to obtain a tailored listing of potential PSCs. Users answer questions regarding area types, functional classification, traffic volumes, issue identified, targeted crash types, and other information to receive a list of PSCs meeting thecriteria. This search function is intended to better serve practitioners, including those with limited safety background, when identifying and considering treatments and strategies that can improve safety as part of their program or project.

Transportation agencies are strongly encouraged to consider widespread implementation of PSCs to accelerate the achievement of local, State, and National safety goals. Reaching our goal of zero deaths and serious injuries requires all of us to take ownership in safety. Together, we can consider the safety needs at every stage of the project development process, the safety impact of every investment decision, and the appropriate safety countermeasures for every Federal-aid project.

1 NHTSA Fatality Analysis Reporting System (FARS) 2016-2018 Final and 2019 Annual Report File (ARF)
2 FHWA Highway Statistics 2019 (https://www.fhwa.dot.gov/policyinformation/statistics/2019/hm16.cfm)
3 Federal-aid apportioned programs under the Fixing America's Surface Transportation (FAST) Act (https://www.fhwa.dot.gov/fastact/funding.cfm)

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Speed Safety Cameras

Safe Speeds is a core principle of the Safe System Approach since humans are less likely to survive high-speed crashes. Enforcing safe speeds has been challenging; however, with more information and tools communities can make progress in reducing speeds. Agencies can use speed safety cameras (SSCs) as an effective and reliable technology to supplement more traditional methods of enforcement, engineering measures, and education to alter the social norms of speeding. SSCs use speed measurement devices to detect speeding and capture photographic or video evidence of vehicles that are violating a set speed threshold.

Safety Benefits:

Fixed units can reduce crashes on urban principal arterials up to:

54% for all crashes.[4]

47% for injury crashes.[4]

P2P units can reduce crashes on urban expressways, freeways, and principal arterials up to:

37% for fatal and injury crashes.[2]

Mobile units can reduce crashes on urban principal arterials up to:

20% for fatal and injury crashes.[5]

In New York City, fixed units reduced speeding in school zones up to 63% during school hours.[6]

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/speedmgt/.

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Applications

Agencies should conduct a network analysis of speeding-related crashes to identify locations to implement SSCs. The analysis can include scope (e.g., widespread, localized), location types (e.g., urban/suburban/rural, work zones, residential, school zones), roadway types (e.g., expressways, arterials, local streets), times of day, and road users most affected by speed-related crashes (e.g., pedestrians, bicyclists).

SSCs can be deployed as:

- **Fixed units**—a single, stationary camera targeting one location.
- **Point-to-Point (P2P) units**—multiple cameras to capture average speed over a certain distance.
- **Mobile units**—a portable camera, generally in a vehicle or trailer.

The table below describes suitable circumstances for SSC deployment.[1]

Considerations

- SSCs can produce a crash reduction upstream and downstream, thus generating a spillover effect.[2]
- Public trust is essential for any type of enforcement. With proper controls in place, SSCs can offer fair and equitable enforcement of speeding, regardless of driver age, race, gender, or socio-economic status. SSCs should be planned with community input and equity impacts in mind.
- Using both overt (i.e., highly visible) and covert (i.e., hidden) enforcement may encourage drivers to comply with limits everywhere, not only at sites they are aware are enforced.
- Agencies should conduct evaluations regularly to determine if SSCs are accomplishing safety goals and whether changes in strategy, scheduling, communications, or public engagement are necessary.
- Agencies should conduct a legal and policy review to determine if SSCs are authorized within a jurisdiction and how the authorization and other traffic laws will affect a SSC program.
- Agencies should develop an SSC program plan with consideration of the USDOT SSC guidelines for planning, public involvement, stakeholder coordination, implementation, maintenance, evaluation, etc.[3]

Considerations for Selection	Fixed	P2P	Mobile
Problems are long-term and site-specific.	X	X	—
Problems are network-wide, and shift based on enforcement efforts.	—	—	X
Speeds at enforcement site vary largely from downstream sites.	—	X	X
Overt enforcement is legally required.	X	X	X
Sight distance for the enforcement unit is limited.	X	X	—
Enforcement sites are multilane facilities.	X	X	—

1 Thomas et al. Speed Safety Camera Program Planning and Operations Guide. FHWA, (2021).
2 Montella et al. "Effects on speed and safety of point-to-point speed enforcement systems". Accident Analysis and Prevention, Vol. 75, (2015). Note that this is an international study.
3 Speed Enforcement Camera Systems Operational Guidelines. NHTSA, (2008).
4 Shin et al. "Evaluation of the Scottsdale Loop 101 automated speed enforcement demonstration program." Accident Analysis and Prevention, Vol. 41, (2009).
5 Li et al. "A Before-and-After Empirical Bayes Evaluation of Automated Mobile Speed Enforcement on Urban Arterial Roads." Presented at the 94th Annual Meeting of the Transportation Research Board, Paper No. 15-1563, Washington, D.C., (2015). Note that this is an international study.
6 Automated Speed Enforcement Program Report 2014-2017. New York City DOT, (2018).

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Variable Speed Limits

Selecting appropriate speed limits on roadways is important in maintaining a safe and efficient transportation network. Speed limits are established with an engineering study based on inputs like traffic volumes, operating speeds, roadway characteristics, and crash history. However, conditions on the roadway are susceptible to change in a short amount of time (e.g., congestion, crashes, weather). Drivers typically determine their operating speeds under normal weather conditions on a straight roadway section with good pavement quality and adequate sight distances. If ideal conditions do not exist and the roadway does not meet the driver's expectations, there is a greater chance that a driver error could result in a crash. Providing variable speeds limits (VSLs) capable of adapting to changing circumstances could reduce crash frequency and severity.

Speed management strategies, including VSLs, are integral to the Safe Speeds element of the Safe System Approach. Because humans are unlikely to survive high-speed crashes, VSLs reduce speeds so that human injury tolerances are accommodated in three ways: improving visibility, providing additional time for drivers to stop, and reducing impact forces.

Safety Benefits:

VSLs can reduce crashes on freeways up to:

34%
for total crashes.[1]

65%
for rear-end crashes.[1]

51%
for fatal and injury crashes.[1]

Benefit/Cost Ratios range between[1]

9:1 - 40:1

Applications

VSLs use prevailing information on the roadway, like traffic speed, volumes, weather, and road surface conditions, to determine appropriate speeds and display them to drivers. This strategy improves safety performance and traffic flow by reducing speed variance (i.e., improving speed harmonization). VSLs may also improve driver expectation by providing information in advance of slowdowns and potential lane closures, which could reduce the probability for secondary crashes. VSLs can mitigate adverse weather conditions or to slow faster-moving traffic as it approaches a queue or bottleneck.

Agencies can implement VSLs for the following applications:


CONGESTION


INCIDENTS


WORK ZONES


INCLEMENT WEATHER

Considerations

- Particularly effective on urban and rural freeways and high-speed arterials with posted speed limits greater than 40 mph.
- Often implemented as part of Active Traffic Management (ATM) plans or incorporated into existing Road Weather Information Systems.
- When used with ATM, VSLs can mitigate rear-end, sideswipe, and other crashes on high-speed roadways.
- May be implemented as a regulatory and/or an advisory system.
- Can be applied to an entire roadway segment or individual lanes.

Source: WSDOT

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/speedmgt/ref_mats/.

1 Avelar et al. Developing Crash Modification Factors for Variable Speed Limit. FHWA, (2020).

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Appropriate Speed Limits for All Road Users

There is broad consensus among global roadway safety experts that speed control is one of the most important methods for reducing fatalities and serious injuries. Speed is an especially important factor on non-limited access roadways where vehicles and vulnerable road users mix.

A driver may not see or be aware of the conditions within a corridor, and may drive at a speed that feels reasonable for themselves but may not be for all users of the system, especially vulnerable road users, including children and seniors. A driver traveling at 30 miles per hour who hits a pedestrian has a 45 percent chance of killing or seriously injuring them.[1] At 20 miles per hour, that percentage drops to 5 percent.[1] A number of cities across the United States, including New York, Washington, Seattle and Minneapolis, have reduced their local speed limits in recent years in an effort to reduce fatalities and serious injuries, with most having to secure State legislative authorization to do so.

States and local jurisdictions should set appropriate speed limits to reduce the significant risks drivers impose on others—especially vulnerable road users—and on themselves. Addressing speed is fundamental to the Safe System Approach to making streets safer, and a growing body of research shows that speed limit changes alone can lead to measurable declines in speeds and crashes.[2]

Safety Benefits:

Traffic fatalities in the City of Seattle decreased 26 percent after the city implemented comprehensive, city-wide speed management strategies and countermeasures inspired by Vision Zero. This included setting speed limits on all non-arterial streets at 20 mph and 200 miles of arterial streets at 25 mph.[5]

One study found that on rural roads, when considering other relevant factors in the engineering study along with the speed distribution, setting a speed limit no more than 5 mph below the 85th-percentile speed may result in fewer total and fatal plus injury crashes, and lead to drivers complying closely with the posted speed limit.[6]

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/speedmgt/ref_mats/.

Applications

Posted speed limits are often the same as the legislative statutory speed limit. Agencies with designated authorities to set speed limits, which include States, and sometimes local jurisdictions, can establish non-statutory speed limits or designate reduced speed zones, and a growing number are doing so. While non-statutory speed limits must be based on an engineering study, conducted in accordance with the *Manual on Uniform Traffic Control Devices* (MUTCD) involving multiple factors and engineering judgment, FHWA is also encouraging agencies to use the following:[3]

- Expert Systems tools.
  - USLIMITS2.
  - NCHRP 966: Posted Speed Limit Setting Procedure and Tool.
- Safe System approach.

Based on international experience and implementation in the United States, the use of 20 mph speed zones or speed limits in urban core areas where vulnerable users share the road environment with motorists may result in further safety benefits.[4]

Considerations

When setting a speed limit, agencies should consider a range of factors such as pedestrian and bicyclist activity, crash history, land use context, intersection spacing, driveway density, roadway geometry, roadside conditions, roadway functional classification, traffic volume, and observed speeds.

To achieve desired speeds, agencies often implement other speed management strategies concurrently with setting speed limits, such as self-enforcing roadways, traffic calming, and speed safety cameras. Additional information is in the following FHWA resources:

- FHWA Speed Management website.
- Self-Enforcing Roadways: A Guidance Report.
- Noteworthy Speed Management Practices.
- Jurisdiction Speed Management Action Plan Development Package.
- Traffic Calming ePrimer.

1 Reducing the speed limit to 20 mph in urban areas: Child deaths and injuries would be decreased.
2 Lowering the speed limit from 30 to 25 mph in Boston: effects on vehicle speeds.
3 FHWA's Methods and Practices for Setting Speed Limits: An Informational Report, (2012).
4 Recommendations of the Academic Expert Group for the 3rd Global Ministerial Conference on Road Safety.
5 https://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa20047/sec8.cfm#foot813
6 Safety and Operational Impacts of Setting Speed Limits below Engineering Recommendations.

