MINNESOTA

2025-2029 STRATEGIC HIGHWAY SAFETY PLAN

FEBRUARY 2025

APPENDICES

DEPARTMENT OF TRANSPORTATION

CONTENTS

APPENDIX A

FOCUS AREA STRATEGIES AND TACTICS

2025-2029 STRATEGIC HIGHWAY SAFETY PLAN

DEPARTMENT OF TRANSPORTATION

CONTENTS

STRATEGIES AND TACTICS

The SHSP defines 20 focus areas, each with corresponding strategies and tactics. Focus areas are grouped within the categories of Umbrella, Primary, Rising Concern, Connected, and Support Solutions.

The focus areas, strategies, and tactics reinforce each other and work on multiple levels to reduce severe crash outcomes on Minnesota roads.

1. **Focus area category** is presented on top.
2. **Focus area name** is identified at the top of the page.
3. **Equity Focus Area** designation is given to the top six focus areas by average equity score.
4. **Strategies** represent the "what." They describe a key opportunity to reduce crashes associated with a specific Focus Area.
5. Corresponding **Safe System Approach** elements are identified at the strategy level, representing the multiple layers of defense that each strategy incorporates.
6. **Tactics** represent the "how." They are specific actions that can be taken by implementation partners to achieve a strategy's objective.
7. **Key Tactics** are considered especially impactful or timely and will be given implementation priority.
8. Leadership categories are identified by showing one or more **4E's** elements for each tactic.
9. Symbols are defined in the **legend** included on each page.

OVERARCHING PRINCIPLE

EMPHASIZE SAFETY NEEDS OF VULNERABLE AND UNDERSERVED POPULATIONS IN SHSP IMPLEMENTATION

Strategy 1: Seek to Prioritize the Needs of Vulnerable and Underserved Populations in the Implementation of SHSP Strategies and Tactics Wherever Relevant

Safe System Approach Elements Addressed:
Safe Road Users, Safe Vehicles, Safe Speeds, Safe Roads, and Post-Crash Care

TACTIC	LEADERSHIP
Key Tactic **1.1:** Invite non-traditional partners, such as Statewide Health Improvement Program staff, to develop implementation approaches that emphasize the safety needs of vulnerable and underserved populations.	Engineering, Enforcement, Emergency Services, Education
Key Tactic **1.2:** Incorporate safety needs of vulnerable and underserved populations into grant scoring criteria.	Engineering, Enforcement, Emergency Services, Education
Key Tactic **1.3:** Expand transportation safety data collection and sharing to better understand and address the needs of vulnerable and underserved populations.	Engineering, Enforcement, Emergency Services, Education
Key Tactic **1.4:** Through multi-agency collaboration, explore enhanced equitable enforcement approaches based on research and review of new and best practices.	Engineering, Enforcement, Emergency Services, Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

UMBRELLA FOCUS AREAS

SPEED

EQUITY FOCUS AREA

Strategy 1: Develop a Comprehensive Plan to Systematically Reduce Speeds

Safe System Approach Elements Addressed:
Safe Road Users, Safe Speeds, Safe Roads, and Post-Crash Care

TACTIC	LEADERSHIP
(Key Tactic) **1.1:** Develop a comprehensive Speed Management Action Plan that identifies locations, times, and strategies to effectively manage speed through enforcement, speed safety cameras, engineering design, and traffic safety culture tactics. Involve staff from State Patrol, local law enforcement, engineering, Toward Zero Deaths and others.	Engineering, Enforcement, Emergency Services, Education

Strategy 2: Improve Speed-Related Crash Data and Driver Violation History

Safe System Approach Elements Addressed:
Safe Road Users and Safe Speeds

TACTIC	LEADERSHIP
2.1: Improve speed crash data quality by educating law enforcement on how to update MNCRASH after crash reconstruction is complete.	Enforcement
(Key Tactic) **2.2:** Provide law enforcement with up-to-date driver violation history and prior convictions at the time of a traffic stop to help identify repeat violators.	Enforcement

Strategy 3: Assess and Expand the Pilot Use of Speed Safety Cameras and Related Public Education Efforts

Safe System Approach Elements Addressed:
Safe Road Users, Safe Speeds, Safe Roads, and Post-Crash Care

TACTIC	LEADERSHIP
3.1: Assess Minnesota's pilot speed safety camera efforts to determine if project goals were met, identify successes, and recommend changes. Identify safety strategies, communications, and public engagement tactics for potential expanded applications.	Engineering, Enforcement, Emergency Services, Education
(Key Tactic) (Legislative Action) **3.2:** Develop a speed safety camera program plan for work zones and school zones based on Minnesota's pilot results. Consider the USDOT speed safety camera guidelines for planning, public involvement, stakeholder coordination, implementation, maintenance, and evaluation.	Engineering, Enforcement, Emergency Services, Education
(Legislative Action) **3.3:** Enable systematic deployment of automated enforcement options to enhance their impact on reducing high-risk driving behaviors.	Engineering, Enforcement
(Key Tactic) **3.4:** Develop messaging to educate the public on how speed safety cameras, when implemented with proper controls, can offer fair and equitable enforcement of speeding laws.	Engineering, Enforcement, Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Strategy 4: Strengthen Speed Enforcement Campaigns and Public Visibility

Safe System Approach Elements Addressed:
Safe Road Users and Safe Speeds

TACTIC	LEADERSHIP
4.1: Evaluate the impact of the Minnesota 2024 Transportation Omnibus Bill legislative funding for increased traffic enforcement and develop recommendations based on the results.	Enforcement, Education
4.2: Increase funding to support highly visible, publicized, and saturated enforcement speed campaigns at locations with a higher incidence of speed-related crashes.	Enforcement, Education
[Key Tactic] [Legislative Action] **4.3:** Strengthen penalties for repeat speeding offenders including the required use of Intelligent Speed Assistance. Intelligent Speed Assistance may be used to provide warnings on vehicle speed, automatically adjust vehicle speed based on the speed limit, or use other features to assist drivers in maintaining a safe and legal speed.	Enforcement, Education
[Legislative Action] **4.4:** Adopt a sliding scale for moving violation penalties whereby fines increase based on the severity of the offense.	Enforcement, Education

Strategy 5: Strengthen Driver Awareness of Speed-Related Consequences

Safe System Approach Elements Addressed:
Safe Road Users and Safe Speeds

TACTIC	LEADERSHIP
5.1: Increase funding for sustained public communication on the dangers and consequences of speeding and on social norming messages to change driver attitudes and cultural norms regarding speed.	Enforcement, Education
[Key Tactic] **5.2:** Fund a Minnesota pilot program coupled with media outreach for the use of telematic monitoring systems to provide real-time feedback on speeding and other high-risk driving behaviors to encourage mid-driving correction and crash prevention.	Education

Strategy 6: Design Roadways to Encourage Appropriate Speeds and Reduce Crash Severities

Safe System Approach Elements Addressed:
Safe Road Users and Safe Speeds

TACTIC	LEADERSHIP
6.1: Incorporate speed-reducing factors leading up to intersections. Highly effective examples include reduced lane width, urbanization, radar feedback devices, raised medians, raised crosswalks, and signalization strategies such as rest in red or signal timing.	Engineering
[Key Tactic] **6.2:** Incorporate speed-reducing design on corridors, especially high-speed to low-speed transition zones. Highly effective examples include reduced lane widths, raised medians, radar feedback devices, transverse pavement markings/converging chevron markings, lane shifts, road diet (four to three-lane conversion), and signal timing.	Engineering

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Emergency Services
Enforcement
Education

INATTENTION

Strategy 1: Improve the Quality of Inattentive Driving Crash Data

Safe System Approach Elements Addressed:
Safe Road Users and Safe Roads

TACTIC	LEADERSHIP
[Key Tactic] **1.1:** In collaboration with Minnesota Traffic Records Coordinating Committee, ensure enforcement crash reporting aligns with the attribute values in the 2024 edition of the Model Minimum Uniform Crash Criteria.	Engineering, Enforcement
1.2: Obtain funding to conduct annual observational surveys to collect inattentive driving behavioral data.	Education

Strategy 2: Improve Education and Awareness to Reduce Inattentive Driving

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
2.1: Analyze crash data to identify demographic characteristics associated with inattentive drivers and develop key messages and effective media platforms to reach them.	Enforcement, Education
[Key Tactic] **2.2:** Increase funding to support public awareness prior to inattentive driving enforcement campaigns, and to support public outreach featuring the campaign's results once the campaign has concluded.	Enforcement, Education
2.3: Promote employer adoption and enforcement of policies that prohibit employees from engaging in distracting behaviors while driving on the job.	Education

Strategy 3: Strengthen Enforcement Tools and Criminal Penalties to Reduce Inattentive Driving

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
3.1: Increase the use of enhanced high-visibility enforcement, coupled with public information campaigns about the enforcement, for higher-risk groups.	Enforcement, Education
[Key Tactic] **3.2:** Identify new funding for law enforcement tools and equipment needed to identify offenders and effectively enforce Minnesota's distracted and careless driving laws.	Enforcement, Education
3.3: Strengthen judicial support to convict and sentence distracted drivers.	Enforcement
[Key Tactic] [Legislative Action] **3.4:** Strengthen criminal penalties for distracted driving causing severe injuries or death through 1) legislative changes to the Criminal Vehicular Homicide and Criminal Vehicular Operation statutes to specifically include "use of an electronic device while driving," and 2) supporting an increase in the severity levels for Criminal Vehicular Homicide and Criminal Vehicular Operation within the Minnesota Sentencing Guidelines Grid.	Enforcement

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Strategy 4: Support the Advancement of Technology Improvements to Reduce Inattentive Driving

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
🔑 **4.1:** Fund pilot program coupled with media outreach for the use of telematic monitoring systems to provide real-time feedback on inattentive and other high-risk driving behaviors to encourage mid-driving correction and crash prevention.	Education
4.2: Promote the use of cell phone settings and apps that limit incoming distractions while driving and provide real-time driver feedback on high-risk driving behavior.	Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

INTERSECTIONS

EQUITY FOCUS AREA

Strategy 1: Improve Safety through Intersection Design Changes and Alternative Intersections

Safe System Approach Elements Addressed:
Safe Road Users, Safe Speeds, and Safe Roads

TACTIC	LEADERSHIP
(Key Tactic) **1.1:** Design intersections to eliminate critical conflict points, especially at high-risk locations or those with a history of severe crashes. Highly effective examples include roundabouts, J-Turns, ¾ intersections, restricted movement intersections, directional medians, and others. Preserve or improve pedestrian mobility where these alternative intersections are implemented.	Engineering
1.2: Incorporate pedestrian, bicycle, and transit facilities in intersection design, especially at high-risk locations or those with high pedestrian and bicyclist activity. Highly effective examples include sidewalks, high visibility crosswalk markings, median refuge islands, and curb extensions. Other effective examples can be found in MnDOT guidance documents, such as the High Priority Pedestrian Safety Improvements Action Plan (HiPPS), the Traffic Engineering Manual (TEM), and the Facilities Design Guide. These examples are most effective when used in combination with each other.	Engineering
1.3: Increase education and public outreach regarding alternative intersection designs and how to use them. Support data-driven solutions and explore ways to communicate the safety benefits of alternative intersections.	Education

Strategy 2: Incorporate Enhanced Safety Features at Intersections

Safe System Approach Elements Addressed:
Safe Roads

TACTIC	LEADERSHIP
(Key Tactic) **2.1:** Improve the visibility of all road users at intersections through use of lighting and unobstructed sightlines, especially at high-risk locations or locations with a history of severe crashes.	Engineering
2.2: Improve and maintain intersection signing and pavement markings, especially at high-risk locations or locations with a history of severe crashes.	Engineering
2.3: Prioritize intersection safety for pedestrians, bicyclists, and transit users through non-motorized safety features, especially at high-risk locations or locations with high pedestrian and bicyclist activity. Highly effective examples include rectangular rapid flashing beacons (RRFB) and pedestrian hybrid beacons, leading pedestrian intervals at signalized intersections, protected intersection design, and other protected pedestrian movements at signalized intersections.	Engineering

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Strategy 3: Update Intersection Planning Policy

Safe System Approach Elements Addressed:
Safe Road Users, Safe Speeds, and Safe Roads

TACTIC	LEADERSHIP
3.1: Incorporate a safety-first approach to intersection planning. Encourage engineering analysis of safety features before exclusion of those options. Utilize MnDOT's adopted slogan of "Safety First, Safety Always" in intersection planning discussions.	Engineering
3.2: Support legislation to improve intersection safety options, such as speed safety cameras or red light safety cameras.	Enforcement
3.3: Facilitate coordination among state, regional, and local agencies for intersection projects, and include participation of user groups. Leverage findings from the District Safety Plans, County Road Safety Plans, and local road safety plans to prioritize county and rural roadway intersection projects for federal Highway Safety Improvement Program funding.	Engineering
3.4: Pursue enhanced analytics and data collection (such as analytics using video/radar detection) for intersection-based crashes and near-miss incidents.	Engineering

LANE DEPARTURE

Strategy 1: Design Roadways to Reduce the Frequency and Severity of Lane Departure Crashes

Safe System Approach Elements Addressed:
Safe Roads

TACTIC	LEADERSHIP
1.1: Design roadways to bring awareness to roadway edges and reduce the frequency of lane departure crashes, especially at high-risk locations or locations with a history of severe crashes. Highly effective examples include rumble strips and edge line markings.	Engineering
1.2: Design edge of roadway to reduce the severity of lane departure crashes, especially at high-risk locations or locations with a history of severe crashes. On rural high-speed roads, highly effective examples include maintaining clear zones, appropriate shoulder widths, cable barrier/other barriers, Safety Edge installation, and appropriate slope design. Combining these treatments can increase overall effectiveness and reduce crashes and severities.	Engineering

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Strategy 2: Design Horizontal Curves to Reduce the Frequency and Severity of Lane Departure Crashes

Safe System Approach Elements Addressed:
Safe Roads

TACTIC	LEADERSHIP
Key Tactic **2.1:** Implement designs to improve curve visibility and reduce the frequency of lane departure crashes, especially at high-risk locations or locations with a history of severe crashes. Highly effective examples include rumble strips, enhanced edge line markings, chevrons/delineators, lighting, and appropriate curve radii. Explore the effectiveness of high friction surface treatment as an additional design solution.	Engineering
Key Tactic **2.2:** Design edge of roadway within curves to reduce the severity of lane departure crashes, especially at high-risk locations or locations with a history of severe crashes. On rural high-speed roads, highly effective examples include clear zones, appropriate shoulder widths, cable barrier/other barriers, Safety EdgeSM installation, and appropriate slope design. Pair with high-visibility enforcement and education to maximize efficacy.	Engineering

Strategy 3: Evaluate and Implement Existing and New Safety Features and Technologies

Safe System Approach Elements Addressed:
Safe Road Users, Safe Speeds, and Safe Roads

TACTIC	LEADERSHIP
3.1: Support new vehicle technologies, such as Advanced Driver Assistance Systems (ADAS), which reduce severe lane departure crashes.	Engineering
Key Tactic **3.2:** Implement ITS and other technologies to reduce severe lane departure crashes at high-risk locations or locations with a sustained crash pattern. Examples include sequential dynamic flashing chevrons, speed warning for sharp curves, changeable message signs and variable advisory speed limits for inclement weather, and wrong way driving detection.	Engineering

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

IMPAIRMENT

EQUITY FOCUS AREA

Strategy 1: Strengthen DWI Strategic Planning and Program Operations

Safe System Approach Elements Addressed:
Safe Road Users, Safe Speeds, and Safe Roads

TACTIC	LEADERSHIP
1.1: Create an impaired driving strategic plan drawing from the MN DWI Task Force initiatives, the three-year Office of Traffic Safety Highway Safety Plan, and the 2022 Impaired Driving Program Assessment. Involve Minnesota tribal nations in the plan's development and implementation.	Engineering, Enforcement, Education
[Key Tactic] **1.2:** Obtain performance feedback and evaluate the effectiveness and return on investment of Law Enforcement Liaison activities. Based on results, refine performance expectations, position descriptions, and ongoing assessment process as needed to achieve the desired outputs and outcomes.	Enforcement
1.3: Convene a 2027 National Highway Traffic Safety Administration Safety Program Assessment of the Office of Traffic Safety Impaired Driving Program to identify strengths, opportunities for improvement, and other resulting recommendations.	Enforcement, Education

Strategy 2: Reduce Excessive Drinking through Responsible Alcohol Service, Community Outreach, and Employer-Based Intervention Programs

Safe System Approach Elements Addressed:
Safe Road Users and Safe Speeds

TACTIC	LEADERSHIP
[Key Tactic] [Legislative Action] **2.1:** Enact state-level comprehensive social host liability statutes that extend social host liability to those who knowingly serve visibly intoxicated adults.	Enforcement, Education
2.2: Provide incentives for alcohol retailers to complete responsible server training, such as liability insurance discounts and use of proof of completion as a mitigating factor in alcohol license violation cases.	Enforcement, Education
[Legislative Action] **2.3:** Implement a per drink tax and dedicate a portion of the proceeds to prevention and treatment of alcohol and other substance abuse problems including impaired driving.	Enforcement, Education
2.4: Promote employer-sponsored screening and brief intervention, assessment, and treatment programs for employees identified with alcohol or substance use problems.	Education
[Key Tactic] [Legislative Action] **2.5:** Adopt the use of Screening, Brief Intervention, and Referral for Treatment at the time of arraignment for all first-time DWI offenders.	Enforcement, Education
[Key Tactic] **2.6:** Promote social norming communication strategies to increase the perceived risk of impaired driving, raise the profile of responsible driving, and expand media campaigns to feature drug-impaired driving. Incorporate the use of medical personnel such as emergency room doctors to educate the public on the consequences of impaired driving.	Enforcement, Emergency Services, Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Strategy 3: Strengthen Support for Law Enforcement to Deter and Remove Impaired Drivers

Safe System Approach Elements Addressed:
Safe Road Users and Safe Speeds

TACTIC	LEADERSHIP
(Key Tactic, Legislative Action) **3.1:** Based on the evaluation results of Minnesota's roadside oral fluid testing pilot, refine operational procedures and processes as needed and expand the pilot to a fully-adopted roadside test for drug-impaired driving.	Enforcement
(Key Tactic) **3.2:** Increase DWI Traffic Safety officers, supported by National Highway Traffic Safety Administration grant funding for the Department of Public Safety Office of Traffic Safety, to provide dedicated year-round impaired driving enforcement.	Enforcement
3.3: Strengthen the frequency of locally-coordinated DWI saturation patrols by using the Office of Traffic Safety's DWI Dashboard to identify high-risk locations and time periods for impaired driving-related crashes.	Enforcement, Education
3.4: Recruit additional Drug Recognition Experts especially in counties or jurisdictions with no Drug Recognition Experts.	Enforcement

Strategy 4: Strengthen DWI Sanctions as Well as the Prosecution and Adjudication of DWI Offenders

Safe System Approach Elements Addressed:
Safe Road Users and Safe Speeds

TACTIC	LEADERSHIP
(Key Tactic, Legislative Action) **4.1:** Strengthen the ignition interlock device law to apply to all offenders, including first time offenders, and require the use of ignition interlock devices for DWI offenders refusing a field sobriety test.	Enforcement
(Legislative Action) **4.2:** Enact legislation to impose immediate driver license sanctions for impaired drivers under the influence of marijuana or other illegal substances.	Enforcement
(Legislative Action) **4.3:** Enact enhanced penalties for multiple impairing substances or polydrug use while driving.	Enforcement
4.4: Implement a formal program, such as pay incentives or professional growth opportunities, designed to attract and retain experienced DWI prosecutors.	Enforcement, Education
(Key Tactic) **4.5:** Increase the number of DWI courts in Minnesota to strengthen repeat DWI offender monitoring and supervision and reduce recidivism.	Enforcement, Education
4.6: Implement an impaired driver tracking system, from the traffic stop through completion of all requirements, to provide DWI data needed for countermeasure system improvements.	Enforcement

Strategy 5: Increase Public Awareness Campaigns to Reduce Drugged-Impaired Driving

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
(Key Tactic) **5.1:** Secure funding for and conduct a public education and outreach campaign on cannabis use and drugged-impaired driving.	Enforcement, Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

UNBELTED

Strategy 1: Improve Data Quality to Strengthen Problem Identification of Unrestrained Occupants

Safe System Approach Elements Addressed:
Safe Road Users and Post-Crash Care

TACTIC	LEADERSHIP
Key Tactic – **1.1:** Conduct and communicate the findings of data-driven analysis on the increased injury severity of unbelted occupants in traffic crashes.	Emergency Services, Education
1.2: Conduct and strengthen Minnesota Toward Zero Deaths Regional Observational Seat Belt Survey by using a consistent annual survey methodology to improve comparison and tracking of regional and state-wide results.	Education
Key Tactic – **1.3:** Expand the annual Minnesota Toward Zero Deaths Regional Observational Seat Belt Survey to include child safety seat use.	Education
1.4: Expand the existing Triennial Minnesota Student Survey to include traffic safety-related behaviors and opinions.	Education
Key Tactic – **1.5:** Adopt use of the National Digital Car Seat Check Form by Minnesota Child Passenger Safety Technicians for all state- and federally-funded activities to improve statewide data collection, tracking, and analysis.	Education

Strategy 2: Examine Allocation of Resources to Strengthen Seat Belt Use

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
Key Tactic – **2.1:** Review funding and resource allocations for seat belt programs and child passenger safety programs to ensure the allotments for each are based on thorough problem identification and sound cost/benefit analysis.	Education

Strategy 3: Strengthen the Enforcement and Monitoring of Unrestrained Occupants and the Adjudication of Citations Issued

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
3.1: Conduct and monitor enhanced high-visibility statewide seat belt enforcement events supported by paid and earned media with emphasis on locations and timeframes demonstrating greater risk of unrestrained vehicle occupants.	Enforcement, Education
Key Tactic – **3.2:** Identify alternative funding sources to increase support for localized seat belt enforcement saturations addressing areas and timeframes demonstrating low belt use.	Enforcement, Education
Key Tactic – **3.3:** Conduct judicial outreach and education to promote the consistent adjudication of seat belt and child passenger seat citations.	Enforcement, Education

The order of the strategies and tactics does not indicate priority.

Key Tactic

Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)

Engineering

Enforcement

Emergency Services

Education

Strategy 4: Strengthen Public Outreach and Training to Increase Seat Belt and Child Restraint Use

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
(Key Tactic) **4.1:** Utilize a single statewide seat belt use and enforcement message during national Click It or Ticket campaigns, balanced with sustained localized social norming messaging addressing higher-risk populations within areas and timeframes demonstrating low belt use.	Enforcement, Education
4.2: Evaluate media strategies to ensure sufficient frequency and reach among target audiences to increase the probability of behavior change.	Education
4.3: Apply best practice models of effective school and community-based outreach methods that target teen drivers and incorporate results in teen-focused Toward Zero Deaths events and materials.	Education
(Key Tactic) **4.4:** Expand messaging within the medical community and schools to increase public understanding of the risk of increased injury severity for failure to wear seat belts or to properly restrain children.	Emergency Services, Education
4.5: Require public agencies to align with best practices for employer traffic safety policies, including seat belt use, and to communicate employee expectations and consequences for non-compliance.	Education
4.6: Increase funding for car seats and for training families, caregivers, and childcare professionals on the proper use of child safety restraints.	Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

RISING CONCERN FOCUS AREAS

UNLICENSED DRIVERS

EQUITY FOCUS AREA

Strategy 1: Enhance Law Enforcement Contact with Unlicensed Drivers

Safe System Approach Elements Addressed:
Safe Road Users and Safe Speeds

TACTIC	LEADERSHIP
(Key Tactic) **1.1:** Increase the frequency of equitable law enforcement contact with unlicensed drivers through consistent enforcement of impaired driving, speeding, distracted driving, and seat belt use.	Enforcement, Education

Strategy 2: Employ Sanctions to Identify and Prevent Invalid Licensed Driving

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
(Key Tactic, Legislative Action) **2.1:** Require the use of ignition interlock devices by all DWI offenders to eliminate invalid license driving during the license sanction period.	Enforcement, Education
2.2: Strengthen law enforcement use of license plate and vehicle sanctions to prevent unlicensed and invalid licensed drivers from continuing to drive.	Enforcement, Education
(Key Tactic) **2.3:** Conduct a scan of best practices from other states for addressing unlicensed driving, including limiting license suspensions to dangerous driving behaviors only (for example, a DWI rather than non-driving license suspensions such as failure to pay child support). Use these findings to develop refined SHSP unlicensed driver safety recommendations.	Enforcement, Education

Strategy 3: Improve Real-Time Driver Monitoring and Feedback to Promote Safe Driving for Inexperienced Drivers

Safe System Approach Elements Addressed:
Safe Road Users and Safe Speeds

TACTIC	LEADERSHIP
(Key Tactic) **3.1:** Fund a pilot program coupled with media outreach for the use of telematic monitoring systems to provide real-time feedback on high-risk driving behavior to encourage mid-driving correction and crash prevention.	Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Strategy 4: Increase Driver Awareness of and Improve Driver Education and Training For All Drivers

Safe System Approach Elements Addressed:
Safe Road Users and Safe Speeds

TACTIC	LEADERSHIP
4.1: Promote outreach and information resources on driver training and licensing procedures to diverse communities and among younger, inexperienced drivers.	Education
[Key Tactic] [Legislative Action] **4.2:** Create a robust driver education and skills training program and make it a requirement for all new drivers (including those 18 and above). Dedicate and sustain funding for the required training program to improve access for all new drivers.	Education
[Legislative Action] **4.3:** Require recurrent on-line driver refresher course every 4 or 8 years, concurrent with a driver's 4-year license renewal cycle.	Education
[Legislative Action] **4.4:** Expand 2021 Minnesota Multicultural Adult Driver Education Project pilot program supporting the education of multicultural community members aged 18 or older to reduce severe crashes involving drivers and members of different cultural communities.	Education

MOTORCYCLISTS

Strategy 1: Strengthen Public Awareness and Education to Improve Motorcycle Safety

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
[Key Tactic] **1.1:** Promote rider understanding of the safety benefits of high-visibility and protective gear and safe riding behaviors. This includes wearing helmets and all personal protective gear, wearing highly visible clothing, ensuring the visibility of the motorcycle, understanding the risks of impaired riding, and new motorcycle licensing/riding laws.	Education
[Key Tactic] **1.2:** Promote peer-to-peer outreach and identify and equip key influencers of motorcycle advocacy groups with safety messages and talking points to strengthen social norms and encourage shared helmet-use behavior.	Education
1.3: Develop and distribute updated informational resources for drivers on sharing the road with motorcycles, emphasizing the need for vigilance at intersections and curves.	Education
1.4: Encourage experienced motorcycle riders to take the Intermediate Rider Course as refresher training.	Education
1.5: Reference injury outcome data and other evidence-based information about the increased risk of severe injuries for motorcycle riders not wearing a helmet when involved in a crash.	Emergency Services, Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Strategy 2: Improve Motorcycle Safety-Related Policies

Safe System Approach Elements Addressed:
Safe Road Users, Safe Speeds, and Safe Roads

TACTIC	LEADERSHIP
Key Tactic: **2.1:** Convene a 2027 National Highway Traffic Safety Administration Safety Program Assessment of the Office of Traffic Safety Motorcycle Safety Program to identify strengths, weaknesses, and opportunities for improvement.	Engineering, Enforcement, Education
Key Tactic: **2.2:** Monitor crashes that may be a result of the Minnesota law in effect 7/1/25 allowing motorcyclists to lane split. Assess crash performance associated with the law and use findings to guide modifications to the law if needed.	Enforcement, Education
Legislative Action: **2.3:** Enact a universal helmet-use law for all riders.	Enforcement, Education
Key Tactic, Legislative Action: **2.4:** In the absence of a universal helmet law for all riders, require motorcycle endorsement holders to wear a helmet for the first two years after receiving their endorsement. This applies regardless of age, and any passengers during that time must also wear a helmet.	Enforcement, Education

Strategy 3: Strengthen Enforcement to Discourage Motorcycle Rider High-Risk Behaviors

Safe System Approach Elements Addressed:
Safe Road Users and Safe Speeds

TACTIC	LEADERSHIP
Key Tactic: **3.1:** Implement the practice of comparing vehicle registration and driver licensing files to help identify unlicensed riders and educate riders on motorcycle endorsement requirements.	Enforcement, Education
3.2: Promote and educate officers in the use of vehicle impoundment and/or forfeiture for substance-impaired and/or high-speed riders.	Enforcement

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

PEDESTRIANS

EQUITY FOCUS AREA

Strategy 1: Improve Road Design and Maintenance for Pedestrian Safety

Safe System Approach Elements Addressed:
Safe Road Users, Safe Speeds, and Safe Roads

TACTIC	LEADERSHIP
(Key Tactic) **1.1:** Improve intersection and roadway design to provide safer walking and crossings for pedestrians, especially at high-risk locations or locations with high pedestrian/cyclist activity. Highly effective examples include installing sidewalks, enhanced crosswalk markings and signs, leading pedestrian intervals, median refuge islands, roadway reconfiguration to fewer lanes, and curb extensions.	Engineering
(Key Tactic) **1.2:** Provide adequate and safe midblock pedestrian crossing facilities. Highly effective examples include pedestrian hybrid beacons or rectangular rapid flashing beacons (RFFB), curb bump outs, median refuge islands, lighting to increase pedestrian visibility, and enhanced pavement markings and signs.	Engineering
1.3: Provide an adequate, accessible network of pedestrian facilities separated from vehicular traffic in locations where there is pedestrian demand or where land use and other conditions show potential suitability for bicycling using appropriate MnDOT or similar analysis tools. Consider Safe Routes to School infrastructure improvements in locations near schools. Require contractors to maintain pedestrian/bike routes during road construction.	Engineering
1.4: Establish policies to maintain pedestrian facilities for all four seasons, including proper snow and ice removal. Expedite maintenance of sidewalks and curb ramps to deter people from walking or rolling in the road. Incorporate maintenance needs in the planning process. Evaluate MnDOT's local agency maintenance agreement requirements and explore opportunities to assume responsibility or offer financial resources so that maintenance isn't a barrier for local agencies planning and building pedestrian facilities.	Engineering

Strategy 2: Promote Policy Changes that Reduce Severe Pedestrian Crashes

Safe System Approach Elements Addressed:
Safe Road Users and Safe Roads

TACTIC	LEADERSHIP
(Key Tactic) **2.1:** Improve pedestrian-related data collection to identify trends with respect to health, law, plans, accessibility, and policies. Data types include pedestrian volumes, ADA-compliance, vehicle speeds, pedestrian crashes, near miss data at locations with safety concerns or limited crash history, and status of existing and planned pedestrian facilities.	Engineering
2.2: Develop pedestrian plans and Complete Streets plans at regional and local levels. Utilize the Minnesota GreenStep Cities & Tribal Nations Program, MnDOT's Active Transportation Assistance program, and Office of Sustainability and Public Health for funding, training, and technical support.	Engineering
2.3: Increase funding for pedestrian facilities at the state, regional, and local levels, including planning efforts such as Complete Streets. Pair with an increase in funding for targeted pedestrian safety campaigns that amplify the effectiveness of engineering.	Engineering, Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

TACTIC	LEADERSHIP
2.4: Explore school bus stop arm violation camera enforcement.	Enforcement
2.5: Streamline the implementation pathway and decision-making process for pedestrian safety improvements by following associated guidance documents, such as completing the actions found in the High Priority Pedestrian Safety Improvements Action Plan (HiPPS).	Engineering

Strategy 3: Increase Education and Awareness about Pedestrian Safety for All Road Users

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
(Key Tactic) **3.1:** Conduct high-profile pedestrian safety education campaigns with increased media coverage for all road users and all professionals that contribute to road safety. Include easy-to-understand information on Safe Routes to School, Walk! Bike! Fun!, Vision Zero programs, and pedestrian-related laws. Collaborate with public health agencies or programs such as the Statewide Health Improvement Program to develop equitable and effective campaigns. Pair with high-visibility enforcement to maximize efficacy.	Enforcement, Education
3.2: Engage with local and regional planning staff to build a culture of pedestrian safety within the agencies that manage roads. Coordinate and develop relationships between local agencies and advocacy groups, parent-teacher organizations, universities, chambers of commerce, and leaders from underserved communities.	Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

OLDER DRIVERS

Strategy 1: Strengthen the Reporting/Referral and Assessment of At-Risk Older Drivers

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
1.1: Expand law enforcement officers' screening of at-risk older drivers using the Driver Orientation Screen for Cognitive Impairment (DOSCI) and systematize using the officers' electronic charging system to electronically file and submit related forms.	Enforcement, Education
(Key Tactic) **1.2:** Increase awareness of and access to MN Department of Public Safety's on-line mechanism for medical staff, family members, or friends to notify Department of Public Safety Driver and Vehicle Services licensing staff of at-risk drivers for an assessment of the driver's ability to safely drive.	Enforcement, Education
1.3: Review and confirm the screening protocol and training for Driver and Vehicle Services licensing personnel to effectively identify drivers demonstrating a decline in physical or cognitive functioning.	Enforcement, Education
1.4: Examine procedures for assessing medical fitness to drive and ensure medical review practices align with Driver Fitness Medical Guidelines (National Highway Traffic Safety Administration) and the American Association of Motor Vehicle Administrators.	Enforcement, Education

Strategy 2: Strengthen Licensing Practices of At-Risk Older Drivers to Extend Driving while Enhancing Safety

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
(Key Tactic) **2.1:** Conduct a comprehensive review of licensing policies and practices for at-risk older drivers; strengthen policies and practices to reflect best practices and proven approaches such as regular interval testing of driving skills, mandatory age and more frequent in-person license renewal, and maximizing restricted licenses (e.g., geographic, time of day, high speed).	Enforcement, Education
(Legislative Action) **2.2:** Adopt a required road test for seniors and retest for license renewal as indicated by best practices review.	Enforcement, Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Strategy 3: Equip Older Drivers to Plan for and Adopt Safe Driving Practices

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
[Key Tactic] [Legislative Action] **3.1:** Require a recurrent on-line driver refresher course every 4 years, concurrent with driver's 4-year license renewal.	Education
3.2: Through an established driver refresher course or a new on-line resource, provide driver education about new infrastructure features, growing road safety issues, vehicle safety technologies, in-vehicle technology distractions, and emerging modes of transportation.	Education
3.3: Promote Department of Public Safety-approved crash prevention/defensive driving courses for drivers aged 55 or older. Promote the use of CarFit programs to promote self-awareness of safety, comfort, and mobility needs.	Education
[Key Tactic] **3.4:** Establish an on-line "one-stop" resource to guide older drivers and their families in navigating changing driving needs and available resources. Include information on driver evaluation processes and assessment of driving capabilities and limitations, skills development, locating CarFit programs, available driving courses, vehicle safety technologies, alternative safe mobility options, licensing restrictions for safe driving, and voluntarily limiting driving to reduce crash risk.	Education

Strategy 4: Use Roadway Design that Meets the Needs of Older Drivers

Safe System Approach Elements Addressed:
Safe Road Users and Safe Roads

TACTIC	LEADERSHIP
[Key Tactic] **4.1:** Use enhanced visibility measures and lighting to accommodate older drivers. Highly effective examples include retroreflective signal back plates and stop signposts, high-visibility or oversized signs, highly legible design elements, enhanced pavement markings, raised pavement markings, curve delineation, and LED stop signs/flashing beacon stop signs.	Engineering
4.2: Use geometric improvements to accommodate older drivers while not encouraging increased speeds. Highly effective examples include removing skew at intersections, increasing the widths of turn lanes and offsetting turn lanes, and using appropriate turning radii and curve radii.	Engineering
4.3: Improve and expand safe, accessible active transportation options for elderly drivers.	Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

YOUNGER DRIVERS

Strategy 1: Strengthen Younger Driver Program Planning and Coordination

Safe System Approach Elements Addressed:
Safe Road Users, Safe Speeds, and Safe Roads

TACTIC	LEADERSHIP
(Key Tactic) **1.1:** Revitalize the Teen Driver Safety Commissioner's Advisory Task force to provide oversight, partner coordination, and input to Department of Public Safety with the goal of reducing teen driver severe traffic injuries.	Enforcement, Education
1.2: Convene a National Highway Traffic Safety Administration Safety Program Assessment of the younger driver traffic safety program to identify strengths, opportunities for improvement, and resulting recommendations.	Enforcement, Education

Strategy 2: Engage Young Drivers to Improve Younger Driver Safety

Safe System Approach Elements Addressed:
Safe Road Users and Safe Speeds

TACTIC	LEADERSHIP
(Key Tactic) **2.1:** Expand the implementation of Minnesota's Impact Teen Drivers Program to engage, educate and empower teens and their influencers on the dangers of high-risk motor vehicle driver and passenger behaviors.	Enforcement, Emergency Services, Education
(Key Tactic) **2.2:** Explore partnership with the Department of Public Safety Driver and Vehicle Services, Office of Traffic Safety, and the Department of Education to incorporate youth traffic safety topics and crash data into classroom curricula and student engagement exercises.	Education

Strategy 3: Strengthen Parent/Guardian Empowerment to Engage with and Monitor Teen Drivers

Safe System Approach Elements Addressed:
Safe Road Users, Safe Speeds and Post-Crash Care

TACTIC	LEADERSHIP
(Key Tactic) **3.1:** Increase community participation in adopting the Point of Impact: Teen Driver Safety Parent Awareness Program to strengthen parents' role and engagement in their teen's safe driving development.	Enforcement, Emergency Services, Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Strategy 4: Strengthen Graduated Driver Licensing Safety Provisions for Young Drivers

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
[Key Tactic] [Legislative Action] **4.1:** Align teen driver provisional license nighttime safety provisions with nationally recommended timeframes for nighttime driving to reduce severe crash risk while gaining driving experience.	Enforcement, Education
[Key Tactic] [Legislative Action] **4.2:** Align teen driver provisional license passenger safety provisions with nationally recommended passenger allowances to reduce severe crash risk while gaining driving experience.	Enforcement, Education

Strategy 5: Publicize, Enforce, and Adjudicate Young Driver Safety Laws

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
5.1: Strengthen enforcement of and media outreach for graduated driver's licensing (which limits driving privileges while new drivers gain experience), zero-tolerance underage drinking and driving/Not a Drop Law, and primary seat belt use laws.	Enforcement, Education
[Key Tactic] **5.2:** Increase parent, law enforcement, prosecutors', and judges' understanding and adjudication of graduated driver's licensing safety provisions for younger drivers.	Enforcement, Education
5.3: Reinstitute youth-oriented driver improvement clinics to support traffic violators age 18 and under to understand and correct high-risk driving practices.	Enforcement, Education

Strategy 6: Strengthen Young and Inexperienced Driver Education and Training

Safe System Approach Elements Addressed:
Safe Road Users and Safe Speeds

TACTIC	LEADERSHIP
[Key Tactic] [Legislative Action] **6.1:** Create a robust driver education and skills training program and make it a requirement for all new drivers (including those 18 and above). Dedicate and sustain funding for the required training program to improve access for all new drivers.	Education
6.2: Strengthen the use of younger driver crash data and trends in driver education curricula and public outreach focused on younger drivers.	Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

COMMERCIAL VEHICLES

Strategy 1: Improve Enforcement for Commercial Vehicles

Safe System Approach Elements Addressed:
Safe Road Users and Safe Vehicles

TACTIC	LEADERSHIP
[Key Tactic] **1.1:** Improve enforcement of unsafe commercial vehicles and their operators and provide training for local law enforcement focused on commercial vehicles. Provide additional law enforcement at commercial vehicle inspection sites to assist with driver impairment checks.	Enforcement
1.2: Encourage more effective communication about motor vehicle enforcement between law enforcement agencies and commercial vehicle enforcement personnel.	Enforcement

Strategy 2: Plan, Design, and Maintain Roads and Rest Areas for Commercial Vehicle Safety

Safe System Approach Elements Addressed:
Safe Roads

TACTIC	LEADERSHIP
[Key Tactic] **2.1:** Design and implement roadway geometric features that reduce severe crashes involving commercial vehicles. Examples include high friction surface treatment (HFST), higher-performance barriers, rumble strips, cross slope breaks, truck climbing lanes and alternate passing lanes, and enhanced drainage.	Engineering
2.2: Address the statewide truck parking shortage by working with public and private sector partners to identify truck parking needs, provide additional parking facilities, coordinate with commercial properties to support auxiliary truck parking, and provide additional information systems to inform truck drivers of available spaces.	Engineering

Strategy 3: Increase Education on Commercial Vehicle Safety

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
[Key Tactic] **3.1:** Provide more public awareness of blind spot dangers for trucks, such as the No Zone campaign.	Education
3.2: Support education for truck drivers and mechanics about the federal Whistleblower Protection Act. Encourage reporting of companies that pressure employees to break federal commercial vehicle laws, including hours of service.	Education
3.3: Educate trucking association members on work zone safety.	Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Strategy 4: Support Safety-Related Commercial Vehicle Technology

Safe System Approach Elements Addressed:
Safe Road Users and Safe Vehicles

TACTIC	LEADERSHIP
4.1: Promote the safety benefits and opportunities of truck platooning to freight groups and provide resources for the development and approval of truck platooning plans.	Education
(Key Tactic) **4.2:** Support education regarding safety technologies in commercial vehicles and explore installing these technologies in MnDOT or state heavy vehicle fleets. Technology examples include speed limiters, on-board impairment detection, lateral side guards, and high-vision cabs.	Education
4.3: Improve freight-related data collection such as truck counts and use innovative data sources to help make data-driven safety decisions. Increase public visibility of freight data.	Engineering
4.4: Support the implementation and advancement of truck parking information management systems, work zone in-cab safety messaging, and other information systems.	Engineering

BICYCLISTS

EQUITY FOCUS AREA

Strategy 1: Improve Road Design and Maintenance for Bicyclist Safety

Safe System Approach Elements Addressed:
Safe Road Users, Safe Speeds, and Safe Roads

TACTIC	LEADERSHIP
(Key Tactic) **1.1:** Provide dedicated bicycle facilities along and across roadways that are physically separated from vehicle traffic. Highly effective examples include shared use paths, wider shoulders (rural roads), separated bike lanes, green colored pavement for bike facilities, bike boxes, and bike signal heads at intersections.	Engineering
(Key Tactic) **1.2:** On lower-volume, low-speed roads, use traffic calming measures to reduce vehicle speeds and allow for safe shared usage of the road. Highly effective examples include lane width reduction, speed humps, chicanes, marked shared lanes (sharrows), and urban landscaping.	Engineering
1.3: Provide an adequate bike network separated from vehicular traffic where there is biking demand or where land use and other conditions show potential suitability for bicycling using MnDOT's Suitability for the Pedestrian and Cycling Environment tool and similar prioritization tools. Consider Safe Routes to School infrastructure improvements in locations near schools. Require contractors to maintain pedestrian/bike routes during road construction.	Engineering
1.4: Establish policies to maintain bike facilities for all four seasons, including proper snow and ice removal. Expedite maintenance of bike lanes and side paths to deter people from riding in vehicle lanes. Incorporate maintenance considerations in the planning process. Evaluate MnDOT's current local agency maintenance agreement requirements and opportunities to assume responsibility or offer financial resources so that maintenance isn't a barrier for local agencies planning and building cycling facilities.	Engineering

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Strategy 2: Promote Policy Change that Reduces Severe Bicycle Crashes

Safe System Approach Elements Addressed:
Safe Road Users and Safe Roads

TACTIC	LEADERSHIP
2.1: Improve bicycle-related data collection to identify trends with respect to health, law, plans, and policies. Data types include bicycle ownership by geographic area, bicycle volumes, vehicle speeds, bicycle crashes and near misses, bicycle facilities, and inventory of outreach and planning efforts.	Engineering
Key Tactic **2.2:** Develop bicycle plans and Complete Streets plans at regional and local levels. Utilize the Minnesota GreenStep Cities & Tribal Nations Program, MnDOT's Active Transportation Assistance program, and Office of Sustainability and Public Health for funding, training, and technical support.	Engineering
2.3: If not already included, incorporate road speed context into design guidance so bicycle facilities are physically separated from vehicle traffic traveling at least 35 mph.	Engineering
2.4: Increase funding for bicyclist facilities at the state, regional, and local levels, including planning efforts such as bicycle plans or Complete Streets. Pair with an increase in funding for targeted bicycling safety campaigns that amplify the effectiveness of engineering.	Engineering, Education
2.5: Evaluate safety data and design needs for electric-assist bicycles and consider how those needs may differ from traditional bicycles.	Engineering

Strategy 3: Increase Education and Awareness for Drivers and Cyclists

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
Key Tactic **3.1:** Conduct high-profile bicyclist safety education campaigns with increased media coverage for all road users and all professionals that contribute to road safety. Include easy-to-understand information on Safe Routes to School, Walk! Bike! Fun!, Vision Zero programs, helmet education, and bike-related laws. Collaborate with public health agencies or programs such as the Statewide Health Improvement Program to develop equitable and effective campaigns.	Education
3.2: Engage with local and regional planning staff to build a culture of bicyclist safety within the agencies that manage roads. Coordinate and develop relationships among local agencies and advocacy groups, parent-teacher organizations, universities, chambers of commerce, and underserved communities/communities with high cycling demand.	Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

WORK ZONES

Strategy 1: Reduce Speeding Within Work Zones

Safe System Approach Elements Addressed:
Safe Road Users and Safe Roads

TACTIC	LEADERSHIP
1.1: Use appropriate enforcement and increase visible enforcement presence to reduce speeding and distracted driving in work zones, especially during peak travel periods. Develop and deploy strategies to best enforce speed limits in work zones.	Enforcement
(Key Tactic) **1.2:** Conduct a pilot project to test automated camera enforcement in work zones. Install automated/enhanced speed enforcement or camera-assisted enforcement in work zones. Following the pilot project, encourage legislative changes to allow for automated camera enforcement in work zones.	Enforcement
(Key Tactic) **1.3:** Encourage drivers to drive slower in work zones through built environment indicators. Examples include dynamic speed feedback signs, "Workers Present" speed limits in work zones during times when workers are present, and traffic calming geometric design such as lane width reduction, lane shifts, and speed humps.	Engineering