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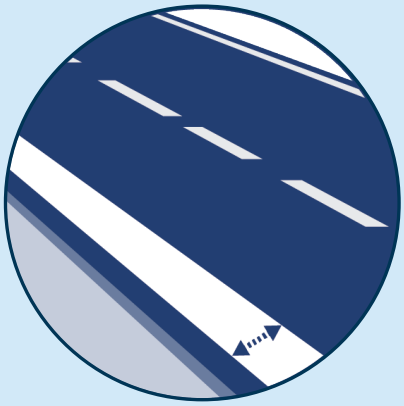

Wider Edge Lines

Roadway departures account for over half of all traffic fatalities in the United States. If drivers cannot clearly identify the edge of the travel lanes and see the road alignment ahead, the risk of roadway departure may be greater. Wider edge lines enhance the visibility of travel lane boundaries compared to traditional edge lines. Edge lines are considered "wider" when the marking width is increased from the minimum normal line width of 4 inches to the maximum normal line width of 6 inches.[1]

Safety Benefits:

Wider edge lines can reduce crashes up to:

37%
for non-intersection, fatal and injury crashes on rural, two-lane roads.[2]

22%
for fatal and injury crashes on rural freeways.[3]

Benefit Cost Ratio
25:1
for fatal and serious injury crashes on two-lane rural roads.[4]

Applications

Wider edge lines increase drivers' perception of the edge of the travel lane and can provide a safety benefit to all facility types (e.g., freeways, multilane divided and undivided highways, two-lane highways) in both urban and rural areas.[2] Wider edge lines are most effective in reducing crashes on rural two-lane highways, especially for single-vehicle crashes.[3] Agencies should also consider implementing a systemic approach to wider edge line installation based roadway departure crash risk factors. Potential risk factors for two-lane rural roads include:

- Pavement and shoulder widths.
- Presence of curves.
- Traffic volumes.
- History of nighttime crashes.

Considerations

- Wider edge lines are relatively low cost.
- Wider edge lines can be implemented using existing equipment during maintenance procedures like re-striping and resurfacing, with the only cost increase being the additional material.
- Paint may have a lower initial cost, but more durable materials (e.g., thermoplastic) may result in a lower life cycle cost based on their longer service life.
- As the number of automated vehicles increases on roadways, wider edge lines may provide better guidance for these vehicles' sensors.

Source: Texas Transportation Institute

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/roadway_dept/night_visib/pavement-markings.cfm.

1 Manual on Uniform Traffic Control Devices, Section 3A.06. FHWA, (2009).
2 Park et al. "Safety effects of wider edge lines on rural, two-lane highways." Accident Analysis and Prevention Vol. 48, pp.317-325, (2012).
3 Potts et al. Benefit/Cost Evaluation of MoDOT's Total Striping and Delineation Program: Phase II. Missouri Department of Transportation, (2011).
4 Abdel-Rahim et al. Safety Impacts of Using Wider Pavement Markings on Two-Lane Rural Highways in Idaho. Idaho Transportation Department, (2018).

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Safety Benefits:

Chevron Signs

25% reduction in nighttime crashes.[1]

16% reduction in non-intersection fatal and injury crashes.[2]

Oversized Chevron Signs

15% reduction in fatal and injury crashes.[3]

Sequential Dynamic Chevrons

60% reduction in fatal and injury crashes.[3]

In-Lane Curve Warning Pavement Markings

35 - 38% reduction in all crashes.[4,5]

New Fluorescent Curve Signs or Upgrade Existing Curve Signs to Fluorescent Sheeting

18% reduction in non-intersection, head-on, run-off-road, and sideswipe in rural areas.[1]

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/roadway_dept/countermeasures/horicurves/.

FHWA-SA-21-035

Enhanced Delineation for Horizontal Curves

Enhanced delineation at horizontal curves includes a variety of potential strategies that can be implemented in advance of or within curves, in combination, or individually.

Potential Strategies	In Advance of Curve	Within Curve
Pavement markings (standard width or wider)	✓	✓
In-lane curve warning pavement markings	✓	
Retroreflective strips on sign posts	✓	✓
Delineators		✓
Chevron signs		✓
Enhanced Conspicuity (larger, fluorescent, and/or retroreflective signs)	✓	✓
Dynamic curve warning signs (including speed radar feedback signs)	✓	
Sequential dynamic chevrons		✓

Enhanced delineation treatments can alert drivers to upcoming curves, the direction and sharpness of the curve, and appropriate operating speed.

Agencies can take the following steps to implement enhanced delineation strategies:

1. Review signing practices and policies to ensure they comply with the Manual on Uniform Traffic Control Devices (MUTCD) principles of traffic control devices. Consistent practice for similar curves sets the appropriate driver expectancy.
2. Use the systemic approach to identify and treat problem curves. For example, Minnesota uses risk factors that include curve radii between 500 and 1,200 ft, traffic volumes between 500 and 1,000 vehicles per day, intersection in the curve, and presence of a visual trap.[1]
3. Match the appropriate strategy to the identified problem(s), considering the full range of enhanced delineation treatments. Once the MUTCD requirements and recommendations have been met, an incremental approach is often beneficial to avoid excessive cost.

Chevron signs with retroreflective strips on sign posts installed along a curve. Source: FHWA

1 Albin et al. Low-Cost Treatments for Horizontal Curve Safety 2016. FHWA-SA-15-084, (2016).
2 Srinivasan et al. Safety Evaluation of Improved Curve Delineation. FHWA-HRT-09-045, (2009).
3 Lyon et al. Safety Evaluation of Two Curve Warning Treatments: In-Lane Curve Warning Pavement Markings and Oversized Chevron Signs. Presented at the 96th TRB Annual Meeting, Paper No. 17-00432, (2017).
4 Hallmark, S. Evaluation of Sequential Dynamic Chevrons on Rural Two-lane Highways. FHWA, (2017).
5 Donnell et al. Reducing Roadway Departure Crashes at Horizontal Curve Sections on Two-lane Rural Highways. FHWA-SA-19-005, (2019).

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Longitudinal Rumble Strips and Stripes

Longitudinal rumble strips are milled or raised elements on the pavement intended to alert drivers through vibration and sound that their vehicle has left the travel lane. They can be installed on the shoulder, edge line, or at or near the center line of an undivided roadway.

Rumble stripes are edge line or center line rumble strips where the pavement marking is placed over the rumble strip. This can increase the visibility and durability of the pavement marking during wet, nighttime conditions, and can improve the durability of the marking on roads with snowplowing operations.

Safety Benefits:

Center Line Rumble Strips

44-64%

reduction in head-on fatal and injury crashes on two-lane rural roads.[4]

Shoulder Rumble Strips

13-51%

reduction in single vehicle, run-off-road fatal and injury crashes on two-lane rural roads.[4]

With roadway departure crashes accounting for more than half of the fatal roadway crashes annually in the United States, rumble strips and stripes are designed to address these crashes by alerting distracted, drowsy, or otherwise inattentive drivers who drift from their lane. They are most effective when deployed systemically.

Transportation agencies should consider milled center line rumble strips (including in passing zone areas) and milled edge line or shoulder rumble strips with bicycle gaps for systemic safety projects, location-specific corridor safety improvements, as well as reconstruction or resurfacing projects.

Considerations

- Rumble strips are relatively low-cost, and economic analyses have indicated benefit/cost ratios that exceed 100.[1]
- Where rumble strips cannot be placed due to noise concerns, agencies may consider a design using an oscillating sine wave pattern (also known as "mumble strips") that reduces noise outside of the vehicle. However, the safety benefits of this design need more study.[2]
- Maintenance concerns:
  - Where rumble strips are placed along a pavement joint, there are typically no issues with joint stability if the pavement structure and joint was already in good condition.
  - Studies have shown no evidence of issues related to snow, ice, or rain build-up in the rumble strip.[3]

Shoulder rumble strips and center line rumble stripes are installed on this roadway. Source: FHWA

Example of an edge line rumble stripe. Source: Missouri DOT

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/roadway_dept/pavement/rumble_strips/.

FHWA-SA-21-036

1 Himes, S., and McGee, H. Decision Support Guide for the Installation of Shoulder and Center Line Rumble Strips on Non-Freeways. Federal Highway Administration Report No. FHWA-SA-16-115. (August 2016).
2 Bedsole et al. *Did You Hear That?* Public Roads Magazine, Volume 80, No. 4. FHWA Publication No. FHWA-HRT-17-002, (2017).
3 NCHRP Synthesis 339: Centerline Rumble Strips – A Synthesis of Highway Practices, (2005).
4 NCHRP Report 641: Guidance for the Design and Application of Shoulder and Centerline Rumble Strips, (2009).

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OFFICE OF SAFETY

Proven Safety Countermeasures

SafetyEdge℠

The SafetyEdge℠ technology shapes the edge of the pavement at approximately 30 degrees from the pavement cross slope during the paving process. This safety practice eliminates the potential for vertical drop-off at the pavement edge, has minimal effect on project cost, and can improve pavement durability by reducing edge raveling of asphalt.

Safety Benefits:

11%
reduction in fatal and injury crashes.[2]

21%
reduction in run-off-road crashes.[2]

19%
reduction in head-on crashes.[2]

Benefit-Cost Ratio Range[3]

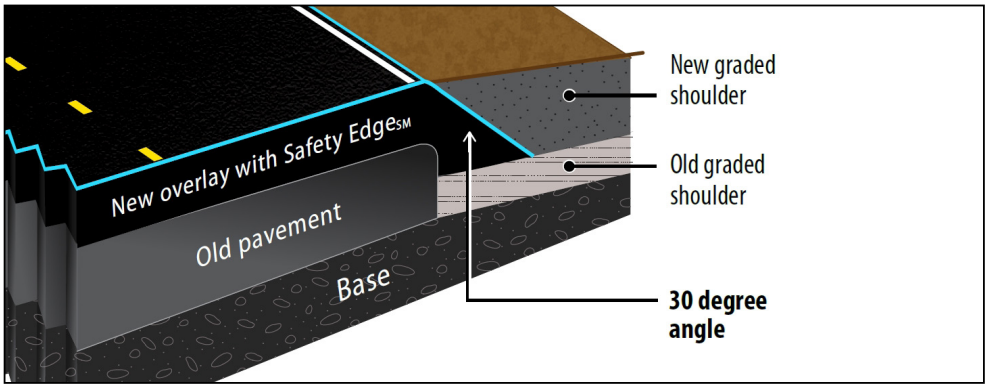
700:1 to 1,500:1

Rural road crashes involving edge drop-offs are 2-4 times more likely to include a fatality than other crashes on similar roads.[1] Vehicles may leave the roadway for various reasons ranging from distracted driver errors to low visibility, or to the presence of an animal on the road. Exposed vertical pavement edges can cause vehicles to become unstable and prevent their safe return to the roadway. The SafetyEdge℠ gives drivers the opportunity to return to their travel lane while maintaining control of their vehicle.

The SafetyEdge℠ technology only requires adding one of several commercially available devices to the screed or endgate when placing hot-mix asphalt. Forms for shaping the edge of concrete pavement are simpler and can be made on site by the contractor. Some agencies allow the SafetyEdge℠ to remain exposed while a segment is under construction, unlike conventional pavement edges. However, before construction ends, agencies should bring the adjacent roadside flush with the top of the pavement for both the SafetyEdge℠ and traditional pavement edge. Over time, regardless of the edge type, the edge may become exposed due to settling, erosion, and tire wear. When this occurs, the gentle slope provided by the SafetyEdge℠ is preferred versus the traditional vertical pavement edge.

Transportation agencies should develop standards for implementing the SafetyEdge℠ systemwide on all new asphalt paving and resurfacing projects where curbs and/or guardrail are not present, while also encouraging standard application for concrete pavements.

Example of the SafetyEdge℠ after backfill material settles or erodes. Source: FHWA



Cross-section view of an overlay with the SafetyEdge℠. Source: FHWA-SA-17-044

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/safetyedge/.

1 Hallmark et al. Safety Impacts of Pavement Edge Drop-offs, (Washington, DC: AAA Foundation for Traffic Safety: 2006), p 93.
2 Donnell et al. Development of Crash Modification Factors for the Application of the SafetyEdge℠ on Two-Lane Rural Roads. FHWA-HRT-17-081, (2017).
3 Safety Effects of the SafetyEdge℠, FHWA-SA-17-044, (2017).

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Safety Benefits:

Flatten sideslope from 1V:3H to 1V:4H:

8%

reduction for single-vehicle crashes.[2]

Flatten sideslope from 1V:4H to 1V:6H:

12%

reduction for single-vehicle crashes.[2]

Increase the distance to roadside features from 3.3 ft to 16.7 ft:

22%

reduction for all crashes.[3]

Increase the distance to roadside features from 16.7 ft to 30 ft:

44%

reduction for all crashes.[3]

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/roadway_dept/countermeasures/safe_recovery/clear_zones/.

FHWA-SA-21-029

Roadside Design Improvements at Curves

Horizontal curves account for 27 percent of all fatal crashes and 80 percent of all fatal crashes at curves are roadway departure crashes.[1] Roadside design improvements at curves is a strategy encompassing several treatments that target the high-risk roadside environment along the outside of horizontal curves. These treatments can reduce roadway departure fatalities and serious injuries by giving vehicles the opportunity to recover safely and by reducing crash severity.

Roadside design improvements can be implemented alone or in combination, and are particularly recommended at horizontal curves—where data indicates a higher risk for roadway departure fatalities and serious injuries.

Roadside Design Improvements to Provide for a Safe Recovery

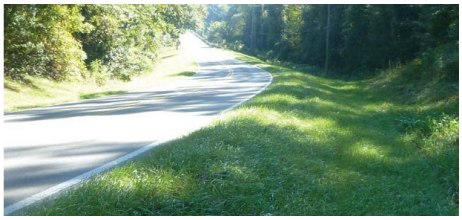
In cases where a vehicle leaves the roadway, having strategic roadside design elements, including an added or widened shoulder, flattened sideslopes, or a widened clear zone can provide drivers with an opportunity to regain control and re-enter the roadway in their lane or come to a safe stop before rolling over or encountering a fixed object.

- A **clear zone** is an unobstructed, traversable roadside area that allows a driver to stop safely or regain control of a vehicle that has left the roadway. Agencies should avoid adding new fixed objects such as trees and utility cabinets or poles in the clear zone. AASHTO's *Roadside Design Guide* details the clear zone width adjustment factors to be applied at horizontal curves.
- **Slope flattening** reduces the steepness of the sideslope to increase drivers' ability to keep the vehicle stable, regain control of the vehicle, and avoid obstacles. Slopes of 1V:4H or flatter are considered recoverable (i.e., drivers can retain control of a vehicle by slowing or stopping). Slopes between 1V:3H and 1V:4H are generally considered traversable, but non-recoverable (i.e., errant vehicle will continue to the bottom of the slope).
- **Adding or widening shoulders** gives drivers more recovery area to regain control in the event of a roadway departure.

Roadside Design Improvements to Reduce Crash Severity

Since not all roadside hazards can be removed, relocated, or redesigned at curves, installing roadside barriers to shield unmovable objects or steep embankments may be an appropriate treatment. Three common types of roadside barriers are:

- **Cable barrier** is a flexible barrier made from steel cables mounted on weak steel posts. Flexible barriers are more forgiving and have the most deflection.
- **Metal-beam guardrail** is a semi-rigid barrier where a W-beam or box-beam is mounted on steel or timber posts. These deflect less than cable barriers, so they can be located closer to objects where space is limited.
- **Concrete barrier** is a rigid barrier that has little to no deflection.



Clear zone provided on the outside of the curve. Source: FHWA.

1 Fatality Analysis Reporting System.
2 NCHRP Report 617: Accident Modification Factors for Traffic Engineering and ITS Improvements, (2008).
3 Elvik, R., and Vaa, T. Handbook of Road Safety Measures, (2004).

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8%

of all fatalities on divided highways are due to head-on crashes.[1]

Safety Benefits:

Median Barriers Installed on Rural Four-Lane Freeways

97%

reduction in cross-median crashes.[2]

Median Barriers

Median barriers are longitudinal barriers that separate opposing traffic on a divided highway and are designed to redirect vehicles striking either side of the barrier. Median barriers significantly reduce the number of cross-median crashes, which are attributed to the relatively high speeds that are typical on divided highways. AASHTO's ***Roadside Design Guide*** (RDG) recommends guidelines for the use of median barriers on high-speed, fully controlled-access roadways for locations where the median is 30 ft in width or less and the average daily traffic (ADT) is greater than 20,000 vehicles per day (vpd). For locations with median widths greater than 50 ft and where the ADT is less than 20,000 vpd, a median barrier is optional. For locations where the median is between 30 and 50 feet, the RDG suggests an analysis to determine the cost effectiveness of median barrier installation. Median barriers can be cable, metal-beam, or concrete.

- **Cable barriers** are flexible barriers, made from steel cables mounted on weak steel posts, resulting in less occupant impact force as it absorbs energy from the crash, capturing or redirecting the vehicle. Due to larger deflection, median width is an important consideration. These barriers are more adaptable to slopes typically found in medians. Cable barriers tend to require more frequent maintenance and repair than other barrier types.
- **Metal-beam guardrails** are considered semi-rigid barriers, where the W-beam or box-beam is mounted to steel or timber posts. When impacted, they are designed to deform and deflect, absorbing some of the crash energy and redirecting the vehicle. Metal-beam guardrails often do not require maintenance after minor impacts. They deflect less than cable barriers, so they can be located closer to objects where space is limited.
- **Concrete barriers** are usually rigid and result in little to no deflection. They redirect rather than absorb energy from the impact. Rigid concrete barriers seldom require repair or maintenance. Some agencies have used portable concrete barriers as median barriers. These barriers require repositioning after an impact but are typically less maintenance than a post mounted barrier.

To reduce cross-median crashes, transportation agencies should review their head-on crash history on divided highways to identify hot spots. Agencies should also consider implementing a systemic approach to median barrier placement based on cross-median crash risk factors. Potential risk factors include:

- Traffic volumes.
- Vehicle classifications.
- Median crossover history.
- Crash incidents.
- Vertical and horizontal alignment.
- Median terrain configurations.

Median cable barrier prevents a potential head-on crash.
Source: Washington State DOT

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/roadway_dept/countermeasures/reduce_crash_severity/.

1 Fatality Analysis Reporting System.
2 NCHRP Report 794: Median Cross-Section Design for Rural Divided Highways, (2011).

FHWA-SA-21-037

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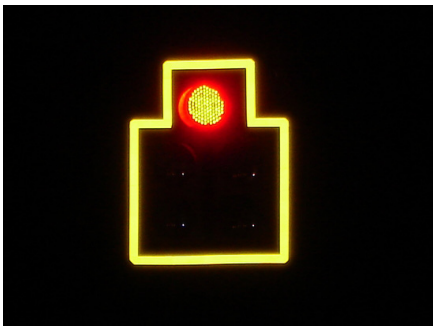
Backplates with Retroreflective Borders

Backplates added to a traffic signal head improve the visibility of the illuminated face of the signal by introducing a controlled-contrast background. The improved visibility of a signal head with a backplate is made even more conspicuous by framing it with a 1- to 3-inch yellow retroreflective border. Signal heads that have backplates equipped with retroreflective borders are more visible and conspicuous in both daytime and nighttime conditions.

Safety Benefits:

15%
reduction in total crashes.[1]

This treatment is recognized as a human factors enhancement of traffic signal visibility, conspicuity, and orientation for both older and color vision deficient drivers. This countermeasure is also advantageous during periods of power outages when the signals would otherwise be dark, providing a visible cue for motorists to stop at the intersection ahead.



Retroreflective borders are highly visible during the night. Source: South Carolina DOT

Considerations

Transportation agencies should consider backplates with retroreflective borders as part of their efforts to systematically improve safety performance at signalized intersections. Adding a retroreflective border to an existing signal backplate is a very low-cost safety treatment. This can be done by either adding retroreflective tape to an existing backplate or purchasing a new backplate with a retroreflective border already incorporated. The most efficient means of implementing this proven safety countermeasure is to adopt it as a standard treatment for signalized intersections across a jurisdiction or State.

Implementation challenges include minimizing installation time, accessing existing signal heads, and structural limitations due to added wind load in instances where an entire backplate is added. Agencies should consider the design of the existing signal support structure to determine if the design is sufficient to support the added wind load.

Signal backplate framed with a retroreflective border. Source: FHWA

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://rosap.ntl.bts.gov/view/dot/42807.

1 Sayed, T., Leur, P., and Pump, J., "Safety Impact of Increased Traffic Signal Backboards Conspicuity." 2005 TRB 84th Annual Meeting: Compendium of Papers CD-ROM, Vol. TRB#05-16, Washington, D.C., (2005).

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Safety Benefits:

Reducing driveway density

5-23%
reduction in total crashes along 2-lane rural roads.[3]

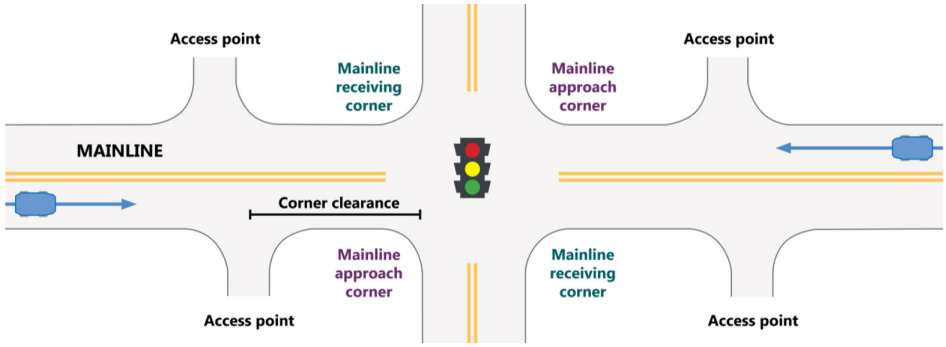
25-31%
reduction in fatal and injury crashes along urban/ suburban arterials.[4]

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/intersection/cam/index.cfm.

FHWA-SA-21-040

Corridor Access Management

Access management refers to the design, application, and control of entry and exit points along a roadway. This includes intersections with other roads and driveways that serve adjacent properties. Thoughtful access management along a corridor can simultaneously enhance safety for all modes, facilitate walking and biking, and reduce trip delay and congestion.



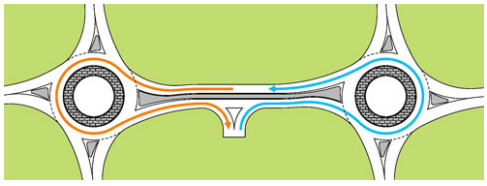
Schematic of an intersection and adjacent access points. Source: FHWA

Every intersection, from a signalized intersection to an unpaved driveway, has the potential for conflicts between vehicles, pedestrians, and bicyclists. The number and types of conflict points—locations where the travel paths of two users intersect—influence the safety performance of the intersection or driveway. FHWA developed corridor-level crash prediction models to estimate and analyze the safety effects of selected access management techniques for different area types, land uses, roadway variables, and traffic volumes.[1]

The following access management strategies can be used individually or in combination with one another:

- Reduce density through driveway closure, consolidation, or relocation.
- Manage spacing of intersection and access points.
- Limit allowable movements at driveways (such as right-in/ right-out only).
- Place driveways on an intersection approach corner rather than a receiving corner, which is expected to have fewer total crashes.[2]
- Implement raised medians that preclude across-roadway movements.
- Utilize designs such as roundabouts or reduced left-turn conflicts (such as restricted crossing U-turn, median U-turns, etc.).
- Provide turn lanes (i.e., left-only, right-only, or interior two-way left).
- Use lower speed one-way or two-way off-arterial circulation roads.