Strategy 2: Improve Work Zone Notifications and Education

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
2.1: Increase public education and training for driving in work zones. Create greater public awareness about moving over for disabled vehicles, law enforcement, maintenance vehicles, etc. (Ted Foss Law).	Education
(Key Tactic) **2.2:** Use consistent and appropriate advance warning signs and temporary transverse rumble strips to alert drivers of work zones and dynamic message signs for changing work zone conditions, travel times, and incidents within work zones.	Engineering
2.3: Establish best practices of radar-based audible and visible warning systems to warn workers of speeding vehicles. Consider installing warning systems within work zones.	Engineering
2.4: Work with phone applications to distribute work zone alerts to drivers when approaching work zones.	Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Strategy 3: Use Technologies and Innovative Work Zone Planning Techniques to Improve Work Zone Safety

Safe System Approach Elements Addressed:
Safe Road Users and Safe Roads

TACTIC	LEADERSHIP
[Key Tactic] **3.1:** Develop worker schedules to diverge from peak vehicle traffic times when possible. Examples include changing traditional work schedules based on traffic trends, avoiding lane closures when excessive queuing could occur, and using full road closures to avoid traffic conflicts and accelerate work where appropriate.	Engineering
3.2: Maintain direct and accessible pedestrian routes with alternative pedestrian routes and temporary pedestrian access routes and provide clear and direct bicycle detour routes. Protect pedestrian routes if they are detoured into the roadway.	Engineering
3.3: Implement countermeasures to limit exposure between vehicles and workers. Examples include flagger devices, temporary signals, and (portable) rumble strips to notify drivers of work zone intrusion.	Engineering

TRAINS

Strategy 1: Design At-Grade Railroad Crossings to Reduce Severe Crashes Between Trains and Road Users

Safe System Approach Elements Addressed:
Safe Road Users and Safe Roads

TACTIC	LEADERSHIP
[Key Tactic] **1.1:** Use gated protection with warning devices and trapped vehicle detection on high-speed rail sections at appropriate crossings. Include strategies which make it difficult for motorists to drive around gates, such as median islands on the approaches to rail grade crossings.	Engineering
[Key Tactic] **1.2:** Close or grade-separate unsafe or closely spaced grade crossings to vehicular traffic.	Engineering
1.3: Consider replacing stop signs at grade crossings with yield signs to reduce overuse of stop signs. If stop signs continue to be used, consider developing new guidelines for their application based on minimum roadway and train volumes and available sight distance.	Engineering
1.4: Improve crossing geometry to 1) remove skew between rails and roads to improve crossing sight distance and 2) to remove humped crossings to reduce the risk of heavy vehicles getting stuck on the crossing.	Engineering
1.5: Design crossings to improve pedestrian and bicyclist awareness and safety. Examples include ‘Another Train Coming’ warning signs, pedestrian gates, appropriate warning times for pedestrians, and additional flashing warning light masts.	Engineering

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Strategy 2: Increase Awareness of Rail Crossing Risks and Education on Rail Crossing Safety and Laws

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP
(Key Tactic) **2.1:** Conduct high-profile rail crossing safety education campaigns with increased media coverage targeted at all road users. Examples include Operation Lifesaver, See Track Think Train, campaigns regarding crossing laws, and suicide prevention initiatives.	Education
2.2: Engage freight groups to educate truck drivers about rail crossing risks and how to respond if their truck gets stuck on a rail crossing.	Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

TRAFFIC SAFETY CULTURE

Strategy 1: Improve Communication and Coordination Among Disciplines, Agencies, and the Public

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP			
1.1: Continue to share fatal and serious injury crash report details with the multi-disciplinary fatal review committee. Encourage localities without a review committee to form a multi-disciplinary group. Ensure data is accessible and searchable to the public as data privacy laws allow.	Engineering	Enforcement	Emergency Services	Education
1.2: Increase coordination and collaboration efforts among zero-fatality programs in the state, such as Toward Zero Deaths committees, regional safety programs, or Vision Zero cities.	Engineering	Enforcement	Emergency Services	Education
(Key Tactic) **1.3:** Develop a Toward Zero Deaths stakeholder and public communications/marketing plan and include consistent monthly communications and positive social norming.				Education
1.4: Build safety culture around understanding of the Safe System Approach and what it means to different stakeholders. Consider utilizing the adopted slogan of “Safety First, Safety Always” in coordination with stakeholders.				Education

Strategy 2: Invest in New and/or Updated Safety Initiatives, Outreach, Studies, and Resources

Safe System Approach Elements Addressed:
Safe Road Users

TACTIC	LEADERSHIP			
(Key Tactic) **2.1:** Restart the Traffic Safety Culture Task Force. Initial projects may include participation in the traffic safety culture pooled fund study, the work zone safety campaign (saturated positive culture campaign), and Department of Natural Resources education about ATV/UTV safety and requirements. Operationalize lessons learned from the Park Rapids pilot project to implement a statewide program.				Education
2.2: Use established tools such as Suitability for the Pedestrian and Cycling Environment, Priority Areas for Walking Study, Equitable Transportation Community Explorer, and Climate and Economic Justice Screening to identify high priority traffic safety risks facing Minnesota’s diverse and underserved populations. Utilize MnDOT’s Advancing Transportation Equity Initiative to support directed traffic safety outreach with these communities through local governmental and community partners. Investigate opportunities (such as through a National Highway Traffic Safety Administration Section 1906 grant) to expand traffic demographic information in traffic safety data collection, such as race in traffic stops and crashes.				Education
(Key Tactic) **2.3:** Use effective outreach methods for contacting diverse and underserved communities, including attending community events, continuing the Tribal Traffic Safety Summit, initiating tribal traffic safety roundtables, and using non-English speaking law enforcement officers to talk with students whose primary language isn’t English.				Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E’S)
Engineering
Enforcement
Emergency Services
Education

TACTIC	LEADERSHIP
2.4: Continue the Impact Teen Driver program to educate high schoolers who can't afford or haven't taken drivers education. Utilize appropriate marketing strategies for the program, such as social media campaigns or school district newsletters.	Education
2.5: Complete an evaluation/survey of drivers to measure traffic safety culture. Use the previous evaluation from 2015 as a baseline to measurement.	Education

EMS AND TRAUMA SYSTEMS

Strategy 1: Improve Post-Crash Care through Innovative Treatments and Technology

Safe System Approach Elements Addressed:
Post-Crash Care

TACTIC	LEADERSHIP
(Key Tactic) **1.1:** Work with the Minnesota EMS Physician's Advisory Council to examine the benefits of implementing prehospital blood administration. Consider the need to train paramedics to perform prehospital blood administration, inventory blood product locations, and coordinate with blood banks to use supply efficiently.	Emergency Services
(Key Tactic) **1.2:** Integrate emerging technology into traffic incident management, such as Automated Incident Detection, FIRST NET communications resources for first responders, Next Gen 911 digital upgrades, up-to-date radio communications, and adding rural internet such as Starlink on ambulances.	Emergency Services
1.3: Train state employees such as Freeway Incident Response Safety Team (FIRST) truck drivers on first responder-level capabilities such as control of bleeding. Utilize the Stop the Bleed program for training material.	Emergency Services

Strategy 2: Upgrade EMS Systems for Efficiency and Resilience

Safe System Approach Elements Addressed:
Post-Crash Care

TACTIC	LEADERSHIP
2.1: Apply for grant funds, such as the Preventing Roadside Death program, to support implementation of EMS improvements. Encourage collaboration between EMS and their Metropolitan Planning Organizations, cities/counties, or tribal nations to apply for funding through the Safe Streets and Roads for All grant program. Review potential solutions to funding and reimbursement challenges for EMS services.	Emergency Services
(Key Tactic) **2.2:** Expand the southwestern Minnesota rural telemedicine pilot to other rural areas to improve post-crash, pre-hospital care and provide peer-to-peer support between medics and first responders in the field and physicians, paramedics, and/or nurses in the hospital.	Emergency Services

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

TACTIC	LEADERSHIP
2.3: Support the Office of EMS in partnership with the Minnesota Department of Health statewide trauma system in analyzing data (such as over triage and under triage in the field, compliance with state law on where patients are transported) to identify areas of improvement related to post crash care. Share data and resources with the EMS community to encourage statewide improvement based on data findings.	+
2.4: Engage with the Statewide Trauma Advisory Council and Office of EMS to improve care and standards for hospital trauma systems and EMS.	+
2.5: Continue to investigate how the level of certification of the EMS provider impacts care outcomes and determine how to best support EMS professionals. Improve recruiting initiatives, specifically among young people, to address the workforce shortage. Support EMTs and paramedics as emergency medical providers.	+
2.6: Consider involvement in the EMS Compact Law which allows EMS practitioners with a valid, unrestricted EMS license in one Compact Member State to have a "Privilege to Practice" recognized in all Compact Member States.	+
2.7: Investigate the impact of alternate innovative care delivery models, including community paramedicine, as a strategy to improve overall system sustainability and operation impacts to post crash care.	+

Strategy 3: Engage First Responders and EMS Professionals in Traffic Incident Management

Safe System Approach Elements Addressed:
Post-Crash Care

TACTIC	LEADERSHIP
3.1: Conduct interagency traffic incident management training for field responders. Integrate traffic incident management training into law enforcement, fire, and EMS-based training programs. Identify and train quality instructors from a variety of disciplinary backgrounds. Provide Minnesota-specific online training opportunities.	+
3.2: Involve medical examiners, crime labs, and the Bureau of Criminal Apprehension in the Open Roads Agreement so examiners agree to make clearing the roadway a priority in the case of fatal crashes.	+
3.3: Follow safe on-scene practices such as safe vehicle positions, emergency-vehicle lighting discipline, high-visibility safety apparel, and traffic control deployment when appropriate. Assist in providing traffic control devices and high-visibility apparel to first responder agencies.	+

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

VEHICLE SAFETY ENHANCEMENTS

Strategy 1: Develop Standards and Policies to Encourage Safe Vehicle Design

Safe System Approach Elements Addressed:
Safe Road Users and Safe Vehicles

TACTIC	LEADERSHIP
1.1: Advocate and work with National Highway Traffic Safety Administration to develop standards for vehicle design that prioritize vulnerable road user safety, such as vehicle size and profile regulations. Research and develop safety policies for electric and hybrid vehicles, which can be quieter and heavier and pose unique safety risks to pedestrians and bicyclists.	Engineering
(Key Tactic) **1.2:** Encourage the implementation of vehicle safety features such as adaptive cruise control, forward-collision warning and automated emergency braking, blind spot monitoring, driver-attention monitoring, lane departure warning and lane-keeping assist, bicyclist and pedestrian detection, and intelligent speed assistance. Discourage the implementation of distracting "infotainment" systems in vehicles.	Engineering
(Key Tactic) **1.3:** Advocate the research of new crashworthiness testing standards for electric vehicles, which can be heavier and have a different weight distribution than gas vehicles.	Engineering

Strategy 2: Share Connected and Autonomous Vehicle (CAV) Knowledge Regarding Safety Benefits with Other Researchers and the Public

Safe System Approach Elements Addressed:
Safe Road Users and Safe Vehicles

TACTIC	LEADERSHIP
(Key Tactic) **2.1:** Document and publish research projects related to CAV and vehicle safety and share internally and broadly across the country. Conduct industry and academic outreach on CAV.	Education
2.2: Provide CAV education and exposure to the public through pilot demonstration programs and educational campaigns.	Education

Strategy 3: Prepare Policy and Planning Initiatives for Connected and Autonomous Vehicles to Realize their Full Safety Benefits

Safe System Approach Elements Addressed:
Safe Road Users and Safe Vehicles

TACTIC	LEADERSHIP
3.1: Assess readiness of roadway assets and geospatial data to determine future needs and gaps related to CAV technology. Develop a process for real-time, accurate work zone and incident information from 511 to be communicated with connected vehicles.	Engineering
3.2: Review planning guidelines to determine alignment with CAV technology and identify needs and gaps within these guidelines.	Engineering
(Key Tactic) **3.3:** Build future policies upon lessons learned from both MnDOT and others' research on CAV and vehicle safety. Prepare policies and programs to achieve desired CAV outcomes.	Engineering, Education

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Strategy 4: Support the Research and Development of Connected and Autonomous Vehicle (CAV) Technology, Focusing on Safety Benefits of these Technologies for All Road Users

Safe System Approach Elements Addressed:
Safe Vehicles

TACTIC	LEADERSHIP			
(Key Tactic) **4.1:** Research technology that improves safe mobility options. Continue to pilot CAV technology related to transit, freight, work zones, and CAV communication technology (C-V2X), focusing on the safety benefits of these technologies for both drivers and people traveling outside vehicles.	Engineering			
4.2: Conduct a safety review of MnDOT fleets and evaluate opportunities for technology modifications to improve vehicle safety and modify risky driver behaviors. Enhance MnDOT and state fleet equipment with technology that has confirmed safety benefits, including intelligent speed assist to limit speeding in government vehicles.	Engineering			
4.3: Participate in national efforts and pooled fund efforts to support the development of CAV technology, safety standards, and best practices.	Engineering			Education

MANAGEMENT SYSTEMS

Strategy 1: Use the Safe System Approach as the Basis for Transportation System Planning and Implementation

Safe System Approach Elements Addressed:
Safe Road Users, Safe Vehicles, Safe Speeds, Safe Roads, and Post-Crash Care

TACTIC	LEADERSHIP			
1.1: Follow guidance from the Advisory Council on Traffic Safety in advancing traffic safety legislation.	Engineering	Enforcement	Emergency Services	Education
(Key Tactic) **1.2:** Utilize the MnDOT Safe System Approach Implementation Plan. Identify performance measures and evaluate the implementation of Safe System Approach on a regular basis.	Engineering	Enforcement	Emergency Services	Education
1.3: Promote the Highway Safety Improvement Program and other funding sources for cost-effective construction projects that reduce fatalities and serious injuries on all public roads.	Engineering			
1.4: Encourage cities and counties to develop Comprehensive Safety Action Plans to leverage available Safe Streets and Roads for All federal grant funding. Provide resources to support the development of these plans and grant applications.	Engineering			

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Strategy 2: Continue to Use Methods that Already Work and Make them More Effective when Possible

Safe System Approach Elements Addressed:
Safe Road Users, Safe Vehicles, Safe Speeds, Safe Roads, and Post-Crash Care

TACTIC	LEADERSHIP			
2.1: Continue efforts to improve education and enforcement strategies. Educational campaigns paired with high visibility enforcement initiatives targeted at driver behaviors such as seat belt use, under 18 motorcycle helmet use, distracted driving, alcohol-impaired driving, speeding, and aggressive driving are proven to reduce these behaviors.		Enforcement		Education
2.2: Build demonstration roadway safety improvement projects to remain until permanent safety improvements can be funded and installed.	Engineering			
(Key Tactic) **2.3:** Find more ways to link traffic safety into existing public health efforts (such as substance prevention, driving under the influence) and provide funding. Include public health offices such as the Office of American Indian Health to address disparities and interpret trends through another lens to increase awareness of the intersection of traffic safety with public health.				Education
2.4: Encourage asset management that maintains the effectiveness of safety assets on the roadway such as lighting, signage, pavement markings, signals, and rumble strips. Inspect and maintain these assets routinely to maintain safety benefits.	Engineering			
2.5: Encourage local agencies to develop asset management databases and policies in line with the Minnesota Advisory Council on Infrastructure established in July 2024.	Engineering			
2.6: Improve legislation for traffic incident management to facilitate effective EMS response to severe crashes. Consider "Steer It/Clear It" legislation, which encourages drivers to move operational vehicles out of the travel lane post-crash. Consider improvements and statewide expansion to the Hold Harmless/Authority Removal policy, which allows public agencies to remove vehicles blocking travel without civil liability.			Emergency Services	

Strategy 3: Train Safety Professionals who are Involved with Safety Planning and Incident Response on Best Practices

Safe System Approach Elements Addressed:
Safe Roads

TACTIC	LEADERSHIP			
3.1: Continue to provide safety training at the local level through Local Road Traffic Safety and County Road Traffic Safety workshops.	Engineering			
(Key Tactic) **3.2:** Encourage the pursuit of training and development opportunities for roadway professionals involved in safety work. Examples include participation in the Toward Zero Deaths conference, Toward Zero Deaths webinar series, or Road Safety Professional 1 and 2 certifications.	Engineering			
3.3: Provide annual training to all roadway safety professionals on laws, policies, and procedures related to design speed and active transportation, particularly in urbanized areas.	Engineering			
3.4: Develop training materials for law enforcement on injury severity reporting.		Enforcement		

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

DATA MANAGEMENT

Strategy 1: Facilitate System Interoperability Between Agencies/Partners

Safe System Approach Elements Addressed:
Safe Road Users, Safe Vehicles, Safe Speeds, Safe Roads, and Post-Crash Care

TACTIC	LEADERSHIP			
(Key Tactic) **1.1:** Catalogue available data sources from county, city, and state agencies in a library and publicize this library so duplicates are not created.	Engineering	Enforcement	Emergency Services	
(Key Tactic) **1.2:** Improve the linking of data between crash, vehicle, driver, roadway, citation/adjudication, and EMS/injury surveillance through the development of the Road Safety Information Center.		Enforcement	Emergency Services	
1.3: Create consistent data sharing agreements and automated data sharing between agencies. This includes the sharing of injury severity outcomes between hospitals and reporting officers.	Engineering	Enforcement	Emergency Services	
1.4: Make data accessible and searchable to the public as data privacy laws allow.	Engineering			
1.5: Continue to use and follow the Minnesota Traffic Records Strategic Plan, especially Plan Year 2025 and future iterations.	Engineering			

Strategy 2: Improve Traffic Incident Management Data Collection and Analysis

Safe System Approach Elements Addressed:
Safe Road Users, Safe Vehicles, Safe Speeds, Safe Roads, and Post-Crash Care

TACTIC	LEADERSHIP			
2.1: Evaluate opportunities for efficient crash data reporting and aggregating with automated data fields for incident locations, incident timelines, responding agencies, recovery times, queue lengths, travel times/delays, speeds, etc. Identify limits and find solutions to improve the reporting of secondary crashes, responder involved, near-miss events, and other crash data fields of interest. Develop a brief training module for these fields if changes are made.	Engineering	Enforcement	Emergency Services	
(Key Tactic) **2.2:** Combine analytics tools such as Regional Integrated Transportation Information System with tools that aggregate incident data and crowd-sourced data (such as HERE, Waze, Streetlight) to help interpret traffic incident management outcomes.	Engineering	Enforcement	Emergency Services	

Strategy 3: Reduce Barriers to Data Sharing that will Help Proactively Address Safety while

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

Maintaining Privacy

Safe System Approach Elements Addressed:
Safe Road Users, Safe Vehicles, Safe Speeds, Safe Roads, and Post-Crash Care

TACTIC	LEADERSHIP			
(Key Tactic) **3.1:** Reduce barriers to sharing Personal Identifiable Information health data related to crash severity between the Department of Health, MnDOT, and the Department of Public Safety while still protecting personal privacy.	Engineering	Enforcement	Emergency Services	
3.2: Reduce barriers to acquiring citation, adjudication, and probation data to support enforcement. The system should include a driver tracking system that can identify potential program improvement for repeat offenders, enable citation and warning issuances to be geolocated, and identify the actions of the involved officer, prosecutor, and judge.		Enforcement		
3.3: Continue to investigate phone-handling data sources and more continuous sharing of data to support enforcement.		Enforcement		

Strategy 4: Fill known Data Gaps to Support the Effectiveness of Safety Initiatives

Safe System Approach Elements Addressed:
Safe Road Users, Safe Roads, and Post-Crash Care

TACTIC	LEADERSHIP			
(Key Tactic) **4.1:** Conduct a statewide inventory of all safety elements (roundabouts, J-Turns, high-tension cable median barrier, **pedestrian/bicycle facilities and safety devices**, etc.) to better track existing gaps and future maintenance requirements. Engage with asset management professionals to assess database improvements that would benefit roadway safety project development.	Engineering			
4.2: Conduct an inventory of safety education initiatives and effectiveness. Maintain a database of these initiatives and the resources used.				Education
4.3: Provide funding for sustained staffing for MNTrauma data management and analysis. MNTrauma data complements the traffic data management center information for prevention, response, and safety decisions.			Emergency Services	

Strategy 5: Enhance and Utilize Data through the Use of Big Data and Emerging Tools

Safe System Approach Elements Addressed:
Safe Road Users, Safe Vehicles, Safe Speeds, Safe Roads, and Post-Crash Care

TACTIC	LEADERSHIP			
(Key Tactic) **5.1:** Incorporate data analytic tools such as artificial intelligence, machine learning, and language learning models to increase the speed of data analysis and support efficient dataset integration	Engineering			
5.2: Use data science to identify locations and opportunities for new countermeasures and programs to reduce severe crashes and evaluate their effectiveness.	Engineering			

The order of the strategies and tactics does not indicate priority.

Key Tactic
Legislative Action

STAKEHOLDER LEADERSHIP (4E'S)
Engineering
Enforcement
Emergency Services
Education

APPENDIX B

CRASH TRENDS TECHNICAL REPORT

2025-2029 STRATEGIC HIGHWAY SAFETY PLAN

DEPARTMENT OF TRANSPORTATION

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INTRODUCTION

The 2025-2029 Minnesota Strategic Highway Safety Plan (SHSP) establishes Minnesota's vision and priorities for how the state will reduce traffic-related deaths and serious injuries. This Crash Trends Technical Report provides detailed information on the crash analysis methodologies and results that supported the SHSP development process and recommendations.

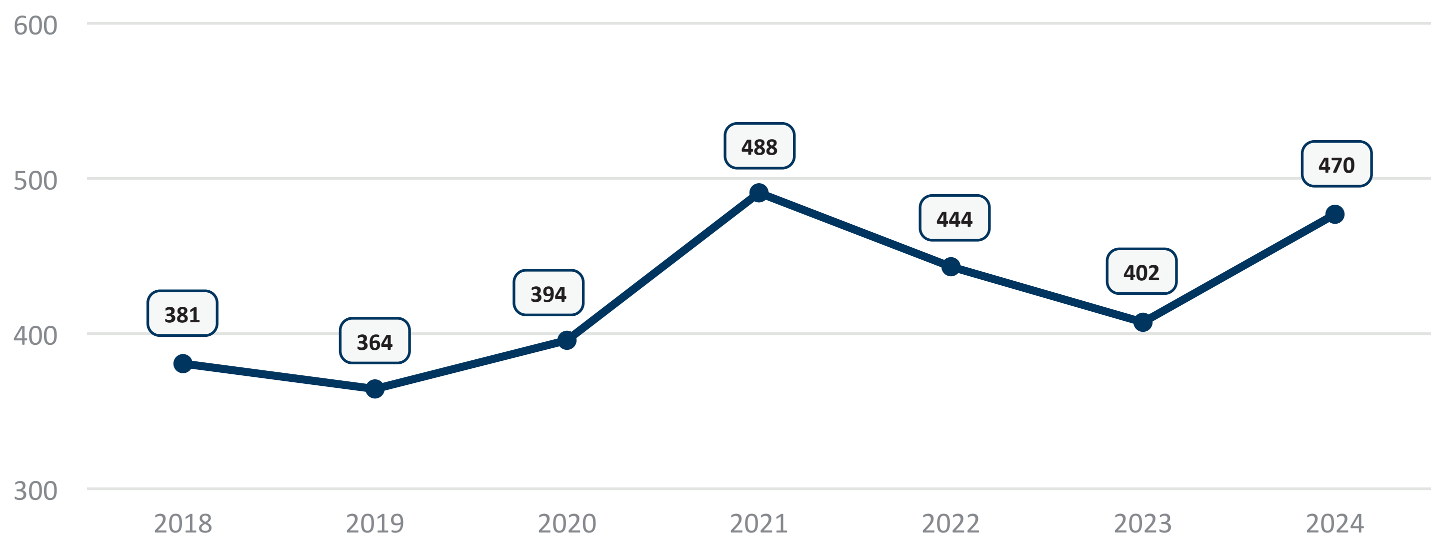
Crash records from calendar years 2018 through 2022 are a foundation of the 2025-2029 SHSP update. This data was obtained from the Department of Public Safety (DPS) MNCRASH Database. The data reflects various characteristics of a crash as recorded by the responding law enforcement officer; examples include crash severity, driver sobriety, weather conditions, and other observations. Using these characteristics, one or more contributing factors – referred to as Focus Areas – are determined and assigned to a crash. Reflective of federal guidance, only fatal and serious injury crashes are included in the SHSP analysis.

The Crash Trends Technical Report is organized in the following sections:

- Statewide Crash Summary
- Focus Area Crash Summary
- Crash Equity Analysis
- Vulnerable Road User Assessment Summary

While the 2025-2029 SHSP reflects only crashes from 2018 through 2022, Minnesota's 2023 and 2024 crash data also became available during development of the plan. For comprehensiveness, 2023 and 2024 fatal crashes are provided in addition to 2018-2022 fatal crash totals in **Figure 1**. As shown, Minnesota's most recent year of data saw a reversal of the positive trend achieved in 2022 and 2023, with preliminary 2024 totals showing 470 fatalities – a 17 percent increase from the 2023 total of 402.

Figure 1. Minnesota Traffic Deaths: 2018-2024*



**Preliminary 2024 total as of February 2025.*

STATEWIDE CRASH SUMMARY

SUMMARY TRENDS

Figure 2 shows fatal and serious injury crash trends over the 2018–2022 analysis period for all Minnesota roadways.

- Fatal crashes were relatively consistent from 2018 to 2020 followed by a 23 percent increase from 2020 to 2021. Fatal crashes decreased slightly from 2021 to 2022, with overall growth of 19 percent for the five-year period.
- Serious injury crashes decreased slightly during the first half of the analysis period but increased by 26 percent from 2020 to 2022. Over the entire five-year analysis period, serious injury crashes increased by 22 percent.

Combined, fatal and serious injury crashes increased by 22 percent over the analysis period.

Figure 2. Annual Statewide Fatal and Serious Injury Crashes (2018-2022)

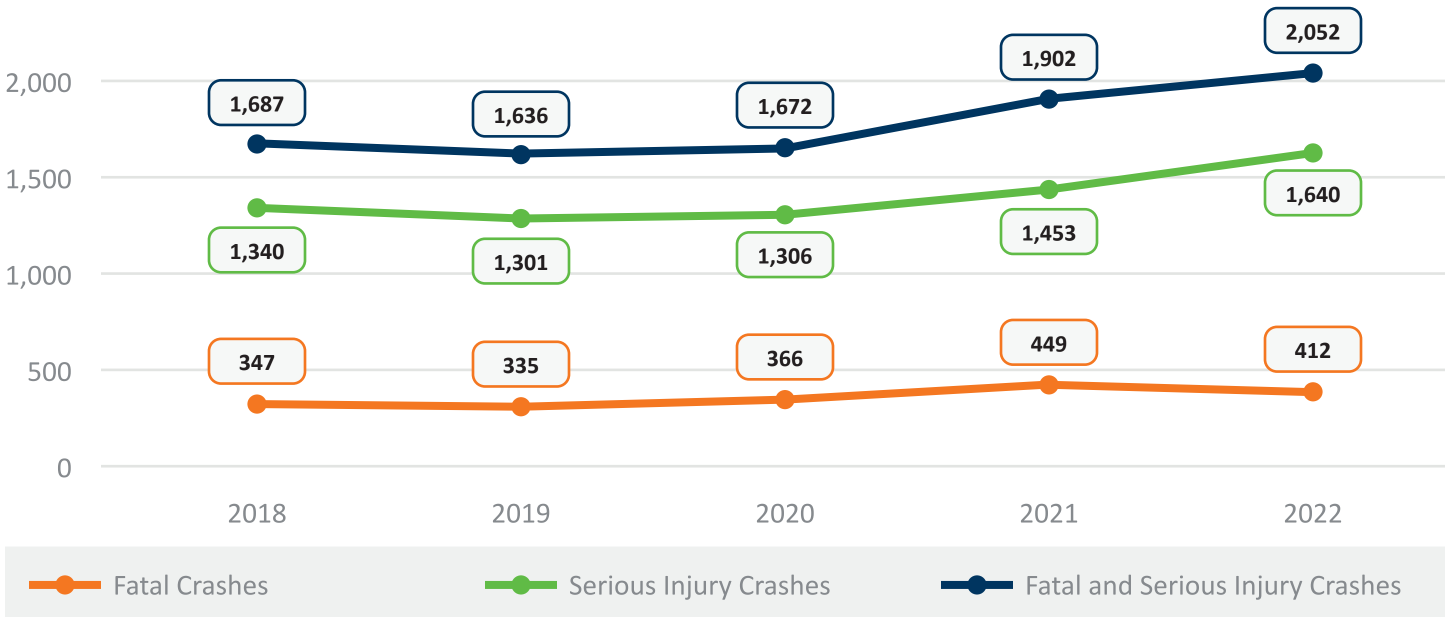


Table 1 shows the 5-year crash data in tabular form, adding percentages to show the share of total 2018–2022 crashes attributable to each year. For example, 19 percent of total crashes occurred in 2018, a share that increased to 23 percent in 2022.

Table 1. Annual Statewide Fatal and Serious Injury Crashes with Share of Total (2018-2022)

	FATAL CRASHES		SERIOUS INJURY CRASHES		FATAL AND SERIOUS INJURY (K+A) CRASHES	
YEAR	Annual Number of Fatal Crashes	Percent of Analyzed Fatal Crashes	Annual Number of Serious Injury Crashes	Percent of Analyzed Serious Injury Crashes	Annual Number of K+A Crashes	Percent of Analyzed K+A Crashes
2018	347	3.9%	1,340	15.0%	1,687	18.9%
2019	335	3.7%	1,301	14.5%	1,636	18.3%
2020	366	4.1%	1,306	14.6%	1,672	18.7%
2021	449	5.0%	1,453	16.2%	1,902	21.3%
2022	412	4.6%	1,640	18.3%	2,052	22.9%
Total	**1909**	**21.3%**	**7,040**	**78.7%**	**8,949**	**100.0%**

Figure 3, **Figure 4**, and **Table 2** show annual vehicle miles traveled (VMT) and the number of fatal and serious injury crashes per 100 million VMT over the five-year period. While VMT decreased over 15 percent from 2019 to 2020, Minnesota's fatal crashes grew by nearly 10 percent over this period and continued to increase in 2021. A similar trend is seen for serious injury crashes. This phenomenon coincides with the beginning of the COVID-19 pandemic, and is observable as increasing fatal and serious injury crash rates through the middle years of the analysis period. These elevated crash rates have persisted even as the pandemic has subsided, highlighting the need to consider what additional factors have contributed to this change.

Figure 3. Annual Vehicle Miles Traveled and Fatal Crash Rate (2018-2022)

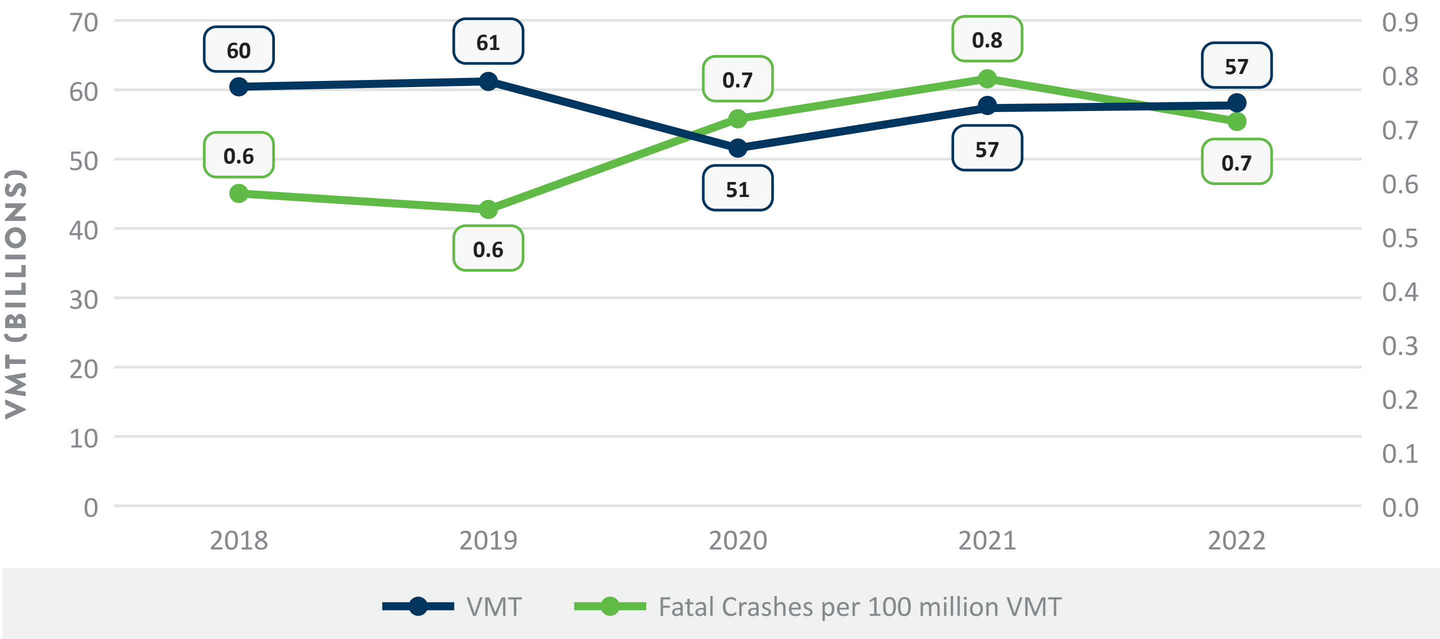


Figure 4. Annual Vehicle Miles Traveled and Serious Injury Crash Rate (2018-2022)

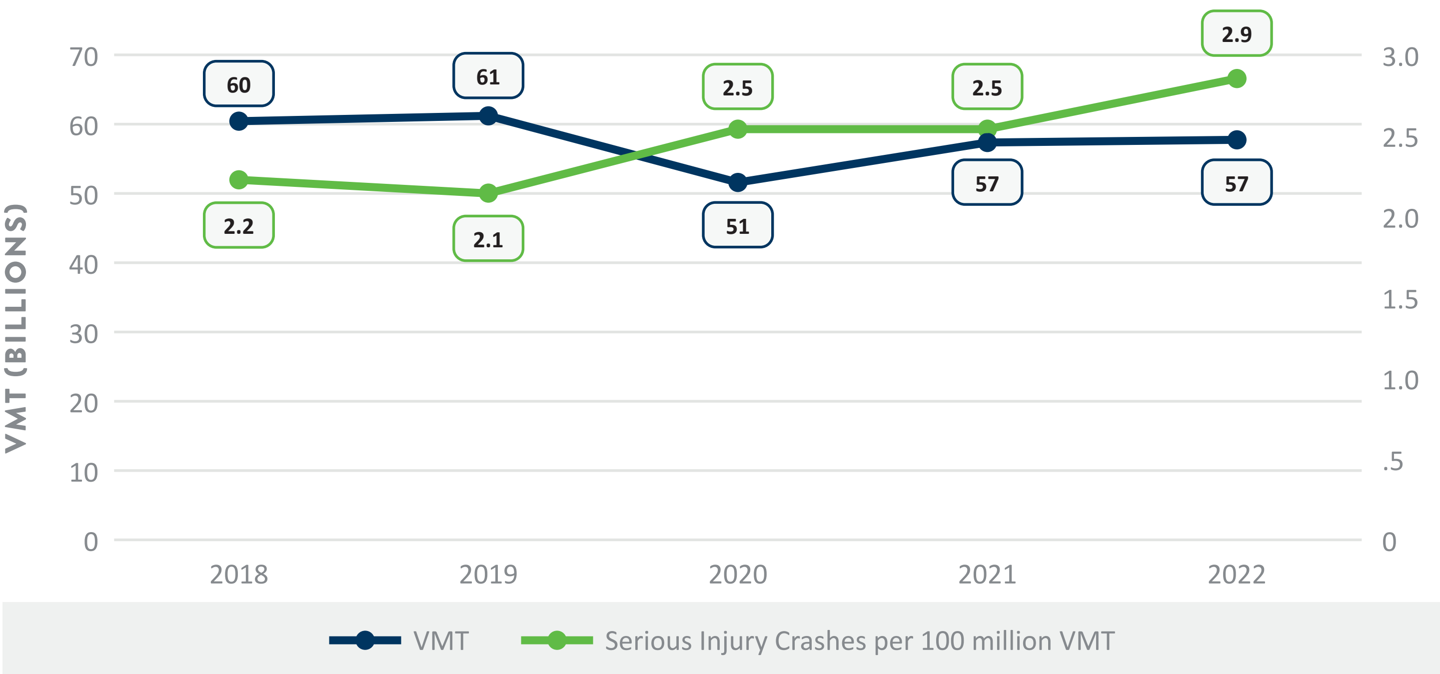


Table 2. Annual Vehicle Miles Traveled with Fatal Crash Rate and Serious Injury Crash Rate (2018-2022)

YEAR	VMT (BILLIONS)	FATAL CRASHES	SERIOUS INJURY CRASHES	FATAL CRASHES PER 100 MILLION VMT	SERIOUS INJURY CRASHES PER 100 MILLION VMT
2018	60.4	347	1,340	0.57	2.22
2019	60.7	335	1,301	0.55	2.14
2020	51.5	366	1,306	0.71	2.54
2021	57.2	449	1,453	0.79	2.54
2022	57.5	412	1,640	0.72	2.85

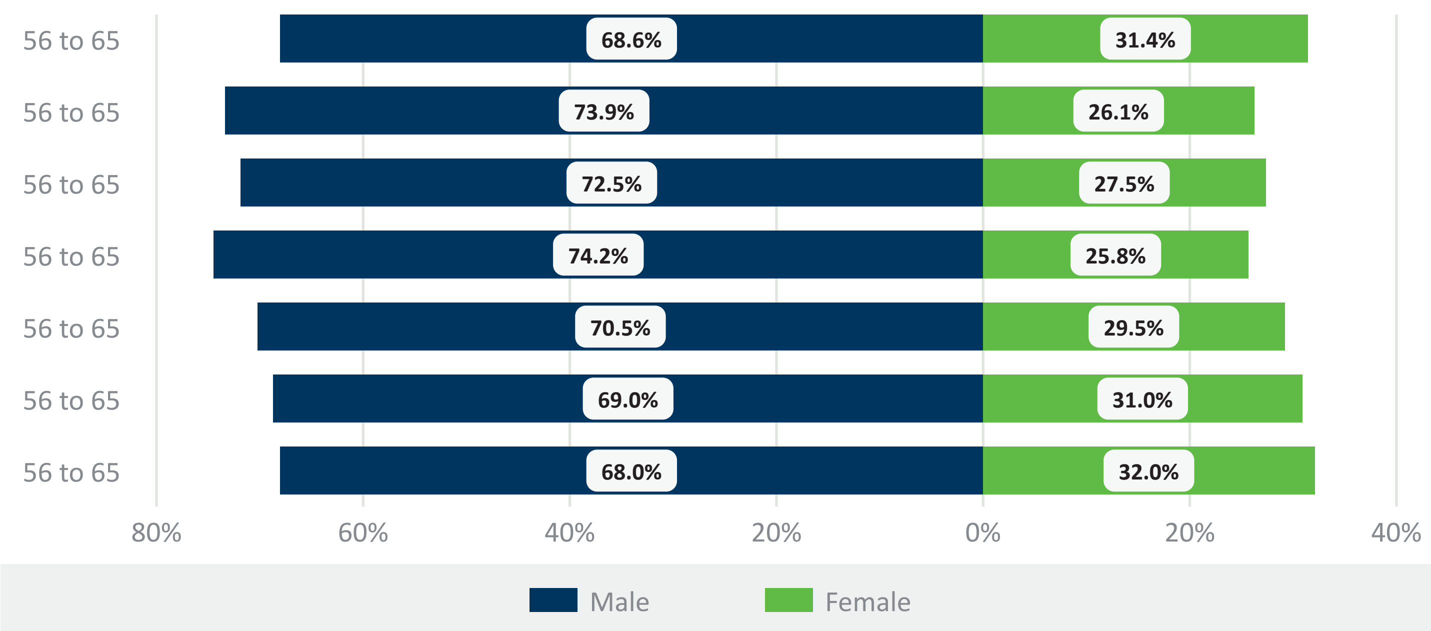
OTHER STATEWIDE TRENDS

The crash data was used to explore a variety of other statewide crash trends. Three of these are shown here: age and sex of driver, crashes by roadway jurisdiction and area type (rural vs. urban), and time of day and year.

CRASHES BY AGE AND SEX OF DRIVER

Figure 5 shows the sex of drivers involved in fatal and serious injury crashes for various age ranges over the analysis period. Data represents the driver at-fault in a crash.[1] It should be noted that 322 crash records within the dataset (about five percent) did not define a driver's sex, did not define a driver's age, or defined neither. For one serious injury crash, an age of "0" was entered. These crashes records were omitted from the age and sex analysis; percentages were computed based on the known population.

Figure 5. Age and Sex of Driver for Statewide Fatal and Serious Injury Crashes (2018-2022)



1 The driver determined to be at fault is assumed to correspond to the "Unit1" fields. As such, age and sex data for **Figure 5** and **Table 3** are sourced from fields "Unit1 Age" and "Unit1 Sex," respectively.

The age and sex of drivers involved in crashes is further examined in **Table 3**, which shows the share of total 2018–2022 crashes attributable to each age group by sex. The highest share of fatal and serious injury crashes (approximately 21 percent) is associated with the "26 to 35" age group. Overall, about 70 percent of fatal and serious injury crashes are associated with male drivers. As stated above, there were several Null values in the data for age and sex, making these percentages only approximate.

Table 3. Age and Sex of Driver for Statewide Fatal and Serious Injury Crashes with Share of Total (2018-2022)

AGE RANGE	MALE		FEMALE		ALL CRASHES	
	#	%	#	%	#	%
<21	743	8.6%	350	4.1%	1,093	12.7%
21 to 25	658	7.6%	295	3.4%	953	11.0%
26 to 35	1,276	14.8%	533	6.2%	1,809	21.0%
36 to 45	1,030	11.9%	358	4.2%	1,388	16.1%
46 to 55	873	10.1%	331	3.8%	1,204	14.0%
56 to 65	853	9.9%	302	3.5%	1,155	13.4%
>65	702	8.1%	322	3.7%	1,024	11.9%
Total	**6,135**	**71.1%**	**2,491**	**28.9%**	**8,626**	**100.0%**

CRASHES BY ROADWAY JURISDICTION AND AREA TYPE

Table 4 shows crashes by roadway jurisdiction and area type (rural or urban) over the analysis period. The rural or urban designation of crashes was assigned according to the 2020 decennial census definition of Urbanized Areas.[2] The roadway jurisdiction associated with specific crashes corresponds to the "Route System" data field. For ease of analysis, Route System data values were aggregated into the "Jurisdiction Categories" shown in **Table 4**.[3] The analysis shows nearly 40 percent of crashes to have occurred on the county road system, approximately 30 percent on MnDOT-owned roadways, and about 28 percent on city and township roadways combined.

Table 4. Roadway Jurisdiction and Area Type for Statewide Fatal and Serious Injury Crashes with Share of Total (2018-2022)

JURISDICTION CATEGORY	FATAL AND SERIOUS INJURY CRASHES					
	RURAL		URBAN		STATEWIDE	
	#	%	#	%	#	%
County Roads	2,208	24.7%	1,320	14.8%	3,528	39.4%
State Trunk Highways	1,618	18.1%	1,089	12.2%	2,707	30.2%
City Roads	214	2.4%	1,899	21.2%	2,113	23.6%
Township Roads	419	4.7%	6	0.1%	425	4.7%
Other	92	1.0%	84	0.9%	176	2.0%
Total	**4,551**	**50.9%**	**4,398**	**49.1%**	**8,949**	**100.0%**

2 U.S. Census Bureau. (n.d.). Urban and rural. Retrieved October 21, 2024, from https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural.html

3 A total of 40 values are defined for the "Route System" field within the DPS MNCRASH database. In coordination with MnDOT, Route System values were aggregated into the jurisdiction categories of "County Roads," "State Trunk Highways," "City Roads," "Township Roads," and "Other."

CRASHES BY TIME OF DAY AND TIME OF YEAR

Table 5 shows the distribution of crashes by time of day and time of year over the analysis period. As shown, the highest shares of crashes by time of day occurred between 12:00 noon and 6:00 pm. The highest shares of crashes by month occurred in June, July, and August.

Table 5. Time of Day and Time of Year for Statewide Fatal and Serious Injury Crashes with Share of Total (2018-2022)

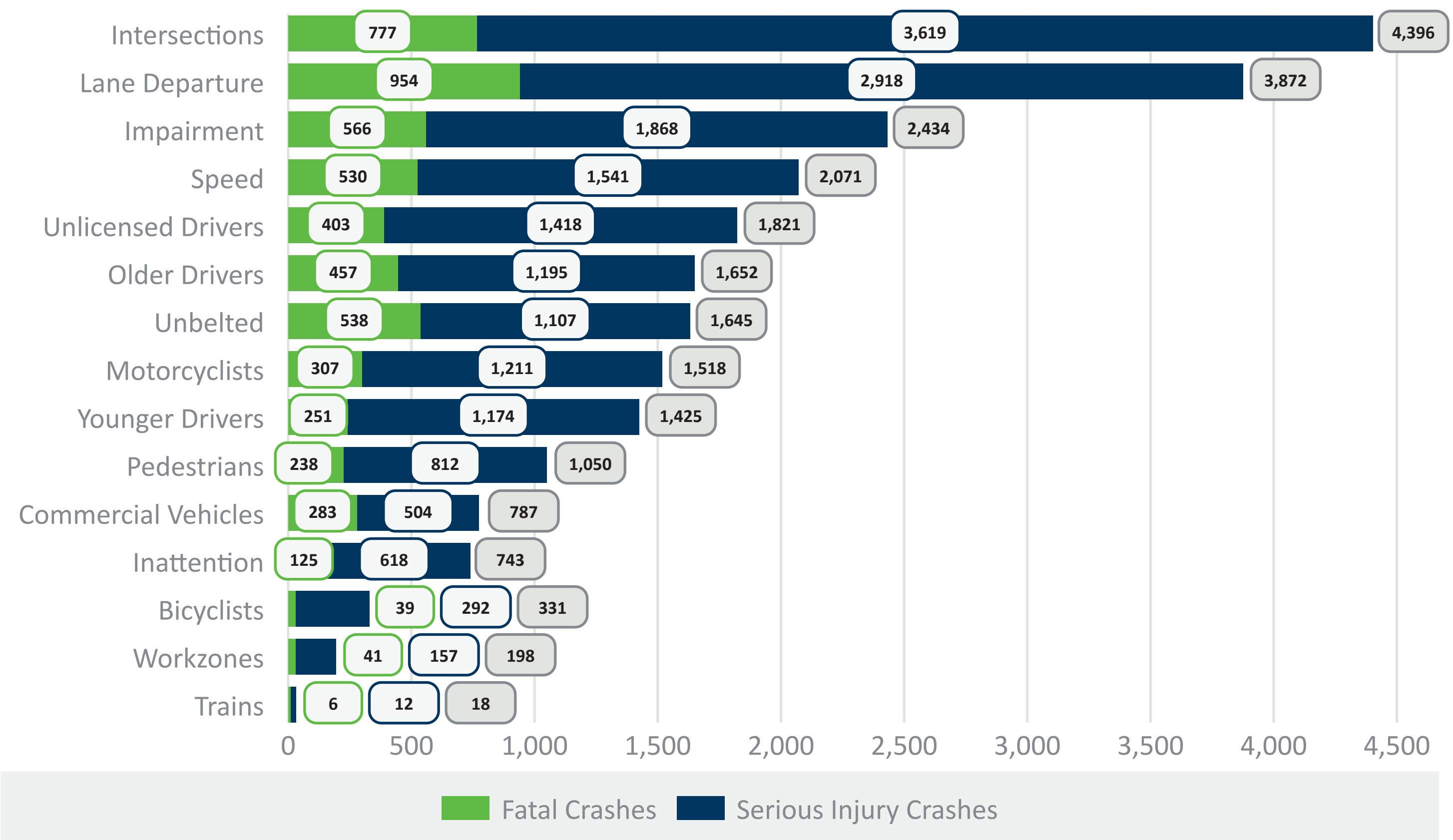
TIME	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL	
Midnight to 2:59 AM	26	39	38	43	79	69	96	92	72	73	63	45	735	8.2%
3:00 AM to 5:59 AM	22	29	29	35	49	42	45	49	41	38	33	27	439	4.9%
6:00 AM to 8:59 AM	59	59	74	46	70	56	67	86	101	117	75	75	885	9.9%
9:00 AM to 11:59 AM	71	55	59	66	75	113	114	93	91	98	77	62	974	10.9%
Noon to 2:59 PM	59	62	71	83	122	153	185	153	202	113	94	71	1,368	15.3%
3:00 PM to 5:59 PM	93	80	91	111	198	216	208	205	191	169	169	121	1,852	20.7%
6:00 PM to 8:59 PM	75	85	72	83	172	180	195	186	158	167	119	96	1,588	17.7%
9:00 PM to 11:59 PM	42	45	68	78	104	158	155	132	104	99	67	56	1,108	12.4%
Total	**447**	**454**	**502**	**545**	**869**	**987**	**1,065**	**996**	**960**	**874**	**697**	**553**	**8,949**	**100.0%**
	3.8%	**4.1%**	**6.1%**	**7.0%**	**9.4%**	**14.3%**	**14.0%**	**11.9%**	**9.4%**	**8.9%**	**6.0%**	**5.1%**		

FOCUS AREA CRASH SUMMARY

FOCUS AREA TOTALS

The DPS MNCRASH Database used for the SHSP assigns one or more Focus Areas to each crash. Focus Areas reflect the principal contributing factors for a specific crash; a given crash may have multiple contributing factors. **Figure 6** shows the number of statewide fatal and serious injury crashes by Focus Area over the analysis period, using the 15 data-driven Focus Areas.

Figure 6. Statewide Fatal and Serious Injury Crashes by Focus Area (2018-2022)



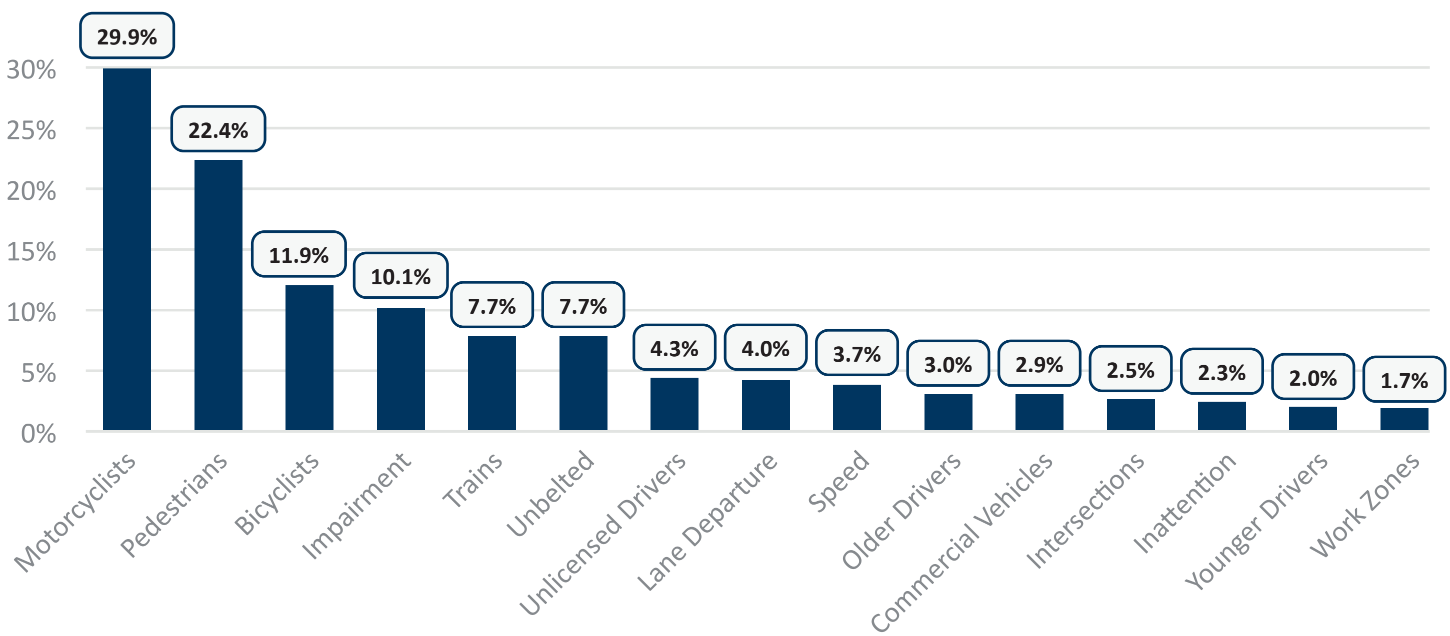
FATAL AND SERIOUS INJURY CRASH PROPORTION BY FOCUS AREA

Figure 6 shows the statewide fatal and serious injury crash proportion by Focus Area. This measure describes the share of all crashes within a particular Focus Area that are of fatal- or serious injury-type. It represents the frequency with which a specific crash type is associated with a fatality or serious injury, and is calculated as follows:

$$\frac{\text{Total Fatal and Serious Injury Crashes for a Focus Area}}{\text{Total Crashes for a Focus Area}} = \text{Fatal and Serious Injury Crash Proportion}$$

As shown in **Figure 7**, approximately 30 of motorcyclist crashes from 2018 to 2022 resulted in death or serious injury, the highest proportion of fatal and serious injury crashes across all Focus Areas. Pedestrian- and bicyclist-involved crashes had the second and third highest fatal and serious injury crash proportions. Crashes associated with impaired driving had the fourth highest fatal and serious injury crash proportion, though this may be even higher given the challenges of accurately determining the presence of alcohol and other drugs at a crash scene.

Figure 7. Statewide Fatal and Serious Injury Crash Proportion by Focus Area (2018-2022)



FOCUS AREA TRENDS

Figure 8 through **Figure 12** show annual statewide crash trends by Focus Area, in five groupings. Within each grouping, fatal and serious injury crashes for each Focus Area are shown as a percentage of fatal and serious injury crashes statewide. Because a crash may involve more than one focus area, the percentages for a calendar year do not add up to 100 percent. The figures show logical groupings of Focus Areas within the categories of Behaviors, Drivers, Modes, Engineering, and Complex Environments.

Figure 8. Annual Statewide Fatal and Serious Injury Crash Prevalence by Focus Area – Behaviors (2018-2022)

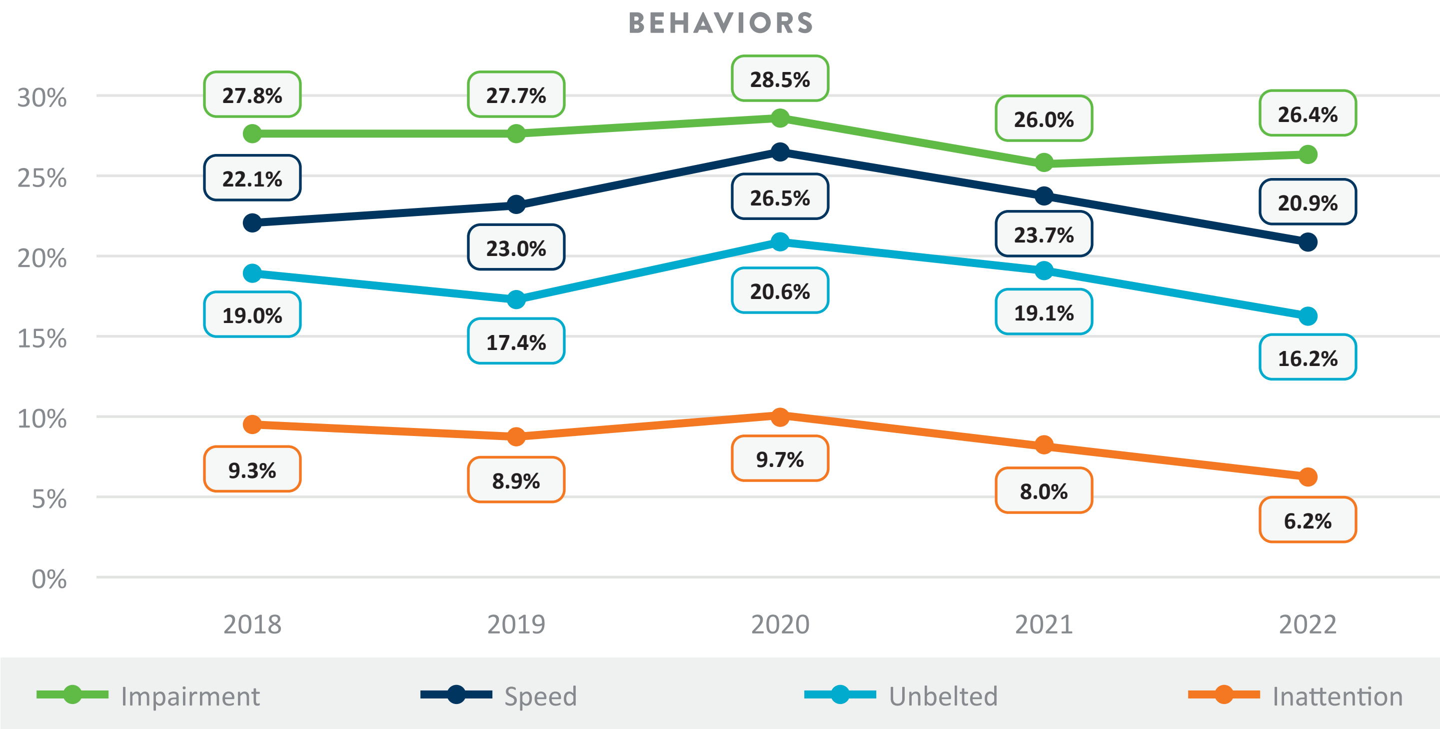


Figure 9. Annual Statewide Fatal and Serious Injury Crash Prevalence by Focus Area – Drivers (2018-2022)

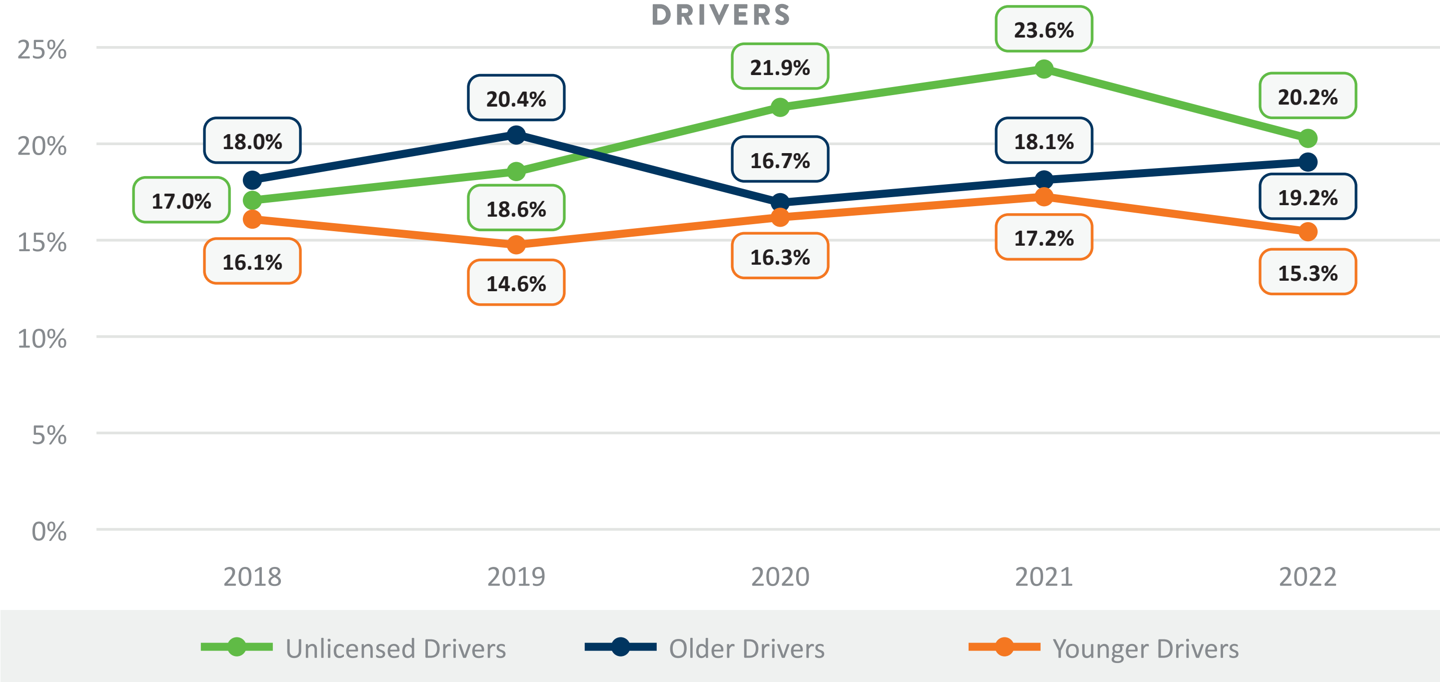


Figure 10. Annual Statewide Fatal and Serious Injury Crash Prevalence by Focus Area – Modes (2018-2022)

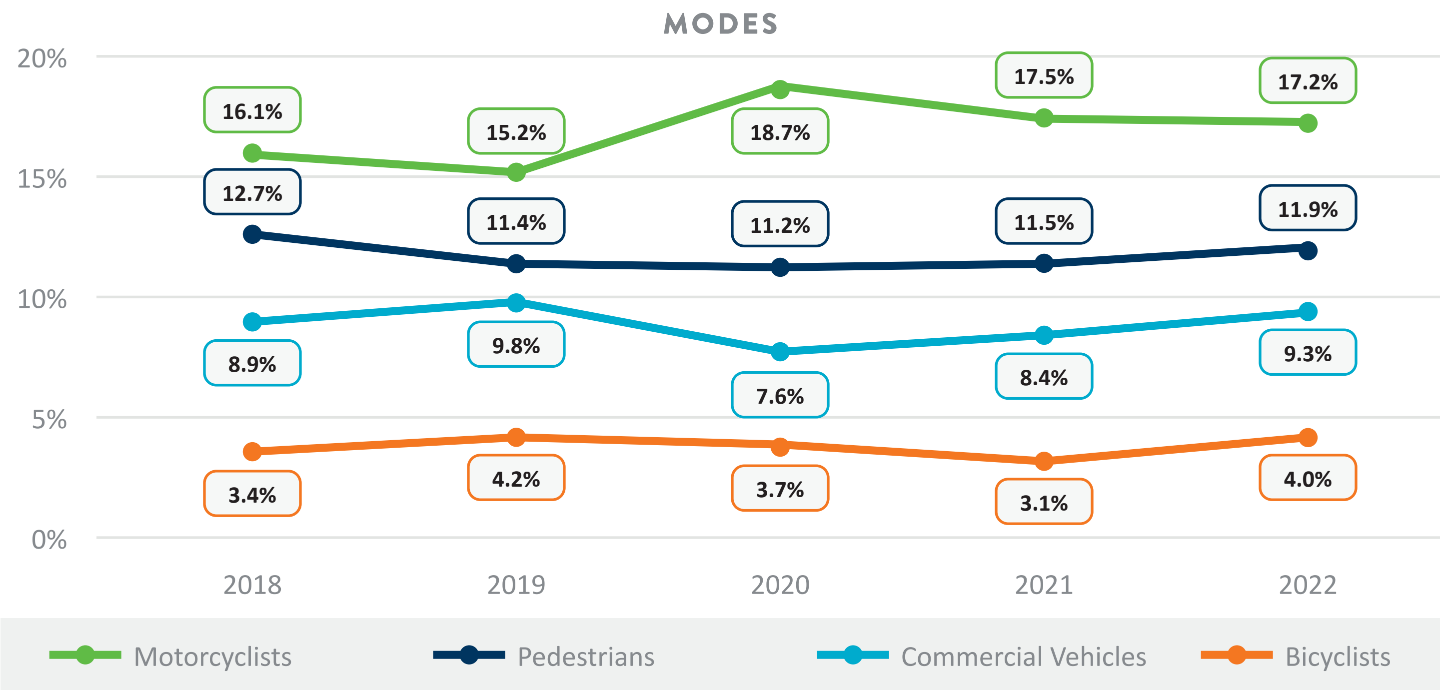


Figure 11. Annual Statewide Fatal and Serious Injury Crash Prevalence by Focus Area – Engineering (2018-2022)

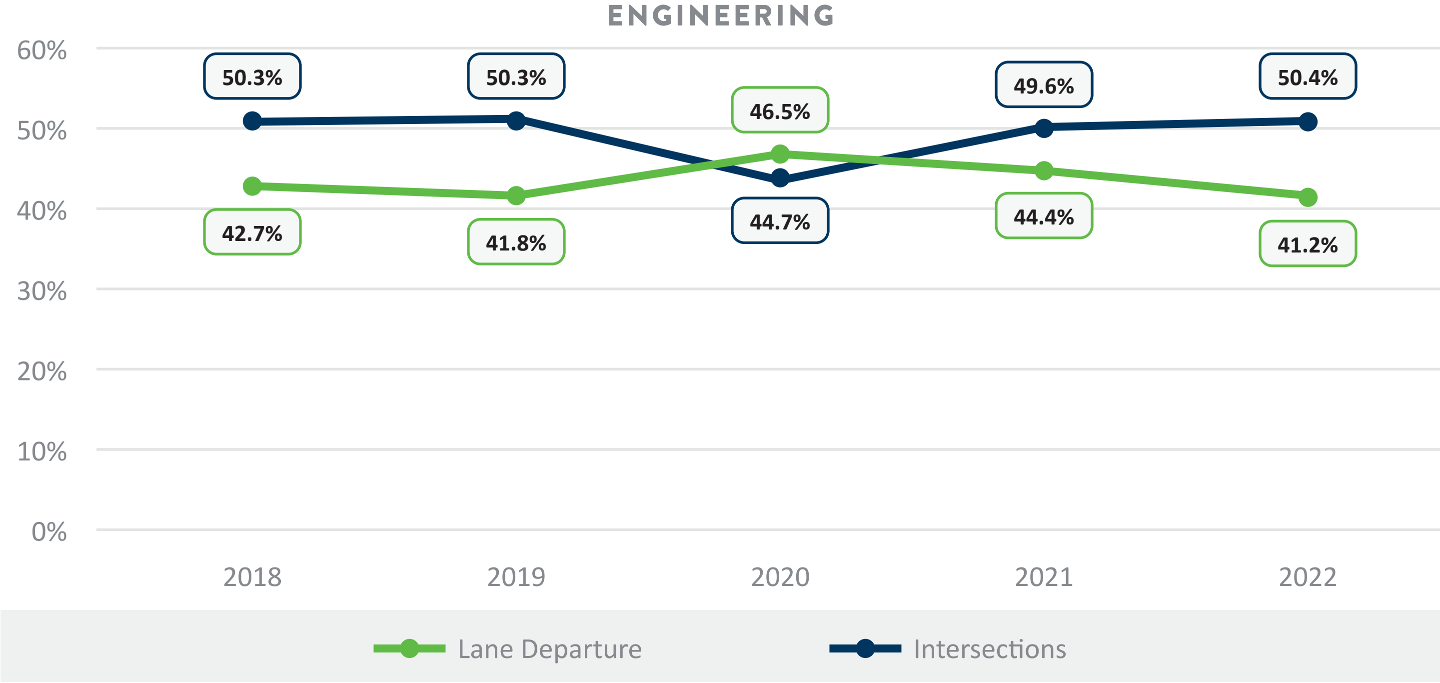
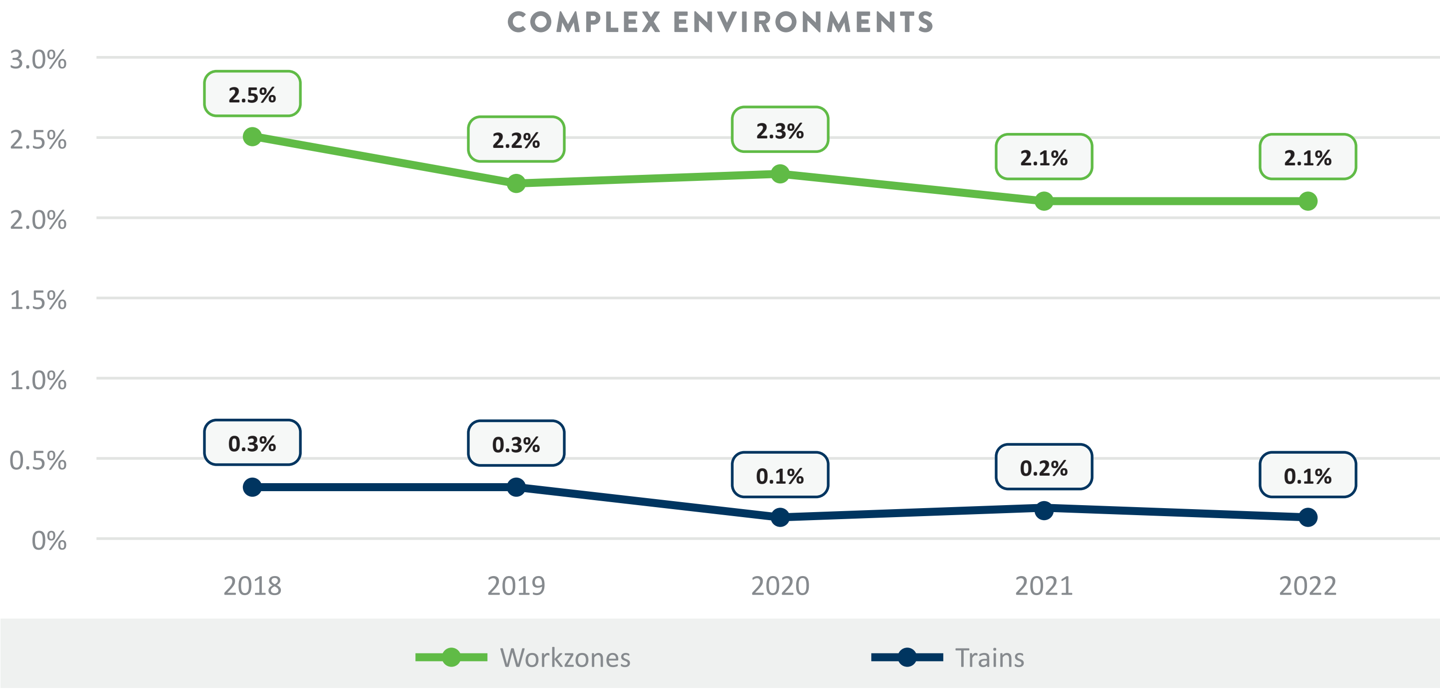


Figure 12. Annual Statewide Fatal and Serious Injury Crash Prevalence by Focus Area – Complex Environments (2018-2022)



FOCUS AREA CLUSTERS

A Focus Area cluster analysis was completed to examine the frequency with which a given contributing factor occurs with other contributing factors. To do this, crashes for each Focus Area were analyzed relative to the number of other Focus Areas they were associated with. **Table 6** provides a summary of the analysis findings. Understanding these associations may provide insight into the development of safety strategies and tactics; specifically, opportunities to develop a strategy or tactic for one focus area that crosses over with other connected focus areas.

As a primary metric, the number and share of crashes with three or more associations (including the base Focus Area) were calculated for each Focus Area – in **Table 6**, these are shown in the fourth and fifth columns from the left. The Speed Focus Area had the largest share of crashes with three or more associations (86 percent). The Unlicensed Drivers and Unbelted focus areas had the second and third largest shares of crashes with three or more associations, having about 85 percent of crashes each.

As a second metric, the analysis looked at the most frequent associations by Focus Area (the three rightmost columns). For each Focus Area, this identified the top three other Focus Areas associated with that Focus Area, and provided the percent of base Focus Area crashes associated with these top three. For example, 100 percent of Train Focus Area fatal and serious injury crashes were also associated with Intersections. As an example focusing on vulnerable road users, 75 percent of Bicyclist crashes were also associated with Intersections, while 17 percent were also associated with Older Drivers. For Pedestrian crashes, 54 percent were also associated with Intersections, while 24 percent were also associated with Impairment.

Table 6. Focus Area Cluster Analysis Summary (2018-2022)

FOCUS AREA (FA)	TOTAL CRASHES ASSOCIATED WITH FA	CRASHES ASSOCIATED ONLY WITH FA	# CRASHES WITH 3 OR MORE ASSOCIATIONS INCLUDING FA	% CRASHES WITH 3 OR MORE ASSOCIATIONS INCLUDING FA	1st Most Frequent Association (% FA Crashes Associated)	2nd Most Frequent Association (% FA Crashes Associated)	3rd Most Frequent Association (% FA Crashes Associated)
Speed	2071	25	1784	86.1%	Lane Departure (59.6%)	Impairment (43.1%)	Intersections (38.2%)
Unlicensed Drivers	1821	26	1544	84.8%	Lane Departure (48.9%)	Intersections (47.4%)	Impairment (40.5%)
Unbelted	1645	22	1390	84.5%	Lane Departure (62.0%)	Intersections (41.3%)	Impairment (37.9%)
Work Zones	198	3	165	83.3%	Intersections (38.9%)	Commercial Vehicles (25.8%)	Lane Departure (25.3%)
Impairment	2434	37	1961	80.6%	Lane Departure (59.8%)	Intersections (37.8%)	Speed (36.6%)
Inattention	743	22	589	79.3%	Intersections (52.2%)	Lane Departure (37.3%)	Speed (24.6%)
Younger Drivers	1425	33	1091	76.6%	Intersections (54.3%)	Lane Departure (42.7%)	Speed (30.0%)
Commercial Vehicles	787	22	567	72.0%	Intersections (51.5%)	Lane Departure (28.6%)	Older Drivers (27.4%)
Older Drivers	1652	54	1131	68.5%	Intersections (60.1%)	Lane Departure (33.4%)	Unbelted (15.5%)
Lane Departure	3872	281	2629	67.9%	Impairment (37.6%)	Speed (31.9%)	Intersections (30.1%)
Trains	18	0	12	66.7%	Intersections (100.0%)	Unbelted (27.8%)	Impairment (22.2%)
Intersections	4396	297	2689	61.2%	Lane Departure (26.5%)	Older Drivers (22.6%)	Impairment (20.9%)
Motorcyclists	1518	212	896	59.0%	Intersections (43.4%)	Lane Departure (37.1%)	Speed (22.8%)
Bicyclists	331	44	135	40.8%	Intersections (74.6%)	Older Drivers (16.6%)	Impairment (13.3%)
Pedestrians	1050	173	417	39.7%	Intersections (54.2%)	Impairment (24.1%)	Unlicensed Drivers (14.6%)

CRASH EQUITY ANALYSIS

INTRODUCTION

While traffic safety affects all people, certain communities are disproportionately impacted by transportation related injuries and fatalities. For the 2025-2029 SHSP, an analysis was conducted to explore which crash Focus Areas are most prevalent within Minnesota's vulnerable communities. Results of this analysis served as inputs and considerations for identifying stakeholders for engagement, prioritizing crash Focus Areas, and developing equity-focused strategies.

The analysis methodology and results are described below.

METHODOLOGY

The Equity Score is a novel crash equity analysis approach developed for the 2025-2029 SHSP update. The Equity Score is a nine-factor composite index derived from MnDOT's SPACE[4] dataset.

The Equity Score was developed using the following steps:

1. MnDOT provided the most recent SPACE dataset in the form of a Shapefile
   - The Shapefile included all core SPACE data:
     - Half-mile diameter hexagon analysis units placed across the state
     - Raw demographic data for each of the 19 SPACE criteria, aggregated to each analysis unit
     - Assignment of 1 or 0 points for each of the 19 SPACE criteria based on MnDOT-established demographic data thresholds, aggregated to each analysis unit
     - SPACE score out of 100 for each analysis unit, calculated using the following formula:

$$\text{Space Score} = 100 \times \frac{1}{19} \times \Sigma \text{ points}$$

2. From the original 19 SPACE criteria, nine equity-focused criteria were selected. The selected criteria represent common indicators of social vulnerability, and were used later in the analysis to assess the extent to which specific crash types affect disadvantaged communities. As with SPACE, the analysis assigned either 1 or 0 points for each of the 9 criteria based on demographic data thresholds. The selected criteria include:

CRITERIA	DATA THRESHOLD DEFINITION
Younger Residents	Population age 5-17 exceeds statewide average
Older Residents	Population age 65+ exceeds statewide average
Nativity	Population non-citizen, foreign born exceeds statewide average
Native American Residents	Population Native American Indian exceeds statewide average
Disability Status	Population with a disability exceeds statewide average
Environmental Justice	MPCA Area of Environmental Concern
Unemployment	Unemployment rate exceeds statewide average
Poverty	Poverty rate exceeds 25%
Household Vehicle Access	Percent of households with access to 0 vehicles is greater than 0%

4 https://mndotspace.mn.gov/

- For each SPACE analysis unit, an Equity Score was calculated using the following formula:

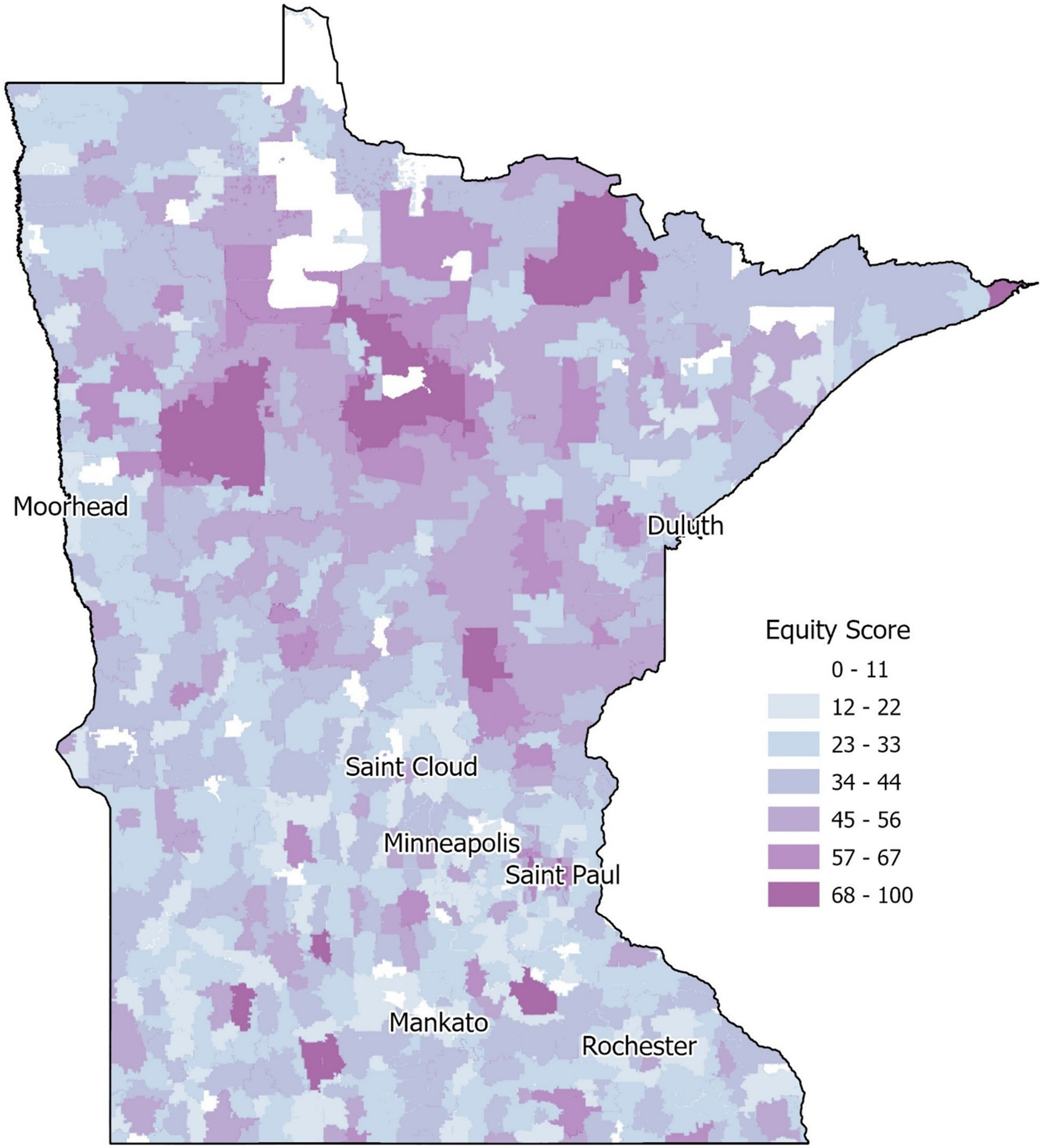
$$\text{Equity Score} = 100 \times \frac{1}{9} \times \Sigma \text{ points}$$

  - **Note:** In general, the criteria used the same demographic data thresholds from the original SPACE dataset to assign 1 or 0 points. The one exception is the Poverty criteria, which (in the SPACE dataset) does not assign a point when an analysis unit is within a rural area. To remove the urban bias, the Poverty criteria was modified as follows:
    - In the SPACE dataset, the Poverty criteria is calculated using the SQL expression "URBAN ≠ RURAL and POV_ALL > 25.0"
    - So that both urban and rural areas were assessed, this expression was updated to the following: "POV_ALL > 25.0"
    - The updated expression assigns a "1" to analysis units with percent of total population in poverty > 25 percent
- Once Equity Scores were calculated for each analysis unit using the methodology described, Minnesota's equity context was visualized (**Figure 13**). Here, a higher Equity Score signifies a higher degree of social vulnerability, specific to the level of one analysis unit (half-mile diameter hexagon).

The equity scores show concentrations of higher social vulnerability distributed across Minnesota. Larger concentrations can be seen in and around Native American reservations and communities, with notable examples being the Boise Forte Reservation, Leech Lake Reservation, and White Earth Reservation. Additional pockets of higher social vulnerability are visible within both urban areas and rural communities throughout the state.

3. An Equity Score was assigned to each of the 2018-2022 fatal and serious injury crashes. This was done by conducting a GIS spatial join between the 2018-2022 crash data and the Equity Score dataset.
   - **Note:**
     - Of the 349,565 crash point features in the original Shapefile provided by MnDOT, only 341,446 had coordinates (8,119 lacked coordinates).
     - The crash point features without coordinates included 1 fatal (out of 1,908 fatal) and 8 serious injury (out of 7,032 serious injury).
     - To rectify the missing coordinates for the 1 fatal and 8 serious injury crashes, it was decided with MnDOT that coordinates would be assigned based on the centroid of the city where the crashes occurred.

Figure 13. Equity Score



4. Once the spatial join was complete, the average Equity Score by Focus Area was calculated
    - The crash data was filtered to include only fatal and serious injury crashes (8,949 total)
    - Crashes were organized by Focus Area, and the average Equity Score for fatal and serious injury crashes within each Focus Area was calculated
5. The average equity scores by Focus Area were normalized
    - Normalization was completed using the following base formula:

$$\frac{\text{Average Equity Score} - \text{Minimum Average Equity Score}}{\text{Range of Average Equity Scores}} = \text{Normalized Average Equity Score}$$

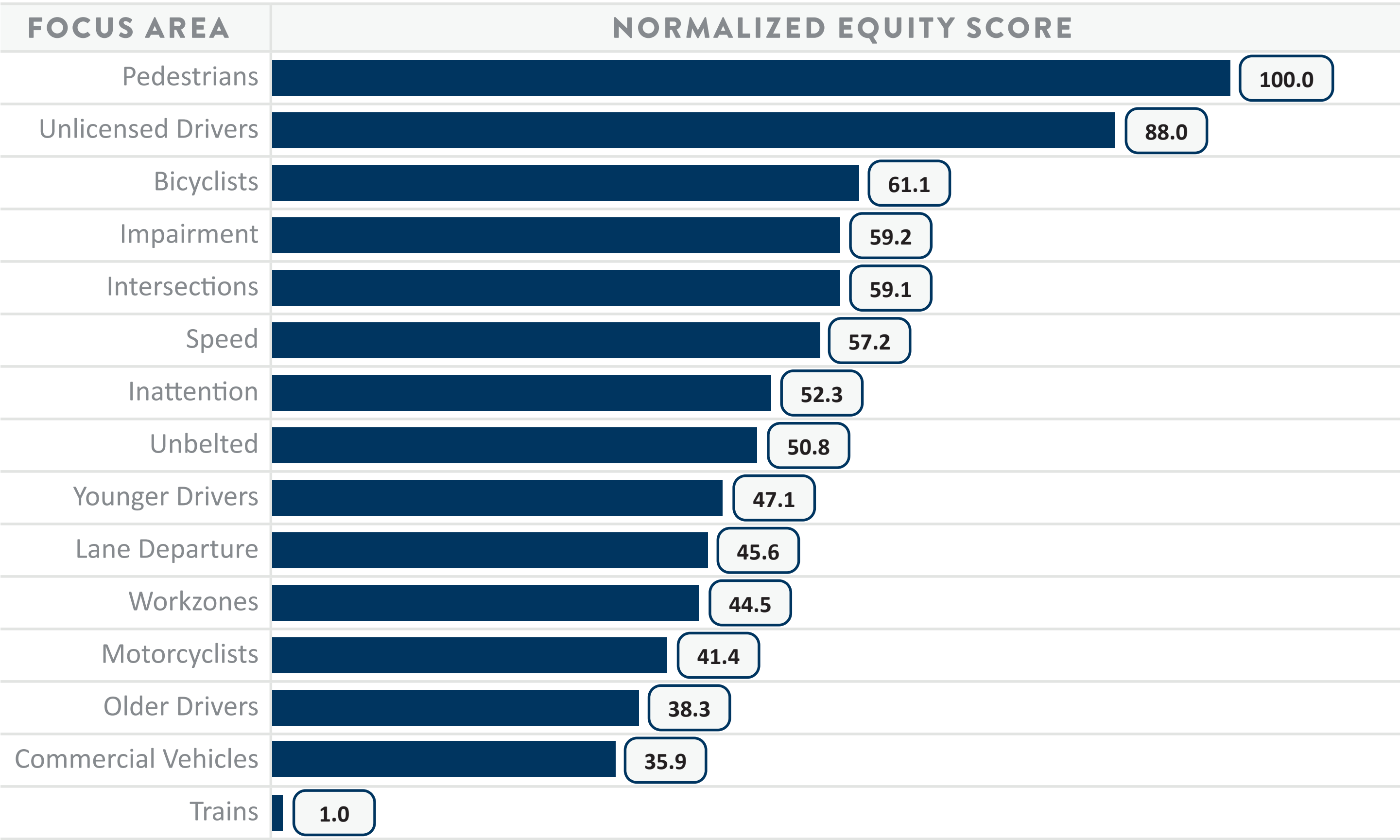
    - For ease of interpretation, the base normalization formula was modified so that the minimum value would be 1. The modified normalization formula is as follows:

$$\frac{\text{Average Equity Score} - \text{Minimum Average Equity Score}}{\text{Range of Average Equity Scores}} = \text{Normalized Average Equity Score} \times 99 + 1$$

    - The normalized average equity scores by Focus Area are shown in **Figure 14**

A Focus Area's average Equity Score communicates the degree to which crashes with that contributing factor are associated with the locations of vulnerable communities. When a Focus Area has a higher average Equity Score, its associated crashes have more often occurred where vulnerable residents live. As shown in **Figure 14**, the transportation system's most vulnerable user groups – pedestrians and bicyclists – are the highest and third-highest Focus Areas, respectively, by average Equity Score. Unlicensed Drivers is the second Focus Area by average Equity Score, highlighting the relationship between licensing, severe crash outcomes, and factors of vulnerability (nativity, English proficiency, poverty, etc.).

Figure 14. Normalized Average Equity Score by Focus Area



VULNERABLE ROAD USER ASSESSMENT SUMMARY

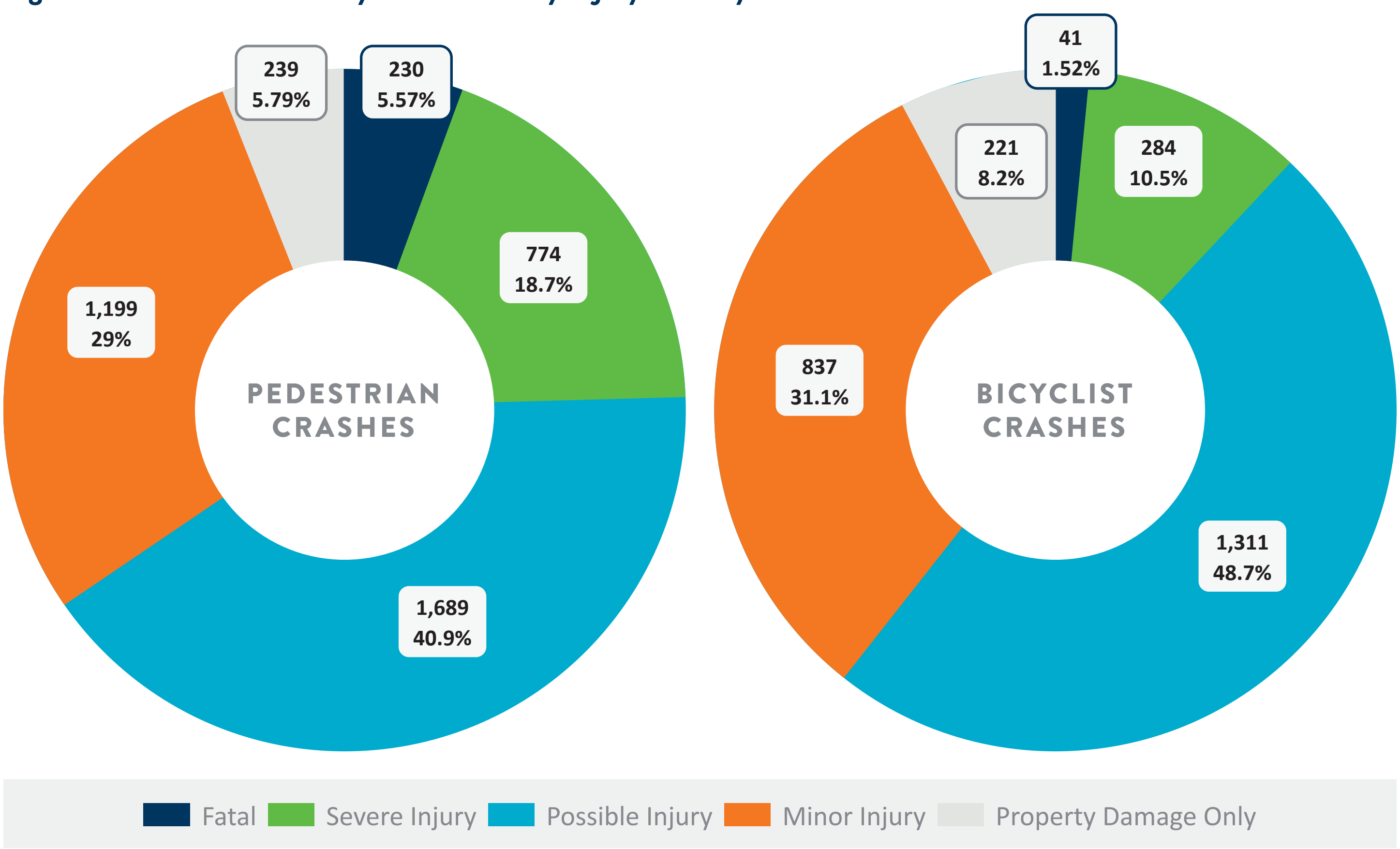
The Bipartisan Infrastructure Law (BIL), passed in 2021, created a new requirement for state departments of transportation to conduct a Vulnerable Road User Safety Assessment (VRUSA) every five years. This assessment uses a data-driven process to identify high-risk areas and incorporate equity and demographics into the analysis. MnDOT completed its initial VRUSA in November 2023. For the 2025-2029 SHSP update, MnDOT updated the VRUSA to reflect the new 2018-2022 five-year analysis period.

Key findings from the updated analysis are highlighted below. The full VRUSA analysis in included in **Appendix D: Vulnerable User Safety Assessment Update**. Because of differences in methodology between the VRUSA and other 2025-2029 SHSP crash analysis, findings may vary slightly between the two.