Successful corridor access management involves balancing overall safety and mobility for all users along with the needs of adjacent land uses.



Tandem roundabouts with a continuous raised median eliminates left-turn and across-roadway conflicts. Source: FHWA

1 Gross et al. Safety Evaluation of Access Management Policies and Techniques. FHWA-HRT-14-057, (2018).
2 Le et al. Safety Evaluation of Corner Clearance at Signalized Intersections. FHWA-HRT-17-084, (2018).
3 Harwood et al. Prediction of the Expected Safety Performance of Rural Two-Lane Highways. FHWA-RD-99-207, (2000).
4 Elvik, R. and Vaa, T., Handbook of Road Safety Measures. Oxford, United Kingdom, Elsevier, (2004).

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Dedicated Left- and Right-Turn Lanes at Intersections

Auxiliary turn lanes—either for left turns or right turns—provide physical separation between turning traffic that is slowing or stopped and adjacent through traffic at approaches to intersections. Turn lanes can be designed to provide for deceleration prior to a turn, as well as for storage of vehicles that are stopped and waiting for the opportunity to complete a turn.

Safety Benefits:

Left-Turn Lanes

28-48%

reduction in total crashes.[1]

Positive Offset Left-Turn Lanes

36%

reduction in fatal and injury crashes.[2]

Right-Turn Lanes

14-26%

reduction in total crashes.[1]

Left- and right-turn lanes on a two-lane road. Source: City of Greeley, CO

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://www.fhwa.dot.gov/publications/research/safety/02103/02103techbrief.pdf.

FHWA-SA-21-041

While turn lanes provide measurable safety and operational benefits at many types of intersections, they are particularly helpful at two-way stop-controlled intersections. Crashes occurring at these intersections are often related to turning maneuvers. Since the major route traffic is free flowing and typically travels at higher speeds, crashes that do occur are often severe. The main crash types include collisions of vehicles turning left across opposing through traffic and rear-end collisions of vehicles turning left or right with other vehicles following closely behind. Turn lanes reduce the potential for these types of crashes.

Installing left-turn lanes and/or right-turn lanes should be considered for the major road approaches for improving safety at both three- and four-leg intersections with stop control on the minor road, where significant turning volumes exist, or where there is a history of turn-related crashes. Pedestrian and bicyclist safety and convenience should also be considered when adding turn lanes at an intersection. Specifically, offset left- and right-turn lanes will lengthen crossing distances for pedestrians.

Offset Turn Lanes

Providing offset of left- and right-turn lanes to increase visibility can provide added safety benefits, and is preferable in many situations, particularly at locations with higher speeds, or where free-flow or permissive movements are possible.

At turn lanes with zero or negative offset, turning vehicles can block sightlines. For left-turn lanes, this usually involves opposing left-turning vehicles occupying the turn lanes at the same time. For right-turn lanes, this typically involves right-turning vehicles from the major road and vehicles entering the intersection from the minor road. In both scenarios, adding positive offset to turn lanes enhances the sight distance to approaching vehicles that conflict with the turning movement. Offset turn lanes should be considered when there is a high frequency of these types of conflicts in order to reduce the likelihood of a severe crash.

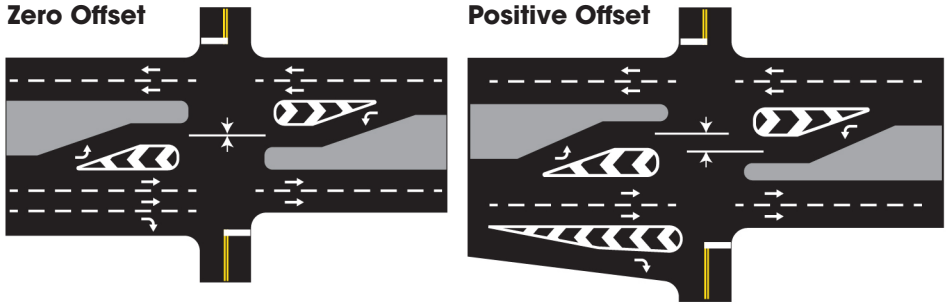

Illustration comparing zero offset to positive offset of left- and right-turn lanes. Source: FHWA

1 Harwood et al. Safety Effectiveness of Intersection Left- and Right-Turn Lanes. FHWA-HRD-02-089, (2002).
2 Persaud et al. Safety Evaluation of Offset Improvements for Left-Turn Lanes. FHWA-HRT-09-035, (2009).

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Safety Benefits:

RCUT
Two-Way Stop-Controlled to RCUT:

54%
reduction in fatal and injury crashes.[2]

Signalized Intersection to Signalized RCUT:

22%
reduction in fatal and injury crashes.[3]

Unsignalized Intersection to Unsignalized RCUT:

63%
reduction in fatal and injury crashes. [4]

MUT

30%
reduction in intersection-related injury crash rate.[5]

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/intersection/rltci/index.cfm.

FHWA-SA-21-030

Reduced Left-Turn Conflict Intersections

Reduced left-turn conflict intersections are geometric designs that alter how left-turn movements occur. These intersections simplify decision-making for drivers and minimize the potential for higher severity crash types, such as head-on and angle. Two highly effective designs that rely on U-turns to complete certain left-turn movements are known as the Restricted Crossing U-turn (RCUT) and the Median U-turn (MUT).

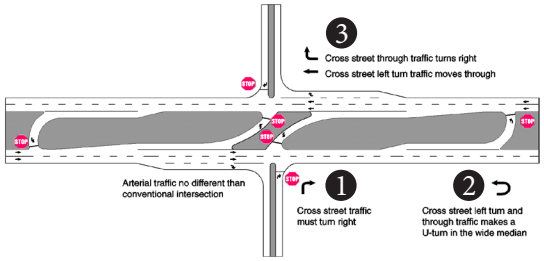
Restricted Crossing U-turn

The RCUT intersection, also known as a J-Turn, Superstreet, or Reduced Conflict Intersection, modifies the direct left-turn and through movements from cross-street approaches. Minor road traffic makes a right turn followed by a U-turn at a designated location—either signalized or unsignalized—to continue in the desired direction. The RCUT is suitable for and adaptable to a wide variety of circumstances, ranging from isolated rural, high-speed locations to urban and suburban high-volume, multimodal corridors. It is a competitive and less costly alternative to constructing an interchange. RCUTs work well when consistently used along a corridor, but also can be used effectively at individual intersections. Studies have shown that installing an RCUT can result in a 30-percent increase in throughput and a 40-percent reduction in network intersection travel time.[1]

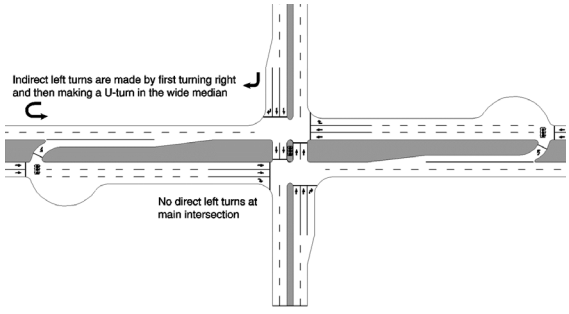
Median U-turn

The MUT intersection modifies direct left turns from the major approaches. Vehicles proceed through the main intersection, make a U-turn a short distance downstream, followed by a right turn at the main intersection. The U-turns can also be used for modifying the cross-street left turns, similar to the RCUT.

The MUT is an excellent choice for intersections with heavy through traffic and moderate left-turn volumes. Studies have shown a 20- to 50-percent improvement in intersection throughput for various lane configurations as a result of implementing the MUT design. When implemented at multiple intersections along a corridor, the efficient two-phase signal operation of the MUT can reduce delay, improve travel times, and create more crossing opportunities for pedestrians and bicyclists.



Example of a unsignalized RCUT intersection. Source: FHWA



Example of a MUT intersection. Source: FHWA

1 Hugher and Jagannathan. Restricted Crossing U-Turn Intersection. FHWA-HRT-09-059, (2009).
2 Edara et al. Evaluation of J-turn Intersection Design Performance in Missouri. MoDOT, (2013).
3 Hummer and Rao. Safety Evaluation of a Signalized Restricted Crossing U-Turn. FHWA-HRT-17-082, (2017).
4 Hummer et al. Superstreet Benefits and Capacities. FHWA/NC/2009-06, NC State University, (2010).
5 Synthesis of the Median U-Turn Treatment, Safety, and Operational Benefits, FHWA-HRT-07-033, (2007).

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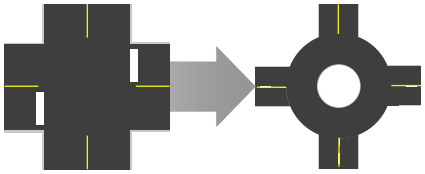
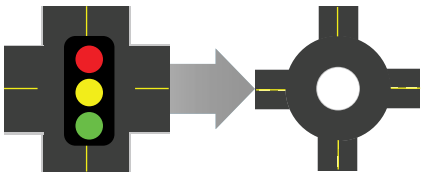
Safety Benefits:

Two-Way Stop-Controlled Intersection to a Roundabout



82%
reduction in fatal and injury crashes.[1]

Signalized Intersection to a Roundabout



78%
reduction in fatal and injury crashes.[1]

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/intersection/roundabouts/index.cfm.

FHWA-SA-21-042

Roundabouts

The modern roundabout is an intersection with a circular configuration that safely and efficiently moves traffic. Roundabouts feature channelized, curved approaches that reduce vehicle speed, entry yield control that gives right-of-way to circulating traffic, and counterclockwise flow around a central island that minimizes conflict points. The net result of lower speeds and reduced conflicts at roundabouts is an environment where crashes that cause injury or fatality are substantially reduced.

Roundabouts are not only a safer type of intersection; they are also efficient in terms of keeping people moving. Even while calming traffic, they can reduce delay and queuing when compared to other intersection alternatives. Furthermore, the lower vehicular speeds and reduced conflict environment can create a more suitable environment for walking and bicycling.

Roundabouts can be implemented in both urban and rural areas under a wide range of traffic conditions. They can replace signals, two-way stop controls, and all-way stop controls. Roundabouts are an effective option for managing speed and transitioning traffic from high-speed to low-speed environments, such as freeway interchange ramp terminals, and rural intersections along high-speed roads.

Illustration of a multilane roundabout. Source: FHWA

Example of a single-lane roundabout. Source: FHWA

1 AASHTO. The Highway Safety Manual, American Association of State Highway Transportation Professionals, Washington, D.C., (2010).

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Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections

This systemic approach to intersection safety involves deploying a package of multiple low-cost countermeasures, including enhanced signing and pavement markings, at a large number of stop-controlled intersections within a jurisdiction. These countermeasures increase driver awareness and recognition of the intersections and potential conflicts.

Safety Benefits:

10%
reduction of fatal and injury crashes at all locations/types/areas.

15%
reduction of nighttime crashes at all locations/types/areas.

27%
reduction of fatal and injury crashes at rural intersections.