INJURY SEVERITY

- **Bicyclists:** There were 2,694 reported bicycle crashes during 2018–2022. Roughly 12% of those crashes were reported to be fatal or result in a serious injury.
- **Pedestrians (Including Other Non-Bicyclist VRUs):** During the same period, there were 4,131 reported pedestrian and other VRU crashes, with 24% resulting in a fatal or serious injury, twice the percentage of fatal and serious injury crashes than bicyclist crashes.

Figure 15. Pedestrian and Bicyclist Crashes by Injury Severity (2018-2022)



TIME OF YEAR

- **Bicyclists:** In general, there were more bicycle crashes during warmer months (June through September). There are not clear peaks in the proportion of crashes resulting in a fatal or serious injury outcome across months (**Table 7**).
- **Pedestrians (Including Other Non-Bicyclist VRUs):** The distribution of crashes is not as heavily concentrated during summer months for pedestrians as it is for bicyclist crashes, instead appearing slightly more concentrated in the early fall. The proportion of crashes resulting in a fatal or serious injury outcome was slightly higher during winter and spring months compared to fall and summer months (**Table 8**).

Table 7. Crashes by Month, Bicyclists (2018-2022)

MONTH	TOTAL CRASHES	% OF TOTAL CRASHES	# OF FATAL & SERIOUS INJURY CRASHES	% OF FATAL & SERIOUS INJURY CRASHES	% CRASHES RESULTING IN FATALITY OR SERIOUS INJURY
January	43	1.6%	5	1.5%	11.6%
February	18	0.7%	1	0.3%	5.6%
March	69	2.6%	11	3.4%	15.9%
April	113	4.2%	13	4.0%	11.5%
May	264	9.8%	28	8.6%	10.6%
June	443	16.4%	59	18.2%	13.3%
July	435	16.1%	54	16.6%	12.4%
August	496	18.4%	51	15.7%	10.3%
September	411	15.3%	48	14.8%	11.7%
October	269	10.0%	41	12.6%	15.2%
November	100	3.7%	12	3.7%	12.0%
December	33	1.2%	2	0.6%	6.1%
Bike Total	**2,694**	**100.0%**	**325**	**100.0%**	**12.1%**

Table 8. Crashes by Month, Pedestrians and Other VRUs (2018-2022)

MONTH	TOTAL CRASHES	% OF TOTAL CRASHES	# OF KA CRASHES	% OF KA CRASHES	% CRASHES RESULTING IN KA
January	283	6.9%	61	6.1%	21.6%
February	271	6.6%	75	7.5%	27.7%
March	279	6.8%	73	7.3%	26.2%
April	229	5.5%	63	6.3%	27.5%
May	327	7.9%	76	7.6%	23.2%
June	334	8.1%	89	8.9%	26.6%
July	394	9.5%	91	9.1%	23.1%
August	371	9.0%	78	7.8%	21.0%
September	467	11.3%	95	9.5%	20.3%
October	449	10.9%	109	10.9%	24.3%
November	379	9.2%	103	10.3%	27.2%
December	348	8.4%	91	9.1%	26.1%
Pedestrian or Other VRU Total	**4,131**	**100.0%**	**1,004**	**100.0%**	**24.3%**

AGE

- **Bicyclists:** When comparing the distribution of those involved in crashes by age to the state's population, younger bicyclists are much more likely to be involved in a crash and a fatal or serious injury crash compared to older populations. Bicyclists aged 10-19 were the most overrepresented in crashes, and bicyclists aged 15-19 were the most overrepresented in fatal and serious injury crashes (**Figure 16**).
- **Pedestrians (Including Other Non-Bicyclist VRUs):** Pedestrians aged 15 through 34 represent the group most frequently involved in a crash. Pedestrians aged between 15-29 and 55-59 were the most overrepresented, and fatal/serious injury victims and pedestrians under 15 years of age were the most underrepresented (**Figure 17**).

Figure 16. Bicyclists and Drivers ("Parties") by Age (2018-2022)

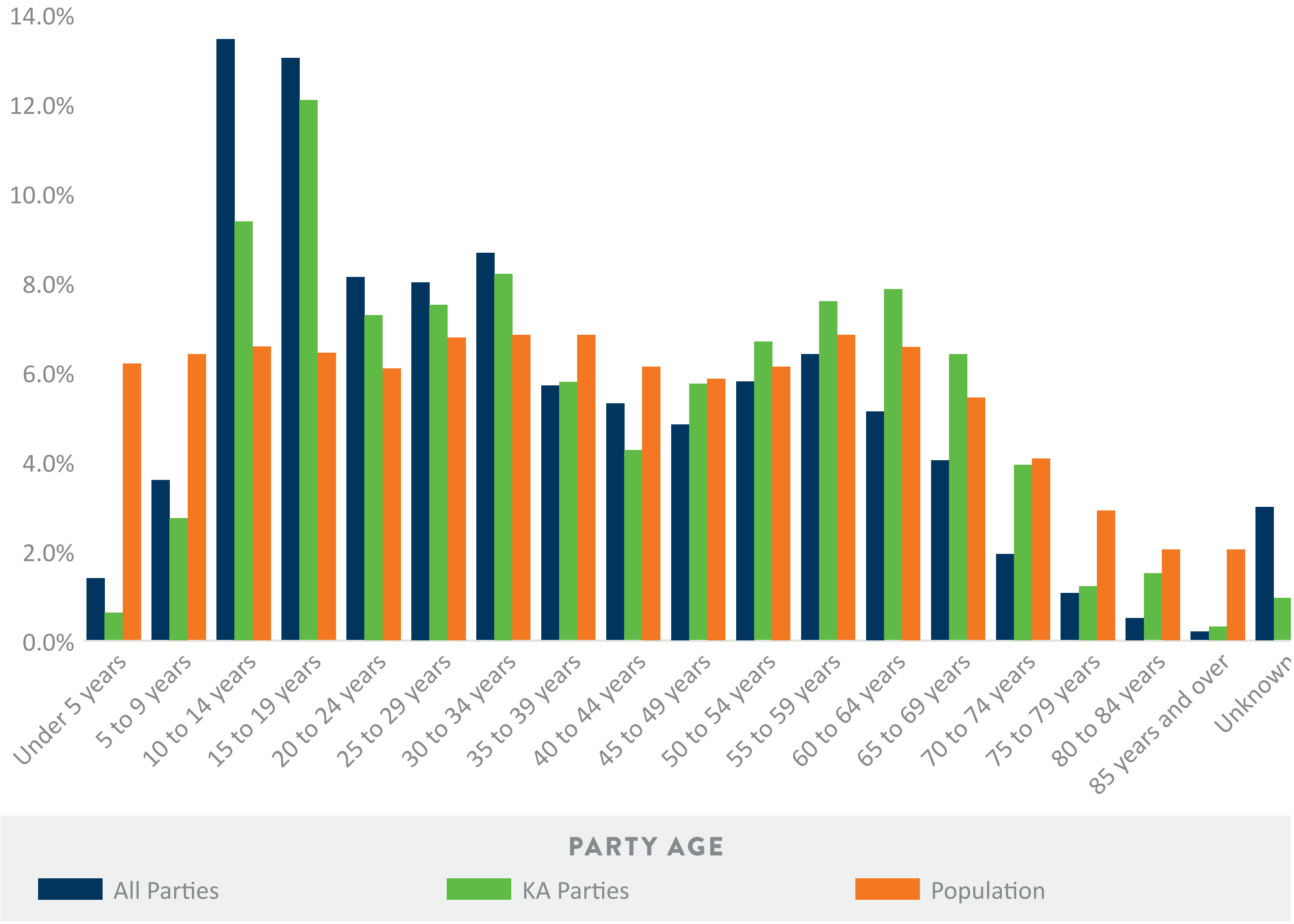
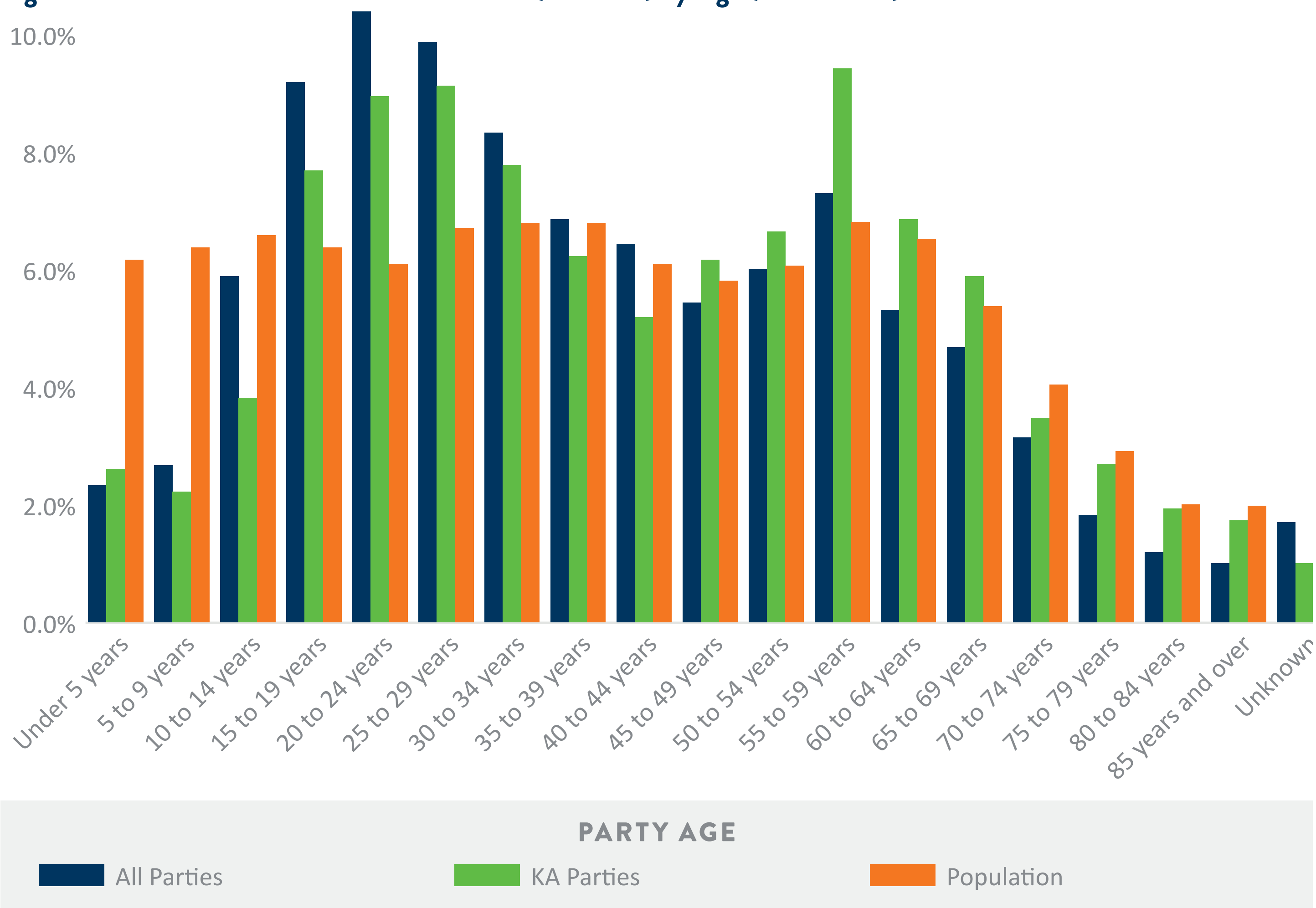


Figure 17. Pedestrian/Other VRU and Drivers ("Parties") by Age (2018-2022)



EQUITY

For both bicyclists and pedestrians, data show that residents of low-income areas and communities of color are exposed to greater risk of crashes. While most crashes occur outside low-income and majority Black, Indigenous, People of Color (BIPOC) community areas, areas where 40% or more of households are low-income and/or 50% or more of residents are BIPOC have a greater concentration of crashes and severe crashes. This pattern is strongest in Minneapolis and St. Paul, but there is evidence of disparities across all geography types, including small urban areas.

APPENDIX C

ENGAGEMENT REPORT

2025-2029 STRATEGIC HIGHWAY SAFETY PLAN

DEPARTMENT OF TRANSPORTATION

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SUMMARY OF ENGAGEMENT ACTIVITIES AND RESULTS

The Minnesota Strategic Highway Safety Plan (SHSP) sets the direction for safety strategies and investments on Minnesota roadways, with the goal of working toward zero deaths and serious injuries for all roadway users. While the SHSP is data-based at its core, identifying and implementing effective safety strategies requires the full-circle involvement and support of a wide variety of stakeholders. This document describes the outreach activities conducted and input received as part of the 2025-2029 SHSP update.

SHSP development included many voices from diverse stakeholder groups around the state – those who work in traffic safety, those who advocate for traffic safety, and those who travel on Minnesota's roadways. The planning process embraced broad outreach to build a greater understanding of traffic safety challenges and opportunities, bring a range of valuable perspectives to discussions, and support the ongoing collaborations that strengthen plan implementation and the state's traffic safety culture. The engagement conducted for the 2025-2029 SHP update is the most extensive and comprehensive yet for Minnesota.

Participants took part in exercises to provide input on an updated traffic fatality goal, to rank the top focus area priorities, and to evaluate past SHSP strategies and offer suggestions for new strategies and tactics. At various in-person events, they shared their thoughts through large- and small-group conversations and online and paper surveys. Engagement also took place through a series of interviews with representatives from vulnerable and underserved communities, and one-on-one meetings and conversations conducted with a wide range of traffic safety stakeholders helped inform the development of strategies and tactics. These included subject matter experts from the Minnesota Departments of Transportation, Public Safety, and Health, the Minnesota Safety Council, and others. The SHSP team engaged members of the public around the state through both in-person and online events.

1.1 PARTICIPANTS

Many stakeholders were engaged during outreach events throughout the project, including:

- Minnesota Advisory Council on Traffic Safety (ACTS)
  - Meetings with full membership
  - Regular meetings with SHSP Working Group
- Minnesota Toward Zero Deaths
  - Two statewide conferences
  - Tribal Traffic Safety Summit
  - 11 workshops or roundtables statewide (direct participation in SHSP activities from more than 800 individuals)
  - Participation by professionals from a variety of fields (engineering, enforcement, emergency medical and trauma services, public health, education, and legislative)
- Vulnerable roadway users (engaged in each activity/ event)
- Equity focused stakeholder groups (seven stakeholder group meetings/interviews)
- General public
  - Participation from all regions of the state
  - Five in-person events
- Twin Cities Auto Show
- Mall of America Traffic Safety Day
- Twin Cities World Refugee Day
- Somali Independence Day
- Worthington International Festival
  - 1,700 website visits
  - 94 online interactive map comments left by 56 contributors
  - 653 survey responses (in person and online)

1.2 INCLUSIVE AND EQUITABLE ENGAGEMENT

The approach to engagement for the 2025-2029 Strategic Highway Safety Plan was designed to align with recommendations for inclusive and equitable engagement identified in the Statewide Multimodal Transportation Plan :

- Ensure people have opportunities to play an active and direct role in transportation decision making.
- Build and strengthen lasting relationships to ensure that people are engaged in transportation projects and activities especially with underserved communities.
- Provide consistent, transparent, fair, just and equitable communication.
- Understand and learn from personal and community experiences on how the transportation system can negatively and positively affect communities.
- Use research and data to drive decision making in pursuit of local, regional, Tribal, statewide and national goals.

The SHSP's commitment to inclusive and equitable engagement is reflected in the wide range of events and diverse participation described in this document, including specific outreach to members of vulnerable and underserved communities.

1.3 ENGAGEMENT THEMES AND INCORPORATION INTO SHSP

Some common themes emerged from the stakeholder feedback:

- Stakeholders consistently selected speed, inattentive drivers, intersection safety, and impaired roadway users as their top focus areas, observations that align well with the data.
- Stakeholders expressed a general concern about crash trend numbers and about the ability to reach the previous SHSP goal of 225 traffic fatalities by 2025.
- Stakeholders most often focused on infrastructure and education tactics as their popular safety solutions.
- There were mixed opinions when it came to automated enforcement tactics as solutions, such as cameras to detect speeding and red-light running, and vehicle automation enhancements that range from lane assist technology to full automation.
- The updated SHSP – particularly strategies and tactics – should be more user friendly and easier to understand at a glance.
- Interest in ATV/UTV safety, specifically in greater Minnesota, has increased in recent years.
- Most people feel a responsibility to keep our roadways and highways safe, but fewer people believe their friends feel the same way, which indicates a need to emphasize and improve traffic safety culture.

By tracking, documenting, and summarizing engagement input following each event, the SHSP project team was able to incorporate the recurring themes and emerging ideas into development of the plan update.

STAKEHOLDER OUTREACH

2.1 ADVISORY COUNCIL ON TRAFFIC SAFETY

In 2023 the Minnesota Legislature established the Advisory Council on Traffic Safety (ACTS) to improve traffic safety for all users on Minnesota roadways and designated it as the lead for the state's TZD program. This group has over thirty members representing various roles within the Department of Transportation (MnDOT), Department of Public Safety (DPS), Department of Public Health (MDH), other statewide agencies, and special interest groups. ACTS' charge includes advising the governor and Minnesota commissioners of Public Safety, Transportation, and Health on policies, programs, and services that affect traffic safety, as well as advising the appropriate state departments on TZD program activities.

The ACTS leadership team contributed to the development of the 2025-2029 Minnesota SHSP throughout the planning process, offering ongoing feedback, reviewing data, and sharing comments and priorities on the plan. The ACTS will play a key leadership role in implementing the SHSP, supporting work to implement and fund the plan's strategies and tactics.

Input from the full ACTS was obtained through regular updates at its bimonthly meetings, review and comment on drafts of the plan, discussion of priorities, and a detailed online and recorded information session. Additional involvement was achieved through the ACTS SHSP Working Group formed specifically for this purpose and comprising 13 ACTS members. The working group met approximately bimonthly during 2024 to receive updates and provide regular input throughout the development of the SHSP.

2.2 TOWARD ZERO DEATHS CONFERENCES AND REGIONAL EVENTS

The Minnesota Toward Zero Deaths (TZD) program is a key partner for developing and implementing the SHSP, with participation from MnDOT, DPS, MDH, and other agencies. The SHSP team engaged TZD regional coordinators and partners through statewide conference sessions and regional workshops and roundtables.

2.2.1 STATEWIDE TZD CONFERENCES

Each year, Minnesota TZD holds a conference focusing on best practices in engineering, enforcement, education, and emergency medical services (EMS) related to reducing the number of traffic fatalities and life-changing injuries on Minnesota roads, with the ultimate goal of zero fatalities and serious injuries.

2023 STATEWIDE TZD CONFERENCE

The 2023 statewide TZD conference was held in November in Rochester. The SHSP team held a session where attendees could learn about the current and upcoming SHSP, provide input, and understand what new items would be incorporated in the 2025-2029 update. At the beginning of the presentation, participants were asked to rank the crash focus areas and distribute imaginary funding to priorities. They were asked the same questions again after learning more about the SHSP and crash trends. Input received before the presentation are shown in **Figure 1** and **Figure 3**, and results from afterwards are shown in **Figure 2** and **Figure 4**.

Prior to seeing the crash data, Inattention was a top priority, but after seeing the data, Intersections rose toward the top. In both instances, Speed was the number one priority. Related to the safe system approach, Safer Roads was the top rated element both before and after the presentation.

2024 STATEWIDE TZD CONFERENCE

The 2024 statewide TZD conference was held in October in St. Cloud. The SHSP team had a session where attendees could hear an update on the SHSP development. This included a summary of crash data, emphasis on equity, engagement conducted since the previous year's conference, an update on strategy development, and sharing the new SHSP prioritization umbrella framework.

Figure 1. 2023 TZD Conference Focus Area Ranking (BEFORE)

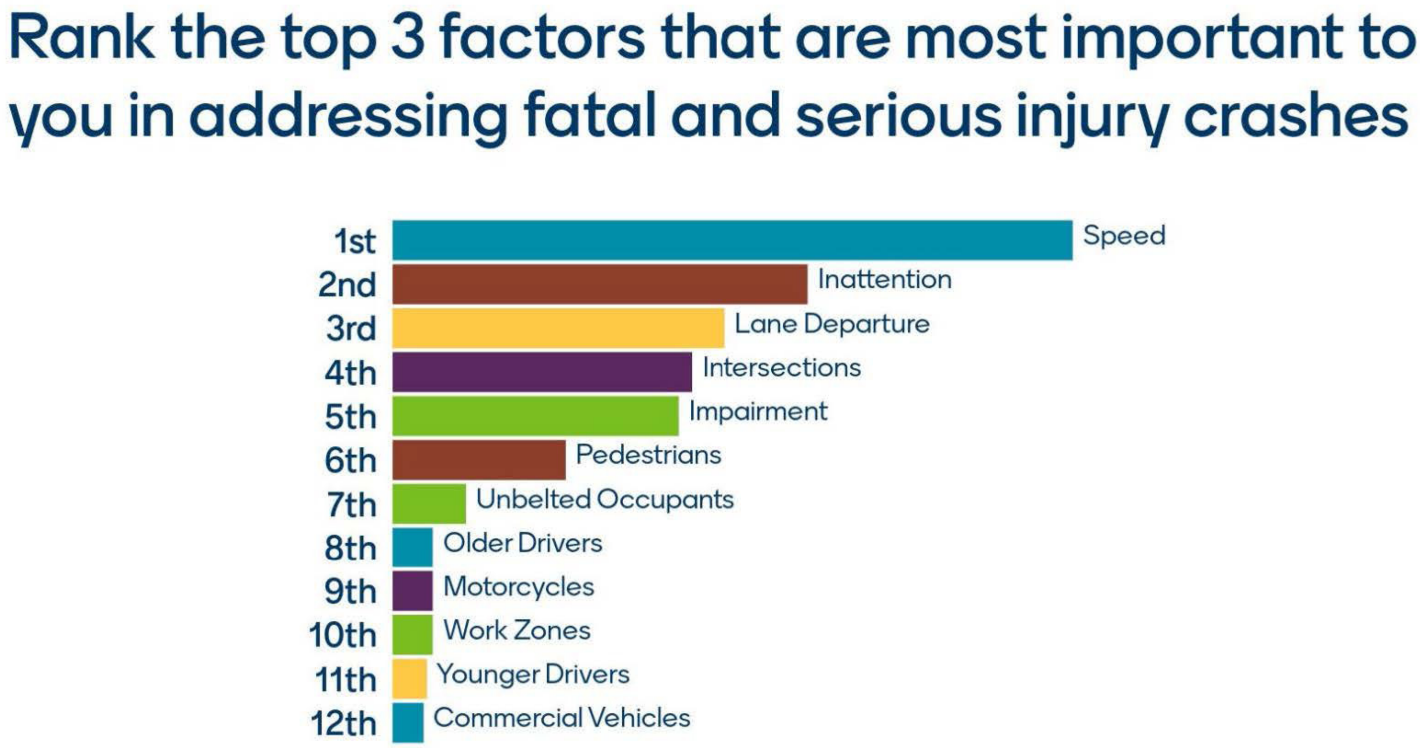


Figure 2. 2023 TZD Conference Focus Area Ranking (AFTER)

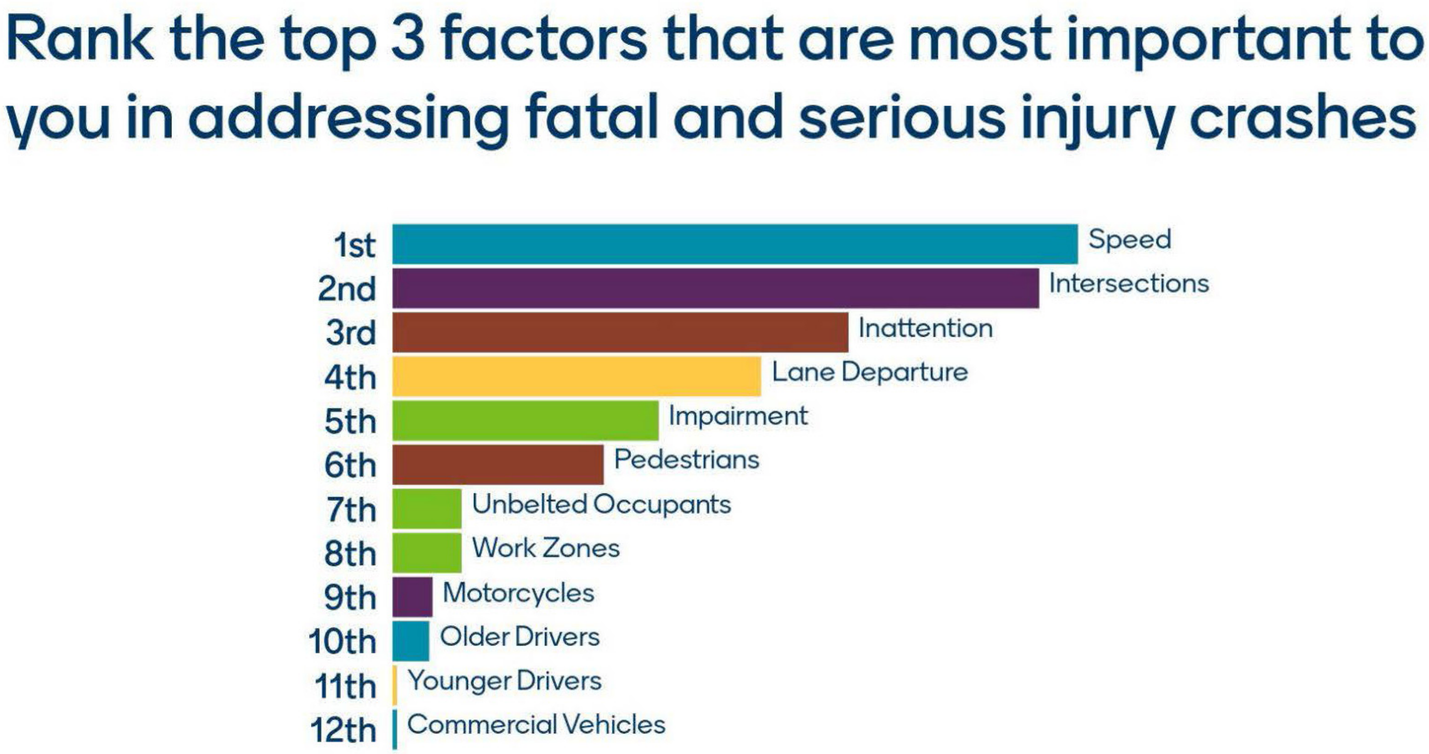


Figure 3. 2023 TZD Conference Safe System Priorities (BEFORE)

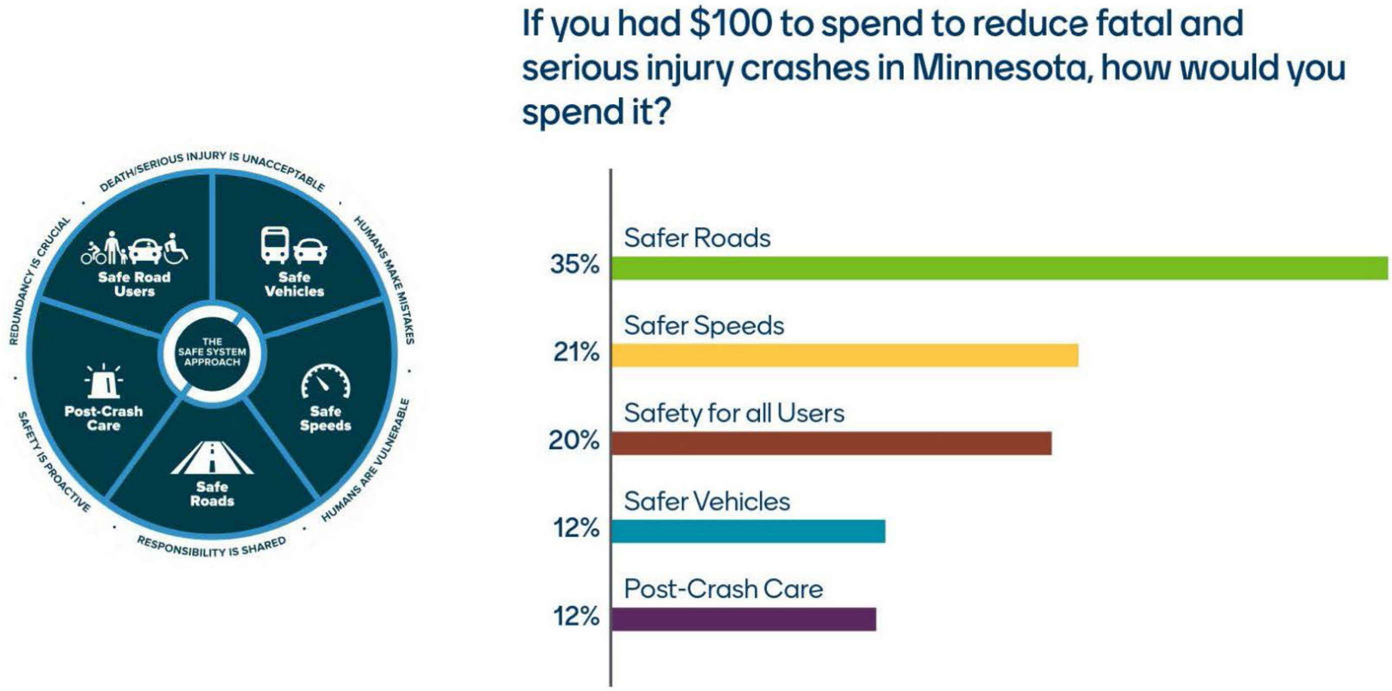
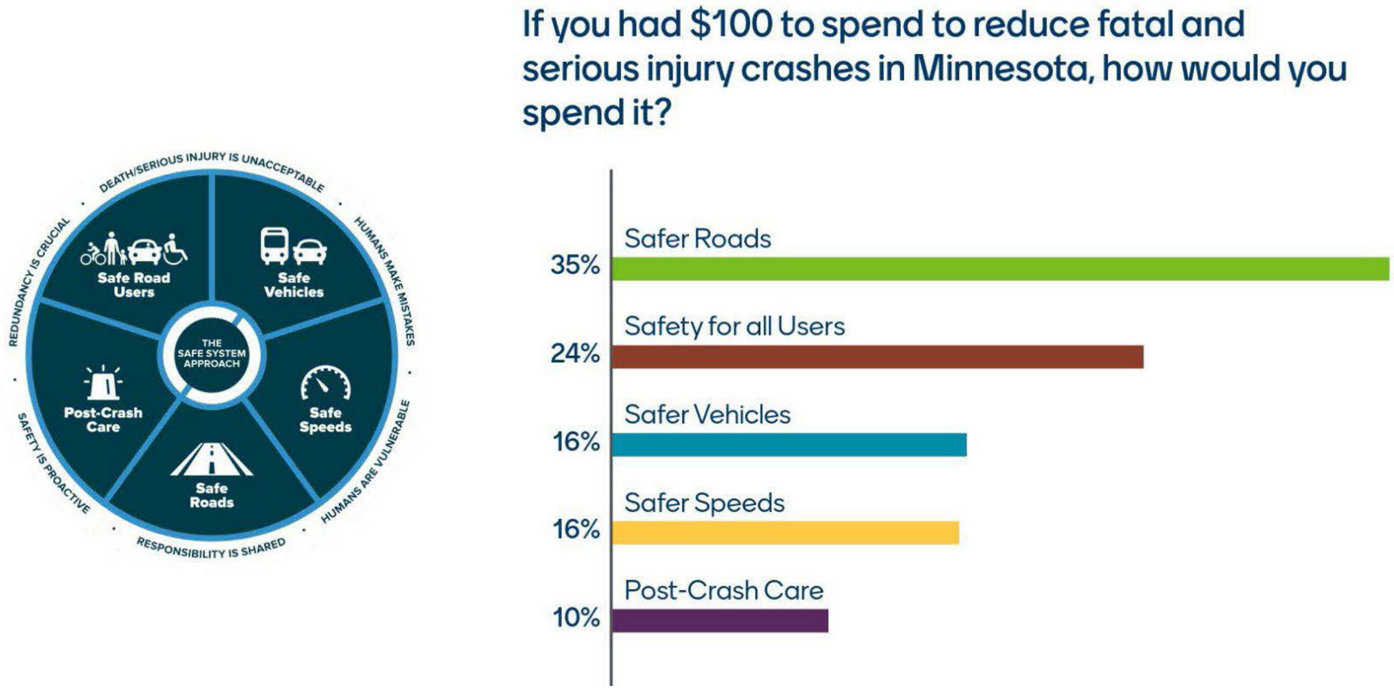


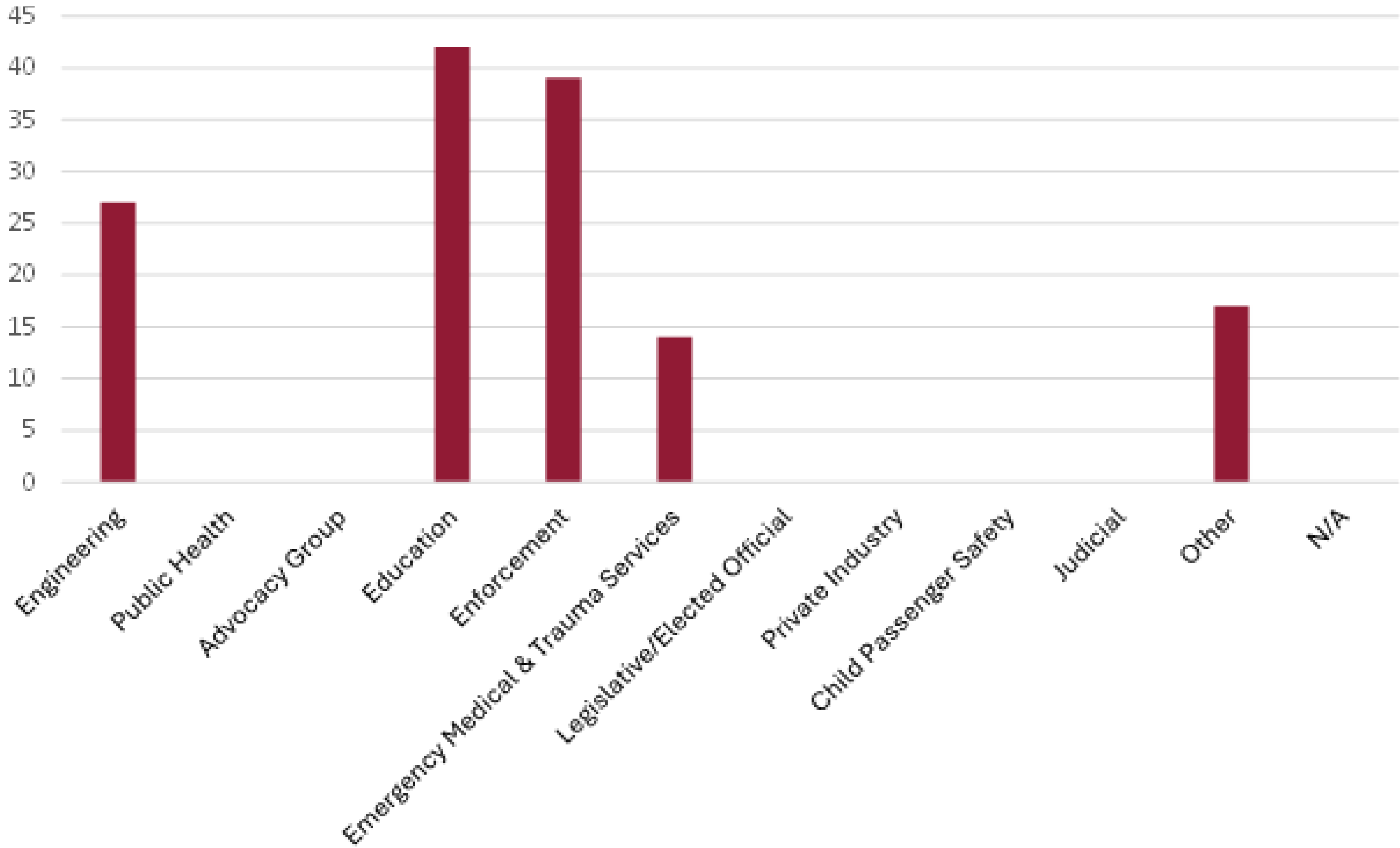
Figure 4. 2023 TZD Conference Safe System Priorities (AFTER)



2.2.2 WEST CENTRAL REGION ROUNDTABLES

The West Central Region opted to have four regional roundtables in place of a single regional workshop. Each quarter, stakeholders from a different part of the region meet, participating in various exercises which were not focused on the SHSP directly but were useful for informing the SHSP. At these half-day roundtables, an overview of the SHSP was presented and attendees were invited to participate in a survey to specifically provide input related to the SHSP.

Figure 5. West Central Roundtable Stakeholder Designations



ROUNDTABLE #1

The first West Central Regional Roundtable took place on January 23rd, 2024, in Detroit Lakes. After a welcome message and introductions by all in attendance, an overview of the SHSP and focus area definitions were presented.

A March Madness-style bracket activity was used to work through each focus area and understand priorities. The seeding for the bracket was based on sticker voting that participants completed as they arrived at the roundtable, indicating their top individual priorities and sharing new ideas. Speed, Impaired, Unlicensed Driver, and "Driver Fitness" (in that order) came out on top in the brackets. Noteworthy new ideas included the concept of "Driver Fitness" (the idea that many medical, physical, and mental conditions affect the ability to drive safely regardless of age), "New Drivers" (not just young drivers, but people who learn to drive later due to immigration or other reasons, like waiting until after they turn 18, and do not take drivers ed), "Off-Road Users" (including ATVs, UTVs, Snowmobiles, Mopeds, etc.), and a suggestion to change "Emergency & Medical Services" to "Post-Crash Care" in alignment with the safe system approach.

Following lunch, the group brainstormed safety messages in an interactive word puzzle activity and shared concerns in a traffic safety peer exchange.

ROUNDTABLE #2

The second West Central Regional Roundtable took place on March 20th, 2024, in Moorhead. The second roundtable had the same activities as the first one: presentation on SHSP and focus areas definitions, bracket activity, safety message activity, and a traffic safety peer exchange.

At this roundtable the focus areas that came out on top during the bracket activity were Inattention, Speed, Impairment, and Traffic Safety Culture. In the afternoon, the group discussion focused on the safe system approach and how to address the issue of inattention. The group brainstormed solutions for safer roads such as rumble strips, enhanced pavement markings, intersection lighting, and using the infrastructure to change behavior. The group also brainstormed solutions for safer people, safer vehicles, safer speeds, and post-crash care. Specific recent post-crash care improvements in this region included a new hangar for helicopters, new helipads at hospitals, and new telehealth features in ambulances.

ROUNDTABLE #3

The third West Central Regional Roundtable took place on June 4th, 2024, in Alexandria. The event also featured a presentation on the development of the SHSP, the bracket activity, the safety messages activity, and a participant round robin.

The focus areas that came out on top during the bracket activity were Inattention, Impairment, Traffic Safety Education, and Speed. Key discussions focused on rising drug-impaired driving, including concerns about marijuana. Regional trends highlighted high unbelted occupant fatalities, increasing motorcycle crashes, and the new law allowing lane-splitting by motorcyclists. Infrastructure solutions like roundabouts and J-turns were noted, alongside EMS improvements such as the overpass in Glenwood, which was reported to reduce emergency response times by 11 minutes. Other anecdotes included Elk River's gravel pad for speed enforcement and Rothsay's reintroduction of driver education in schools to reduce novice driver risks.

At this roundtable, participants were provided data on recent annual roadway fatalities for the state and for their region and reminded that the state had previously set a goal of no more than 225 fatalities by 2025 as a benchmark on the way to zero. Participants provided a range of input for what a potential 2030 goal could be, for both the state and the region. Results of this activity, aggregated into tens, are shown in the next two figures. The median number for the state goal was 210, and the median number for the regional goal was 16.5.

Figure 6. West Central TZD 2030 Traffic Fatalities Benchmark (Statewide)

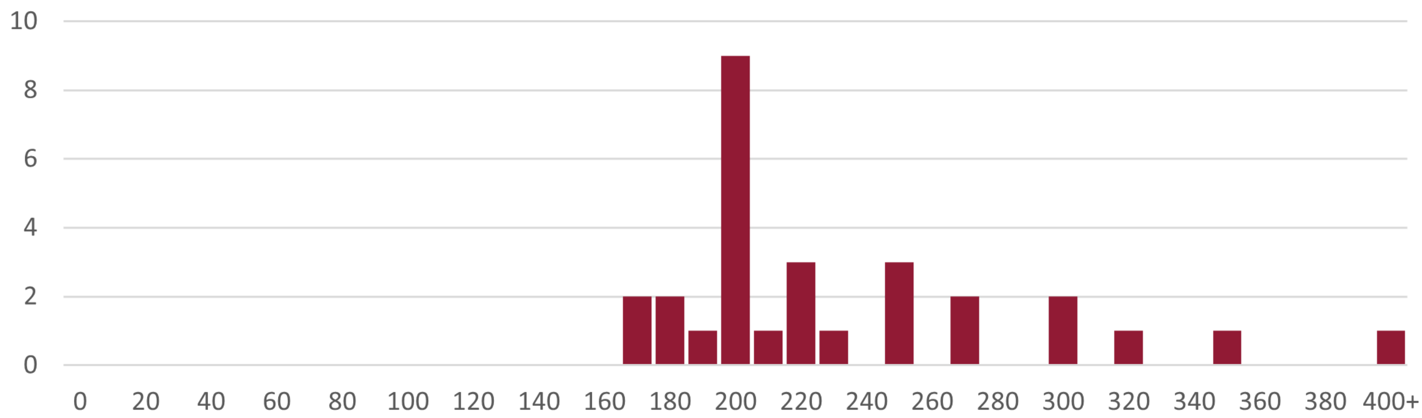
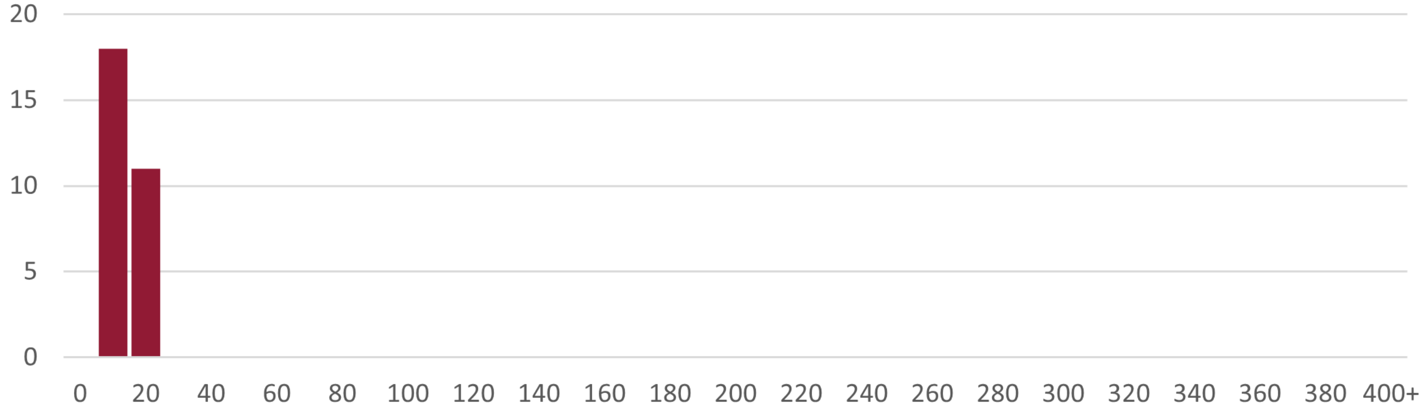


Figure 7. West Central TZD 2030 Traffic Fatalities Benchmark (Region)



ROUNDTABLE #4

The fourth West Central Regional Roundtable took place on September 18th, 2024, in Fergus Falls. Similar to the other roundtables, the day consisted of a presentation, bracket activity, safety messages activity, and open discussion.

2.2.3 TZD REGIONAL WORKSHOPS

During the development of the SHSP, regional workshops were held in seven of the Minnesota Toward Zero Death (TZD) regions; the West Central Region held roundtables instead, which are described in the next section. These workshops take place annually and bring together participants from all the "E's" (engineering, enforcement, EMS, education). These workshops provided the project team with extensive, invaluable feedback from statewide stakeholders with expertise in highway safety, which has been integrated into the SHSP.

Following a presentation on the basics of the SHSP, the focus areas, and what to expect with the 2025-2029 update, the project team facilitated three primary activities during the workshops:

- **Benchmark Activity.** Participants provided input on a 2030 goal for fatalities across the state and within their region, as a benchmark on the way to the ultimate goal of zero.
- **Crazy Eights Activity.** In groups, participants identified their top focus areas, narrowing down from a top eight to top one priority focus area.
- **Focus Area Strategies Activity.** Participants used "Yes" and "No" stickers to indicate whether individual tactics from the current SHSP should be carried over to the new plan. They were also provided the opportunity to mark up the existing strategies and tactics and suggest new ones. For reference in the analysis of this activity, tactics are denoted by the abbreviation of the strategy name, followed by the tactic number. This creates a unique identifier for each tactic. For example, Tactic 1.1 of the Inattentive Drivers strategy becomes ID 1.1.

Each TZD workshop was different both geographically and in the makeup of its participants, resulting in varied feedback. Summarized below is information from each TZD workshop. Following that is a combined summary of all the workshops and how the feedback was included in the plan.