19%
reduction of fatal and injury crashes at 2-lane by 2-lane intersections.

Average Benefit-Cost Ratio

12:1

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/intersection/stop/fhwasa18047.pdf.

There are several benefits to systemically applying multiple low-cost countermeasures at stop-controlled intersections, including,

- Resources are maximized because the treatments are low cost.
- A high number of intersections can receive treatment.
- Improvements are highly cost-effective, with an average benefit-cost ratio of 12:1, even assuming a conservative 3-year service life.

Example of countermeasures on the through approach.
Source: South Carolina DOT

Example of countermeasures on the stop approach.
Source: South Carolina DOT

The low-cost countermeasures for stop-controlled intersections generally consist of the following treatments:

On the Through Approach

- Doubled-up (left and right), oversized advance intersection warning signs, with supplemental street name plaques (can also include flashing beacon).
- Retroreflective sheeting on sign posts.
- Enhanced pavement markings that delineate through lane edge lines.

On the Stop Approach

- Doubled-up (left and right), oversized advance "Stop Ahead" intersection warning signs (can also include flashing beacon).
- Doubled-up (left and right), oversized Stop signs.
- Retroreflective sheeting on sign posts.
- Properly placed stop bar.
- Removal of vegetation, parking, or obstructions that limit sight distance.
- Double arrow warning sign at stem of T-intersections.

Source: T. Le et al. "Safety Effects of Low-Cost Systemic Safety Improvements at Signalized and Stop-Controlled Intersections," 96th Annual Meeting of the Transportation Research Board, Paper Number 17-05379, January 2017.

FHWA-SA-21-031

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Safety Benefits:

36-50%
reduction in red light running.[2]

8-14%
reduction in total crashes.[2]

12%
reduction in injury crashes.[2]

Yellow Change Intervals

At a signalized intersection, the yellow change interval is the length of time that the yellow signal indication is displayed following a green signal indication. The yellow signal confirms to motorists that the green has ended and that a red will soon follow.

Since red-light running is a leading cause of severe crashes at signalized intersections, it is imperative that the yellow change interval be appropriately timed. Too brief an interval may result in drivers being unable to stop safely and cause unintentional red-light running. Too long of an interval may result in drivers treating the yellow as an extension of the green phase and invite intentional red-light running. Factors such as the speed of approaching and turning vehicles, driver perception-reaction time, vehicle deceleration, and intersection geometry should all be considered in the timing calculation.

Transportation agencies can improve signalized intersection safety and reduce red-light running by reviewing and updating their traffic signal timing policies and procedures concerning the yellow change interval. Agencies should institute regular evaluation and adjustment protocols for existing traffic signal timing. Refer to the *Manual on Uniform Traffic Control Devices* for basic requirements and further recommendations about yellow change interval timing. As part of strategic signal system modernization and updates, incorporating automated traffic signal performance measures (ATSPMs) is a proven approach to improve on traditional retiming processes. ATSPMs provide continuous performance monitoring capability and the ability to modify timing based on actual performance, without requiring expensive modeling or data collection.[1]

Appropriately timed yellow change intervals can reduce red-light running and improve overall intersection safety. Source: FHWA

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/intersection/signal/fhwasa13027.pdf.

FHWA-SA-21-043

1 Federal Highway Administration. "Automated Traffic Signal Performance," (2020).
2 NCHRP Report 731: Guidelines for Timing Yellow and All-Red Intervals at Signalized Intersections, (2011).

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Crosswalk Visibility Enhancements

Poor lighting conditions, obstructions such as parked cars, and horizontal or vertical roadway curvature can reduce visibility at crosswalks, contributing to safety issues. For multilane roadway crossings where vehicle volumes are in excess of 10,000 Average Annual Daily Traffic (AADT), a marked crosswalk alone is typically not sufficient. Under such conditions, more substantial crossing improvements could prevent an increase in pedestrian crash potential.

Three main crosswalk visibility enhancements help make crosswalks and the pedestrians, bicyclists, wheelchair and other mobility device users, and transit users using them more visible to drivers. These include high-visibility crosswalks, lighting, and signing and pavement markings. These enhancements can also assist users in deciding where to cross. Agencies can implement these features as standalone or combination enhancements to indicate the preferred location for users to cross.

Safety Benefits:

High-visibility crosswalks can reduce pedestrian injury crashes up to:

40% [1]

Intersection lighting can reduce pedestrian crashes up to:

42% [2]

Advance yield or stop markings and signs can reduce pedestrian crashes up to:

25% [3]

High-visibility crosswalks

High-visibility crosswalks use patterns (i.e., bar pairs, continental, ladder) that are visible to both the driver and pedestrian from farther away compared to traditional transverse line crosswalks. They should be considered at all midblock pedestrian crossings and uncontrolled intersections. Agencies should use materials such as inlay or thermoplastic tape, instead of paint or brick, for highly reflective crosswalk markings.

Improved Lighting

The goal of crosswalk lighting should be to illuminate with positive contrast to make it easier for a driver to visually identify the pedestrian. This involves carefully placing the luminaires in forward locations to avoid a silhouette effect of the pedestrian.

Enhanced Signing and Pavement Markings

On multilane roadways, agencies can use "YIELD Here to Pedestrians" or "STOP Here for Pedestrians" signs 20 to 50 feet in advance of a marked crosswalk to indicate where a driver should stop or yield to pedestrians, depending on State law. To supplement the signing, agencies can also install a STOP or YIELD bar (commonly referred to as "shark's teeth") pavement markings.

In-street signing, such as "STOP Here for Pedestrians" or "YIELD Here to Pedestrians" may be appropriate on roads with two- or three-lane roads where speed limits are 30 miles per hour or less.

Source: FHWA

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/ped_bike/step/docs/techSheet_VizEnhancemt2018.pdf.

1 Chen, L., C. Chen, and R. Ewing. The Relative Effectiveness of Pedestrian Safety Countermeasures at Urban Intersections - Lessons from a New York City Experience. (2012).
2 Elvik, R. and Vaa, T. Handbook of Road Safety Measures. Oxford, United Kingdom, Elsevier, (2004).
3 Zeeger et al. Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments, FHWA, (2017).

FHWA-SA-21-049

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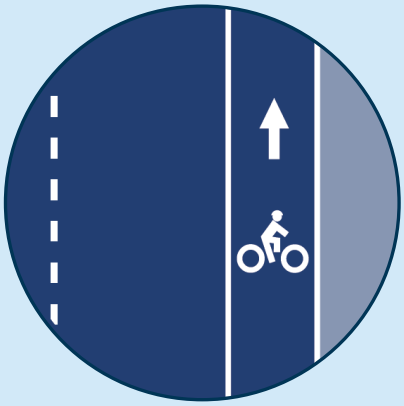

Bicycle Lanes

Most fatal and serious injury bicyclist crashes occur at non-intersection locations. Nearly one-third of these crashes involve overtaking motorists[1]; the speed and size differential between vehicles and bicycles can lead to severe injury. To make bicycling safer and more comfortable for most types of bicyclists, State and local agencies should consider installing bicycle lanes. These dedicated facilities for the use of bicyclists along the roadway can take several forms. Providing bicycle facilities can mitigate or prevent interactions, conflicts, and crashes between bicyclists and motor vehicles, and create a network of safer roadways for bicycling. Bicycle Lanes align with the Safe System Approach principle of recognizing human vulnerability—where separating users in space can enhance safety for all road users.

Safety Benefits:

Bicycle Lane Additions can reduce crashes up to:

49%
for total crashes on urban 4-lane undivided collectors and local roads.[6]

30%
for total crashes on urban 2-lane undivided collectors and local roads.[6]

Separated bicycle lane in Washington, DC. Source: Alex Baca, Washington Area Bicyclist Association

Separated bicycle lanes may provide further safety benefits. FHWA is anticipating completion of research in Fall 2022.

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf.

FHWA-SA-21-051

Applications

FHWA's *Bikeway Selection Guide* and *Incorporating On-Road Bicycle Networks into Resurfacing Projects* assist agencies in determining which facilities provide the most benefit in various contexts. Bicycle lanes can be included on new roadways or created on existing roads by reallocating space in the right-of-way.

In addition to the paint stripe used for a typical bicycle lane, a lateral offset with painted buffer can help to further separate bicyclists from vehicle traffic. State and local agencies may also consider physical separation of the bicycle lane from motorized traffic lanes through the use of vertical elements like posts, curbs, or vegetation.[2] Based on international experience and implementation in the United States, there is potential for further safety benefits associated with separated bicycle lanes. FHWA is conducting research on separated bicycle lanes, which includes the development of crash modification factors, to be completed in 2022 to address significant interest on this topic.

Considerations

- City and State policies may require minimum bicycle lane widths, although these can differ by agency and functional classification of the road.
- Bicycle lane design should vary according to roadway characteristics (e.g., motor vehicle volumes and speed) in order to maximize the facility's suitability for riders of all ages and abilities and should consider the travel needs of low-income populations likely to use bicycles. The *Bikeway Selection Guide* is a useful resource.
- While some in the public may oppose travel lane narrowing if they believe it will slow traffic or increase congestion, studies have found that roadways did not experience an increase in injuries or congestion when travel lane widths were decreased to add a bicycle lane.[3]
- Studies and experience in US cities show that bicycle lanes increase ridership and may help jurisdictions better manage roadway capacity without increased risk.
- In rural areas, rumble strips can negatively impact bicyclists' ability to ride if not properly installed. Agencies should consider the dimensions, placement, and offset of rumble strips when adding a bicycle lane.[4]
- Strategies, practices, and processes can be used by agencies to enhance their ability to address equity in bicycle planning and design.[5]

1 Thomas et al. Bicyclist Crash Types on National, State, and Local Levels: A New Look. Transportation Research Record 673(6), 664-676, (2019).
2 Separated Bike Lane Planning and Design Guide. FHWA-HEP-15-025, (2015).
3 Park and Abdel-Aty. "Evaluation of safety effectiveness of multiple cross sectional features on urban arterials". Accident Analysis and Prevention, Vol. 92, pp. 245-255, (2016).
4 FHWA Tech Advisory Shoulder and Edge Line Rumble Strips, (2011).
5 Sandt et al. Pursuing Equity in Pedestrian and Bicycle Planning. FHWA, (2016).
6 Avelar et al. Development of Crash Modification Factors for Bicycle Lane Additions While Reducing Lane and Shoulder Widths. FHWA, (2021).

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Rectangular Rapid Flashing Beacons (RRFB)

A marked crosswalk or pedestrian warning sign can improve safety for pedestrians crossing the road, but at times may not be sufficient for drivers to visibly locate crossing locations and yield to pedestrians. To enhance pedestrian conspicuity and increase driver awareness at uncontrolled, marked crosswalks, transportation agencies can install a pedestrian actuated Rectangular Rapid Flashing Beacon (RRFB) to accompany a pedestrian warning sign. RRFBs consist of two, rectangular- shaped yellow indications, each with a light-emitting diode (LED)-array-based light source.[1] RRFBs flash with an alternating high frequency when activated to enhance conspicuity of pedestrians at the crossing to drivers.

For more information on using RRFBs, see the Interim Approval in the *Manual on Uniform Traffic Control Devices (MUTCD)*.[1]

Safety Benefits:

RRFBs can reduce crashes up to:

47%

for pedestrian crashes.[4]

RRFBs can increase motorist yielding rates up to:

98%

(varies by speed limit, number of lanes, crossing distance, and time of day).[3]

RRFBs used at a trail crossing.
Source: LJB

Applications

The RRFB is applicable to many types of pedestrian crossings but is particularly effective at multilane crossings with speed limits less than 40 miles per hour.[2] Research suggests RRFBs can result in motorist yielding rates as high at 98 percent at marked crosswalks, but varies depending on the location, posted speed limit, pedestrian crossing distance, one- versus two-way road, and the number of travel lanes.[3] RRFBs can also accompany school or trail crossing warning signs.

RRFBs are placed on both sides of a crosswalk below the pedestrian crossing sign and above the diagonal downward arrow plaque pointing at the crossing.[1] The flashing pattern can be activated with pushbuttons or passive (e.g., video or infrared) pedestrian detection, and should be unlit when not activated.

Considerations

Agencies should:[2]

- Install RRFBs in the median rather than the far-side of the roadway if there is a pedestrian refuge or other type of median.
- Use solar-power panels to eliminate the need for a power source.
- Reserve the use of RRFBs for locations with significant pedestrian safety issues, as over-use of RRFB treatments may diminish their effectiveness.

Agencies shall not:[2]

- Use RRFBs without the presence of a pedestrian, school or trail crossing warning sign.
- Use RRFBs for crosswalks across approaches controlled by YIELD signs, STOP signs, traffic control signals, or pedestrian hybrid beacons, except for the approach or egress from a roundabout.

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/ped_bike/step/docs/techSheet_RRFB_2018.pdf.

1 *MUTCD* Interim Approval 21 - RRFBs at Crosswalks.
2 "Rectangular Rapid Flash Beacon" in PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System. FHWA, (2013).
3 Fitzpatrick et al. "Will You Stop for Me? Roadway Design and Traffic Control Device Influences on Drivers Yielding to Pedestrians in a Crosswalk with a Rectangular Rapid-Flashing Beacon." Report No. TTI-CTS-0010. Texas A&M Transportation Institute, (2016).
4 NCHRP Research Report 841 Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments, (2017).

FHWA-SA-21-053

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Safety Benefits:

13%

reduction in pedestrian-vehicle crashes at intersections.[1]

Leading Pedestrian Interval

A leading pedestrian interval (LPI) gives pedestrians the opportunity to enter the crosswalk at an intersection 3-7 seconds before vehicles are given a green indication. Pedestrians can better establish their presence in the crosswalk before vehicles have priority to turn right or left.

LPIs provide the following benefits:

- Increased visibility of crossing pedestrians.
- Reduced conflicts between pedestrians and vehicles.
- Increased likelihood of motorists yielding to pedestrians.
- Enhanced safety for pedestrians who may be slower to start into the intersection.

FHWA's Handbook for ***Designing Roadways for the Aging Population*** recommends the use of the LPI at intersections with high turning vehicle volumes. Transportation agencies should refer to the ***Manual on Uniform Traffic Control Devices*** for guidance on LPI timing and ensure that pedestrian signals are accessible for all users. Costs for implementing LPIs are very low when only signal timing alteration is required.

An LPI allows a pedestrian to establish a presence in the crosswalk before vehicles are given a green indication. Source: FHWA

LPIs reduce potential conflicts between pedestrians and turning vehicles. Source: FHWA

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/ped_bike/step/resources/docs/fhwasa19040.pdf.

FHWA-SA-21-032

1 Goughnour, E., D. Carter, C. Lyon, B. Persaud, B. Lan, P. Chun, I. Hamilton, and K. Signor. "Safety Evaluation of Protected Left-Turn Phasing and Leading Pedestrian Intervals on Pedestrian Safety." Report No. FHWA-HRT-18-044. Federal Highway Administration. (October 2018)

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Medians and Pedestrian Refuge Islands in Urban and Suburban Areas

A **median** is the area between opposing lanes of traffic, excluding turn lanes. Medians in urban and suburban areas can be defined by pavement markings, raised medians, or islands to separate motorized and non-motorized road users.

A **pedestrian refuge island** (or crossing area) is a median with a refuge area that is intended to help protect pedestrians who are crossing a road.

Safety Benefits:

Median with Marked Crosswalk

46%

reduction in pedestrian crashes.[2]

Pedestrian Refuge Island

56%

reduction in pedestrian crashes.[2]

Pedestrian crashes account for approximately 17 percent of all traffic fatalities annually, and 74 percent of these occur at non-intersection locations.[1] For pedestrians to safely cross a roadway, they must estimate vehicle speeds, determine acceptable gaps in traffic based on their walking speed, and predict vehicle paths. Installing a median or pedestrian refuge island can help improve safety by allowing pedestrians to cross one direction of traffic at a time.

Transportation agencies should consider medians or pedestrian refuge islands in curbed sections of urban and suburban multilane roadways, particularly in areas with a significant mix of pedestrian and vehicle traffic, traffic volumes over 9,000 vehicles per day, and travel speeds 35 mph or greater. Medians/refuge islands should be at least 4-ft wide, but preferably 8 ft for pedestrian comfort. Some example locations that may benefit from medians or pedestrian refuge islands include:

- Mid-block crossings.
- Approaches to multilane intersections.
- Areas near transit stops or other pedestrian-focused sites.

Example of a road with a median and pedestrian refuge islands. Source: City of Charlotte, NC

Median and pedestrian refuge island near a roundabout. Source: www.pedbikeimages.org / Dan Burden

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/ped_bike/step/docs/techSheet_PedRefugeIsland2018.pdf.

1 National Center for Statistics and Analysis. (2020, March). Pedestrians: 2018 data (Traffic Safety Facts. Report No. DOT HS 812 850). National Highway Traffic Safety Administration
2 Desktop Reference for Crash Reduction Factors, FHWA-SA-08-011, September 2008, Table 11.

FHWA-SA-21-044

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Safety Benefits:

55%
reduction in pedestrian crashes.[2]

29%
reduction in total crashes.[3]

15%
reduction in fatal and serious injury crashes.[3]

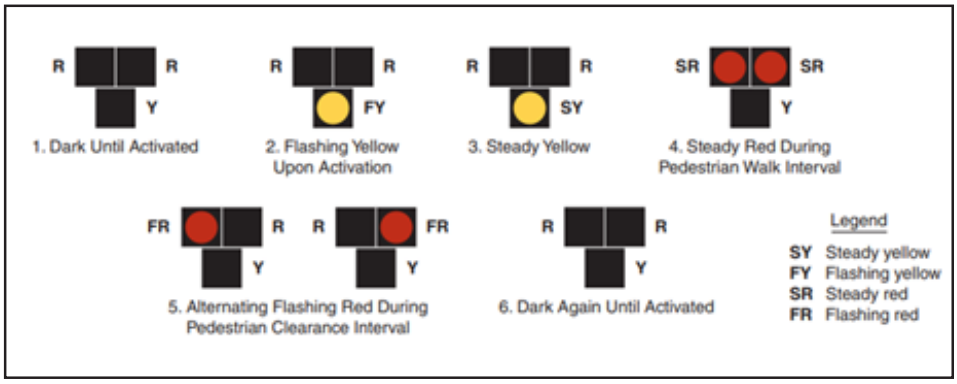
Example of PHBs mounted on a mast arm. Source: FHWA

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/ped_bike/step/resources/docs/fhwasa18064.pdf.

FHWA-SA-21-045

Pedestrian Hybrid Beacons

The pedestrian hybrid beacon (PHB) is a traffic control device designed to help pedestrians safely cross higher-speed roadways at midblock crossings and uncontrolled intersections. The beacon head consists of two red lenses above a single yellow lens. The lenses remain "dark" until a pedestrian desiring to cross the street pushes the call button to activate the beacon, which then initiates a yellow to red lighting sequence consisting of flashing and steady lights that directs motorists to slow and come to a stop, and provides the right-of-way to the pedestrian to safely cross the roadway before going dark again.



Sequence for a PHB. Source: MUTCD 2009 Edition, p. 511, FHWA

Nearly 74 percent of pedestrian fatalities occur at non-intersection locations, and vehicle speeds are often a major contributing factor.[1] As a safety strategy to address this pedestrian crash risk, the PHB is an intermediate option between a flashing beacon and a full pedestrian signal because it assigns right of way and provides positive stop control. It also allows motorists to proceed once the pedestrian has cleared their side of the travel lane(s), reducing vehicle delay.

Transportation agencies should refer to the *Manual on Uniform Traffic Control Devices* (MUTCD) for information on the application of PHBs.

In general, PHBs are used where it is difficult for pedestrians to cross a roadway, such as when gaps in traffic are not sufficient or speed limits exceed 35 miles per hour. They are very effective at locations where three or more lanes will be crossed or traffic volumes are above 9,000 annual average daily traffic. Installation of a PHB must also include a marked crosswalk and pedestrian countdown signal. If PHBs are not already familiar to a community, agencies should conduct appropriate education and outreach as part of implementation.

1 National Center for Statistics and Analysis. (2020, March). Pedestrians: 2018 data (Traffic Safety Facts. Report No. DOT HS 812 850). National Highway Traffic Safety Administration
2 Zegeer et al. NCHRP Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments. TRB, (2017).
3 Fitzpatrick, K. and Park, E.S. Safety Effectiveness of the HAWK Pedestrian Crossing Treatment, FHWA-HRT-10-042, (2010).

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Safety Benefits:

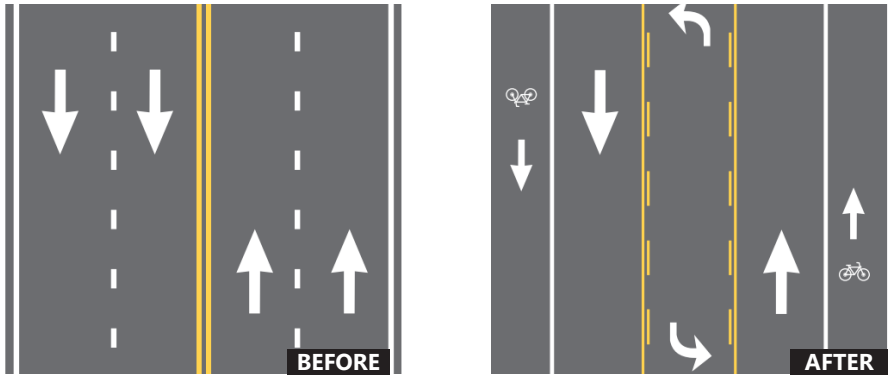
4-Lane to 3-Lane Road Diet Conversions

19-47%

reduction in total crashes.[1]

Road Diets (Roadway Reconfiguration)

A Road Diet, or roadway reconfiguration, can improve safety, calm traffic, provide better mobility and access for all road users, and enhance overall quality of life. A Road Diet typically involves converting an existing four-lane undivided roadway to a three-lane roadway consisting of two through lanes and a center two-way left-turn lane (TWLTL).



Before and after example of a Road Diet. Source: FHWA

Benefits of Road Diet installations may include:

- Reduction of rear-end and left-turn crashes due to the dedicated left-turn lane.
- Reduced right-angle crashes as side street motorists cross three versus four travel lanes.
- Fewer lanes for pedestrians to cross.
- Opportunity to install pedestrian refuge islands, bicycle lanes, on-street parking, or transit stops.
- Traffic calming and more consistent speeds.
- A more community-focused, Complete Streets environment that better accommodates the needs of all road users.

A Road Diet can be a low-cost safety solution when planned in conjunction with a simple pavement overlay, and the reconfiguration can be accomplished at no additional cost. Typically, a Road Diet is implemented on a roadway with a current and future average daily traffic of 25,000 or less.