Figure 8. SHSP Input at 2024 TZD Workshops

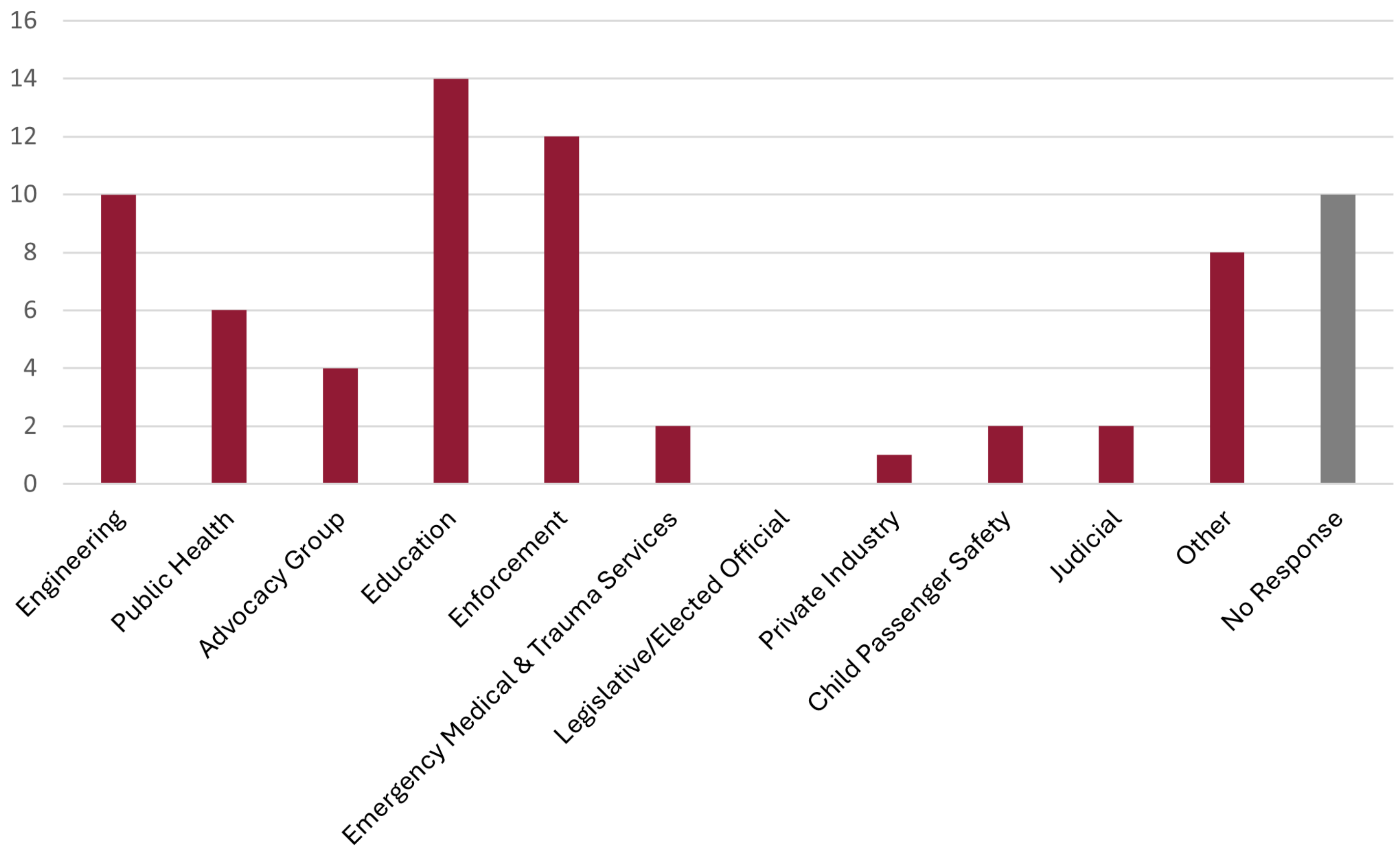
NORTHWEST TZD

The Northwest TZD workshop occurred on Tuesday, April 23, 2024, in Thief River Falls. This workshop used a group-based approach for placing stickers during the focus area strategies activity (compared to individually at the other workshops). Key themes included concerns about inattention while driving and the need for stronger speed enforcement. Intersection safety was also a recurring topic, with suggestions for infrastructure improvements to reduce crashes. Participants strongly supported enhancing education and enforcement efforts. Off-highway vehicles (OHV), such as all-terrain vehicles (ATV) and utility task vehicles (UTV), were also a common focus of discussion. It was noted that in recent years OHV crashes on roadways have been added to the statewide crash dataset and usage has been increasing, leading to an increase (or perhaps a perceived increase) in crashes.

ATTENDEES

This workshop had 71 attendees. Education, Enforcement, and Engineering disciplines represented the greatest share of participants based on stakeholder designation, with 14, 12, and 10 participants, respectively. Stakeholder designations are self-reported. At this workshop, 10 participants did not report a stakeholder designation. See **Figure 9** below for further detail.

Figure 9. Northwest TZD Workshop Stakeholder Designations



BENCHMARK ACTIVITY

Participants were provided data on recent annual roadway fatalities for the state and for their region and were reminded that the state had previously set a goal of no more than 225 fatalities by 2025 as a benchmark on the way to zero. The region-specific goal was no more than 13 fatalities by 2025. Participants provided a range of input for what a potential 2030 goal could be, for both the state and the region. Results of this activity, aggregated by tens, are shown in the next two figures. The median number for the state goal was 200, and the median number for the regional goal was 7.

Figure 10. Northwest TZD 2030 Traffic Fatalities Benchmark Input (Statewide)

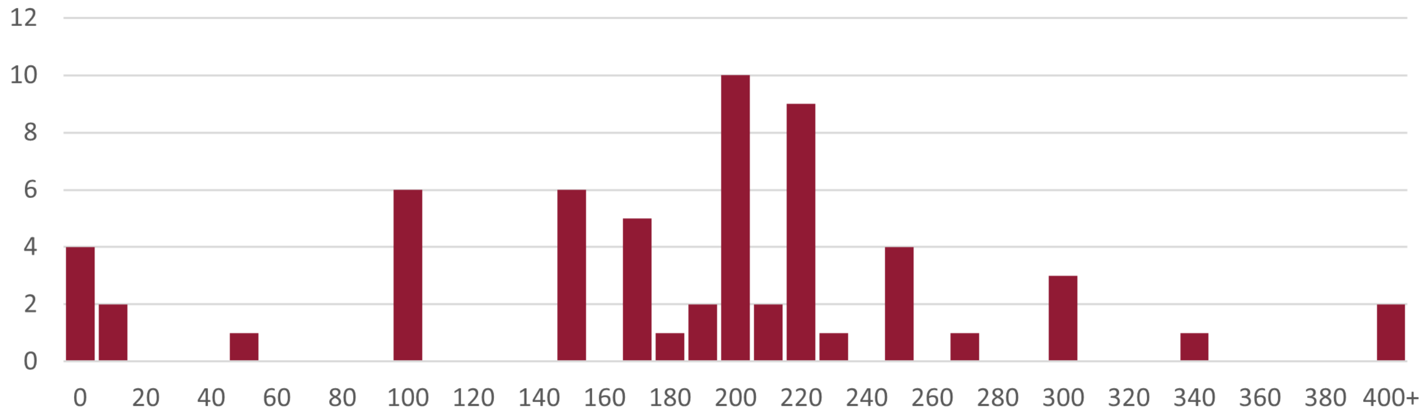
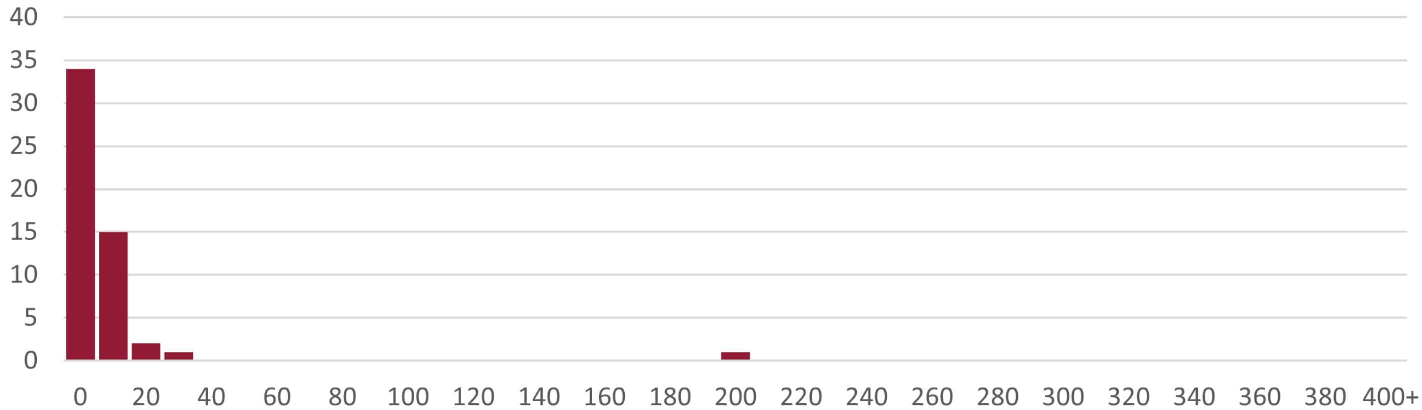


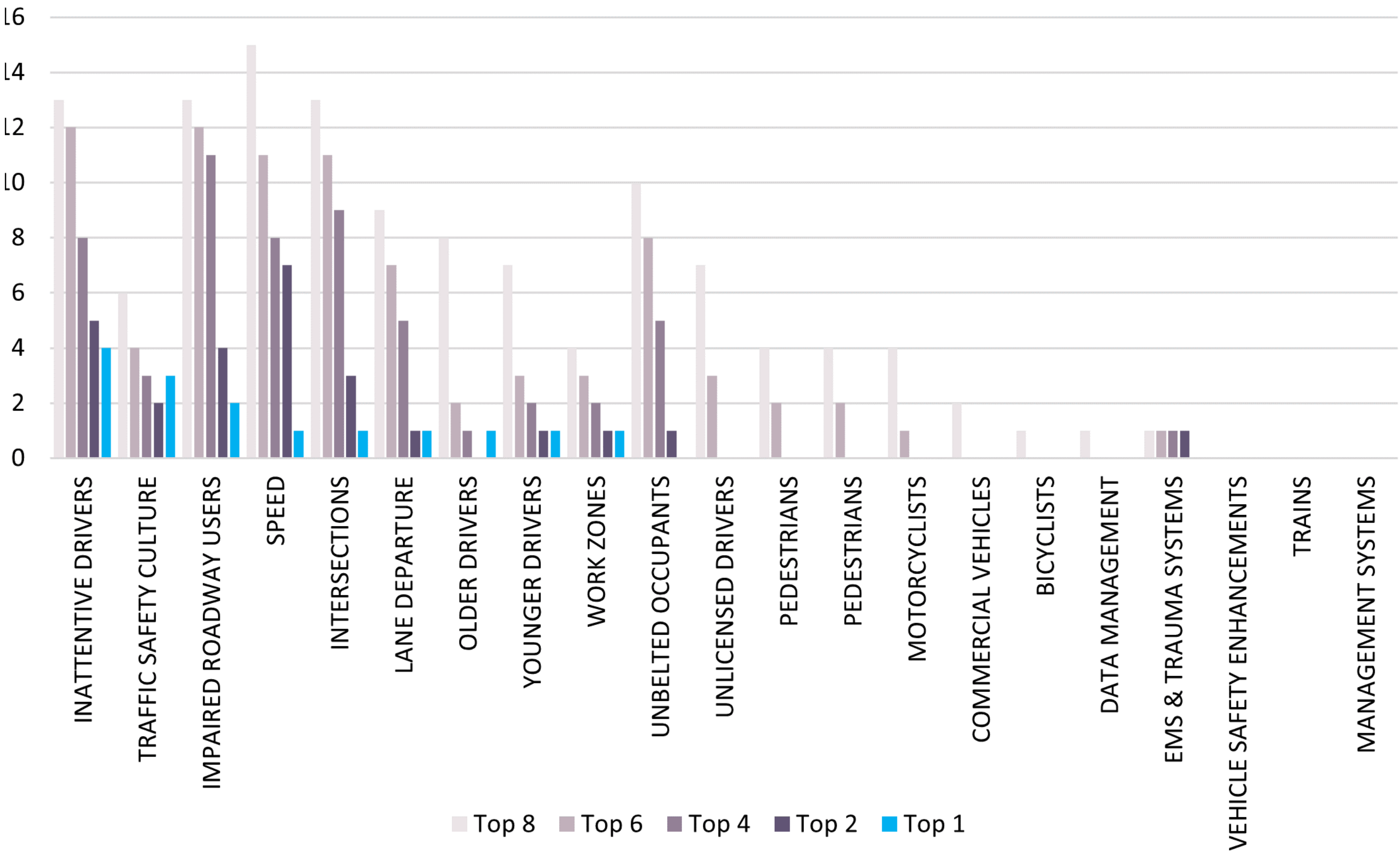
Figure 11. Northwest TZD 2030 Traffic Fatalities Benchmark Input (Region)



CRAZY EIGHTS ACTIVITY

During the Crazy Eights activity, participants identified Inattentive Drivers, Speed, and Traffic Safety Culture as high priority focus areas. Intersection safety and lane departure were also important, particularly in rural areas. The activity revealed that driver behavior was viewed as a critical focus for improving safety.

Figure 12. Northwest TZD Crazy Eights Results



FOCUS AREA STRATEGIES ACTIVITY

In the group activity, Tactic TSC4 from the 2020-2024 SHSP—focused on educational resources for safe behaviors in schools—received the most positive feedback, as shown in the table below. Other tactics related to intersection safety and speed management were also discussed, though the group format made it harder to establish clear priorities compared to other regional workshops. Overall, participants emphasized education and infrastructure improvements.

Table 1. Northwest TZD Top Tactic by "Yes" Stickers

TACTIC	DESCRIPTION	YES	NO
TSC4	For school-based health educators and school resource officers, develop and distribute updated age-appropriate informational resources on safe behaviors while walking/bicycling in or near roadways and while riding in passenger vehicles.	5	0

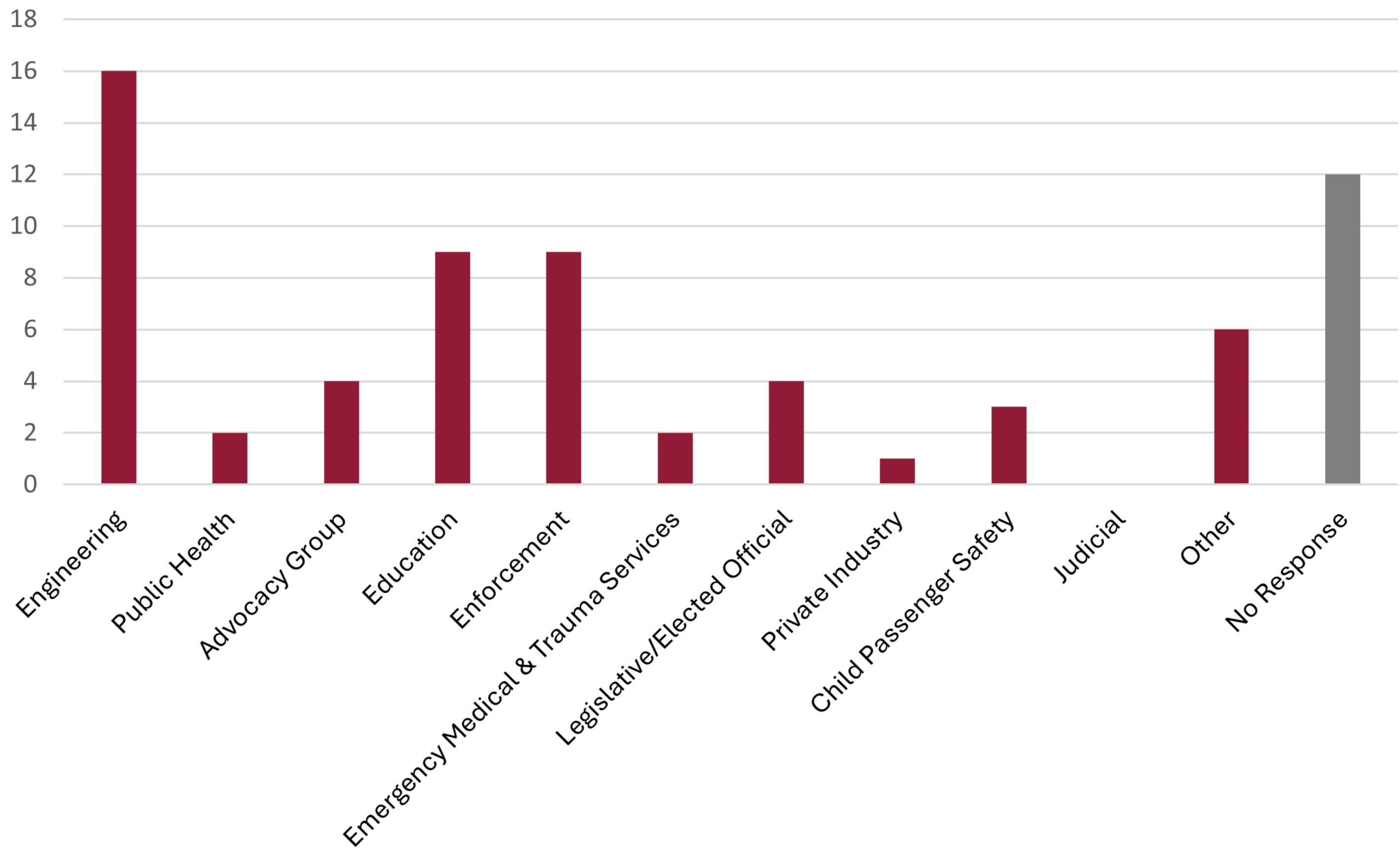
EAST CENTRAL TZD

The East Central TZD workshop occurred on May 2, 2024, in Waite Park. Participants focused on promoting safe ride home options, increasing education about inattentive driving, implementing road safety measures like rumble strips, and addressing driver behavior, distraction, and the need to improve Driver's Education for novice drivers. During the large group discussion, discussion focused on improving education around traffic safety and driver behavior at J-turns, roundabouts, and zipper merges. It was noted that social media works well to reach young people and that local news outlets are better for reaching older drivers.

ATTENDEES

This workshop had 68 attendees. Engineering had the largest representation, with 16 participants.

Figure 13. East Central Workshop TZD Stakeholder Designations



BENCHMARK ACTIVITY

Participants were provided data on recent annual roadway fatalities for the state and for their region and reminded that the state had previously set a goal of no more than 225 fatalities by 2025 as a benchmark on the way to zero. The region-specific goal was no more than 43 fatalities by 2025. Participants provided a range of input for what a potential 2030 goal could be, for both the state and the region. Results of this activity, aggregated into tens, are shown in the next two figures. The median number for the state goal was 225, and the median number for the regional goal was 50.

Figure 14. East Central TZD 2030 Traffic Fatalities Benchmark Input (Statewide)

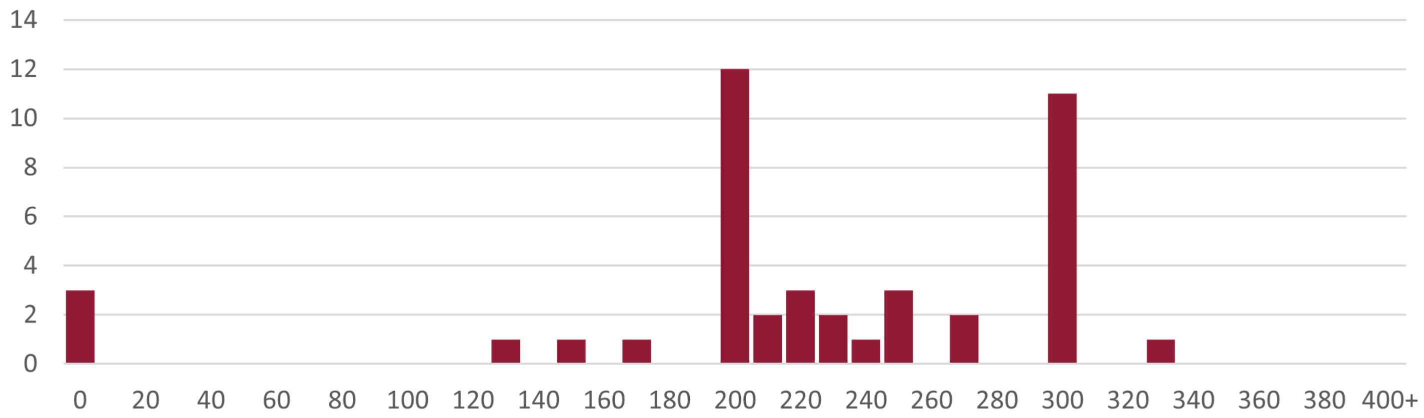
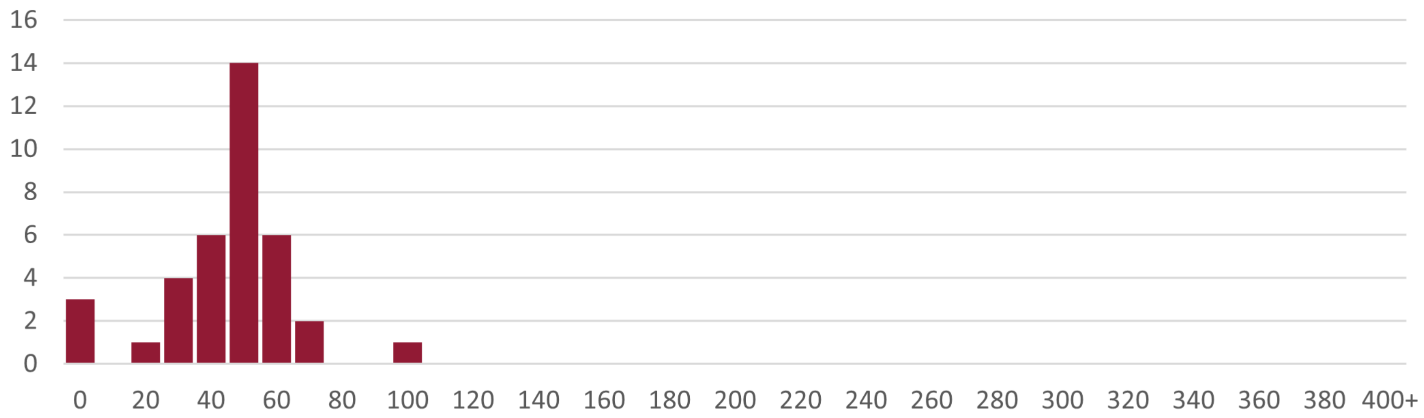


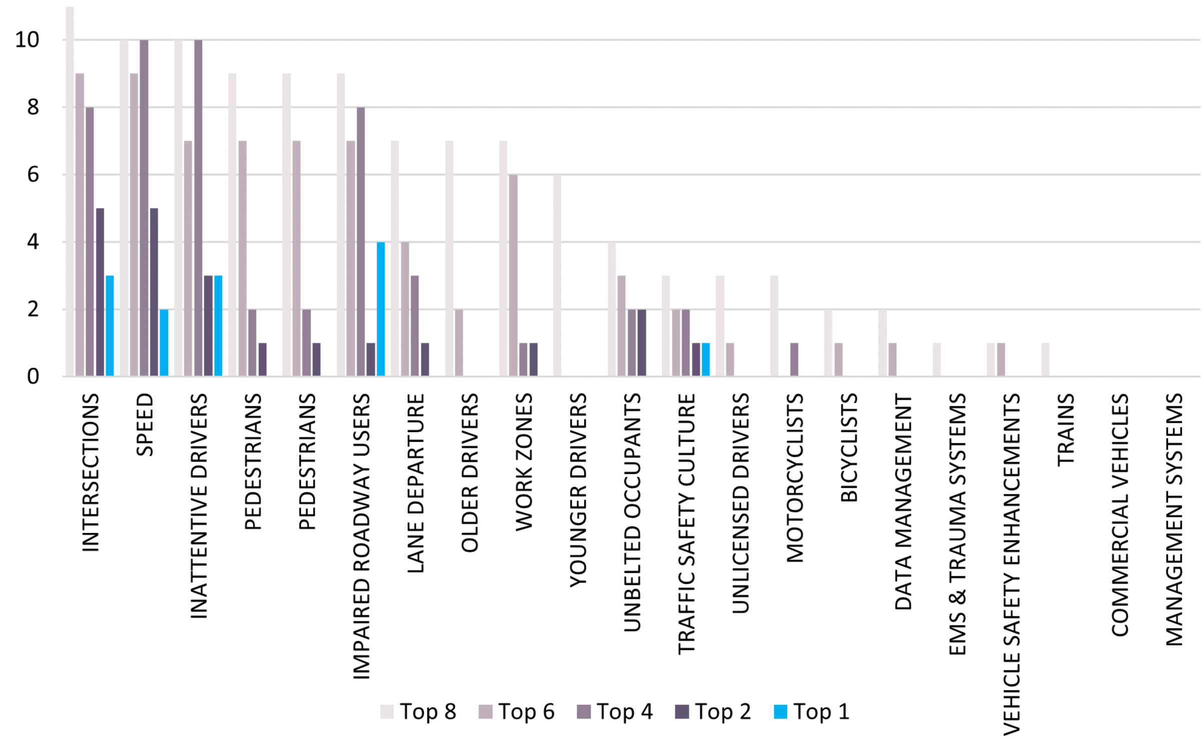
Figure 15. East Central TZD 2030 Traffic Fatalities Benchmark Input (Region)



CRAZY EIGHTS ACTIVITY

Participants prioritized Inattentive Drivers, Speed, and Intersections as top focus areas, mirroring regional concerns discussed related to statewide driving behaviors and speeding. Impaired Roadway Users was the top result in the Crazy Eights Activity, with four top one votes. Attendees emphasizing the need for improved infrastructure and enforcement to address these issues during discussion time.

Figure 16. East Central TZD Crazy Eights Results



FOCUS AREA STRATEGIES ACTIVITY

As shown in the tables below, the tactics from the 2020-2024 SHSP that received the most positive feedback was IRU2.1, promoting the expansion and use of safe ride home options. Another well-supported tactic was ID1.1, which focused on increasing education about inattentive driving for all age groups. In contrast, S3.4, which proposed variable speed limits, received the most negative feedback. In general, participants supported education and behavioral interventions as key strategies.

Table 2. East Central TZD Top Tactic by “Yes” Stickers

TACTIC	DESCRIPTION	YES	NO
IRU2.1	Promote expansion and use of safe ride home options.	22	0
ID1.1	Increase education about inattentive driving and provide background data and statistics that highlight the dangers of inattentive driving. Educate on other distractions in addition to cell-phone use related to inattentive driving. Provide education to people of all ages (not just teen drivers).	19	0

Table 3. East Central TZD Top Tactic by “No” Stickers

TACTIC	DESCRIPTION	YES	NO
S3.4	Implement variable speed limits to account for changing driving conditions. Encourage legislative changes to allow for regulatory variable speed limits.	1	15

SOUTH CENTRAL TZD

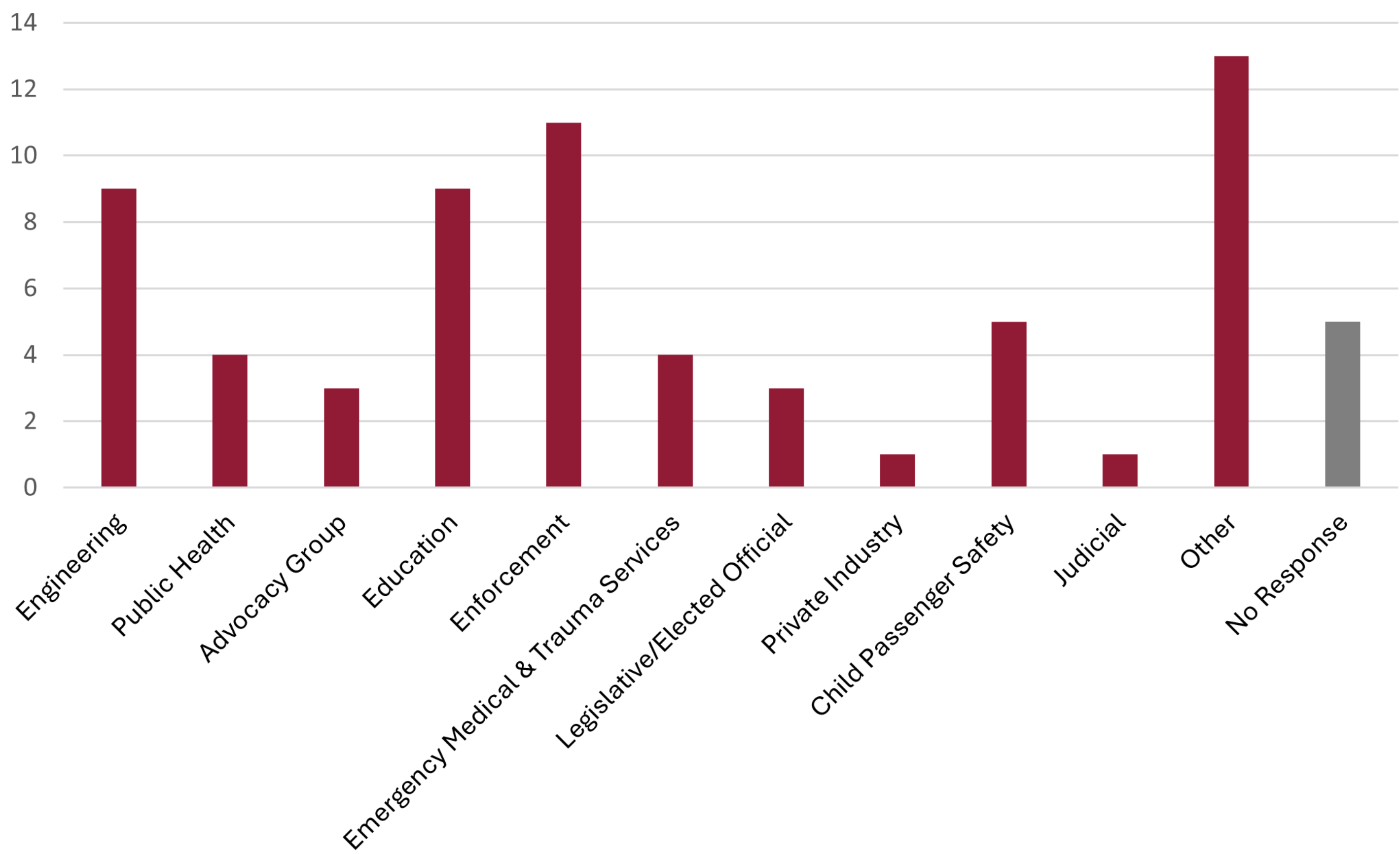
The South Central TZD workshop occurred on May 6, 2024, in Mankato. In this workshop, the top priorities included expanding education on the dangers of speeding, particularly for younger drivers, and redesigning intersections to reduce severe at fatal crashes. Participants also supported installing rumble strips on two-lane roads. Responses to tactics related to autonomous vehicles and crash-reduction technologies were mixed, with participants voicing concerns about the readiness of these technologies for implementation.

Discussion during the large group discussion and covered a range of topics. According to participants, intersections with high crash rates are a prevalent issue, often resulting from drivers failing to yield, and one way to address this is by implementing alternative intersection designs. There were mixed opinions related to vehicle automation improvements (such as an auditory alert if a driver veers out of lane); some indicated that it could add to distractions and be cost-prohibitive, while others said that the only way to get to zero deaths is by minimizing human error. In the discussion, law enforcement officers emphasized the “Core 4” issues: speed, distraction, impairment, and seatbelts.

ATTENDEES

This workshop had 68 attendees. “Other” was the most reported self-designation, at 13. Other top stakeholder designations included Enforcement, Education, and Engineering.

Figure 17. South Central TZD Workshop Stakeholder Designations



BENCHMARK ACTIVITY

Participants were provided data on recent roadway fatalities for the state and for their region and reminded that the state had previously set a goal of no more than 225 fatalities by 2025 as a benchmark on the way to zero. The region-specific goal was no more than 18 fatalities by 2025. Participants provided a range of input for what a potential 2030 goal could be, for both the state and the region. Results of this activity, aggregated into tens are shown in the next two figures. The median number for the state goal was 225, and the median number for the regional goal was 20.

Figure 18. South Central TZD 2030 Traffic Fatalities Benchmark Input (Statewide)

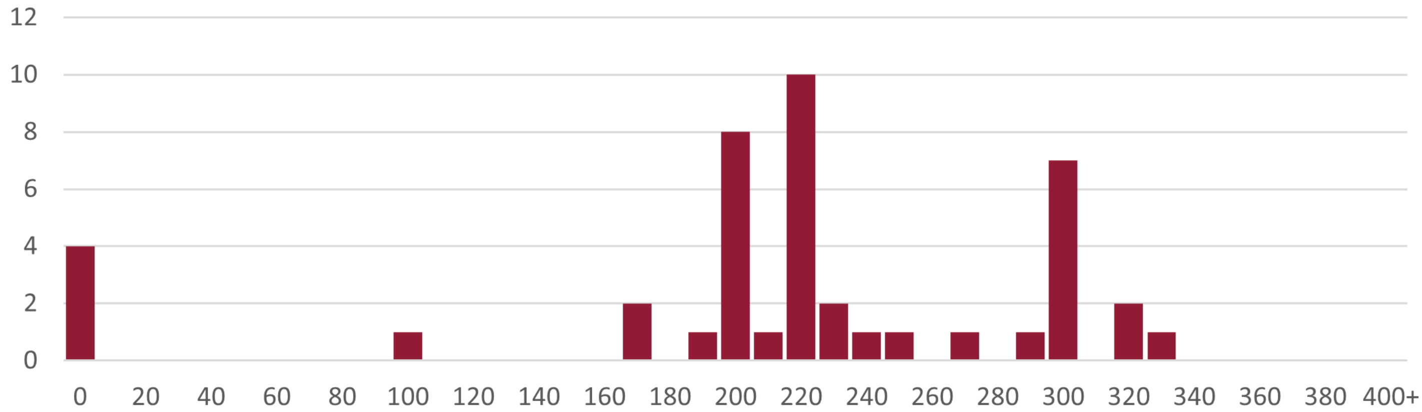
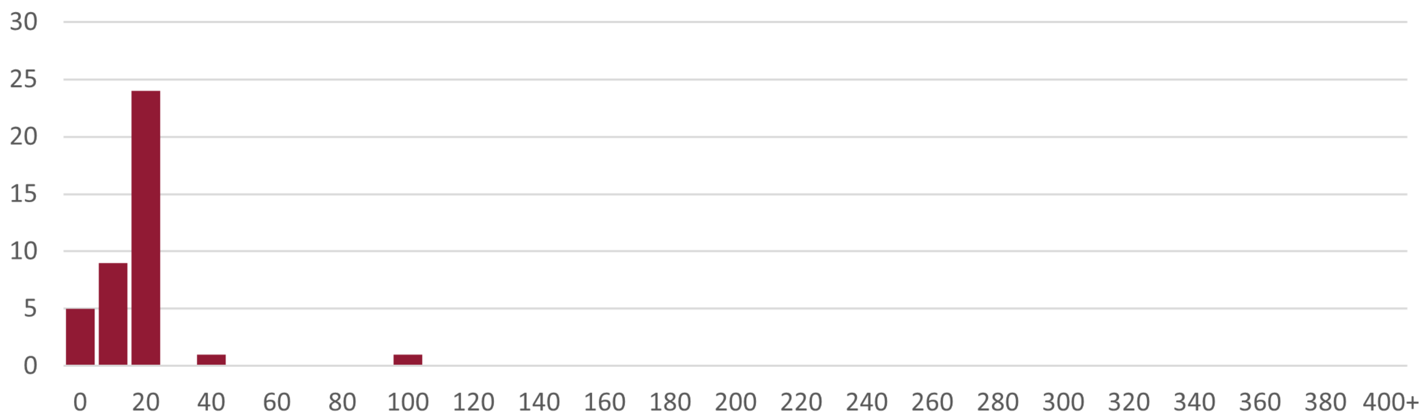


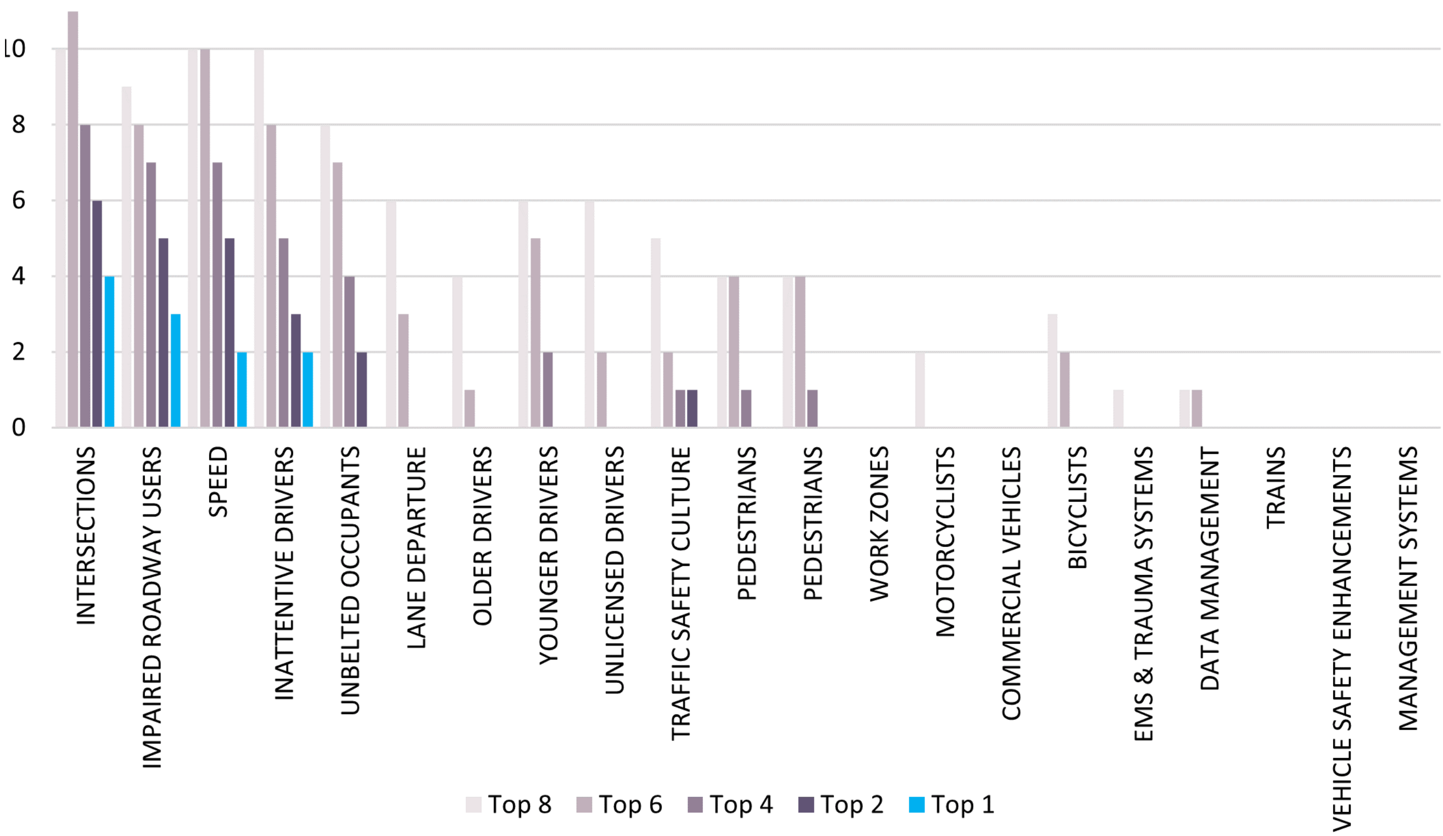
Figure 19. South Central TZD 2030 Traffic Fatalities Benchmark Input (Region)



CRAZY EIGHTS ACTIVITY

During the Crazy Eights activity, participants prioritized Speed and Intersections as the top issues, emphasizing the need for enhanced driver education and infrastructure improvements. Lane Departure and Inattentive Driving were also highlighted, especially in relation to rural roads.

Figure 20. South Central TZD Crazy Eights Results



FOCUS AREA STRATEGIES ACTIVITY

As shown in the tables below, the most supported tactics from the 2020-2024 SHSP included S1.1, expanding education on speeding and aggressive driving for younger drivers, and I1.3, designing safer intersections. LD1.1, installing rumble strips on two-lane roads, was also well-supported. In contrast, ID3.4, which focused on autonomous vehicle technology, received the most negative feedback. Participants seemed to prefer infrastructure-based solutions over emerging technologies.

Table 4. South Central TZD Top Tactic by “Yes” Stickers

TACTIC	DESCRIPTION	YES	NO
S1.1	Expand education efforts about the dangers of speeding and aggressive driving, especially among younger drivers. Utilize data and statistics along with a story narrative to deliver the point effectively.	17	0
I1.3	Design intersections to lower crossing conflict points, manage access points, and reduce the number of severe crashes at intersections. Apply alternative design to intersections with a high frequency of severe crashes or systemic risk factors.	16	0
LD1.1	Install rumble strips and mumble strips on centerlines and edges of roads, especially along two-lane roadways, to tactically warn drivers if their vehicles leave the desired travel area.	16	0

Table 5. South Central TZD Top Tactic by “No” Stickers

TACTIC	DESCRIPTION	YES	NO
ID3.4	Support the transition to autonomous vehicles and other emerging motor vehicle technology to reduce human error, including in interactions with people walking, rolling, and bicycling.	2	8

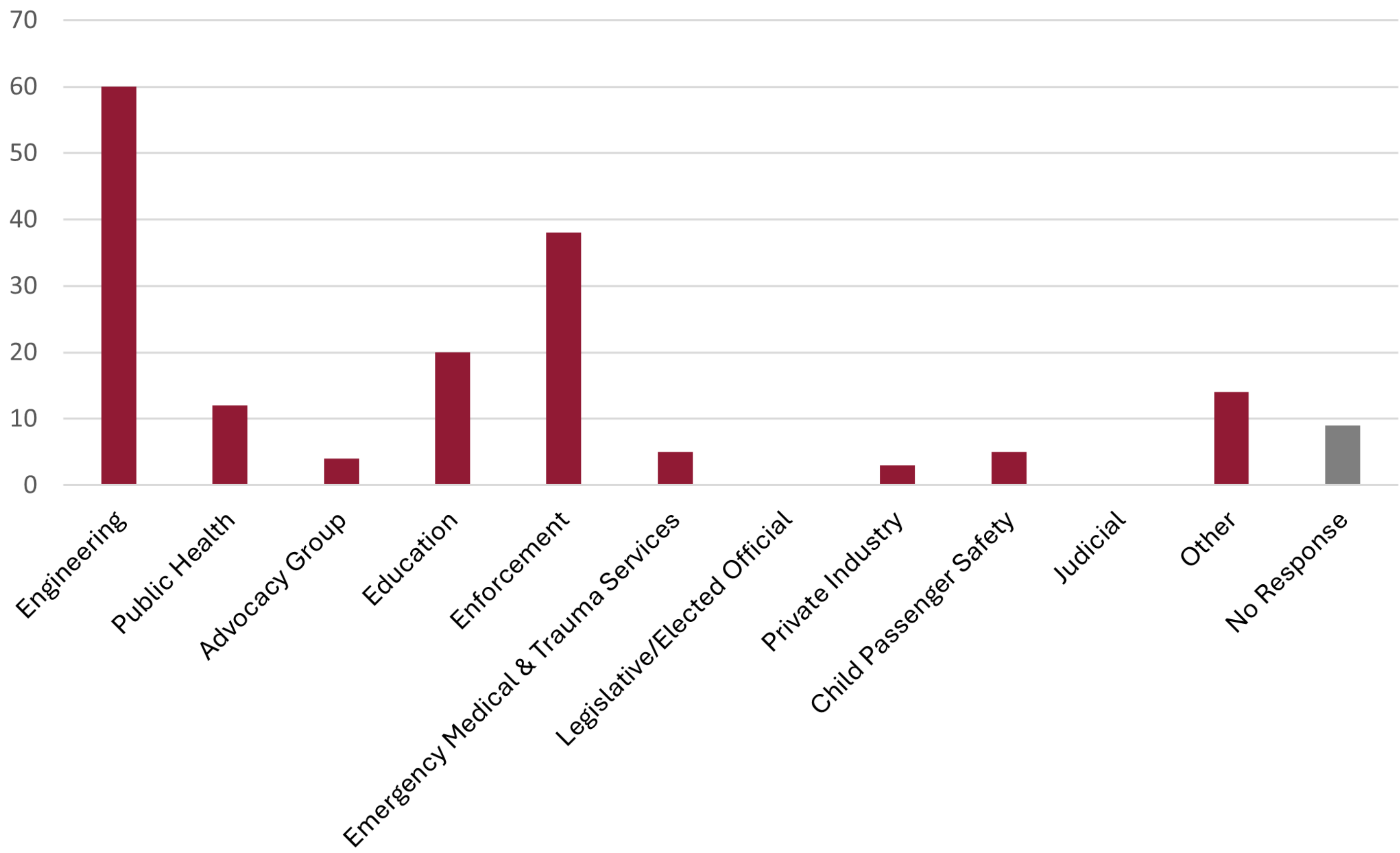
SOUTHEAST TZD

The Southeast TZD workshop occurred on May 8, 2024, in Rochester. Participants focused heavily on inattentive driving and speeding as the most critical safety issues. Discussions also underscored the need for increased driver education and enforcement, particularly targeting distractions such as mobile phone use. Over half of the participating groups indicated that inattention was the top priority, with a common reason being the understanding that many crashes that fall in the other focus areas could be prevented with increased attention in drivers. Speeding was another top concern, with many participants advocating for stricter speed enforcement and improved road design to mitigate the effects of excessive speed. While participants were generally supportive of safety enhancements, there was commonly negative feedback to automated enforcement technologies like speed cameras and red-light enforcement due to concerns about privacy and their effectiveness.

ATTENDEES

This workshop had 170 attendees. The distribution of stakeholder designations skewed towards Engineering and Enforcement. 35 percent of participants self-reported as being in the Engineering stakeholder designation and 22 percent self-reported as being in the Enforcement stakeholder designation.

Figure 21. Southeast TZD Workshop Stakeholder Designations



BENCHMARK ACTIVITY

Participants were provided data on recent annual roadway fatalities for the state and for their region and reminded that the state had previously set a goal of no more than 225 fatalities by 2025 as a benchmark on the way to zero. The region-specific goal was no more than 26 fatalities by 2025. Participants provided a range of input for what a potential 2030 goal could be, for both the state and the region. Results of this activity, aggregated into tens are shown in the next two figures. The median number for the state goal was 225, and the median number for the regional goal was 30.