Road Diet project in Honolulu, Hawaii. Source: Leidos

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/road_diets/.

1 *Evaluation of Lane Reduction "Road Diet" Measures on Crashes*, FHWA-HRT-10-053, (2010).

FHWA-SA-21-046

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Safety Benefits:

Sidewalks

65-89%

reduction in crashes involving pedestrians walking along roadways.[3]

Paved Shoulders

71%

reduction in crashes involving pedestrians walking along roadways.[3]

Walkways

A walkway is any type of defined space or pathway for use by a person traveling by foot or using a wheelchair. These may be pedestrian walkways, shared use paths, sidewalks, or roadway shoulders.

With more than 6,200 pedestrian fatalities and 75,000 pedestrian injuries occurring in roadway crashes annually,[1] it is important for transportation agencies to improve conditions and safety for pedestrians and to integrate walkways more fully into the transportation system. Research shows people living in low-income communities are less likely to encounter walkways and other pedestrian-friendly features.[2]

Well-designed pedestrian walkways, shared use paths, and sidewalks improve the safety and mobility of pedestrians. Pedestrians should have direct and connected network of walking routes to desired destinations without gaps or abrupt changes. In some rural or suburban areas, where these types of walkways are not feasible, roadway shoulders provide an area for pedestrians to walk next to the roadway, although these are not preferable.

Transportation agencies should work towards incorporating pedestrian facilities into all roadway projects unless exceptional circumstances exist. It is important to provide and maintain accessible walkways along both sides of the road in urban areas, particularly near school zones and transit locations, and where there is a large amount of pedestrian activity. Walkable shoulders should also be considered along both sides of rural highways when routinely used by pedestrians.

Example of a sidewalk in a residential area. Source: pedbikeimages.org / Burden

Paved shoulder used as a walkway. Source: pedbikeimages.org / Burden

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=1.

FHWA-SA-21-047

1 National Center for Statistics and Analysis. (2020, March). Pedestrians: 2018 data (Traffic Safety Facts. Report No. DOT HS 812 850). National Highway Traffic Safety Administration.
2 Gibbs, et all. Income Disparities in Street Features that Encourage Walking. Bridging the Gap, (2012, March).
3 Gan et al. Update of Florida Crash Reduction Factors and Countermeasures to Improve the Development of District Safety Improvement Projects. Florida DOT, (2005).

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Safety Benefits:

HFST can reduce crashes up to:

63%
for injury crashes at ramps.[2]

48%
for injury crashes at horizontal curves.[2]

20%
for total crashes at intersections.[3]

Automated application of HFST.
Source: FHWA

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/roadway_dept/pavement_friction/high_friction/.

FHWA-SA-21-052

Pavement Friction Management

Friction is a critical characteristic of a pavement that affects how vehicles interact with the roadway, including the frequency of crashes. Measuring, monitoring, and maintaining pavement friction—especially at locations where vehicles are frequently turning, slowing, and stopping—can prevent many roadway departure, intersection, and pedestrian-related crashes.

Pavement friction treatments, such as High Friction Surface Treatment (HFST), can be better targeted and result in more efficient and effective installations when using continuous pavement friction data along with crash and roadway data.

Continuous Pavement Friction Measurement

Friction data for safety performance is best measured with Continuous Pavement Friction Measurement (CPFM) equipment. Spot friction measurement devices, like locked-wheel skid trailers, cannot safely and accurately collect friction data in curves or intersections, where the pavement polishes more quickly and adequate friction is so much more critical. Without CPFM equipment, agencies will assume the same friction over a mile or more.

CPFM technology measures friction continuously at highway speeds and provides both network and segment level data. Practitioners can analyze the friction, crash, and roadway data to better understand and predict where friction-related crashes will occur to better target locations and more effectively install treatments.[1]

High Friction Surface Treatment

HFST consists of a layer of durable, anti-abrasion, and polish-resistant aggregate over a thermosetting polymer resin binder that locks the aggregate in place to restore or enhance friction and skid resistance. Calcined bauxite is the aggregate shown to yield the best results and should be used with HFST applications.

Applications

HFST should be applied in locations with increased friction demand, including:

- Horizontal curves.
- Interchange ramps.
- Intersection approaches.
  - Higher-speed signalized and stop-controlled intersections.
  - Steep downward grades.
- Locations with a history of rear-end, failure to yield, wet-weather, or red-light-running crashes.
- Crosswalk approaches.

Considerations

- HFST is applied on existing pavement, so no new pavement is added.
- If the underlying pavement structure is unstable, then the HFST life cycle may be shortened, resulting in pre-mature failure.
- The automated installation method is preferred as it minimizes issues often associated with manual installation: human error due to fatigue, inadequate binder mixing, improper and uneven binder thickness, delayed aggregate placement, and inadequate aggregate coverage.
- The cost can be reduced when bundling installations at multiple locations.

1 Izeppi et al. Continuous Friction Measurement Equipment as a Tool for Improving Crash Rate Prediction: A Pilot Study. Virginia Department of Transportation, (2016).
2 Merritt et al. Development of Crash Modification Factors for High Friction Surface Treatments. FHWA, (2020).
3 NCHRP Report 617: Accident Modification Factors for Traffic Engineering and ITS Improvements, (2008).

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OFFICE OF SAFETY

Proven Safety Countermeasures

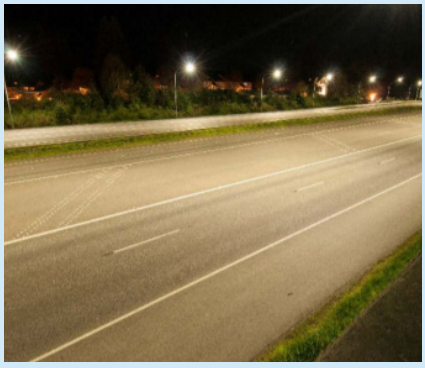
Safety Benefits:

Lighting can reduce crashes up to:

42%
for nighttime injury pedestrian crashes at intersections.[1]

33-38%
for nighttime crashes at rural and urban intersections.[1]

28%
for nighttime injury crashes on rural and urban highways.[1]



Source: WSDOT

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/roadway_dept/night_visib/roadwayresources.cfm.

FHWA-SA-21-050

Lighting

The number of fatal crashes occurring in daylight is about the same as those that occur in darkness. However, the nighttime fatality rate is three times the daytime rate because only 25 percent of vehicle miles traveled (VMT) occur at night. At nighttime, vehicles traveling at higher speeds may not have the ability to stop once a hazard or change in the road ahead becomes visible by the headlights. Therefore, lighting can be applied continuously along segments and at spot locations such as intersections and pedestrian crossings in order to reduce the chances of a crash.

Adequate lighting (i.e., at or above minimum acceptable standards) is based on research recommending horizontal and vertical illuminance levels to provide safety benefits to all users of the roadway environment. Adequate lighting can also provide benefits in terms of personal security for pedestrians, wheelchair and other mobility device users, bicyclists, and transit users as they travel along and across roadways.

Applications

Roadway Segments

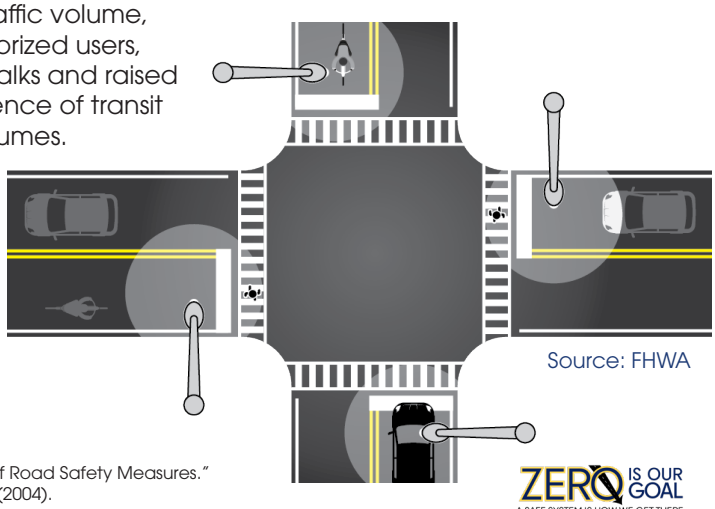
Research indicates that continuous lighting on both rural and urban highways (including freeways) has an established safety benefit for motorized vehicles.[1] Agencies can provide adequate visibility of the roadway and its users through the uniform application of lighting that provides full coverage along the roadway and the strategic placement of lighting where it is needed the most.

Intersections and Pedestrian Crossings

Increased visibility at intersections at nighttime is important since various modes of travel cross paths at these locations. Agencies should consider providing lighting to intersections based on factors such as a history of crashes at nighttime, traffic volume, the volume of non-motorized users, the presence of crosswalks and raised medians, and the presence of transit stops and boarding volumes.

Considerations

Most new lighting installations are made with breakaway features, shielded, or placed far enough from the roadway to reduce the probability and/or severity of fixed-object crashes. Modern lighting technology gives precise control with minimal excessive light affecting the nighttime sky or spilling over to adjacent properties. Agencies can equitably engage with underserved communities to determine where and how new and improved lighting can most benefit the community by considering their priorities, including eliminating crash disparities, connecting to essential neighborhood services, improving active transportation routes, and promoting personal safety.



Source: FHWA

1 Elvik, R. and Vaa, T., "Handbook of Road Safety Measures." Oxford, United Kingdom, Elsevier, (2004).

ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE

U.S. Department of Transportation
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Safety Benefits:

Agencies have experienced the following benefits after LRSP implementation:

25%
reduction in county road fatalities in Minnesota.

17%
reduction in fatal and serious injury crashes on county-owned roads in Washington State.

35%
reduction in severe curve crashes in Thurston County, WA.

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/LRSPDIY/.

FHWA-SA-21-033

Local Road Safety Plans

A local road safety plan (LRSP) provides a framework for identifying, analyzing, and prioritizing roadway safety improvements on local roads. The LRSP development process and content are tailored to local issues and needs. The process results in a prioritized list of issues, risks, actions, and improvements that can be used to reduce fatalities and serious injuries on local roads. FHWA has developed several resources including an LRSP Do-It-Yourself website which further explains the process and includes resources local agencies and their partners need to create and implement an LRSP.[1]

Approximately 75 percent of rural roads are owned by local agencies.[2] While local roads are less traveled than State highways, they have a much higher rate of fatal and serious injury crashes.[2] Developing an LRSP is an effective strategy to improve local road safety for all road users and support the goals of a State's overall Strategic Highway Safety Plan (SHSP).

Although the development process and resulting plan can vary depending on the local agency's needs, available resources, and targeted crash types, aspects common to LRSPs include:

- Stakeholder engagement representing the 4E's: engineering, enforcement, education, and emergency medical services.
- Collaboration among municipal, county, Tribal, State, and/or Federal entities to leverage expertise and resources.
- Identification of target crash types and crash risk with corresponding recommended proven safety countermeasures.
- Timeline and goals for implementation and evaluation.

Local road agencies should consider developing an LRSP to be used as a tool for reducing roadway fatalities, injuries, and crashes.[3] LRSPs can help agencies create a prioritized list of improvements. LRSPs are also a proactive risk management technique to demonstrate an agency's responsiveness. The plan should be viewed as a living document that can be updated to reflect changing local needs and priorities.

Infographic showing the LRSP process. Source: FHWA

1 https://safety.fhwa.dot.gov/LRSPDIY/
2 Anderson et al. Noteworthy Practices: Addressing Safety on Locally-Owned and Maintained Roads A Domestic Scan, FHWA-SA-09-019, (2010).
3 Developing Safety Plans: A Manual for Local Rural Road Owners, FHWA-SA-12-017, provides guidance on developing an LRSP.

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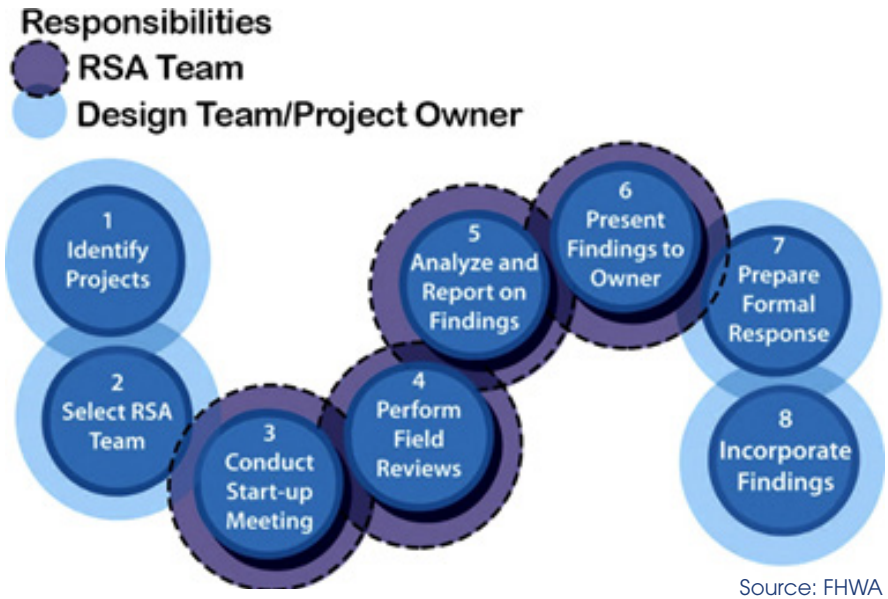
Safety Benefits:

10-60%
reduction in total crashes.[1]

Road Safety Audit

While most transportation agencies have established traditional safety review procedures, a road safety audit (RSA) or assessment is unique. RSAs are performed by a multidisciplinary team independent of the project. RSAs consider all road users, account for human factors and road user capabilities, are documented in a formal report, and require a formal response from the road owner. (See the eight steps for conducting an RSA below.)



Source: FHWA

RSAs provide the following benefits:

- Reduced number and severity of crashes due to safer designs.
- Reduced costs resulting from early identification and mitigation of safety issues before projects are built.
- Increased opportunities to integrate multimodal safety strategies and proven safety countermeasures.
- Expanded ability to consider human factors in all facets of design.
- Increased communication and collaboration among safety stakeholders.
- Objective review by independent multidisciplinary team.

RSAs can be performed in any phase of project development, from planning through construction. Agencies may focus RSAs specifically on motorized vehicles, pedestrians, bicyclists, motorcyclists, or a combination of these roadway users. Agencies are encouraged to conduct an RSA at the earliest stage possible, as all roadway design options and alternatives are being explored.

Multidisciplinary team performs field review during an RSA. Source: FHWA

For more information on this and other FHWA Proven Safety Countermeasures, please visit https://safety.fhwa.dot.gov/provencountermeasures/ and https://safety.fhwa.dot.gov/rsa/.

1 Road Safety Audits: An Evaluation of RSA Programs and Projects, FHWA-SA-12-037; and FHWA Road Safety Audit Guidelines, FHWA-SA-06-06.

FHWA-SA-21-048

https://safety.fhwa.dot.gov/provencountermeasures/

FHWA-SA-21-071

APPENDIX 3: REGIONAL TRANSPORTATION PLAN PRIORITIZATION

7. IMPLEMENT SELECTED STRATEGIES & MANAGE TRANSPORTATION SYSTEM

The RTP project prioritization framework is a crucial element in the CMP. The projects identified in the 2050 RTP were compiled from a variety of sources, including:

- The 2040 RTP (developed in 2017).
- Corridor plans and studies such as the South Meadows Multimodal Transportation Study, University Area Transportation Study, and other corridor plans.
- Road Safety Assessments and Safety Management Plans.
- Community workshops and other public comments.
- A series of online surveys.
- Input from local governing bodies.
- Input from the 2050 RTP Agency Working Group, RTC Citizens Multimodal Advisory Committee, RTC Technical Advisory Committee, and RTC Regional Road Impact Fee Advisory Committee.

After all project suggestions were reviewed for feasibility and any inconsistencies, each project was evaluated based on a series of criteria developed in support of the RTP Guiding Principles and CMP.

Projects were distributed into one of the following four categories in an effort to establish a basis for comparison amongst similar project types.

- Freeway projects.
- Capacity projects (widening or expansion of existing roadways, inclusive of multimodal amenities where feasible and appropriate).
- New roadways.
- Multimodal projects (transportation infrastructure improvements exclusive of new capacity).

The framework described in the following sections was developed to assist in the prioritization process for regional roadway projects. It provided input and data for the RTC Board to consider during the project evaluation and selection process. It is important to note that a mathematical formula did not provide the final determination on project rankings and that professional judgement and community/agency staff input was considered by the RTC staff and Board in making final recommendations and decisions. Separate evaluation frameworks were applied to projects on existing roadways and construction of new roads. The factors for evaluating projects on existing roadways consists of the criteria below.

Evaluation Criteria for Projects on Existing Regional Roads

- Safety – Crash Frequency, Rate, Severity
- Congestion – Travel Demand Model Existing/Forecasted Level of Service (LOS)
- Bike/Pedestrian Score – Criteria in Bicycle & Pedestrian Master Plan
- Equity
- Project Readiness
- Regional Plan Land Use Priority – TMRPA Tier System
- Pavement Condition Index (PCI)/ Bridge Rating
- Flood Mitigation
- Private/Other Agency Funding
- Public Input
- Agency Working Group Input

For analysis of new roads, a different methodology was developed because safety, congestion, pavement condition, and other data used to evaluate projects on existing roads would not be available for new construction.

RTC developed cost estimates for each proposed new road project, identified the projected average daily traffic (ADT) that would use the road, and developed an estimate for cost per ADT.

Evaluation Criteria for New Road Construction

- Average Daily Traffic
- Cost per ADT
- Project Readiness
- Regional Plan Land Use Priority – TMRPA Tier System
- Private/Other Agency Funding
- Flood Mitigation
- Emergency Response/Fire Evacuation
- Public Input
- Agency Working Group Input

Methodology

Safety

An analysis of all regional roads and freeways was conducted based on the three most recent years of crash data available from the Nevada Department of Transportation. Projects were scored based on a combination of crash frequency, rate, and severity.

Traffic Congestion

Traffic congestion is derived from 2020 (existing) traffic level of service as well as from the 2050 “no build” level of service obtained through the RTC Travel Demand Model.

Bicycle & Pedestrian Score

The bicycle and pedestrian score for each project was provided by the rating identified in the RTC Bicycle and Pedestrian Master Plan when applicable.

Project Readiness

This criteria is intended to reflect the analysis, community input, and vetting of projects that occurs through other stages of the planning process. It recognizes a commitment to completing a project that has progressed to the design phase, and the level of community support for projects that have been adopted into the Program of Projects (POP) or Regional Transportation Improvement Program (RTIP).

Equity

Higher priority is given to the extent to which a project improves transportation in an underserved community. Additional emphasis on equity in the 2050 RTP was requested during the RTC Citizens Multimodal Advisory Committee, and the following factors were considered in determining the level of equity a project has.

Is the project located in or in proximity to the following areas:

- Food desert as identified by the USDA.
- Census track with higher than Washoe County average proportion of disabled residents.
- Census track with higher than Washoe County average proportion of low income households.
- Census track with higher than Washoe County average proportion of zero vehicle households.
- Census track with higher than Washoe County average proportion of minority residents.
- Census track with higher than Washoe County average proportion of residents age 65 and older.
- Within 1/4 mile of a school or hospital.

Regional Land Designations (i.e., Tiers)

The Regional Land Designations were established by the 2019 Truckee Meadows Regional Plan, and refine the Truckee Meadows Service Area to prioritize growth and investment in the core of the region. For the 2050 RTP, this criteria is based on the tiered land use system identified in the TMRPA Regional Plan.

Pavement/Bridge Condition

This criteria recognizes the benefit of investing in the state of good repair for regional roads and bridges. Projects with a lower pavement condition index (PCI) or bridge rating receive higher priority.

Flood Impact

Projects that address a critical need for flood mitigation are given a higher priority. An example of this would be road access that was cut off by flood waters for extended period. Other projects that are identified as Truckee River Flood Projects are given medium priority.

Private or Other Agency Funding

The purpose of this criteria is to recognize that the opportunity to maximize RTC revenues through public-private partnerships or financial participation of other agencies is a benefit to the region.

Criteria for New Road Construction

For construction of roads on new locations, the following additional criteria were evaluated.

- Projected ADT.
- Cost per ADT.
- Emergency Response/Fire Evacuation – This need was identified by both members of the public and the Truckee Meadows Fire Protection District. Proposed roadways that improve regional connectivity or provide a secondary route to isolated areas received higher priority. Projects that provide improved access within a neighborhood or community received medium priority.
- Projects Identified in a Plan or Study – Similar to Project Readiness for projects on existing roads, this criteria is intended to reflect the analysis, community input, and vetting of projects that occurs through other stages of the planning process. It recognizes a commitment to completing a project that has been identified as a recommendation in an individual corridor or area study, apart from the RTP.

Following the project screening, RTC staff developed a draft fiscally constrained project listing for review by the RTC Agency Working Group, RTC advisory committees, and ultimately the RTC Board. The list was also provided for public comment prior to finalizing the RTP.

APPENDIX 4: PROJECT DEMOGRAPHICS

Action Items 2l - 2w: Demographics within 1/4-mile of Project Corridors

	Population	Jobs	% of people in poverty	% of people who are non-White or of Hispanic / Latino origin	% of households that are car free	% of households with one car	% of people living with a disability	% of people who are 65+	% of people who are 17-	% of people who speak English less than "very well"
4th St - Multimodal	3,354	7,568	29%	33%	30%	52%	24%	22%	5%	8%
5th St - Multimodal	3,209	7,723	33%	31%	31%	48%	22%	22%	5%	6%
E 6th St - Bicycle Facility & Safety Improvements	1,820	4,570	28%	37%	20%	53%	19%	19%	4%	9%
Kirman Ave - Sidewalks & Buffered Bike Lanes	6,927	9,004	22%	48%	17%	44%	17%	14%	20%	14%
Prater Wy - Bike Lanes	9,749	7,227	13%	44%	8%	38%	16%	19%	21%	11%
Rock Blvd - Enhanced Sidewalks & Bike Lanes	8,138	4,222	17%	61%	11%	37%	17%	14%	22%	20%
Sun Valley Blvd - Multimodal Improvements	4,087	3,471	16%	57%	5%	25%	14%	10%	28%	13%
Sutro St - Multimodal	4,951	2,248	24%	64%	18%	39%	12%	10%	24%	11%
Vassar St - Bike Facility	5,175	5,318	23%	54%	12%	44%	14%	9%	22%	10%
Vine St - Bike Facility	4,601	3,845	26%	40%	16%	50%	13%	17%	7%	8%
Wells Ave - Bike Lanes & Bike/Ped Facilities	4,692	6,188	20%	42%	28%	45%	15%	16%	14%	7%

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visionzerotruckeemeadows.com