Figure 22. Southeast TZD 2030 Traffic Fatalities Benchmark Input (Statewide)

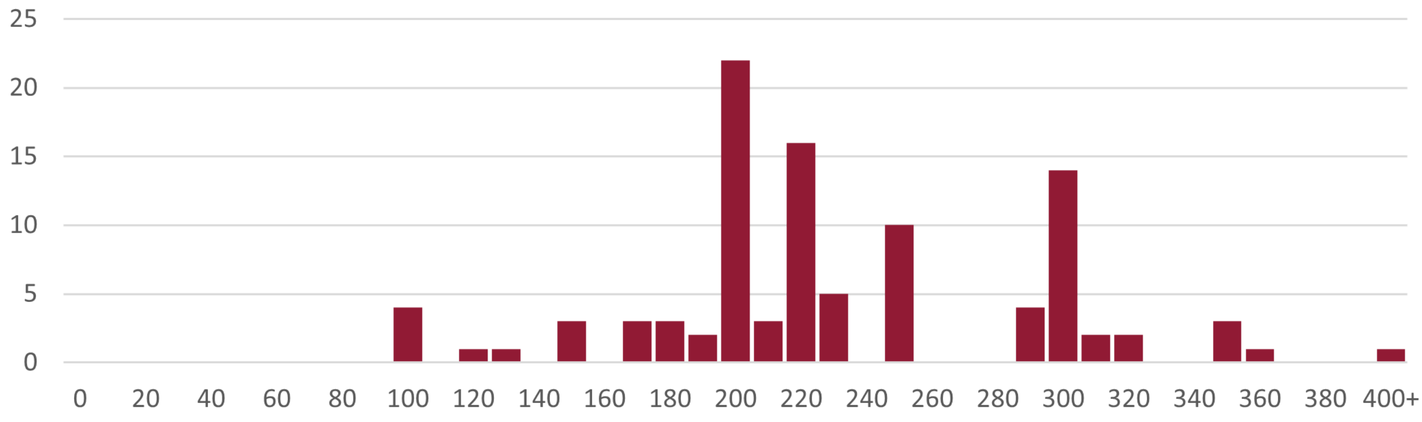
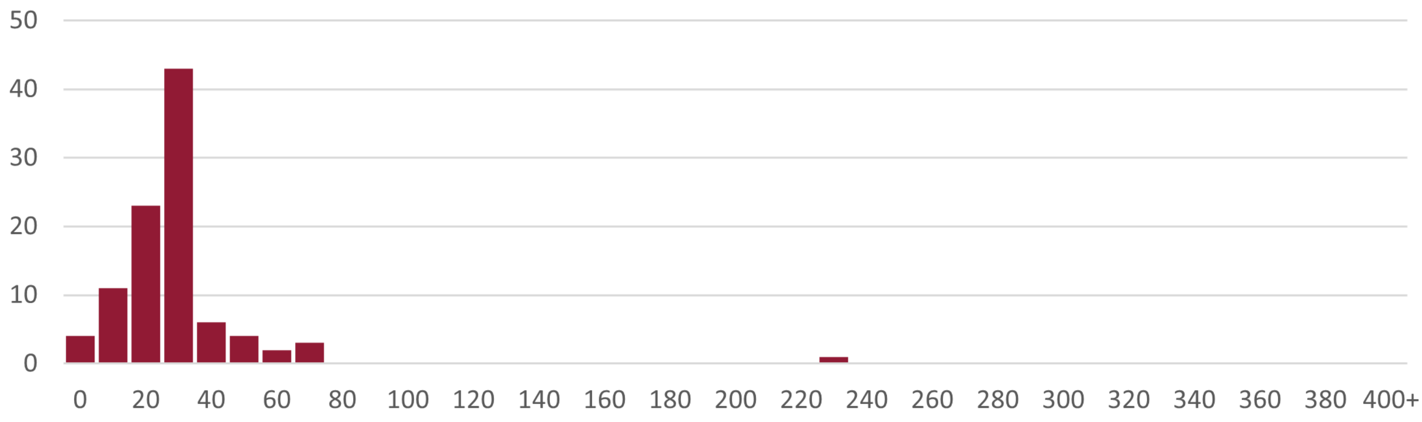


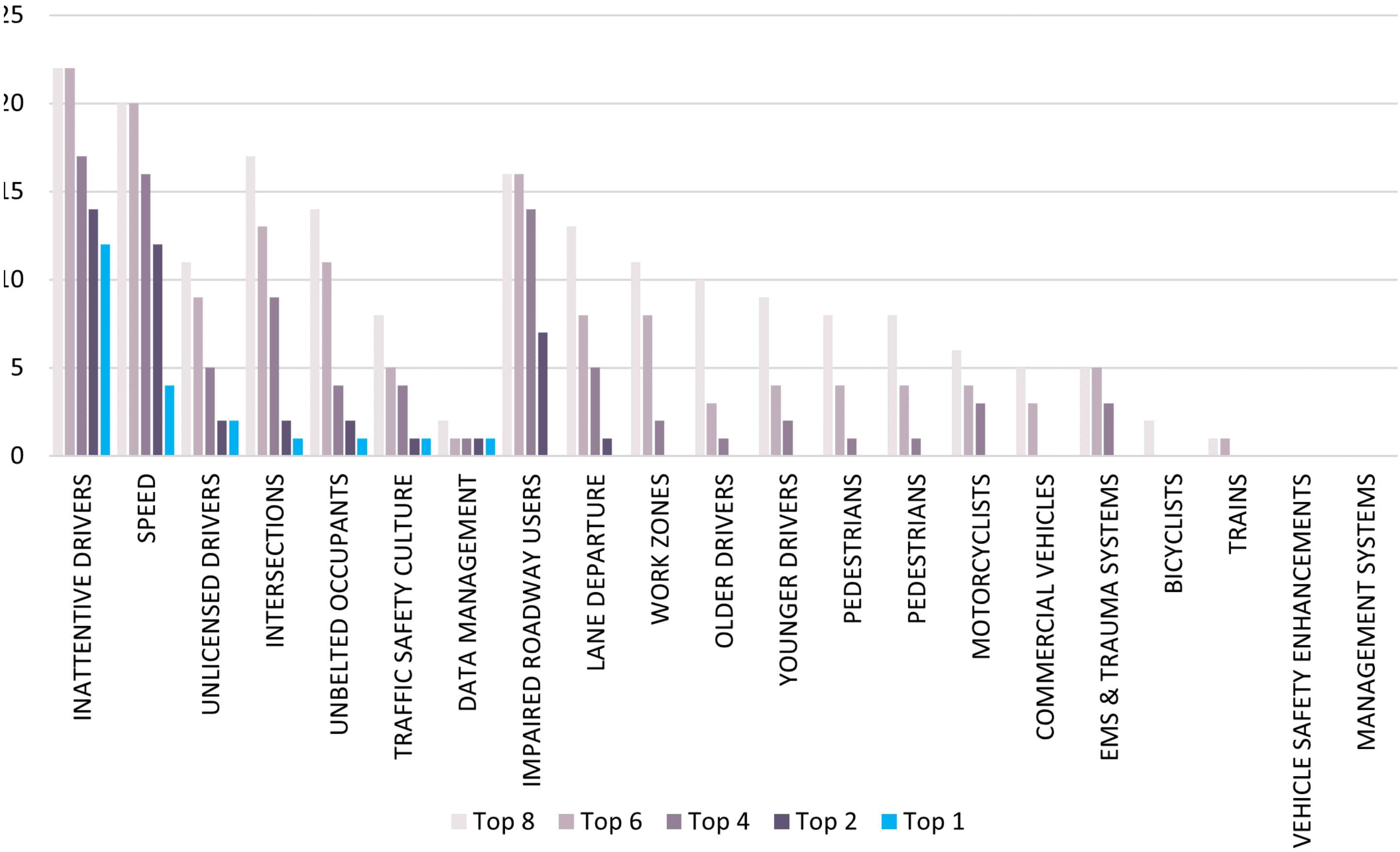
Figure 23. Southeast TZD 2030 Traffic Fatalities Benchmark Input (Region)



CRAZY EIGHTS ACTIVITY

During the Crazy Eights activity, participants identified Inattentive Drivers and Speed as their top priorities. They emphasized the growing dangers of distracted driving. These two focus areas were consistently highlighted as the most urgent issues for the region, with calls for a combination of education, enforcement, and infrastructure improvements to address them.

Figure 24. Southeast TZD Crazy Eights Results



FOCUS AREA STRATEGIES ACTIVITY

As shown in the tables below, the most supported tactics in this session from the 2020-2024 SHSP were TSC1, which focused on sharing crash reports with multidisciplinary review committees, and UO2.4, promoting localized seat belt enforcement efforts. I1.3, which emphasized intersection redesign to reduce severe crashes, was also widely supported. On the other hand, tactics like S2.2, proposing automated speed enforcement cameras, received negative feedback. Many of the tactics selected during this activity suggested a preference for prioritizing enforcement, education, and practical road safety improvements.

Table 6. Southeast TZD Top Tactic by "Yes" Stickers

TACTIC	DESCRIPTION	YES	NO
TSC1	Share fatal and serious injury crash report details with multi-disciplinary review committees. Encourage localities without a review committee to form a multi-disciplinary group.	32	1
I1.3	Design intersections to lower crossing conflict points, manage access points, and reduce the number of severe crashes at intersections. Apply alternative design to intersections with a high frequency of severe crashes or systemic risk factors.	30	0
UO2.4	Encourage use of discretionary OTS provided traffic safety enforcement funding for localized seat belt saturation enforcement that targets known high risk locations and time periods.	27	0

Table 7. Southeast TZD Top Tactic by "No" Stickers

TACTIC	DESCRIPTION	YES	NO
S2.2	Explore the potential for automated speed enforcement cameras in Minnesota by researching its effectiveness in states that have implemented it and any technical, legal, privacy, and equity barriers.	7	37
ID3.4	Support the transition to autonomous vehicles and other emerging motor vehicle technology to reduce human error, including in interactions with people walking, rolling, and bicycling.	3	27

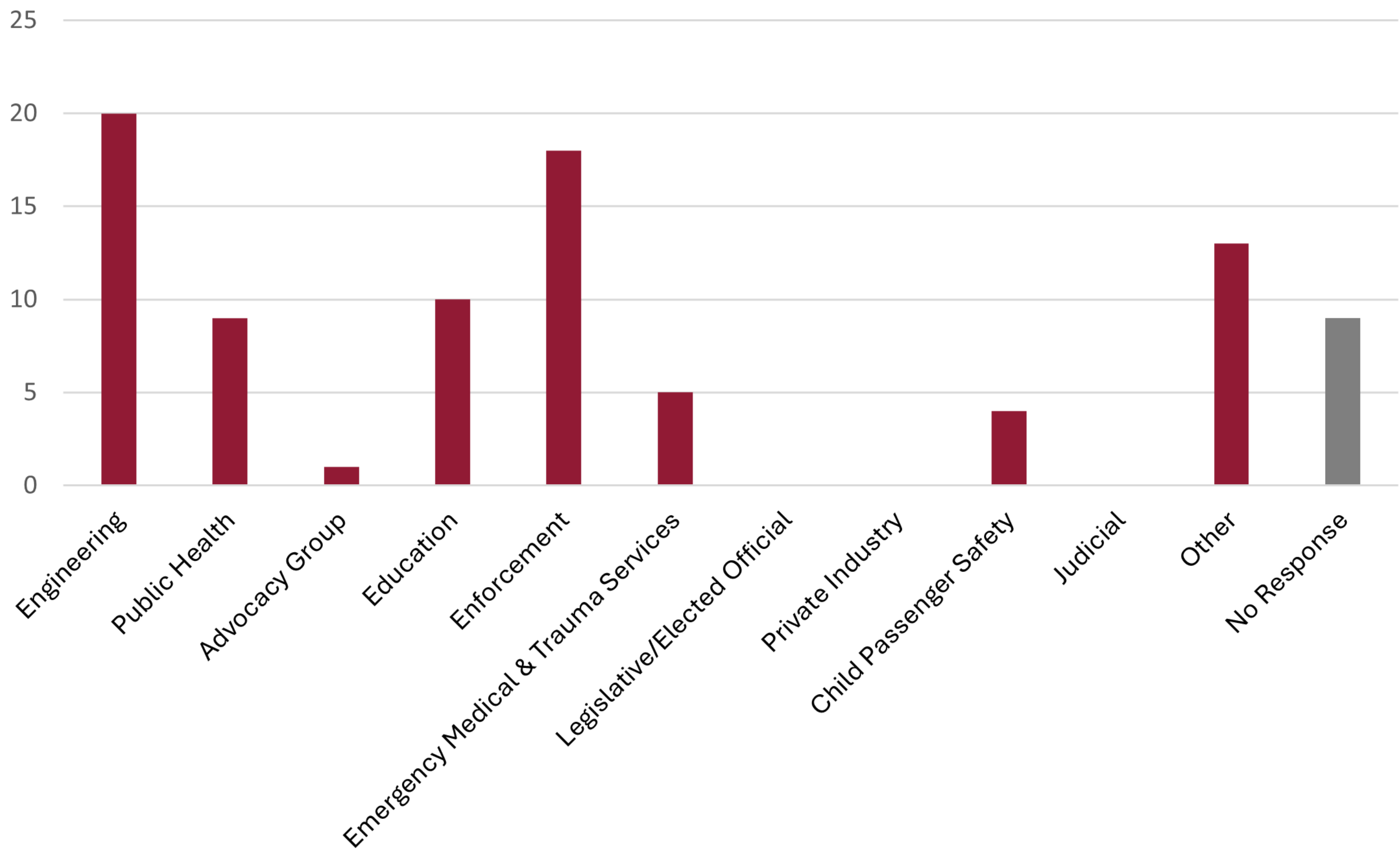
SOUTHWEST TZD

The Southwest TZD workshop occurred on May 14, 2024, in Morton. In this workshop, participants most supported tactics focused on infrastructure improvements, such as installing rumble strips, improving pavement markings, and promoting helmet safety through public awareness campaigns. Participants generally opposed adding child passenger safety seat training to driver education and implementing variable speed limits. Alternative ideas posed included incorporating child passenger safety education as a part of prenatal classes and pediatric checkups, and to target speeding education efforts to people who are most likely to rush or multitask, such as parents. Participants of this workshop also provided many new ideas for tactics, particularly related to traffic safety culture, impairment, younger drivers, and older drivers. Comments from the large group discussion also emphasized concerns around inattentive driving, impaired roadway users, and ensuring affordable access to driver education. The sections below include a summary of discussions and activities related to the SHSP.

ATTENDEES

This workshop had 89 attendees. The top stakeholder designation was Engineering, followed closely by Enforcement.

Figure 25. Southwest TZD Workshop Stakeholder Designations



BENCHMARK ACTIVITY

Participants were provided data on recent annual roadway fatalities for the state and for their region and reminded that the state had previously set a goal of no more than 225 fatalities by 2025 as a benchmark on the way to zero. The region-specific goal was no more than 18 fatalities by 2025. Participants provided a range of input for what a potential 2030 goal could be, for both the state and the region. Results of this activity, aggregated into tens, are shown in the next two figures. The median number for the state goal was 200, and the median number for the regional goal was 9.

Figure 26. Southwest TZD 2030 Traffic Fatalities Benchmark Input (Statewide)

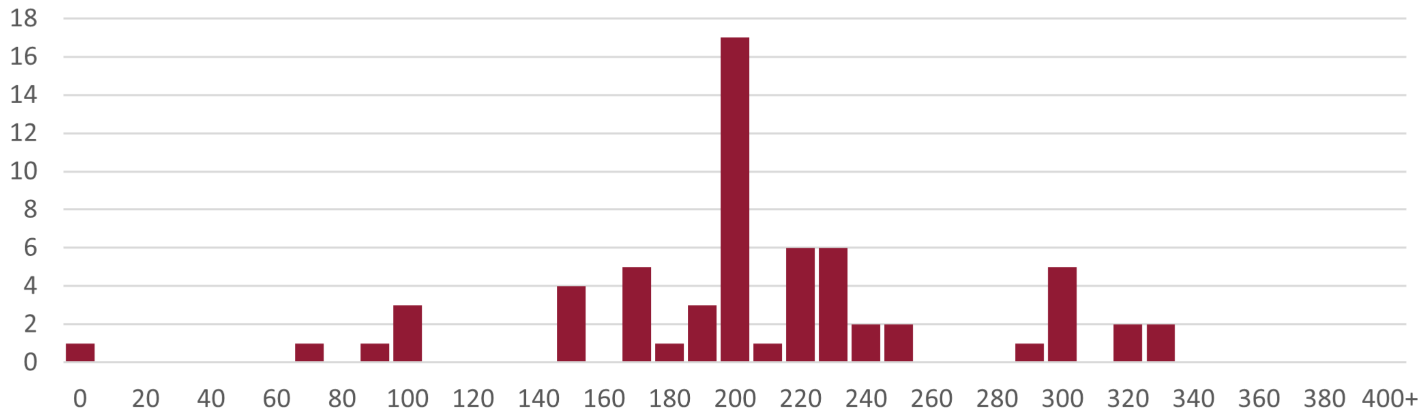
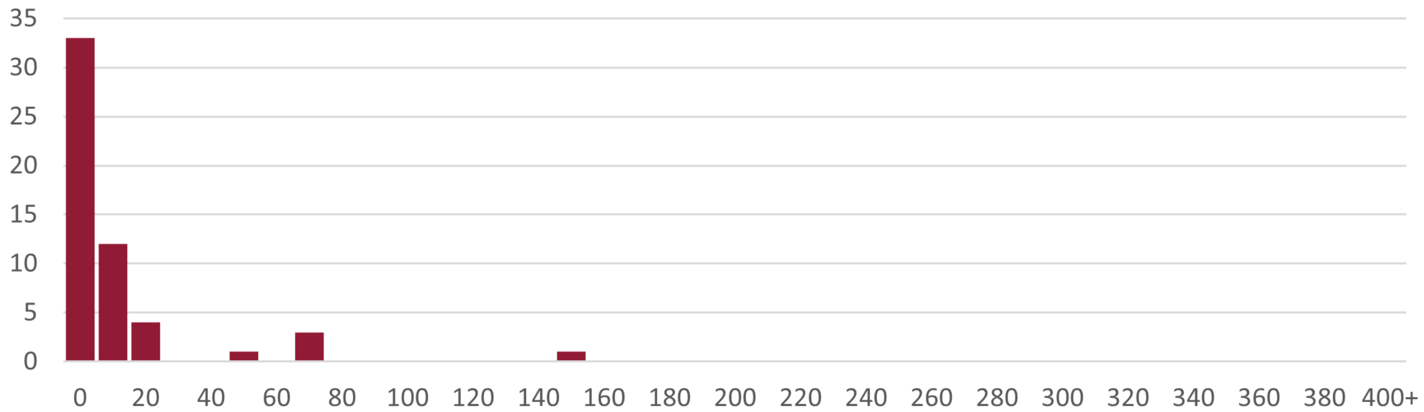


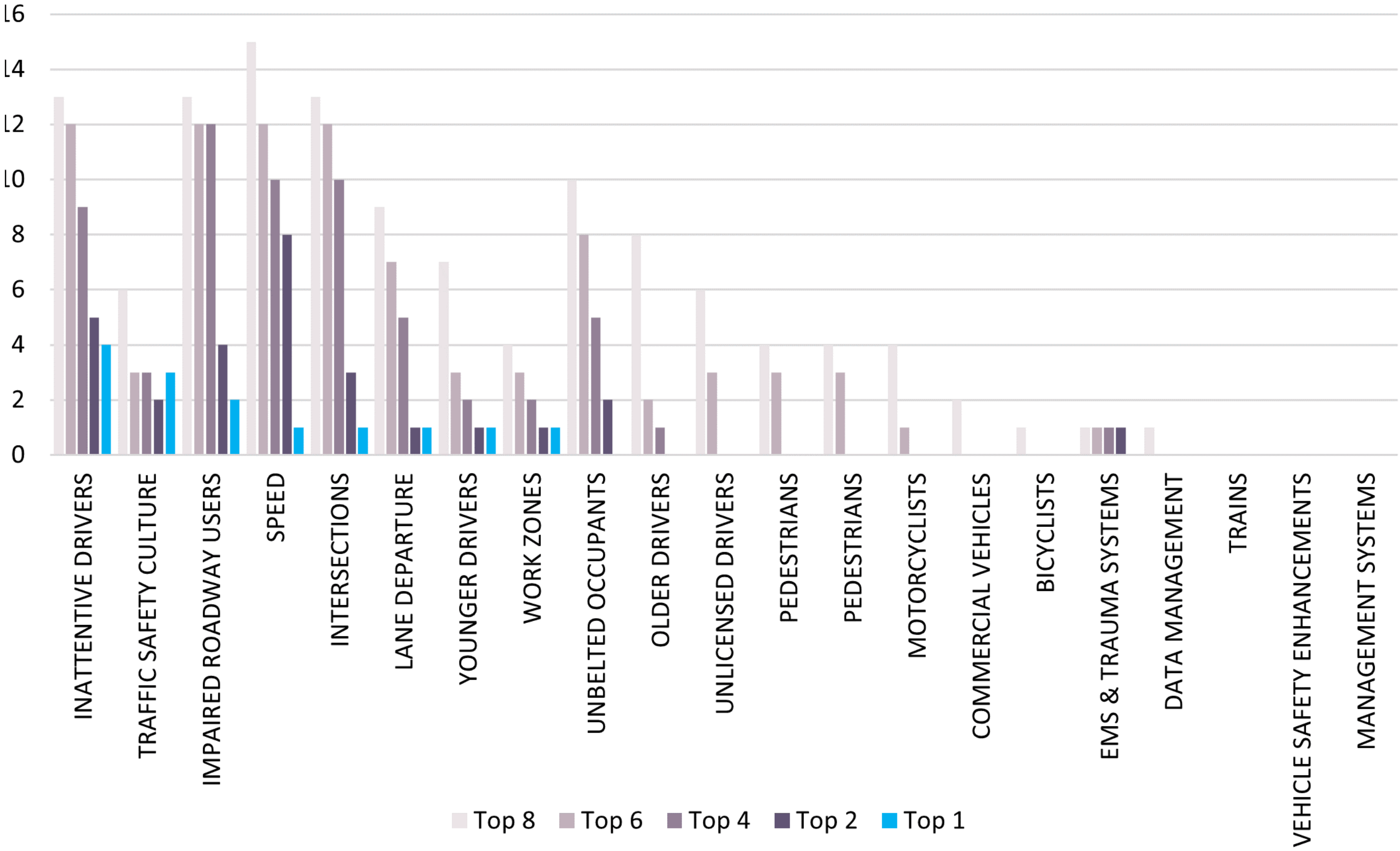
Figure 27. Southwest TZD 2030 Traffic Fatalities Benchmark Input (Region)



CRAZY EIGHTS ACTIVITY

During the Crazy Eights activity, participants identified Inattentive Driving and Speed as the top focus areas. Intersections and Impaired Driving also emerged as significant safety issues, with attendees calling for stronger enforcement and infrastructure interventions to address these problems.

Figure 28. Southwest TZD Crazy Eights Results



FOCUS AREA STRATEGIES ACTIVITY

As shown in the tables below, the top-supported tactics from the 2020-2024 SHSP were LD1.1, installing rumble strips on two-lane roads, LD1.2, improving pavement markings, and M2.4, initiating a public awareness campaign about helmet safety. In contrast, UO3.2, which proposed adding child passenger safety seat training to driver education, received the most negative feedback. Overall, participants favored infrastructure-based solutions and public education over adding new training requirements.

Table 8. Southwest TZD Top Tactic by "Yes" Stickers

TACTIC	DESCRIPTION	YES	NO
LD1.1	Install rumble strips and mumble strips on centerlines and edges of roads, especially along two-lane roadways, to tactically warn drivers if their vehicles leave the desired travel area.	20	0
LD1.2	Install improved pavement markings, such as wet reflective edge stripes and wider (i.e. 6" instead of 4") markings.	20	0
M2.4	Initiate a public awareness campaign about the safety benefits of wearing helmets.	20	0

Table 9. Southwest TZD Top Tactic by "No" Stickers

TACTIC	DESCRIPTION	YES	NO
UO3.2	Add training on the importance of proper use of child passenger safety seats to driver education curriculum standards.	1	12

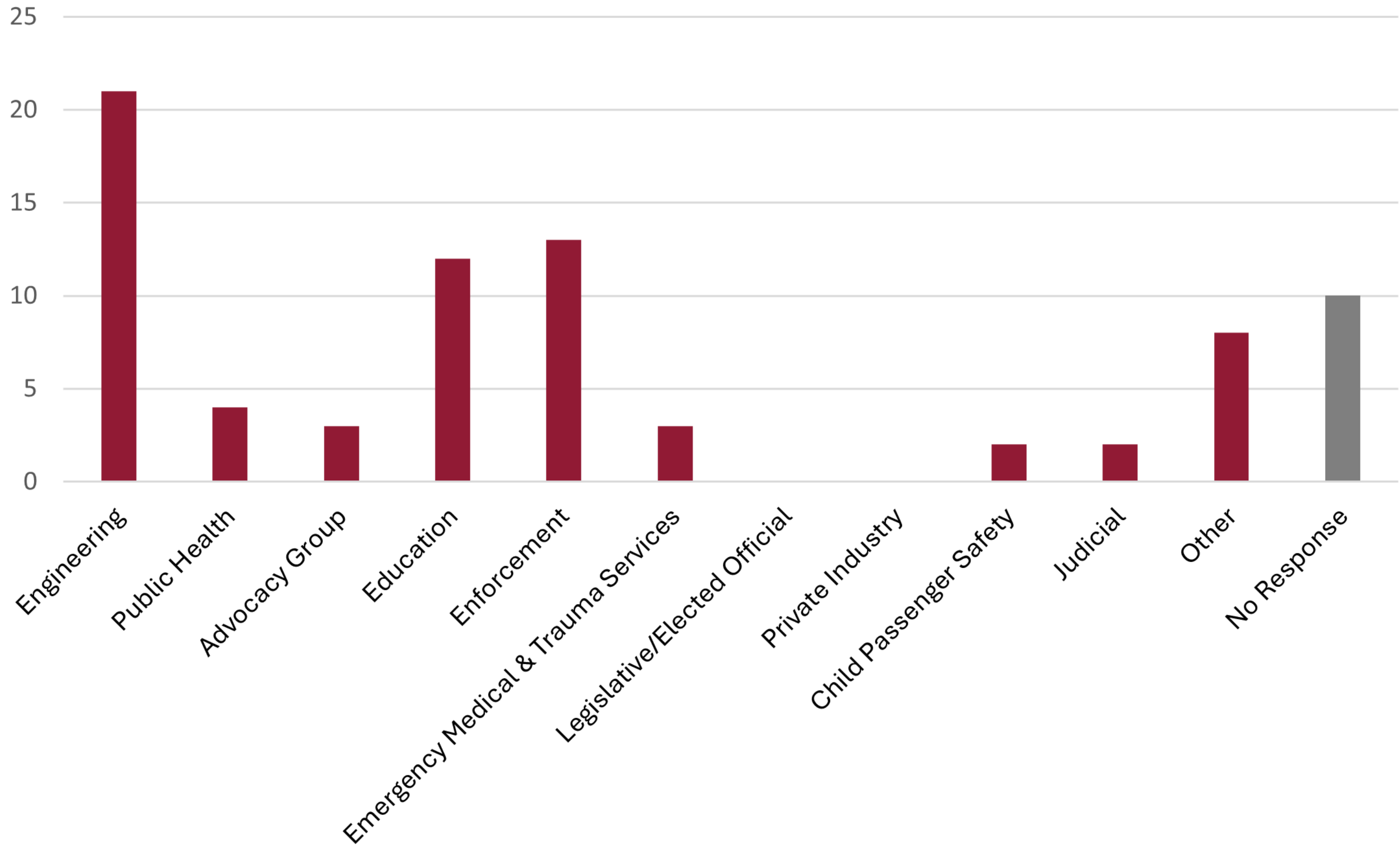
NORTHEAST TZD

The Northeast TZD workshop occurred on May 21, 2024, in Duluth. In this workshop, key discussions focused on reducing distracted driving and improving intersection safety. The most supported tactics included encouraging judges to reduce leniency for distracted driving offenses and applying alternative intersection designs to improve safety. Mixed opinions were expressed toward driver assist technology, automated enforcement in work zones, and addressing motorcycle endorsement barriers. Participants also voiced concerns about speeding, lane departure, and impaired driving, emphasizing a need for practical, infrastructure-based solutions.

ATTENDEES

This workshop had 78 attendees. The top stakeholder designation was Engineering, followed by Enforcement and Education.

Figure 29. Northeast TZD Workshop Stakeholder Designations



BENCHMARK ACTIVITY

Participants were provided data on recent annual roadway fatalities for the state and for their region and reminded that the state had previously set a goal of no more than 225 fatalities by 2025 as a benchmark on the way to zero. The region-specific goal was no more than 23 fatalities by 2025. Participants provided a range of input for what a potential 2030 goal could be, for both the state and the region. Results of this activity, aggregated into tens, are shown in the next two figures. The median number for the state goal was 200, and the median number for the regional goal was 25.

Figure 30. Northeast TZD 2030 Traffic Fatalities Benchmark Input (Statewide)

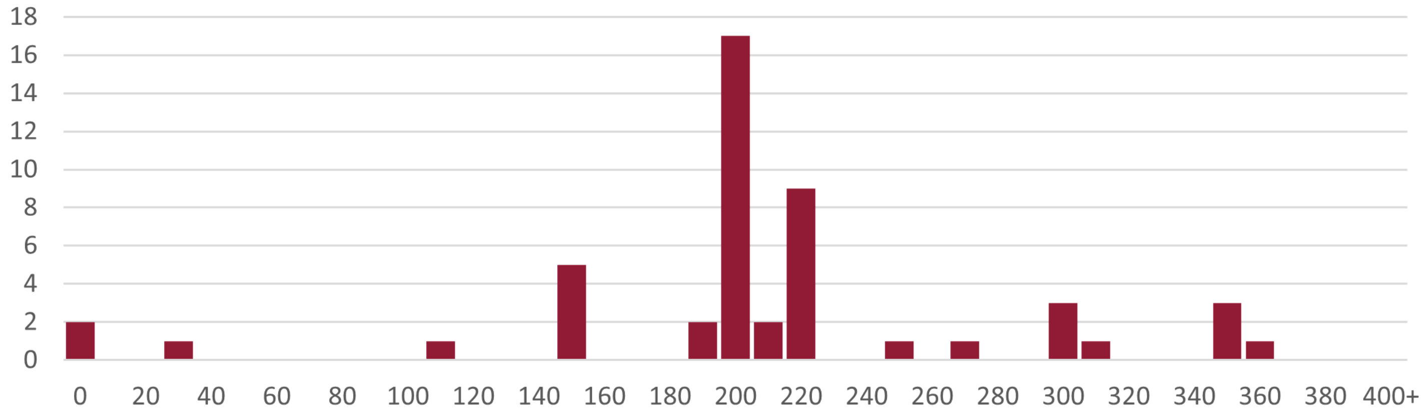
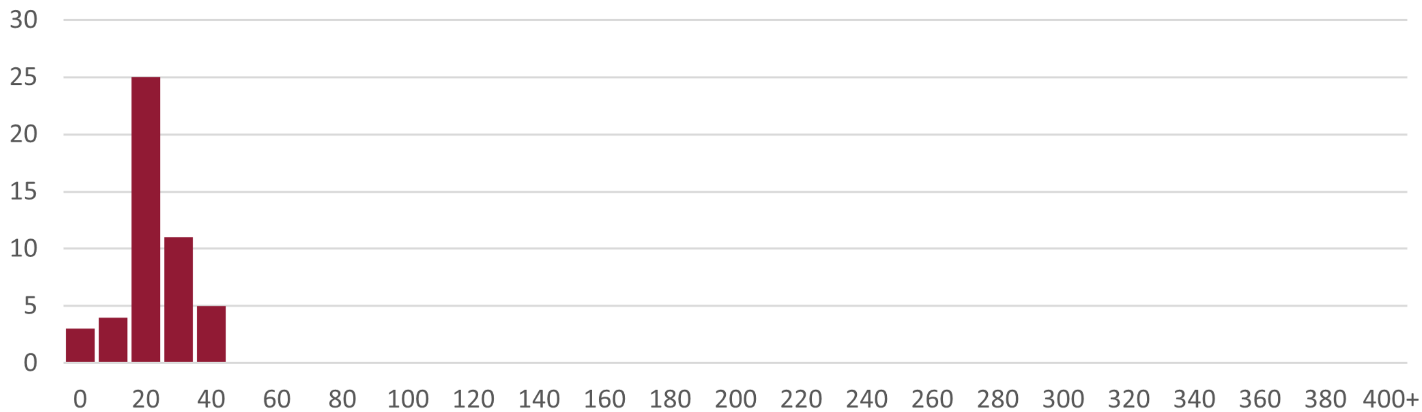


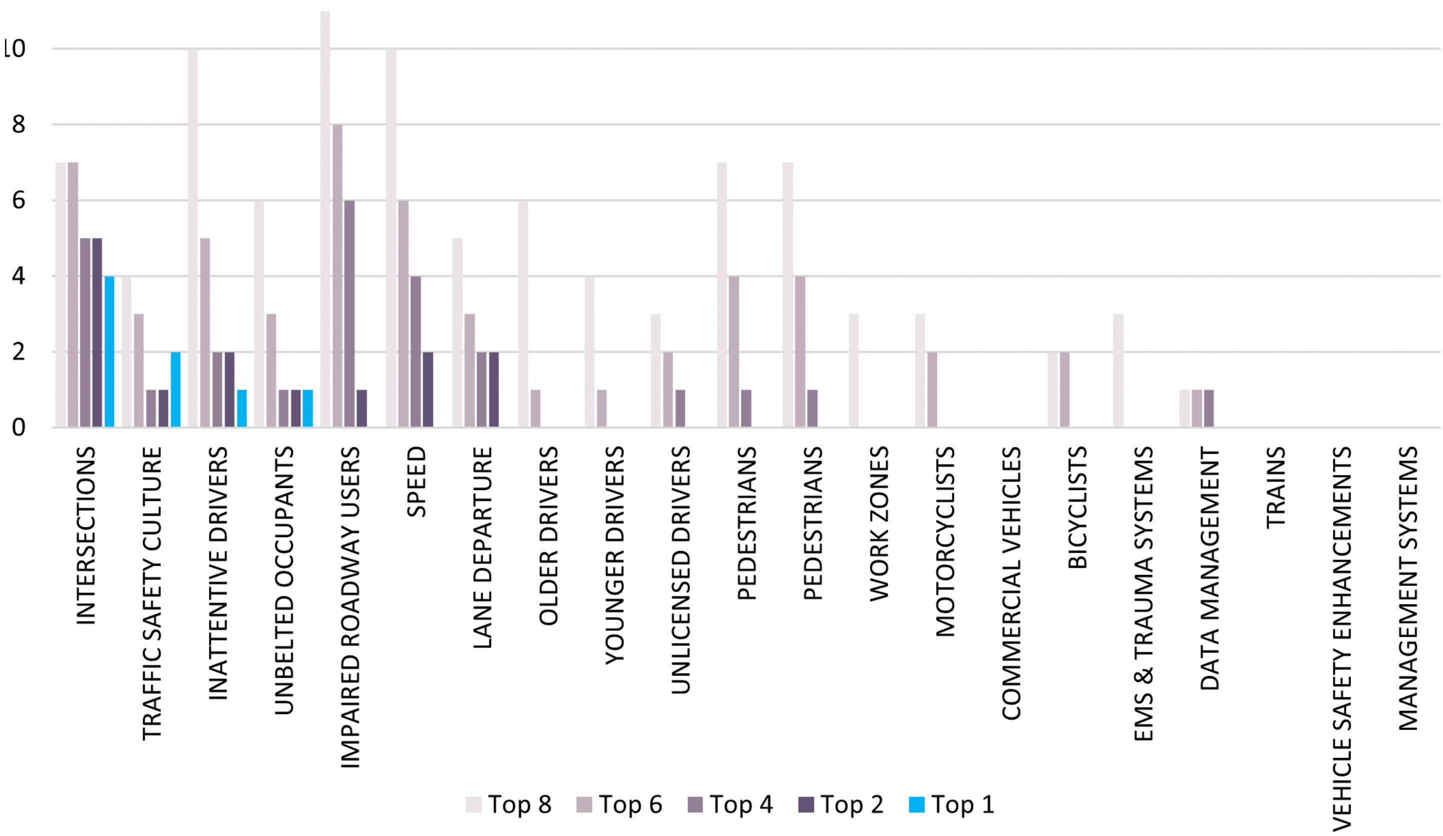
Figure 31. Northeast TZD 2030 Traffic Fatalities Benchmark Input (Region)



CRAZY EIGHTS ACTIVITY

During the Crazy Eights activity, participants prioritized Inattentive Drivers and Intersections as the top focus areas. Speed and Impaired Driving were also frequently mentioned, reflecting the region's challenges with both driver behavior and road design.

Figure 32. Northeast TZD Crazy Eights Results



FOCUS AREA STRATEGIES ACTIVITY

As shown in the tables below, the most supported tactics in the activity from the 2020-2024 SHSP were ID2.2, which encourages stricter sentencing for distracted driving offenders, and I1.4, promoting alternative intersection designs to reduce crash risks. The least supported tactics were WZ1.3, which proposed testing automated camera enforcement in work zones, and M2.5, removing barriers to obtaining motorcycle endorsements.

Table 10. Northeast TZD Top "Yes" Stickers

TACTIC	DESCRIPTION	YES	NO
ID2.2	Encourage judges to reduce leniency in sentencing distracted driving offenders.	15	4
I1.4	Apply alternative intersection designs on a corridor level approach	15	0

Table 11. Northeast TZD Top "No" Stickers

TACTIC	DESCRIPTION	YES	NO
WZ1.3	Encourage legislative changes to allow for a pilot project to test automated camera enforcement in work zones.	4	8
M2.5	Identify and remove barriers to obtaining a motorcycle endorsement.	0	8

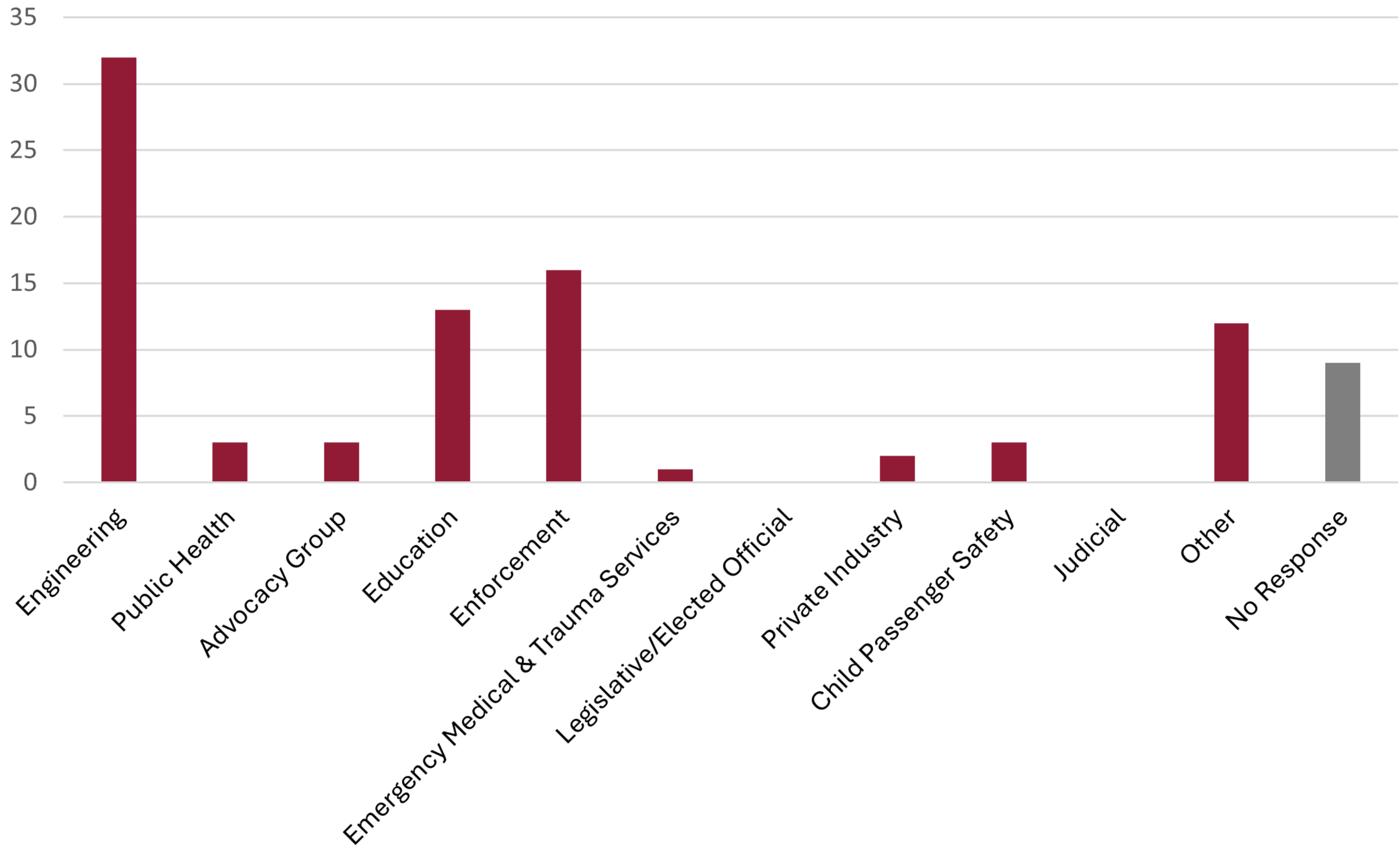
METRO TZD

The Metro TZD workshop occurred on May 23, 2024, in Brooklyn Center. In this workshop, participants favored tactics related to educational resources for safe walking, bicycling, and vehicle use, installing rumble strips, and improving driver education programs. An idea was shared to improve vehicle safety enhancements by studying the relationship between vehicle size and injuries. There were mixed opinions on implementing variable speed limits and supporting existing automated driving assist systems. Key focus areas discussed included Speed, Inattentive Driving, and lane departure. Many comments also addressed improving vehicle safety, work zone safety, and Traffic Safety Culture. The sections below include a summary of discussions and activities related to the SHSP.

ATTENDEES

This workshop had 94 attendees. The top stakeholder designation was Engineering, followed by Enforcement and Education.

Figure 33. Metro TZD Workshop Stakeholder Designations



BENCHMARK ACTIVITY

Participants were provided data on recent annual roadway fatalities for the state and for their region and reminded that the state had previously set a goal of no more than 225 fatalities by 2025 as a benchmark on the way to zero. The region-specific goal was no more than 72 fatalities by 2025. Participants provided a range of input for what a potential 2030 goal could be, for both the state and the region. Results of this activity, aggregated into tens, shown in the next two figures. The median number for the state goal was 221, and the median number for the regional goal was 100.

Figure 34. Metro TZD 2030 Traffic Fatalities Benchmark Input (Statewide)

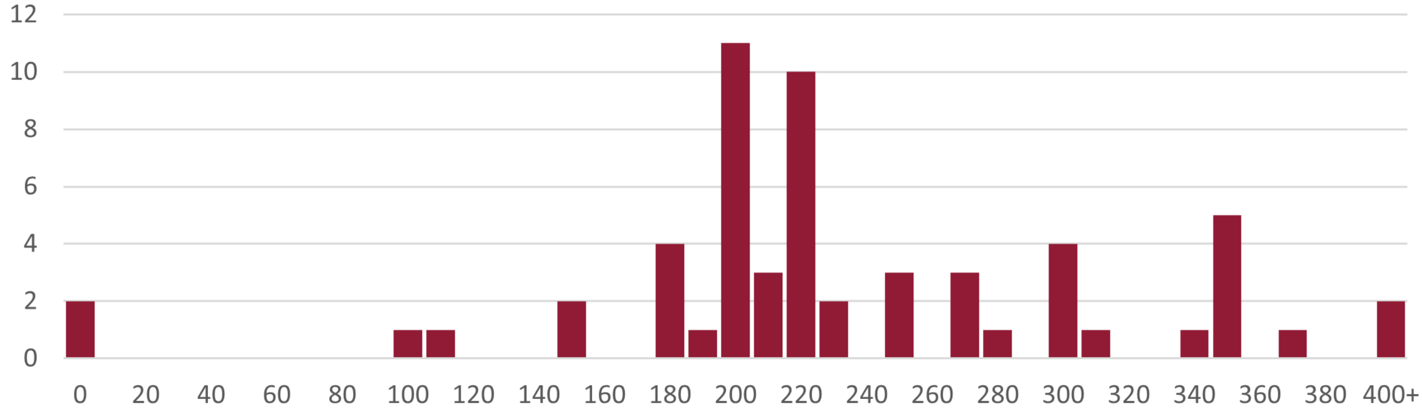
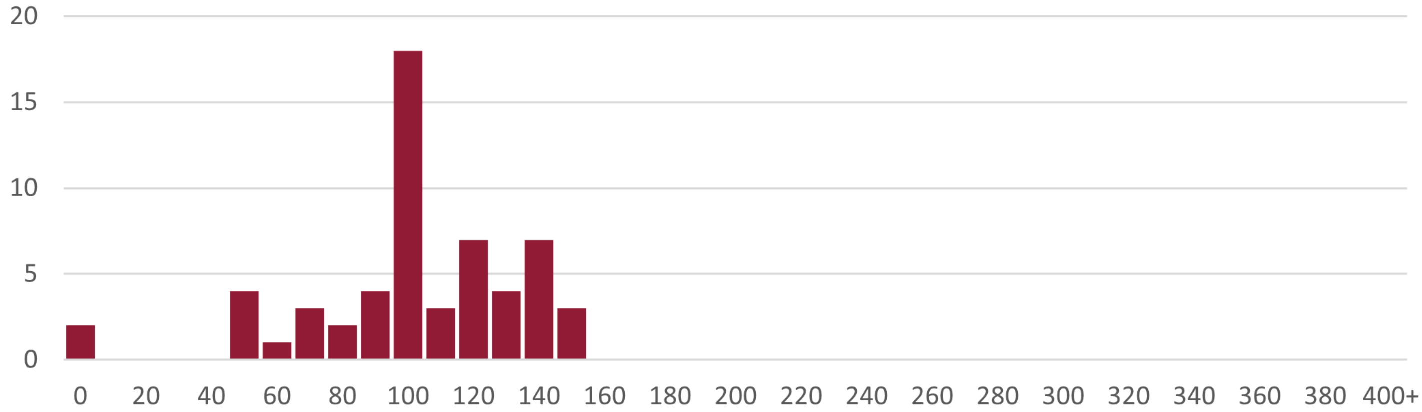


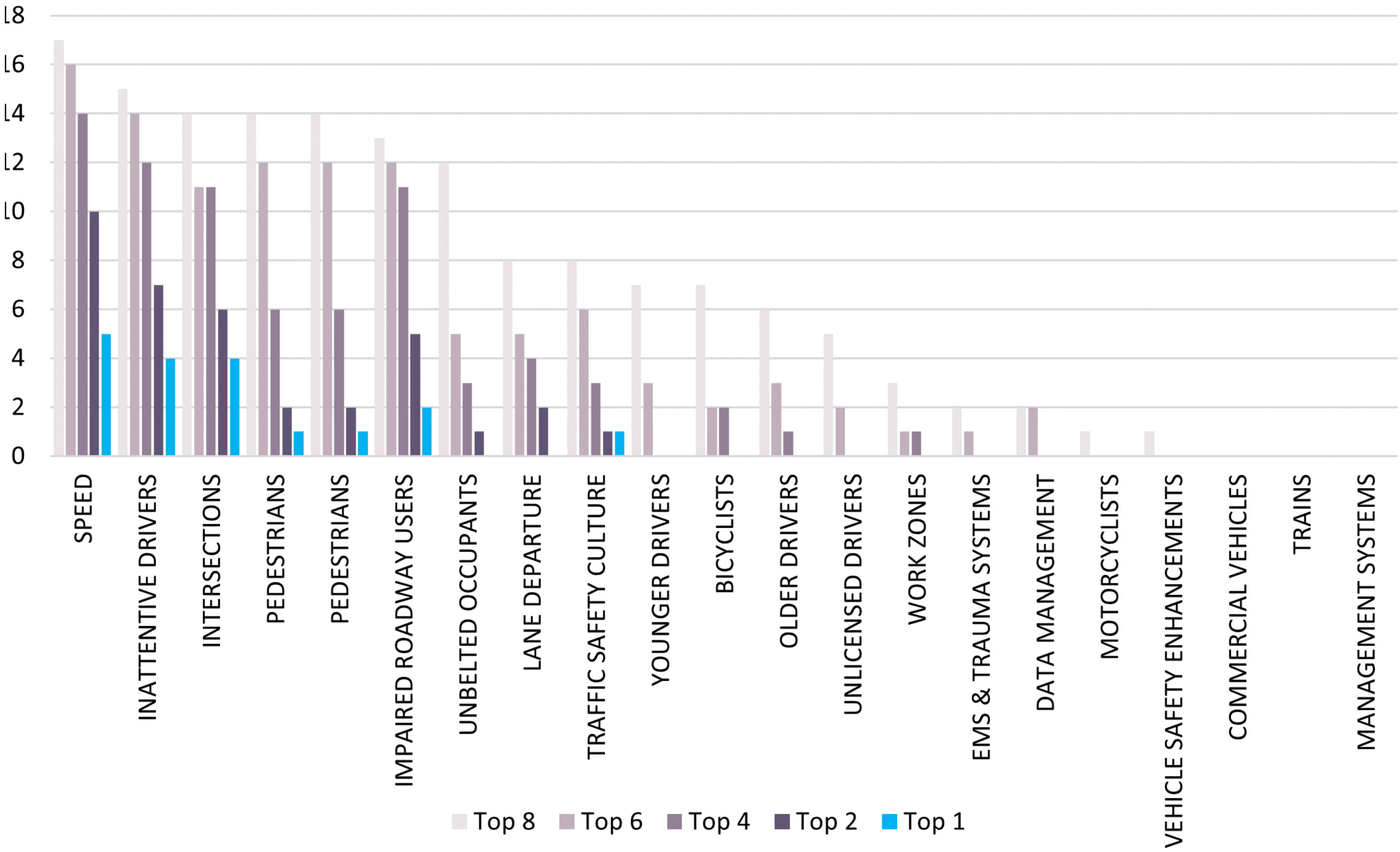
Figure 35. Metro TZD 2030 Traffic Fatalities Benchmark Input (Region)



CRAZY EIGHTS ACTIVITY

The Crazy Eights activity revealed that participants viewed Speed and Inattentive Driving as the top focus areas. Intersection safety and pedestrian safety were also highlighted as critical issues, which notably is the only inclusion of the Pedestrians focus area in the top four across all workshops. Participants expressed concerns about the high risks associated with speeding and distracted driving, especially in urban environments, emphasizing the need for education and enforcement.

Figure 36. Metro TZD Crazy Eights Results



FOCUS AREA STRATEGIES ACTIVITY

As shown in the tables below, the most supported tactics from the 2020-2024 SHSP were TSC4, distributing educational resources for walking, bicycling, and vehicle safety, LD1.1, installing rumble strips on two-lane roads, and YD2.1, reviewing and improving driver education programs. S3.4, implementing variable speed limits, received the most negative feedback. Participants focused on practical measures such as education and infrastructure improvements rather than automated enforcement or technology-driven solutions.

Table 12. Metro TZD Top Tactic by "Yes" Stickers

TACTIC	DESCRIPTION	YES	NO
TSC4	For school-based health educators and school resource officers, develop and distribute updated age-appropriate informational resources on safe behaviors while walking/bicycling in or near roadways and while riding in passenger vehicles.	22	0
LD1.1	Install rumble strips and mumble strips on centerlines and edges of roads, especially along two-lane roadways, to tactically warn drivers if their vehicles leave the desired travel area.	17	0
YD2.1	Review the current driver education program and identify ways to strengthen and improve it.	17	0

Table 13. Metro TZD Top Tactic by "No" Stickers

TACTIC	DESCRIPTION	YES	NO
S3.4	Implement variable speed limits to account for changing driving conditions. Encourage legislative changes to allow for regulatory variable speed limits.	0	10

2.2.4 TZD WORKSHOPS AND ROUNDTABLES SUMMARY

In all workshops, the focus areas most discussed were Inattentive Driving, Speed, and Intersections. Participants shared a desire for enhanced education on distracted driving and speeding, especially for younger drivers. Intersection improvements were frequently cited as a critical area for reducing crashes, with suggestions for redesigning high-risk intersections and adding safety measures such as rumble strips and improved pavement markings. There were mixed opinions generally related to automated enforcement tactics, particularly in relation to speed and red-light cameras, with concerns about effectiveness and privacy.

There were seven regional workshops in various locations throughout the state and four roundtables in the West Central Region (in place of one workshop for that region). Together, these workshops and roundtables covered all eight TZD regions around the state and were attended by more than 800 individuals.

SUMMARY OF ROUNDTABLES

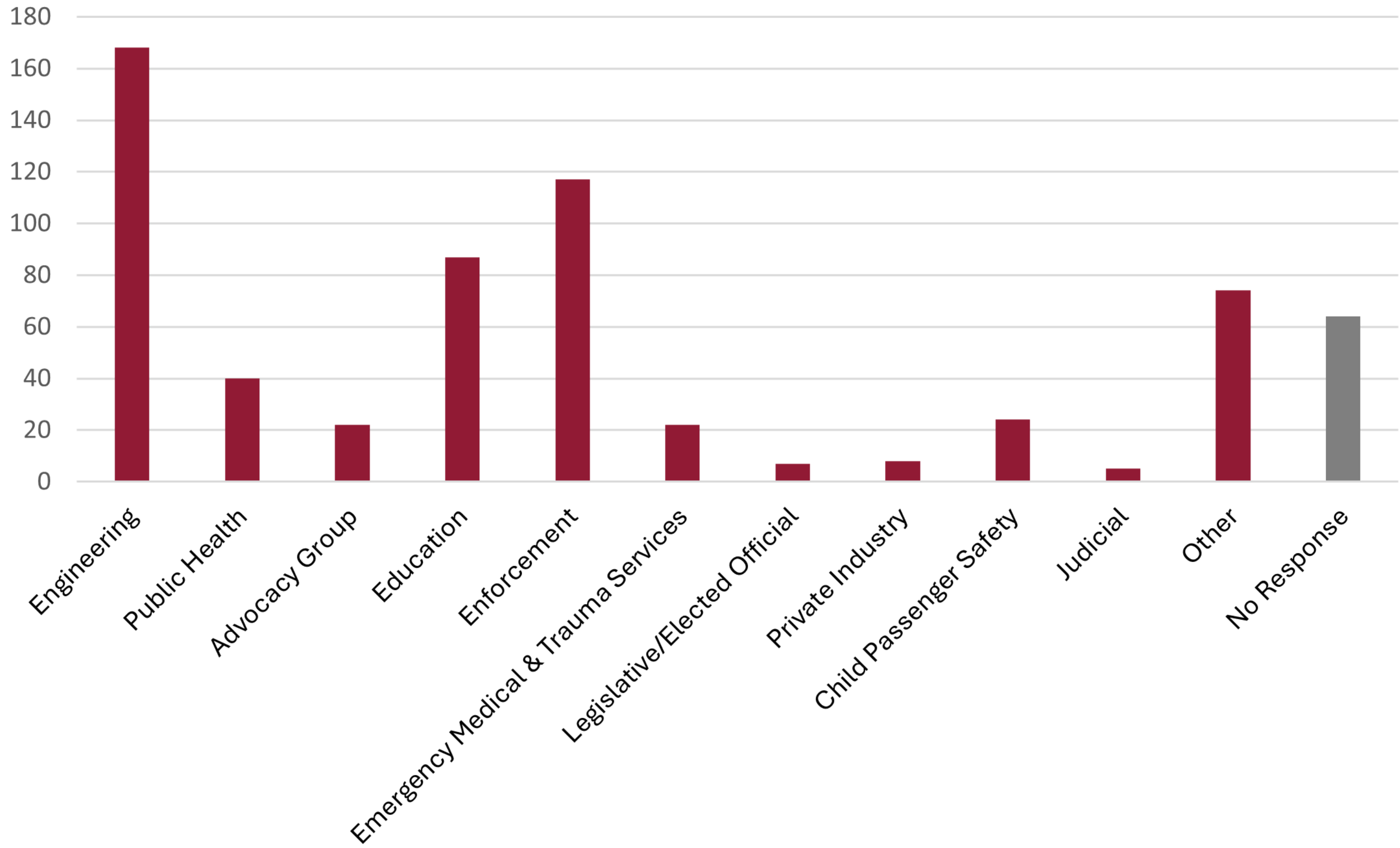
Concerns about Inattention, Speed, Impairment, and Unlicensed Drivers were common among roundtable participants, with Traffic Safety Culture and Traffic Safety Education viewed as key solutions. Emerging themes included concerns about rising drug-impaired driving, high unbelted fatalities, increasing motorcycle crashes, and increasing off-road user crashes. Recent successes discussed within the region included post-crash care improvements (including new helicopter and telehealth infrastructure).

SUMMARY OF WORKSHOPS

ATTENDEES

Across all the TZD workshops there were 679 attendees. Participants had diverse stakeholder designations, with Engineering, Enforcement, and Education consistently making up the largest shares of participants. The highest percentage of Engineering participants was seen in the Metro TZD (35%). Public Health representation was lower in most workshops but was notable in the Southwest TZD, where it made up 10% of attendees. Southeast had the highest attendance with 170 participants. Overall, the stakeholder designations included a balance of Engineering, Enforcement, Educational, and EMS/Public Health perspectives.

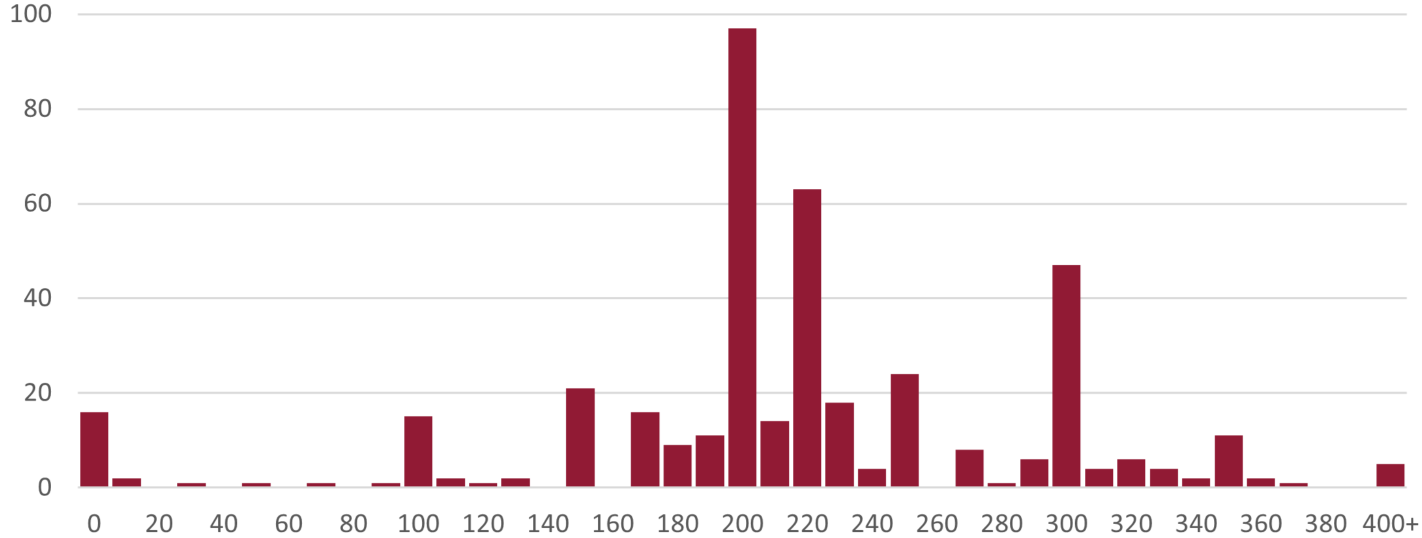
Figure 37. Stakeholder Designations Across all TZD Workshops



BENCHMARK ACTIVITY

The following figure shows the combined results of the benchmark activity at all the TZD workshops. The median number was 215.

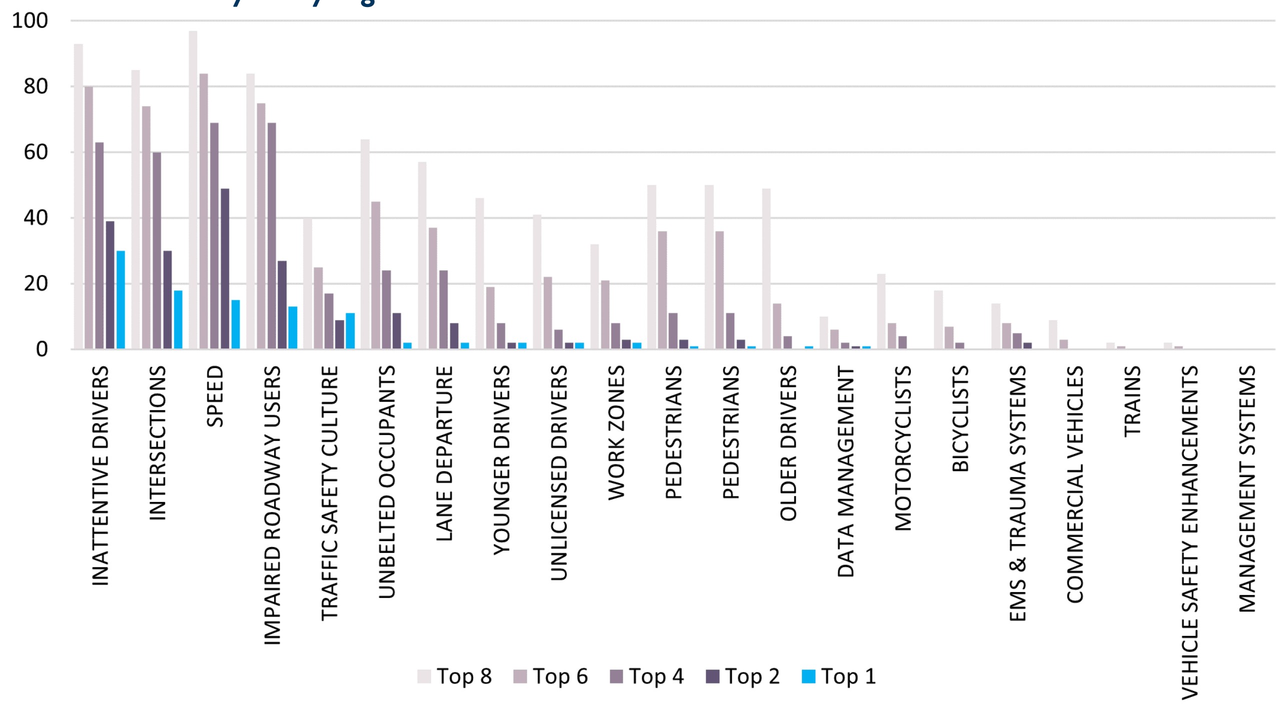
Figure 38. TZD Workshops 2030 Traffic Fatalities Benchmark Input (Statewide)



CRAZY EIGHTS ACTIVITY

In the Crazy Eights activity, Inattentive Drivers, Intersections, and Speed were consistently in the top four across all workshops. Participants viewed distracted driving as a growing threat and expressed concern over speeding. Intersections, Impaired driving, and Lane Departure were also frequently highlighted, reflecting widespread agreement on the most pressing safety concerns. Discussions often pointed to the need for a combination of education, enforcement, and infrastructure improvements to address these issues.

Figure 39. TZD Summary Crazy Eights Results



FOCUS AREA STRATEGIES ACTIVITY

As shown in the tables below, the most supported tactics from the 2020-2024 SHSP across all workshops included TSC4 (developing and distributing educational resources on safe walking, bicycling, and vehicle use), LD1.1 (installing rumble strips on rural roads), and I1.3 (redesigning intersections to reduce severe crashes). Tactics related to automated enforcement, such as S3.4 (implementing variable speed limits) and WZ1.3 (using automated enforcement in work zones), received significant negative feedback. Participant feedback generally favored infrastructure-based solutions and education over automated or technology-driven enforcement strategies.

Table 14. Summary TZD Top Tactic by "Yes" Stickers

TACTIC	DESCRIPTION	YES	NO
TSC4	For school-based health educators and school resource officers, develop and distribute updated age-appropriate informational resources on safe behaviors while walking/bicycling in or near roadways and while riding in passenger vehicles.	100	0
LD1.1	Install rumble strips and mumble strips on centerlines and edges of roads, especially along two-lane roadways, to tactically warn drivers if their vehicles leave the desired travel area.	98	1
I1.3	Design intersections to lower crossing conflict points, manage access points, and reduce the number of severe crashes at intersections. Apply alternative design to intersections with a high frequency of severe crashes or systemic risk factors.	90	0

Table 15. Summary TZD Top Tactic by "No" Stickers

TACTIC	DESCRIPTION	YES	NO
TSC 3	Support the transition to autonomous vehicles and other emerging motor vehicle technology to reduce human error, including in interactions with people walking, rolling, and bicycling.	12	53
TSC 6	Encourage the use of existing motor vehicle technology designed to reduce distracted driving crashes, such as lane departure warning alerts, forward collision warning alerts, and automatic braking.	42	46

Tactic ID 2.2, which stated, "Encourage judges to reduce leniency in sentencing distracted driving offenders", was also a highly voted upon tactic, but the phrasing confused participants. Although in total 59 said "yes" and 40 said "no", many who indicated no understood the question to mean the opposite of what was intended (judges should be less lenient). As a result, these numbers should not be used.

2.3 CONSULTATION WITH VULNERABLE ROADWAY USERS

The Vulnerable Road User Safety Assessment (VRUSA) is a requirement under the Bipartisan Infrastructure Law (BIL) signed in 2021. Each state is required to complete this assessment to address the safety of vulnerable road users, such as pedestrians and cyclists, within two years of the law's enactment. The goal is to develop a data-driven approach to improve non-motorist safety and identify high-risk areas where additional countermeasures can be implemented. This includes analyzing crash data and developing strategies to protect these road users in various transportation planning efforts.

Minnesota's initial VRUSA was published in late 2023. An update to the VRUSA reflecting an additional year of data was prepared as part of the 2025-2029 SHSP update and is included as an appendix to the SHSP update document.

Vulnerable roadway users were engaged throughout the SHSP update process. This is consistent with federal guidance for the VRUSA which directs states to involve the public in the SHSP development process, particularly addressing the needs of underserved and underrepresented populations. Underserved communities include racial and ethnic minorities, LGBTQ+ individuals, persons with disabilities, rural residents, and those impacted by poverty or other inequalities.

Specific events and activities to engage vulnerable roadway users and to represent related safety needs include:

- **ACTS and ACTS SHSP Working Group:** Included participation and comments from individuals representing bicyclists, pedestrians, persons with disabilities, and vulnerable roadway users generally
- **MnDOT Office of Transit and Active Transportation:** Staff from this office conducted a focused review of the SHSP draft strategies and tactics regarding pedestrian and bicyclist safety
- **Public Health Coordination:** The SHSP included specific discussions with public health practitioners regarding the needs of vulnerable populations into the SHSP, which resulted in inclusion of an overarching principle to prioritize the needs of vulnerable and historically underserved populations
- **TZD Workshops/Roundtables:** These events engaged with stakeholders around the state, including substantial input from those representing rural populations
- **Equity-Focused Outreach Meetings:** As detailed in **Section 2.4**, the SHSP team conducted a series of equity-focused outreach meetings with key community stakeholders to ensure input reflects diverse participation
- **Tribal Coordination:** Provide opportunities for input and shared information at meetings focused on tribal transportation and safety issues (see **Section 2.5**)
- **Public Events:** Engaged wide range of the public both in person and online (see **Section 3**)

In combination, these inputs and discussions provided robust engagement with vulnerable roadway users that is reflected throughout the SHSP update and the recommended focus area strategies and tactics.

2.4 EQUITY-FOCUSED OUTREACH MEETINGS

The SHSP team conducted a series of eight equity-focused outreach meetings with key community stakeholders in the metro and state-based organizations to ensure input reflects diverse participation. Stakeholders were identified based on high crash rates, high equity scores based on demographic data (see Crash Trends Technical Report Appendix to the SHSP), geographic diversity, and known groups experiencing transportation inequities (disability, racial, and income/class advocacy).

2.4.1 EQUITY ENGAGEMENT STAKEHOLDER GROUPS

The team identified a list of dozens of potential organizations, groups, and individuals based on the communities that were identified as overrepresented in fatal and serious injury crash data throughout the state.

- The team looked at geographic areas with high ped/bike crashes and equity scores based on analysis using the MnDOT SPACE tool.
- The team also looked specifically at Metro and non-Metro contacts to identify organizations and individuals currently working on initiatives towards equity efforts in their respective fields.
- The team took a general identity focus and identified disability, racial, and income/class advocacy groups—known groups experiencing transportation inequities based on previous analysis.

After identifying potential stakeholders, the team reviewed the list to identify if any stakeholders were already being brought into other areas of the project. A goal was to focus the equity engagement on bringing new voices into the process, and then grouped similar stakeholders together for broader listening sessions. The final list of organizations that accepted interviews is below.

GROUP	ORGANIZATION
Tribal advocates	MnDOT Director of Tribal Affairs
Neighborhoods of Minneapolis	Phillips West Neighborhood Organization
Neighborhoods of Saint Paul	North End Neighborhood Organization
Disability advocates	The Arc Minnesota, Mobility Mania, and an advocate for travelers with vision loss
Racial justice advocates	Diversity Council of Mankato
Ped/bike advocates	BikeMN, Our Streets MPLS
Motorcyclist advocates	A.B.A.T.E.

2.4.2 KEY THEMES

Each session included the same set of questions related to safety, accessibility, priorities for MnDOT to consider, and who should be included in the conversations moving forward.

Below are the main themes that emerged.

ACCESSIBILITY AND ACCESS

- Everyone should be able to access the same public transportation resources safely regardless of mode of transportation.
- Prioritizing disabled voices will ensure that all accessibility requirements are within MnDOT projects and the greater system.
- Increase focus on snow clearing to enhance accessibility for all modes of transportation.
- Actively upkeep road and crosswalk markings for pedestrian safety.

EDUCATION

- Allow for traffic education catering to different cultural backgrounds and languages.
- Create and include educational resources through community-building events and outreach.
- Continued education of new and unfamiliar road features, (i.e. roundabouts, J-turns, etc.) specifically for rural and elder populations.

ENGINEERING

- Update and improve current infrastructure to equally cater to all modes of transportation (pedestrians, drivers, cyclists, wheelchairs, etc.).
- Addressing bicyclist and pedestrian safety through proper infrastructure (bump outs, shoulder widening, etc.) is critical to attaining more equitable traffic safety.
- Consider improved shoulders, lane widths, and other minimal cost enhancements throughout the roadway systems.

- Construct clear, consistent, and safe separation between bike lanes and car lanes.
- Invest in proven countermeasures as much as possible.
- Consider including near misses when looking at crash statistics, in addition to fatalities and serious injuries.

ENFORCEMENT

- Further enforcement of speeding, distracted driving, and reckless driving is needed.
- Consistent enforcement of drivers disregarding pedestrian and cyclist safety is needed.
- Increase law enforcement funding within tribal lands.

CULTURE

- Change messaging in traffic signage and social advertisements to be more explicit.
- Changing driver behavior starts with connections in the community that can help share good driver behaviors and values.
- Increased efforts to understand safety values between other states and countries will help our state improve.

Additional comments that were not consistent throughout all sessions but that were noted:

- Create phone applications for accessibility users that can interact with street intersections and public transportation services. Phone application would interact with updated maps to warn the user of upcoming construction, a closed sidewalk, or uneven roads.
- Utilizing asphalt art, specifically in crosswalks and curb extensions, would help improve street and pedestrian safety by increasing the visibility of users on those spaces and encourage drivers to slow down and be more alert to vulnerable road users.
- Create interactive car functions that can communicate with drivers to notify them of crossing pedestrians.
- Volunteer programs could be created for non-native speakers to support driving education and enforce a positive safety culture.
- Engineers should closely coordinate with tribes on the counties and trunk highway systems. Coordination should begin with establishing and maintaining relationships with tribal contacts.

2.5 TRIBAL COORDINATION

Tribal coordination was a key element of the SHSP engagement effort, as tribal lands are known to have an overrepresentation of crashes compared to other parts of the state.

2.5.1 ADVOCACY COUNCIL FOR TRIBAL TRANSPORTATION

The SHSP team shared information on the SHSP update process at the March 2024 meeting of the Advocacy Council for Tribal Transportation. The group is hosted by MnDOT and its membership includes representatives of Minnesota's tribal nations.

2.5.2 TRIBAL TRAFFIC SAFETY SUMMIT

The SHSP team participated in the 2024 Tribal Traffic Safety Summit on April 3rd to share a presentation about the SHSP and gather input from other participants. A goal of SHSP team attendance was also to gain a better understanding of tribal traffic safety issues generally to better incorporate solutions into the plan. Opportunities for comment on priorities for the SHSP update were provided.

Figure 40. SHSP Input Opportunity at the Tribal Traffic Safety Summit

2.5.3 OTHER TRIBAL OUTREACH

During the public survey round #1 (described below), advertising information was provided for each tribal nation to distribute in their print or online communications as desired. Additional tribal engagement was also conducted as a part of the equity-focused outreach meetings described above.

2.5.4 OTHER AGENCY COORDINATION

The SHSP team also specifically engaged other agencies and professional through the following channels:

- Minnesota Metropolitan Planning Organization (MPO) Directors Meeting (May 7th, 2024)
- 2024 MN Transportation Conference (May 30th, 2024) – interactive presentation
- Informational Updates to the 12 counties preparing County Road Safety Plans

Figure 41. Photos from the 2024 MN Transportation Conference

GENERAL PUBLIC ENGAGEMENT

The SHSP team engaged members of the public around the state through both in-person and online events.

3.1 GENERAL PUBLIC IN-PERSON EVENTS

The SHSP team attended two well-attended public events to provide information on the SHSP update and gather input related to the SHSP and safety priorities.

3.1.1 TWIN CITIES AUTO SHOW

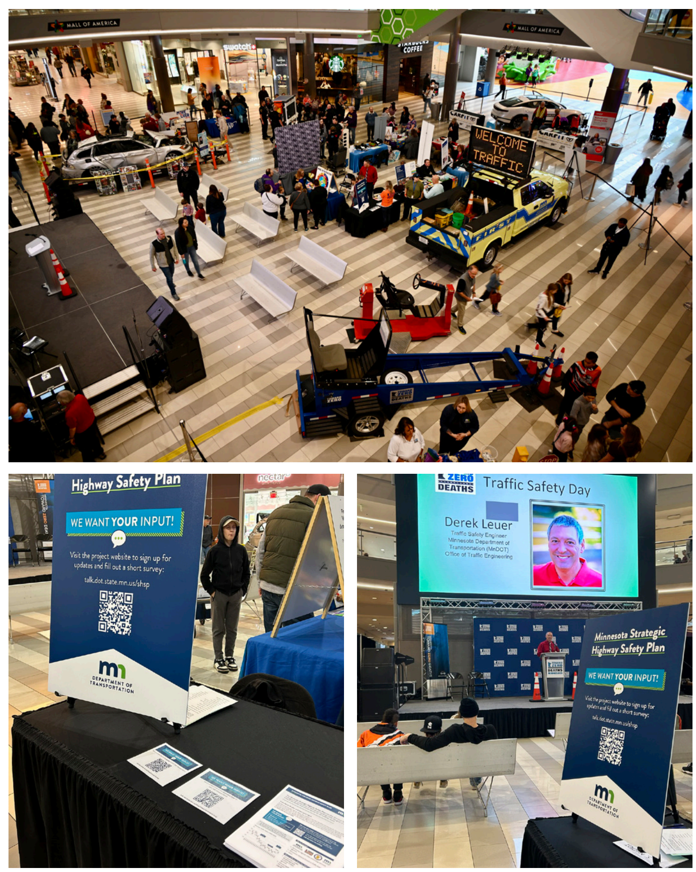
The Twin Cities Auto show was held in Minneapolis from April 1st through April 7th, 2024. Information on the SHSP was provided at the Minnesota TZD booth at the event (see photos). Information provided included a handout on the SHSP, and a survey on safety priorities available both online and in paper format. An estimated 80 surveys were completed by Auto Show attendees, with many more taking information and speaking with TZD staff. Survey results are included in the discussion in **Section 3.3**, below.

Figure 42. TZD Booth with SHSP Information – Twin Cities Auto Show

3.1.2 TRAFFIC SAFETY DAY AT THE MALL OF AMERICA

The first annual Traffic Safety Day was held in the rotunda at the Mall of America in Bloomington on April 20th, 2024. The event, sponsored by Minnesota TZD, included two dozen safety related information booths and vendors. The SHSP team had a table with informational handouts and a survey on safety priorities available both online and in paper format. In addition, MnDOT and other staff held live presentations on a range of safety topics. The event was well attended by a wide range of individuals and families as they passed through the mall. 128 people engaged directly with staff and collected information on the SHSP, with many others passing by. Survey results are included in the discussion in **Section 3.3**, below.

Figure 43. Participants at Traffic Safety Day at the Mall of America



3.2 JOINT EVENTS WITH THE DEPARTMENT OF PUBLIC SAFETY

As a part of ongoing coordination with DPS, partners at DPS brought SHSP materials (handouts, surveys, QR codes for the website) to community events they attended to raise awareness and get input from the public:

- Twin Cities World Refugee Day (June 22nd, 2024)
- Somali Independence Day (June 29th, 2024)
- Worthington International Festival (July 12th – 13th, 2024)

These events were targeted toward reaching immigrant communities and others who may be less familiar with traffic safety topics, practices, resources, and laws.

3.3 ONLINE ENGAGEMENT ROUND 1 AND SURVEY RESULTS

MnDOT created a “Let’s Talk Transportation” webpage for the SHSP to solicit input and inform the general public of efforts. The webpage went live in April 2024 and included two rounds of engagement. The purpose of the first round was to gather input on priorities and needs, and the purpose of the second round was to gather input on the draft plan.

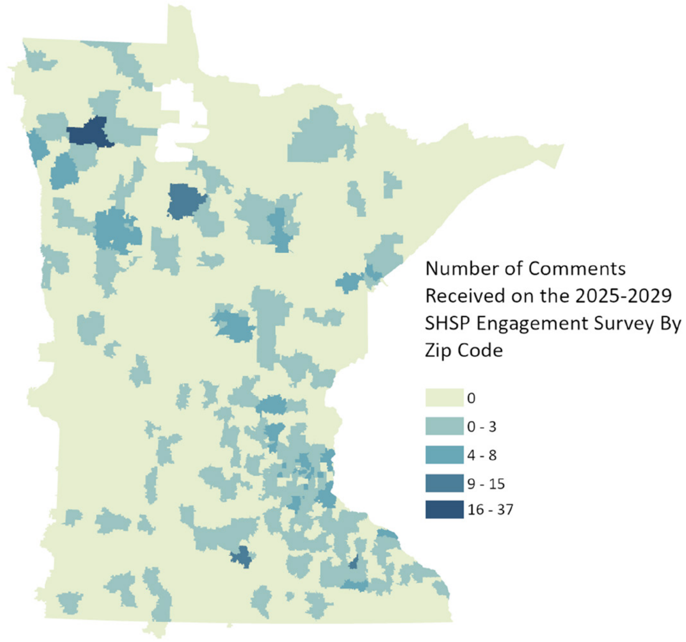
The public survey was live between April and September 2024, with advertising to the public focused in August. During this time, the webpage included basic information about the SHSP with links to learn more, a schedule, contact information, a survey, and an interactive comment map.

3.3.1 SURVEY QUESTIONNAIRE

The survey received a total of 682 submissions between April and September 2024. The survey was divided into four sections: zip code, traffic safety focus area priorities, safety statements (agree/disagree), and write-in comments. All questions were optional, resulting in varying response rates across sections.

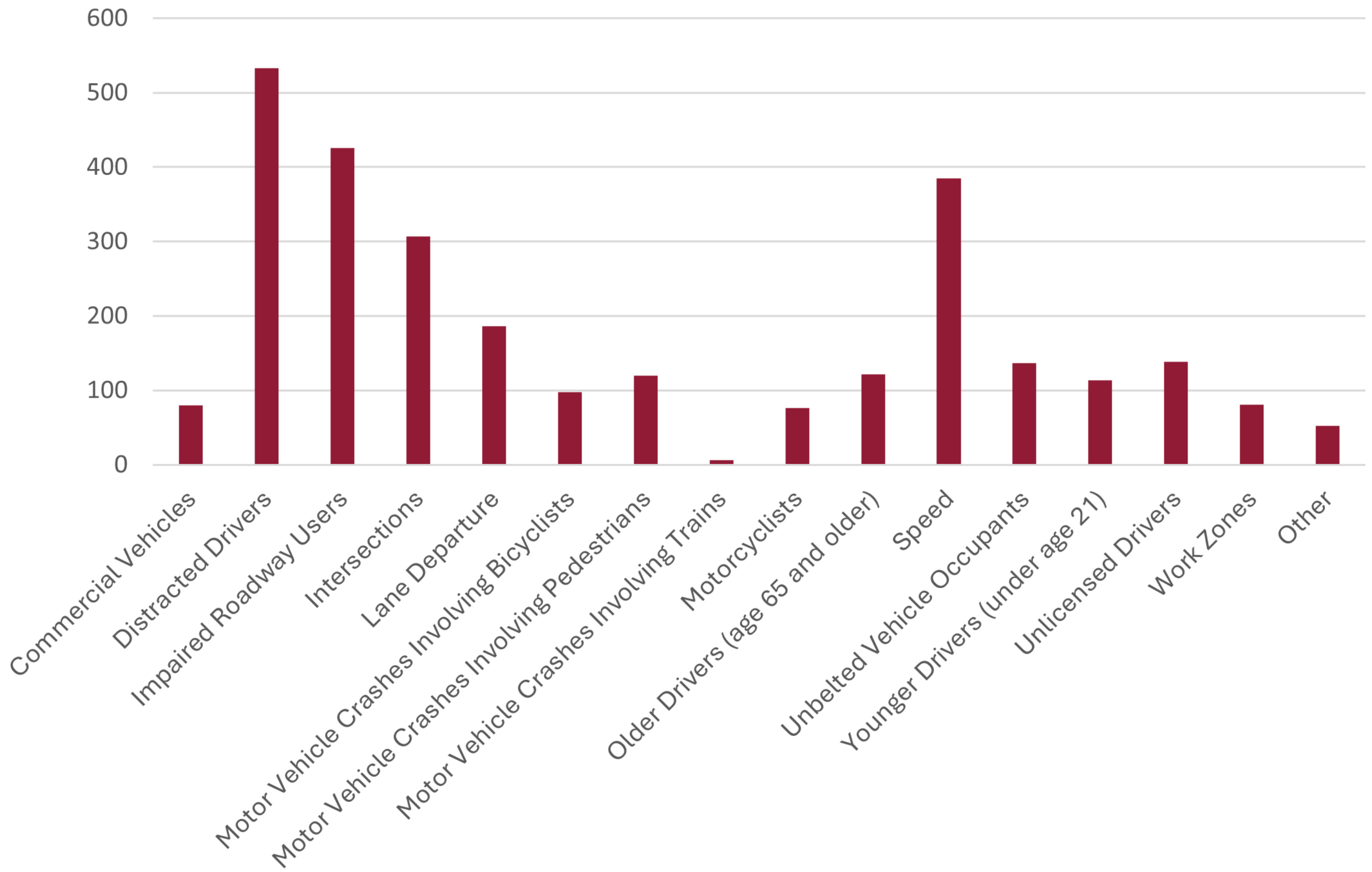
A total of 593 participants answered the question, “What is your home zip code?”, representing 325 unique zip-codes out of the 875 in Minnesota. Responses were generally aligned with population density, with higher participation in the Twin Cities metro area and other urban regions. The distribution of responses by zip code is illustrated in **Figure 44**.

Figure 44. Self-reported zip codes of online survey respondents.



In the survey, respondents were asked to choose 5 of the 16 traffic safety focus areas for Minnesota which they feel are most important to address fatal and serious injury crashes. The top three focus areas and numbers of responses were as follows: Distracted Drivers (533 responses); Impaired Roadway Users (426 responses); and Speed (385 responses). Complete results are shown in **Figure 45**.

Figure 45. Top Traffic Safety Focus Areas to Address for Reducing Fatal and Serious Injury Crashes Based on the Online Survey

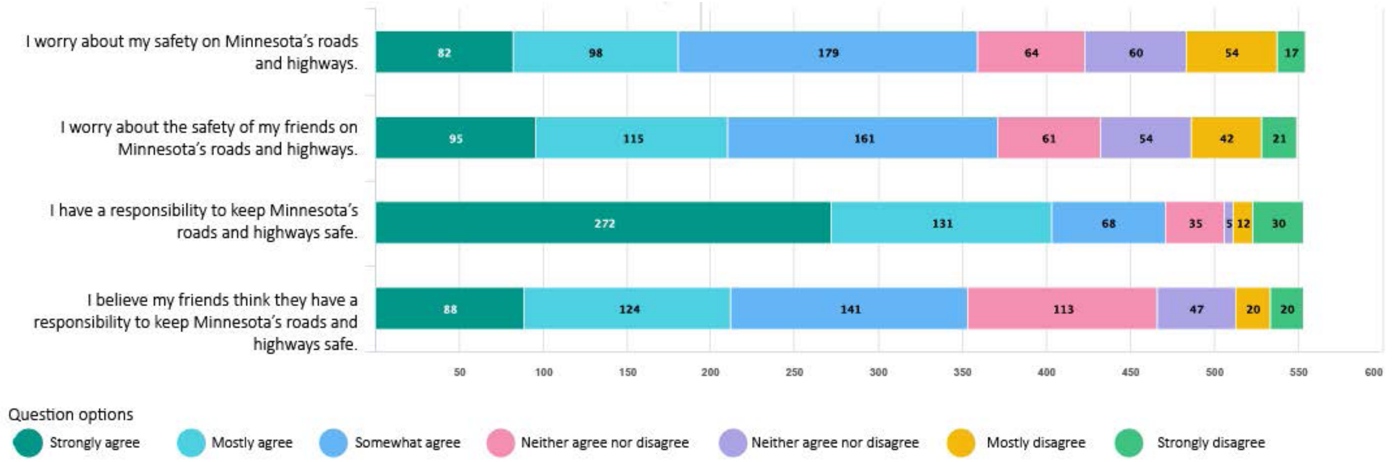


The following question asked respondents to rate four safety statements from “strongly agree” to “strongly disagree.” The statements were as follows:

- I worry about my safety on Minnesota’s roads and highways
- I worry about the safety of my friends on Minnesota’s roads and highways
- I have a responsibility to keep Minnesota’s roads and highways safe
- I believe my friends think they have a responsibility to keep Minnesota’s roads and highways safe

The responses to these safety statements are shown below in **Figure 46**.

Figure 46. Agree/Disagree Responses to Traffic Safety Statements



3.3.2 ANALYSIS OF SURVEY QUESTIONNAIRE WRITE-INS

The analysis of public responses to the question, "Are there any other concerns you have about safety on Minnesota roadways that you would like to share?" revealed recurring themes. These findings were categorized into the 16 focus areas defined in the Strategic Highway Safety Plan, along with three additional emergent subcategories that encapsulate broader themes from the responses:

- **Speed:** 58 mentions
  - Speeding, particularly in neighborhoods and on high-speed corridors, emerged as the most cited concern.
- **Traffic Safety Culture:** 57 mentions
  - Responses underscored the need for fostering a stronger culture of safety, including greater awareness of the shared responsibility for safe roadways.
- **Distracted Drivers:** 28 mentions
  - Public comments highlighted the prevalence of phone use and inattentive driving as significant risks.
- **Intersections:** 29 mentions
  - Concerns included roundabouts, signage, and stop sign adherence.
- **Motor Vehicle Crashes Involving Pedestrians:** 25 mentions
  - Many respondents emphasized the need for safer pedestrian crossings and better awareness among drivers.
- **Motor Vehicle Crashes Involving Bicyclists:** 19 mentions
  - Issues included the lack of protected bike lanes and unsafe interactions between vehicles and cyclists.
- **Impaired Roadway Users:** 8 mentions
  - Alcohol, marijuana, and other substances were highlighted as factors contributing to unsafe driving.

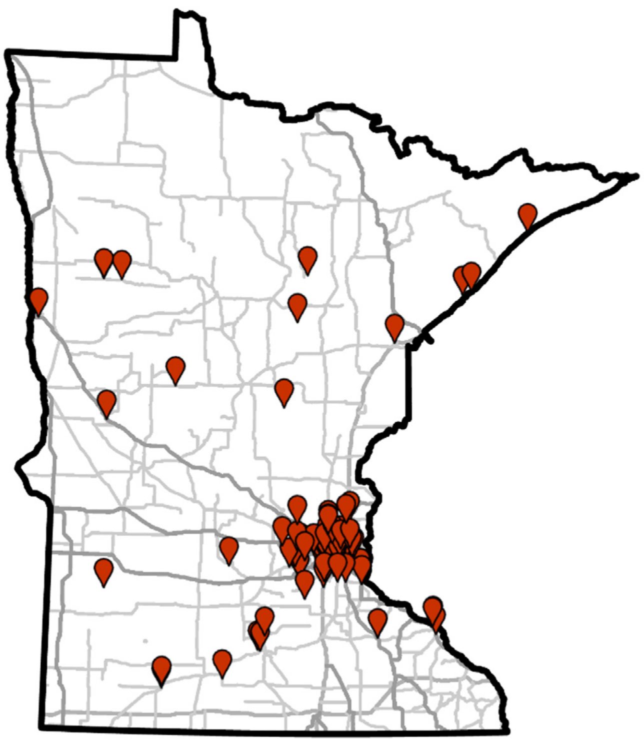
Several other focus areas, including Commercial Vehicles, Lane Departure, and Work Zones, received fewer mentions but still highlighted critical safety concerns. In addition to the defined focus areas, two focus area subcategories were identified from the responses:

- **Enforcement and Compliance:** 34 mentions
  - Calls for stricter enforcement of traffic laws, increased patrol presence, and higher fines for violations were prominent in the feedback.
- **Infrastructure Needs:** 98 mentions
  - Respondents frequently cited concerns about road conditions, maintenance, and the need for infrastructure improvements, such as better lane designs, pothole repairs, and expanded pedestrian and cyclist facilities.

3.3.3 INTERACTIVE COMMENT MAP

The interactive comment map had 233 visitors and 94 pinned contributions from 56 individual contributors during the June – September 2024 posting period. There is a clear clustering of comments within urbanized areas, particularly the Twin Cities metro where populations are greater. Additionally, comments frequently align with major corridors and intersections, regardless of population density. **Figure 47** maps each pin placed during the duration of the interactive comment map.

Figure 47. Map of Interactive Comments Across Minnesota



An analysis of public comments highlights a broad range of traffic safety concerns, with common themes centered on infrastructure deficiencies (such as inadequate lighting, and poor road design), dangerous driver behaviors (such as speeding, distracted driving, and failure to yield), and the safety of vulnerable road users. These comments highlighted risks to pedestrians and bicyclists, citing insufficient crosswalks, sidewalks, and bike lanes gaps.

Most comments covered overlapping themes, with many commenters linking multiple issues, such as speeding combined with poor visibility or traffic congestion exacerbated by confusing intersections. Respondents were asked to list any number of concerns associated with their comment. The frequency of traffic safety concerns cited are listed below in **Table 16**.

Table 16. Frequency of Traffic Safety Concern selections in the Interactive Comment Map

TRAFFIC SAFETY CONCERN	FREQUENCY OF SELECTION
Intersections	57
Speed	41
Other	39
Distracted Drivers	33
Commercial Vehicles	25
Motor Vehicle Crashes Involving Pedestrians	18
Lane Departure	16
Motor Vehicle Crashes Involving Bicyclists	16
Younger Drivers	14
Older Drivers	10
Motorcyclists	9
Unlicensed Drivers	8
Work Zones	5
Unbelted Vehicle Occupants	5
Motor Vehicle Crashes Involving Trains	4

If respondents responded with “Other”, they were asked to write-in the reason for their response. Many respondents used this section to highlight location-specific issues, emphasizing the nuanced nature of traffic safety challenges. Commonly mentioned topics include wildlife interactions, with frequent references to “deer crossings” and “wildlife hazards,” particularly in areas adjacent to natural habitats or rural environments. Several respondents also raised concerns about high traffic volumes and congestion, using terms like “overwhelming traffic” and “bottlenecks,” suggesting that capacity issues exacerbate perceived safety risks.

Infrastructure gaps were another prevalent theme in the “Other” write-ins, with commenters frequently describing the need for roadway expansions, updated designs, or better maintenance. Comments mentioning “highway capacity,” “lane narrowing,” and “inadequate shoulders” point to dissatisfaction with current road configurations. Additionally, environmental and community impacts emerged as a secondary focus, with mentions of noise pollution, air quality, and the need for more pedestrian-friendly spaces. A smaller subset of comments highlighted concerns about driver behaviors not explicitly covered in the predefined themes, such as aggressive driving or confusion over roadway rules.

3.4 ONLINE ENGAGEMENT ROUND 2

TO BE COMPLETED FOLLOWING PUBLIC REVIEW PERIOD

RECOMMENDATIONS FOR SHSP CONTENT

The engagement process for the 2025-2029 SHSP was the most comprehensive to date, highlighting recurring topics that informed the development of SHSP tactics and strategies. All engagement input was considered in shaping the new SHSP.

Specific topics, such as safer infrastructure for vulnerable road users, systematic speed management, improved distracted driving enforcement, driver education, work zone safety improvements, and ATV/UTV safety were recurrent themes. These were incorporated into the new SHSP as follows:

The updated plan prioritizes safer infrastructure for vulnerable road users.

Systematic speed management strategies, particularly in rural areas and school zones, are included, and "speed" is identified as an "umbrella" focus area.

The updated plan introduces new strategies to combat distracted driving include stronger penalties and the introduction of innovative tools; inattentive driving is identified as an "umbrella" focus area

The updated plan describes safer intersection designs in high-crash areas to reduce critical conflict points.

Driver education is highlighted as a priority, with an emphasis on improving programs for younger drivers to promote safer driving habits from an earlier age.

The new plan emphasizes enhanced work zone safety improvement strategies.

The updated plan applies increased attention to ATV/UTV safety, particularly in rural regions.

APPENDIX D

VULNERABLE ROAD USER SAFETY ASSESSMENT

2025-2029 STRATEGIC HIGHWAY SAFETY PLAN

DEPARTMENT OF TRANSPORTATION

CONTENTS

INTRODUCTION

Fatalities of vulnerable road users (VRUs) in the United States are increasing at a greater rate than all roadway fatalities in the United States, with both pedestrian and bicyclist facilities increasing by over 40 percent from 2010 to 2020.[1] This compares to a 17 percent national increase for all roadway fatalities during this period.

The urgent need to address VRUs safety was reflected in the Bipartisan Infrastructure Law (BIL), signed into law on November 15, 2021. The BIL included a requirement for states to complete a Vulnerable Road User Safety Assessment (VRUSA) which leverages crash analysis, engagement, and demographic considerations to develop VRU safety strategies. An initial VRUSA was required for states within two years of the BIL's enactment; the VRUSA is to be updated on a five-year cycle as part of a state's SHSP update. Additionally, states that complete their SHSP update more than one year after completion of the initial VRUSA must also provide an updated VRUSA.

MnDOT completed its initial VRUSA in November 2023. With the 2025-2029 SHSP update completed in Fall of 2025, MnDOT was also required to update its VRUSA. This document describes and documents the activities conducted to satisfy this requirement, including updating the original VRUSA with new analysis and engagement and incorporating findings into the 2025-2029 SHSP. Specifically, the VRUSA update includes:

- **Data Analysis:** Refreshes the original VRUSA's findings by incorporating the latest year of available data (2022) into the analysis and recommendations. It uses similar methodologies as the previous VRUSA and continues to align with federal requirements. The results and key themes from the updated analysis are largely consistent with the results of the 2023 VRUSA, which underscored the importance of speed, lanes, and volume for vulnerable road user safety.
- **Consultation:** Provides new consultation, including focused engagement with equity stakeholders. Results of this engagement provide updated input for the VRUSA safety strategies.
- **Safety Strategies:** Using the results of the updated analysis and consultation, the VRUSA safety strategies were reviewed and revised as needed to reflect any changes revealed by the data.

Given that the results of the original (2023) VRUSA remain largely unchanged following the update, as described below, the original VRUSA will remain the primary VRUSA document referenced on MnDOT's website (https://www.dot.state.mn.us/trafficeng/safety/shsp/) pending the next SHSP/VRUSA update (2030-2034). The website will also include the updated data analysis.

The sections below further document and summarize the VRUSA update process relative to the statutory requirements of the VRUSA:

- Data Driven Process
- Consultation
- Program of Projects or Strategies

1 National Roadway Safety Strategy (January 2022)

DATA DRIVEN PROCESS

UPDATE APPROACH

The updated VRUSA crash analysis followed the methodology of the initial VRUSA while incorporating 2022 data to reflect the 2025-2029 SHSP analysis period (2018-2022). Similar to the initial VRUSA, the updated analysis isolates VRU crashes from the 2018-2022 dataset and combines them with roadway and environmental characteristics to create an enriched dataset. Examples of data used to enrich the 2018-2022 crash records include injury severity, lighting condition, roadway functional classification, development intensity, Suitability of Pedestrian and Cyclist Environment (SPACE) scores and related factors, and bicycle infrastructure. The analysis provides a comprehensive view of where VRU crashes have occurred and where they are likely to occur in the future, key contributing factors, and to what degree these trends have disproportionately impacted disadvantaged communities.

The updated data analysis results are presented in the form of both descriptive and systemic analysis:

- **Descriptive Analysis:** Tabulates key variables to identify attributes linked to VRU crashes and crash severity over the 2018-2022 analysis period. Variables explored include temporal (month and year), lighting condition, age, functional classification, SPACE score, and others.
- **Systemic Analysis:** Presents the High Injury Network, an analysis approach combining both retrospective analysis (where the greatest crash concentrations have occurred) and proactive analysis (where crash sequences can be used to predict future crash occurrence).

SUMMARY OF FINDINGS

The results and key themes from the updated crash analysis are largely consistent with the results of the 2023 VRUSA, which underscored the importance of speed, lanes, and volume for vulnerable road user safety. Key findings of the updated analysis are summarized in pages 10-16 of the VRUSA Crash Analysis Technical Memo.

CONSULTATION

2025-2029 SHSP ENGAGEMENT

Consultation was conducted with a broad range of stakeholders throughout the 2025-2029 SHSP update process. This included:

- The **Advisory Council on Traffic Safety (ACTS)** with over thirty members representing the Department of Transportation (MnDOT), Department of Public Safety (DPS), Department of Public Health (MDH), other statewide agencies, and special interest groups.
- The **ACTS SHSP Working Group**, a subset of ACTS members providing guidance and input for development of the SHSP.
- **Toward Zero Deaths Regional Conferences and Roundtables** with participation from law enforcement and a variety of other traffic safety professionals.
- **Community events** including the Twin Cities Auto Show, Mall of America Traffic Safety Day, Minnesota Farmfest, Tribal Traffic Safety Summit, and others.
- Engagement with the **general public** including a digital survey, online comment map, email blasts, and social media posts.
- **Equity-focused outreach meetings** with key community stakeholders identified based on high crash rates, equity-centered demographic data, geographic diversity, and groups experiencing transportation inequities (disability-, race-, and income-based).
- **Local Roads Traffic Safety Workshops** at 24 locations across Minnesota to engage local agencies on best practices (both engineering- and behavior-focused) for reducing fatal and serious injury crashes involving VRUs, among other topics.

VRUSA CONSULTATION

The equity-focused outreach provided engagement that is specifically relevant to the VRUSA consultation requirement. The outreach process began by analyzing crash and demographic data to identify potential organizations, groups, and individuals representing equity stakeholders. This analysis considered populations overrepresented in fatal and serious injury crash data, geographic areas with higher numbers of pedestrian and bicycle crashes, and equity scores based on MnDOT Suitability for the Pedestrian and Cycling Environment (SPACE) analysis, among other factors. The list of potential stakeholders was refined based on availability and to avoid duplication with groups already being engaged through other areas of the project. The final list of stakeholders engaged thought equity-focused outreach is shown below.

- **Tribal Advocates:** Levi Brown, MnDOT
- **Neighborhoods of Minneapolis:** Phillips West Neighborhood Organization
- **Neighborhoods of Saint Paul:** North End Neighborhood Organization
- **Disability Advocates:** Annie Young, The Arc Minnesota, Mobility Mania
- **Racial justice Advocates:** Diversity Council of Mankato
- **Ped/bike Advocates:** BikeMN, Our Streets MPLS
- **Motorcyclist Advocates:** A.B.A.T.E.

Input from the equity-focused engagement highlighted several themes relevant to VRU safety. Central themes include:

- **Accessibility and Access:** Everyone should be able to access the same public transportation resources safely regardless of mode of transportation.
- **Education:** Emphasize education that caters to different cultural backgrounds and languages. Provide education on new and unfamiliar road features (i.e. roundabouts, J-turns, etc.), specifically for rural and elder populations.
- **Engineering:** Update current infrastructure to cater equally to all modes of transportation (pedestrians, drivers, cyclists, wheelchairs, etc.).
- **Enforcement:** Further enforcement of speeding, distracted driving, and reckless driving is needed. Increase law enforcement funding within tribal lands.
- **Culture:** Change messaging in traffic signage and social advertisements to be more explicit. Leverage community connections to help promote good driver behaviors and values.

This consultation provided key feedback in support of the VRUSA safety strategies. Full engagement results for the SHSP update process are provided in **Appendix C**.

PROGRAM OF PROJECTS OR STRATEGIES

Strategies from the original VRUSA were assessed relative to the updated data analysis and consultation results. This assessment asked the following question for each strategy: Does this strategy remain relevant after considering an additional year of data and collecting new feedback from stakeholders?

The review confirmed that the strategies developed for the November 2023 VRUSA remain relevant as of the 2025-2029 SHSP update. Thus, the 2025-2029 SHSP formally incorporates the VRUSA strategies as part of its larger body of safety strategies and tactics.

MEMO

TO: Tim Burkhardt, Alliant Engineering, Inc.
FROM: Brian Almdale, MUPP; Jessica Schoner, PhD; & Rebecca Sanders, PhD RSP2B
DATE: 2024-11-01
RE: VRUSA Update
PROJECT: MnDOT SHSP Update

Table of contents

1. Introduction

This report provides an update to the Minnesota Department of Transportation's (MnDOT) Vulnerable Road User Safety Assessment (VRUSA). It was prepared to support the agency's 2029 Strategic Highway safety Plan (SHSP) update.

The VRUSA is a statewide, data-driven effort to identify conditions that contribute to a higher risk of vulnerable road user death or serious injury. The original VRUSA was published in 2023 and built off the 2019 Pedestrian Statewide Safety Analysis. This VRUSA update builds off the original VRUSA by incorporating the latest year of available data (2022) into the analysis and recommendations. It uses similar methodologies as the previous VRUSA and continues to align with federal requirements. The results and key themes from this updated analysis are largely consistent with the results of the 2023 VRUSA, which underscored the importance of speed, lanes, and volume for vulnerable road user safety.

This report provides detailed information regarding the analysis methodology, which included a descriptive analysis of bicyclist, pedestrian, and other vulnerable road user crashes, a systemic safety analysis[1], and the development of a High Injury Network (HIN). This data-driven approach allows a better understanding of pedestrian and bicyclist crashes and the conditions that may contribute to pedestrian and bicyclist fatalities and serious injuries (KA). The findings from this report can be used to systematically address pedestrian and bicyclist safety through the application of engineering countermeasures.

Identified conditions include not only existing roadway design features but also surrounding contextual features, such as existing non-motorized trip-attracting land uses or the presence of public transit facilities.

1 A systemic safety analysis was done only for variables that were available statewide, which largely explored crash patterns on a per-mile basis.

All acronyms used throughout this report are defined in Table 1.

Table 1: Acronyms

Acronym	Definition
AADT	Annual Average Daily Traffic
ADA	Americans with Disabilities Act
BIPOC	Black, Indigenous, People of Color
FHWA	Federal Highway Administration
GIS	Geographic Information System
HIN	High Injury Network
KA	Killed of severely injured
MSI	Most severely injured
MC	Motorcycle
MV	Motor Vehicle
PED	Pedestrian
PHB	Pedestrian Hybrid Beacon
RRFB	Rectangular Rapid Flashing Beacon
SSA	Safe System Approach
SPACE	Suitability of the Pedestrian and Cycling Environment
VPD	Vehicles per day
VRU	Vulnerable road user
VRUSA	Vulnerable Road User Safety Assessment
K [**K**ABCO]	Fatal Injury Severity
A [K**A**BCO]	Suspected Serious Injury
C [KA**B**CO]	Minor Injury
C [KAB**C**O]	Possible Injury
O [KABC**O**] or PDO	Property Damage Only

The Bipartisan Infrastructure Law (BIL), passed in 2021, created a new requirement for state departments of transportation to conduct a Vulnerable Road User Safety Assessment (VRUSA) every five years. Anchored in the Safe System Approach (SSA), this assessment uses a data-driven process to identify high-risk areas and incorporate equity and demographics into the analysis. Official guidance around the VRUSA recommends the use of a High Injury Network, predictive analysis, and/or systemic analysis to identify high-risk areas[2].

To improve the safety of vulnerable road users (VRU) in the state of Minnesota and satisfy the new VRUSA requirements, the Minnesota Department of Transportation's Office of Traffic Engineering commissioned a Vulnerable Road User Safety Assessment in 2022[3], including the development of a High Injury Network for the state and a study of bicycling crashes from 2016-2019 in urban and rural areas within the state. The initial VRUSA built upon a recently completed study of pedestrian safety in the state[4]. This report builds on the prior VRUSA and safety work and updates the vulnerable road user safety analysis through:

1) a descriptive safety analysis of more recent crash data (2018-2022), updating the time period used in the prior VRUSA from 2017-2021 for bicyclists and 2016-2019 for pedestrians; and
2) an updated Statewide High Injury Network, which was built on 6,825 bicyclist, pedestrian, and other vulnerable road user crashes from 2018-2022.

While bicyclists and pedestrians are different roadway users, use different infrastructure in many places, and have both overlapping and distinct safety concerns, both groups are vulnerable roadway users who are disproportionately killed and seriously injured in the transportation system. Often, bicycle and pedestrian countermeasures are planned and implemented in tandem, and an understanding of bicycle and pedestrian crash trends needs to inform these processes. Collectively, the 2021 Minnesota Statewide Pedestrian Safety Analysis, the 2022 VRUSA, and the current VRUSA update (including the development of a High Injury Network for vulnerable road users) constitute a robust, data-driven process for identifying higher-risk areas in the transportation system.

2. Methodology

This report follows the methodology of the initial Minnesota Vulnerable Road User Safety Assessment. For the descriptive and systemic analyses, VRU crashes from 2018-2022 are conflated with roadway and environmental characteristics to create a dataset for analysis, including variables about injury severity, lighting, roadway functional classification, development intensity, Suitability of Pedestrian and Cyclist Environment (SPACE) scores and related factors, and bicycle infrastructure. Given data limitations, some of the detailed analysis focuses only on MnDOT's trunk highway network.

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2 https://highways.dot.gov/safety/hsip/vru-safety-assessment-guidance
3 https://www.dot.state.mn.us/trafficeng/safety/vrusa.html
4 https://edocs-public.dot.state.mn.us/edocs_public/DMResultSet/download?docId=26158751

This report also presents a statewide High Injury Network, which uses a standard sliding window analysis to measure severity-weighted crash density by mode. The HIN section of the analysis includes all vulnerable road users: bicyclists, pedestrians, and other personal conveyances.

The rest of the report includes an overview of the crash data and the findings from the descriptive and systemic analyses. The descriptive analyses present trends among crash and temporal variables. The systemic analysis presents the High Injury Network.

Key findings from this report are outlined at the end of this section (see section 2.4 Key Findings).

2.1 Data Overview

2.1.1 Crash Data

Crash, party, and vehicle data that were provided to the consultant team include reported crashes from 2018 through 2022 for crashes for all modes (pedestrians, bicyclists, other - personal conveyances, and motorists).

All crash data were processed by Safe Streets Research & Consulting ("Safe Streets") and loaded into a Postgres database for additional analysis using Python, SQL, and R programming languages. The crash, party, and vehicle tables have a relational structure, which is common for storing crash data. For every reported crash, there is one crash record. The party and vehicle tables contain information for all the primary "actors" and their respective "vehicles" involved in the crash and have a many-to-one relationship – i.e., all relevant party records are matched via a case identification number to the one crash record. The party and vehicle tables contain information for each primary person and their "vehicle" such as age, sex, pre-crash action, injury severity, and vehicle characteristics. This structure is shown in Figure 1.

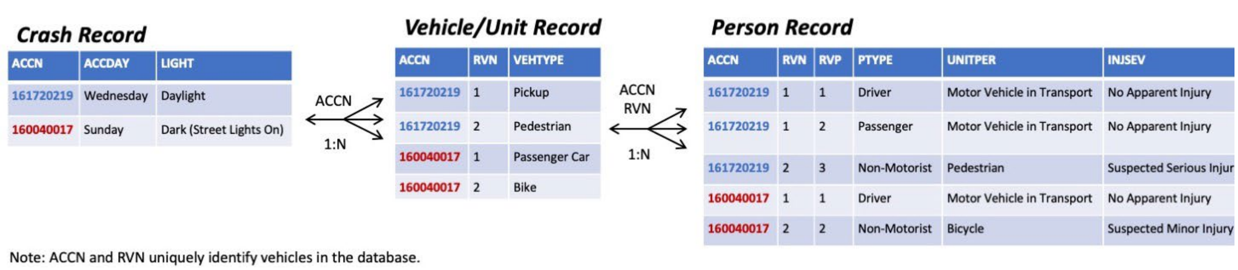

Figure 1: Crash Database Schema

Safe Streets processed and restructured the crash data used in this analysis. New variables were calculated and assigned, and the quality of the data was assessed through a robust quality control process. All reported crashes were processed (not just VRU crashes), but only crashes that involved at least one VRU and at least one motorist is included in this analysis.

Crashes involving a person using a scooter (e.g., shared e-scooter or ADA assistive device) are defined in the State of Minnesota as pedestrian crashes. However, they are coded in MnDOT's crash database as the unit type "Other – Personal Conveyance" rather than as "Pedestrian".

The “Other – Personal Conveyance” category also includes many modes that are not pedestrians, such as farm equipment (tractor, combine), all-terrain vehicles, snowmobiles, horse and buggy, and the like. There is no single coded field in the crash database that differentiates between pedestrians using personal conveyance devices and these other modes. A targeted effort was conducted to classify these crashes based on a keyword scan of officer narratives. While we could reliably differentiate these crashes from farm equipment based on this procedure, we could not consistently differentiate between mobility scooters and other devices used by people with mobility impairments and other types of scooters or pedestrian devices. As stated in the 2019 Pedestrian Safety Analysis, a long-term solution to facilitate routine analysis of these modes in Minnesota would be to update the crash form with a field to indicate the type of scooter or device involvement (e.g., e-scooter, kick-scooter, ADA assistive device, moped scooter) and retrain officers to utilize the new field to record accurate and detailed information for more streamlined analysis.

Crashes that met one or more of the criteria listed below were removed from the original (raw) crash dataset during the data processing and consolidation steps (see Table 2 for the number of crashes that met each criterion; crashes can meet more than one criterion). This effort mirrors the methodology used in the 2022 VRUSA and was implemented to 1) allow for a systemic safety analysis (which requires accurate coordinates), 2) identify vulnerable road users that were not correctly classified in the crash data through systematically scanning the crash narratives, and 3) remove motorist-only crashes. In total, there were 337 vulnerable road user crashes that were removed from the original crash dataset due to missing coordinates or the location was too far from a public roadway.

- Motorist-only (non-VRU) – The research team received a complete crash database for the years of interest (2018-2022). Because the scope of this project is only to analyze vulnerable road users, crashes that do not include a bicyclist, pedestrian, or someone potentially using a personal conveyance device are excluded from the analysis.
- Missing coordinates - Crash location GPS coordinates were not available.
- Farm Equipment – The “unit type” is coded as “Other – Personal Conveyance” and the officer narrative includes the words “tractor”, “horse”, or “trailer.”
- Too far away from the street or along a private street - The geospatial location of the crash is greater than 300 feet from any street or the street was a private roadway.
- The crash occurred in a parking lot – The location type recorded in the crash data is a parking lot.
- All crash data used in this analysis requires the involvement of at least one motor vehicle.

Table 2: Crash records removed from study dataset, 2018-2022

Drop Reason	# of Instances (all modes)	% of Crashes (all modes)	# of Instances (VRU Only)	% of Crashes (VRU Only)
Crash is Missing Coordinates (only VRU crashes)	8,306	2.4%	300	4.2%
Non-motorist considered Farm-equipment	101	0.0%	0	0.0%
Crash was Too far away from street or Private Street (only VRU crashes)	745	0.2%	37	0.5%
Non-VRU including motorists and Farm-equipment	343,817	98.0%	0	0.0%
# of Instances	352,969	NA - Above do not sum to 100%	337	NA - Above do not sum to 100%
# of Crashes Dropped	344,154	100.0%	337	100.0%
# of Crashes (regardless of drop status)	350,979	100.0%	7,162	100.0%
# of Crashes included in analysis	6,825	100.0%	6,825	100.0%

2.2 Injury Severity Assignment

The officer-reported injury severity levels used in this analysis are specific to the most severely injured (MSI) road user involved in the crash. This injury severity is different than the reported MSI assigned to each crash record. In most cases, VRUs are the most severely injured victim involved in the crash. Using the victim-level severity helps improve the accuracy of summarizing injury severities. It should be noted that research from the San Francisco Department of Public Health has documented reporting errors related to miscoded injury severities, particularly for suspected serious injuries[5], suggesting a need for some fluidity when discussing minor and serious injuries. This analysis does not have access to hospital records to verify injury severities stored in the crash data, so the results in this document reflect the best available data at the time. For reference, the injury severities recorded in the crash data and summarized in this analysis are defined as followed:

- **K - Fatal**: A fatal injury is any injury that results in death within 30 days after the motor vehicle crash in which the injury occurred. If the person did not die at the scene but died within 30 days of the motor vehicle crash in which the injury occurred, the injury classification should be changed from the injury previously assigned to “Fatal Injury.”

5 https://www.visionzerosf.org/wp-content/uploads/2021/11/Severe-Injury-Trends 2011-2020 final report.pdf

- **A – Suspected Serious Injury**: An incapacitating injury is any injury, other than a fatal injury, which prevents the injured person from walking, driving, or normally continuing the activities the person was capable of performing before the injury occurred. Also called "Serious Injury" or "Injury A". This category includes:
    - severe lacerations
    - broken or distorted limbs
    - skull or chest injuries
    - abdominal injuries
    - unconsciousness at or when taken from the scene of the crash, or unable to leave the crash scene without assistance
- **B – Suspected Minor Injury**: A minor injury is any injury that is evident at the scene of the crash, other than fatal or serious injuries. Also called "Minor Injury" or "Injury B". Examples include:
    - lump on the head
    - abrasions
    - bruises
    - minor lacerations (cuts on the skin surface with minimal bleeding and no exposure of deeper tissue/muscle)
- **C – Possible Injury**: A possible injury is any injury reported or claimed which is not a fatal, suspected serious, or suspected minor injury. Possible injuries are those that are reported by the person or are indicated by their behavior, but no wounds or injuries are readily evident. Examples include:
    - momentary loss of consciousness
    - claim of injury
    - limping
    - complaint of pain or nausea
- **O – Property Damage Only**: Crash where only property is damaged. No injuries resulted from the crash.

2.3 Roadway and Contextual Data

The crash dataset includes many useful variables for analyzing VRU safety; however, detailed information about roadway conditions and nearby land uses is also necessary to provide a more complete understanding of the context in which crashes occurred and support future countermeasure selection. A robust data collection and consolidation process was conducted as part of the 2021 MnDOT Statewide Pedestrian Safety Analysis. Data from that effort was provided to the study team for use in this VRU assessment. Data collected during the Statewide Pedestrian Safety Analysis was re-processed using the same methods documented in the data collection section of the Pedestrian Safety Analysis. Please refer to the Statewide Pedestrian Crash Analysis[6] for a detailed summary regarding data usage and limitations.

6 https://edocs-public.dot.state.mn.us/edocs_public/DMResultSet/download?docId=26158751

2.4 Key Findings

This section only includes selected findings from the descriptive, systemic, and HIN analysis sections of this report. For additional context, tables, figures, statistics, and additional components of the analysis, please review the associated section next to each topic. The order of topics summarized in this section follows the order in the table of contents.

2.4.1 Data Assessment:

- While crash data provided important insights, several characteristics or trends in crashes were not discernible from the data. To supplement, the study team scanned crash narratives from crash reports. These provided clearer details in some cases, especially related to the pre-crash positioning of bicyclists and vehicles and sidewalk bicycling. While officer narratives are not always the most reliable source of information for some pedestrian and bicyclist crash factors, keyword searching on their narratives proved useful to add nuance to the data being analyzed, particularly where roadway data were limited or missing, or attributes in the crash report were ambiguous or not reported on.

2.4.2 Descriptive and Systemic Crash Analysis:

- **Injury Severity** (see Section 3.2):
  - Bicyclists: There were 2,694 reported bicycle crashes during 2018–2022. Roughly 12% of those crashes were reported to be fatal or result in a serious injury.
  - Pedestrians: During the same period, there were 4,131 reported pedestrian and other VRU crashes, with 24% resulting in a fatal or serious injury, twice the percentage of KA crashes than bicyclist crashes.
- **Area Land Development Intensity** (see Section 3.3):
  - Bicyclists: Most bicyclist crashes (37.4%) and KA crashes (36.6%) occurred within the TCMA - Other Cities areas, followed by TCMA - Minneapolis and St. Paul areas (36.8% of all crashes; 30.2% of KA crashes). Small urban communities (defined as rural downtown in SPACE) had the third largest share of crashes (13.1%) and KA crashes (12.9%).
  - Pedestrians: Most pedestrian and other VRU crashes (46.9%) and KA crashes (34.9%) occurred within the TCMA - Minneapolis and St. Paul areas, which is likely related to the walkability and population density of those communities and generally higher levels of pedestrian exposure. Additionally, crashes and KA crashes were heavily concentrated in these two cities on a per square mile basis. TCMA - Other Cities had the second highest share of crashes 27.7% and KA crashes 31.4%. Both of the communities accounted for 74.7% of all crashes and 66.2%, which mirrors the bicyclist findings.
- **Month** (see Section 3.4):
  - Bicyclists: In general, there were more bicycle crashes and KA crashes during warmer months (June through September). There are not clear peaks in the proportion of crashes resulting in a KA outcome across months.
  - Pedestrians: The distribution of crashes is not as heavily concentrated during summer months for pedestrians as it is for bicyclist crashes. Pedestrian crashes and KA crashes instead appear slightly more concentrated in the early fall. The

proportion of crashes resulting in a KA outcome was slightly higher during winter and spring months compared to fall and summer months.

- **Lighting Condition** (see Section 3.5):
  - Bicyclists and Pedestrians: Most of the crashes happened in well-lit conditions, although KA crashes are slightly overrepresented in dark and low-light conditions. Both dark conditions with no street lighting and sunrise/sunset hours appear to be especially severe for people walking, rolling, and riding bicycles.
- **Age** (see Section 3.6):
  - This section summarizes who was involved in crashes using victim records, not crash (event) records. For additional information about the difference between victim and crash records, please review the victim section (see Section 3.6).
  - Bicyclists: When comparing the distribution of victims by age to the state's population, younger bicyclists are much more likely to be involved in a crash and a KA crash compared to older populations. Bicyclists aged 10-19 were the most overrepresented in crashes and bicyclists aged 15-19 were the most overrepresented in KA crashes.
  - Pedestrians: Pedestrians aged between 15 through 34 generally had the highest share of victims involved in a crash with victims aged 20-24 accounting for the largest share of victims. Pedestrians aged between 15-29 and 55-59 were the most overrepresented, and KA victims and pedestrians under 15 years of age were the most underrepresented victims.
- **Crash Location Type** (see Section 3.7):
  - Bicyclists: Overall crashes and KA crashes occurred most frequently at stop-controlled intersections (40.2% of all crashes; 34.5% of KA crashes), which the data suggest are partial stop-controlled intersections rather than all-way stop-controlled intersections. While stop-controlled intersections are the most common intersection type, this may be a systemic issue across the state, particularly with bicyclists riding along lower-intensity streets (often residential streets) needing to cross major streets at partial stop-controlled intersections. This combination of lower-stress streets without crossing accommodations likely contributes to bicyclists attempting to cross a major street and being struck by a motorist who does not have a traffic control device.
  - Pedestrians: Roughly two-thirds of pedestrian crashes occurred at or near intersections regardless of intersection control. Crashes occurred most frequently at signalized intersection locations followed by segment (i.e., midblock) locations. Crashes tend to be more severe at midblock locations than intersection locations regardless of intersection control.
- **MnDOT Trunk Highways** (see Section 3.8):
  - Bicyclists: A larger share of crashes occurred on the trunk network in small urban communities (33.1%) compared to TCMA and greater MN metro areas (9.8% - 14.1%), and more of these crashes were severe (37.0% in rural areas compared to 11.8% to 12.2% in TCMA locations). Controlling for mileage, bicyclist crashes along the trunk highway network were concentrated in more urban areas. Crashes along the trunk network in rural and small urban communities could be

in places where the trunk network becomes a central roadway within smaller urban areas or rural towns. Even if cyclists are not traveling along these locations, they may need to cross them, as these highways cut through urban areas and become main streets in smaller towns.

  - Pedestrians: The results are similar to bicyclist crash trends with most crashes having occurred off the trunk highway system (81.5%, n=3,367), though there was a slightly larger percentage of pedestrian crashes and KA crashes that occurred along trunk highways compared to bicyclist crashes. Additionally, crashes that did occur along the trunk highway system resulted in more severe outcomes (30.5% resulted in a KA) compared to crashes that were not along the trunk highway system (22.9%).

- **MnDOT Trunk Highways – Urban/Rural** (see Section 3.8):
  - Bicyclists: Most bicycle crashes happened off the trunk highway system within Minneapolis and St. Paul (89.8%), which is likely due to both higher numbers of cyclists and proportionally fewer trunk highways compared to locally owned roadways in Minneapolis and St. Paul than in other locations in the state. Most KA crashes (n=121) both on and off the trunk highway network within the TCMA metro occurred in the surrounding suburban communities. Crashes that occurred along the trunk highway system most frequently occurred within small urban communities (33.1%).
  - Pedestrians: A larger share of pedestrian crashes occurred along the trunk network in small urban communities (34.0%) compared to TCMA and greater MN metro areas (12.9% - 18.3%). More than half of the pedestrian crashes (56.1%) that occurred along the trunk highway network within the rural context resulted in a KA outcome, nearly three times the rate for pedestrian crashes in the TCMA Minneapolis and St. Paul area (18.4%).
- **MnDOT Trunk Highways – Sidewalks** (see Section 3.8):
  - Bicyclists: Cyclists may use sidewalk infrastructure to avoid bicycling on high speed or uncomfortable facilities, especially younger or less-confident bicyclists. While sidewalk riding is believed to pose a safety risk for bicyclists at intersections, cyclists may be choosing to ride along sidewalks in order to mitigate their overall risk (and perception of risk) in the absence of dedicated bicycle facilities.
    - Sidewalk riding appears to be more common on high-risk facilities where there are large shares of serious injury and fatal crashes; prohibiting sidewalk riding or enforcing sidewalk riding bans could potentially increase crashes and injury severity outcomes. Sidewalk bicycle riding points to the need for more infrastructure that facilitates safe and comfortable riding for people with different levels of bicycling confidence and ability. Bicyclist crashes that occurred along trunk highways with an existing sidewalk most frequently occurred if the bicyclist was using the sidewalk rather than riding within the road (60% or n=154 using the sidewalk and 40% or n=104 in the road). This is not surprising given that most trunk highways lack low-stress on-street bicycle facilities designed

to encourage bicyclists of all ages and abilities to ride on the roadway. The need for these low-stress facilities is not just preference- based: most trunk highway severe crashes occurred where there was no reported sidewalk and no indication that the bicyclist was riding along the sidewalk (50% of KA crashes). It is possible that many of these crashes could have been prevented if the cyclist had been separated from vehicular traffic.

- **Hit and Run** (see Section 3.9):
  - Bicyclists: Most bicycle crashes (86.9%) and KA crashes (91.1%) were not hit and run. The distribution of hit-and-run crashes was similar between most urban and rural areas in terms of the percentage of crashes and severe crashes that were hit-and-run. However, TCMA Minneapolis and St. Paul had the largest relative share of hit-and-run responses for all crashes (24.1%) and KA crashes (18.8%).
  - Pedestrians: Like bicyclist crashes, most pedestrian crashes (79.7%) and KA crashes (82.2%) were not hit and run. TCMA Minneapolis and St. Paul had an alarmingly high relative share of hit and run crashes (31.0%) and KA crashes (32.7%).
- **Functional Classification** (see Section 3.10):
  - Bicyclists: More than half of all crashes (52.1%) and KA crashes (50.5%) occurred on minor arterials. While minor arterials often see a mix of higher traffic volumes and pedestrian and bicyclist generators, they comprise relatively little of the state's roadway mileage, indicating a serious safety issue with these roadways. Local roadways and major collectors had the next two largest shares of crashes and KA crashes. Minor arterials also have the highest number of crashes per mile for all crashes (7.6 crashes per 100 miles) and KA crashes (0.9 KA crashes per 100 miles), followed by principal arterials (2.8 crashes per 100 miles; 0.4 KA crashes per 100 miles).
  - Pedestrians: Pedestrian crashes (52.7%) and KA crashes (49.0%) occurred most frequently along minor arterials, followed by local roadways and major collectors. When looking at crashes on a per mile basis, minor arterials had the highest rate of crashes per 100 miles for all crashes (11.8 crashes per 100 miles) and KA crashes (2.7 KA crashes per 100 miles), followed by principal arterials (3.5 crashes per 100 miles; 1.1 KA crashes per 100 miles).
- **Functional Classification Intersections** (see Section 3.10):
  - Bicyclists: Most crashes (30.2%) and KA crashes (29.7%) occurred at intersections between minor arterials and local streets followed by major collectors and local streets (14% of all intersection crashes). Nearly half of all crashes (48%) and more than half of KA crashes (56%) indicate the bicyclist was cycling across traffic/roadway. Looking only at crashes at these locations with this crossing pre-crash action, 60% of crashes and 68% of KA crashes were at an intersection with some type of stop control (most likely two- way stop signs with the major street uncontrolled). This finding indicates an important safety issue at locations where bicyclists are attempting to cross a major street but the cross traffic does not have traffic control to facilitate a safe bicyclist crossing.

- Pedestrians: Most crashes (30.8%) and KA crashes (30.3%) occurred at intersections between minor arterials and local streets, followed by minor arterials and minor arterials (15.2% of all intersection crashes) and minor arterials and major collectors (14.4% of all intersection crashes).

- **Number of Through Lanes** (see Section 3.11):
    - Bicyclists: Most crashes occur on two- and four-lane roadways. Roadways with five or more lanes had the most severe crashes with 13.8% crashes resulting in a KA outcome.
    - Pedestrians: Most crashes occurred along two- and four-lane roads. One- and three-lane roads had the lowest share of crashes and KA crashes, which are likely related to there being fewer streets with one or three lanes, however crashes at these locations had the lowest proportion of crashes that resulted in a KA outcome.
- **Speed limit** (see Section 3.12):
    - Bicyclists: Most crashes (52.1%) and KA crashes (45.8%) occurred in places where there are 30 mph speed limits. This could be due to several possible reasons, such as the prevalence of roadways where the posted speed limit is 30 mph or a perception by cyclists that roadways with 30 mph speed limits are “low enough” stress for riding. However, there are notably fewer crashes and KA crashes on roadways signed at 25 mph or lower. Note that the crash data used in this analysis predates the legislative action in 2020 that allowed communities to lower speed limits on many locally owned roads, so relatively few roads in the state had speed limits lower than 30 mph for crashes in this study.
    - Pedestrians: Streets with a posted speed limit of 30 mph had the largest share of all crashes (59.9%) and the largest share of KA crashes (51.6%). Streets with a speed limit of 50+ had the second largest share of KA crashes (10.9%) and the second largest share of all crashes (18.5%). The data show us that, as the posted speed limit increases, the proportion of crashes that resulted in a KA also increases.
- **Traffic Volume**[7] (see Section 3.13):
    - Bicyclists and Pedestrians: The relationship between bicyclist/pedestrian safety and motorist volumes is multi-faceted and nonlinear. Areas with the highest motorist volumes have relatively fewer bicyclist crashes. Mid-range AADT areas (5k-15k) appear to have the greatest concentrations of bike crashes.
- **HERE – Entertainment, Retail, and Restaurants** (see Section 3.14):
    - Bicyclists: Destinations such as entertainment establishments, retail, and restaurants appear to have some correlation with crashes, as 40.3% of all crashes were within 328 feet (100 meters) of one of the target destinations; however, only 35.4% of KA crashes were within this buffer.
    - Pedestrians: Like bicyclist crashes, destinations appear to have some correlation with crashes, though the relationship appears to be slightly stronger for

7 Nearly 20% of bicyclist and pedestrian crashes and KA crashes occurred along streets without recorded AADT data.

pedestrians with 48.3% of all crashes and 40.4% KA crashes within 100 meters of one of the target destinations.

- **Presence of Transit near Intersection Crashes** (see Section 3.15):
  - Bicyclists: There were no bicycle crashes in proximity to transit stops (not on-demand transit service) in the rural context. In larger urbanized areas, crashes in Minneapolis and St. Paul and severe crashes oftentimes occurred near transit stops or stations.
  - Pedestrians: The percentage of crashes and KA crashes that occurred near a transit stop is much higher for pedestrians than for bicyclists. This difference between modes is likely associated with higher pedestrian volumes and a higher frequency of pedestrians crossing the street to access a bus stop compared to bicyclists.
- **Suitability of Pedestrian and Cyclist Environment (SPACE) Score** (see Section 3.16):
  - Bicyclists and Pedestrians: Most crashes occurred in areas with mid-range SPACE scores. There appears to be an inverse correlation between the percentage of severe crashes and the SPACE score. This possible inverse correlation may be due to lower motor vehicle speeds in locations with higher SPACE scores (for example, due to congestion, existing roadway design, or lower posted speed limits) or greater motorist expectations of bicyclist or pedestrian presence.
- **Equity** (see Section 3.17):
  - Bicyclists and Pedestrians: Residents in low-income areas and communities of color are exposed to greater risk of crashes. While the majority of all crashes happen outside low-income and majority Black, Indigenous, People of Color (BIPOC) community areas, areas where 40% or more of households are low-income and/or 50% or more of residents are BIPOC have a greater concentration of crashes and severe crashes. This pattern is strongest in Minneapolis and St. Paul, but there is evidence of disparities across all geography groups – including small urban areas.

2.4.2 High Injury Network (HIN)

A High Injury Network identifies areas of the road network where crashes have been concentrated in sequence, suggesting priorities for traffic safety investment. See Section 4 for the HIN overview and methodology.

- On average, 30% of all VRU crashes and 33% of severe VRU crashes are on the HIN, though this varies from year to year (Section 4.9).
- Serious injury VRU crashes have the greatest representation on the HIN, with 35% of them falling on the HIN (Section 4.9.2).
- Pedestrian and other VRU crashes were more tightly clustered on the network, with nearly 33% of them being on the HIN compared to only 25% of bicyclist crashes (Section 4.9.2).
- Across all VRU modes, the Minneapolis and St. Paul HIN capture the greatest share of crashes with nearly half of all VRU crashes falling on the network.

- The HIN does a much better job of capturing signalized intersection VRU crashes than crashes at other location types (midblock, stop-controlled intersections, etc.), with 49.4% of all VRU crashes at signalized intersections and 58.6% of severe crashes at signalized intersections falling on the HIN.
- The HIN is concentrated in areas with medium and high SPACE suitability scores, with the greatest concentration in the 70-74 and 75- 79 score range (28.8% and 35.0%, respectively).
- The HIN is overrepresented among areas where 50% or more of residents in BIPOC communities.

3. Descriptive Crash Analysis

The descriptive crash analysis consists of tabulations of key variables of interest to identify attributes that are linked to crashes and crash severity. The descriptive analysis reviewed the following factors:

- Injury severity
- Temporal variables (year and month)
- Lighting condition
- Proximity to transit stops
- Functional classification (of the road on which the crash occurred)
- Location type (segment vs. signalized intersection, other intersection control type)
- Area land development intensity
- Roadway characteristics (posted speed limit, number of through lanes, traffic volume, etc.)
- Suitability of Pedestrian and Cyclist Environment (SPACE) scores and their contributing factors tabulated to the SPACE score hexagons, including demographics and intersection star ratings[8]
- Variables from the SPACE tool related to environmental justice, such as the racial and income demographics of areas surrounding crash locations[9]
- Location types stratified by the crash's occurrence on or off of the trunk highway network

3.1 All VRU

3.1.1 Injury Severity - All VRU

The data used in this study contained all vulnerable road user (VRU) crashes that occurred in Minnesota during 2018-2022, representing five years of crash data. Several modes are considered in the VRU category, including bicyclists, pedestrians, other personal conveyances, and other VRUs. The following tables show trends in the data for all VRU modes contained in the data.

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8 Visit https://mndotspace.mn.gov/ to view the SPACE Tool.
9 Note: These variables were derived from data sources that are not maintained by MnDOT.

Table 3 shows the crash distribution by injury severity for all VRUs. Pedestrians have the largest share of fatal crashes at 5.6%, followed by other VRU crashes. Most bicyclist crashes are minor injury and possible injury crashes, although 10.5% are serious injury crashes.

Table 3: All Study Crashes by Severity, All VRU, 2018-2022

Mode		Fatal	Severe Injury	Minor Injury	Possible Injury	Property Damage Only	Total
Bicyclist	Count	42	295	1,374	873	228	2,812
	Percentage	1.5%	10.5%	48.9%	31.0%	8.1%	100.0%
Pedestrian	Count	232	771	1,728	1,207	203	4,141
	Percentage	5.6%	18.6%	41.7%	29.1%	4.9%	100.0%
Other - Personal Conveyance	Count	0	7	32	22	190	251
	Percentage	0.0%	2.8%	12.7%	8.8%	75.7%	100.0%
Other - VRU	Count	4	19	79	64	43	209
	Percentage	1.9%	9.1%	37.8%	30.6%	20.6%	100.0%

3.1.2 Year – All VRU

Table 4 describes the distribution of VRU crashes by year, including the number of Fatal and Serious Injury crashes (KA), and the shares of total and KA crashes among each VRU mode per year. The same data are displayed in Figure 2 and Figure 3. Table 4 shows several trends. First, while total bicyclist and pedestrian crash numbers are lower than in 2018, KA crash numbers for these modes reached a 5-year high in 2022. Additionally, pedestrian crashes comprise the largest share of both total and KA VRU crashes each year. Pedestrian KA crash shares are also consistently larger than shares of all pedestrian crashes. Both of these trends indicate that pedestrians are overburdened for serious and fatal injuries in the Minnesota statewide transportation system.

Another trend is that bicyclist crashes make up a similar share of VRU crashes each year. The overall number of bicyclist crashes (and all VRU crashes) decreased during the COVID-19 pandemic but has increased since that time. Bicyclists represented 36.1%- 40.5% of all crashes and 21.1%- 26.1% of all KA crashes each year.

Table 4: Crashes by Year, All Modes, 2018-2022

Year	Mode	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
2018	Pedestrian	932	58.5%	205	77.4%	22.0%
	Bike	575	36.1%	56	21.1%	9.7%
	Other - Personal Conveyance	53	3.3%	2	0.8%	3.8%
	Other - VRU	33	2.1%	2	0.8%	6.1%
	2018	***1,593***	***100.0%***	***265***	***100.0%***	***16.6%***
2019	Pedestrian	906	54.8%	176	70.4%	19.4%
	Bike	642	38.8%	65	26.0%	10.1%
	Other - VRU	46	2.8%	5	2.0%	10.9%
	Other - Personal Conveyance	60	3.6%	4	1.6%	6.7%
	2019	***1,654***	***100.0%***	***250***	***100.0%***	***15.1%***
2020	Pedestrian	617	55.4%	171	71.8%	27.7%
	Bike	433	38.9%	62	26.1%	14.3%
	Other - VRU	29	2.6%	4	1.7%	13.8%
	Other - Personal Conveyance	35	3.1%	1	0.4%	2.9%
	2020	***1,114***	***100.0%***	***238***	***100.0%***	***21.4%***
2021	Pedestrian	654	53.5%	195	73.9%	29.8%
	Bike	495	40.5%	59	22.3%	11.9%
	Other - VRU	41	3.4%	8	3.0%	19.5%
	Other - Personal Conveyance	32	2.6%	2	0.8%	6.2%
	2021	***1,222***	***100.0%***	***264***	***100.0%***	***21.6%***
2022	Pedestrian	816	55.3%	239	72.4%	29.3%
	Bike	549	37.2%	85	25.8%	15.5%
	Other - VRU	57	3.9%	5	1.5%	8.8%
	Other - Personal Conveyance	53	3.6%	1	0.3%	1.9%
	2022	***1,475***	***100.0%***	***330***	***100.0%***	***22.4%***

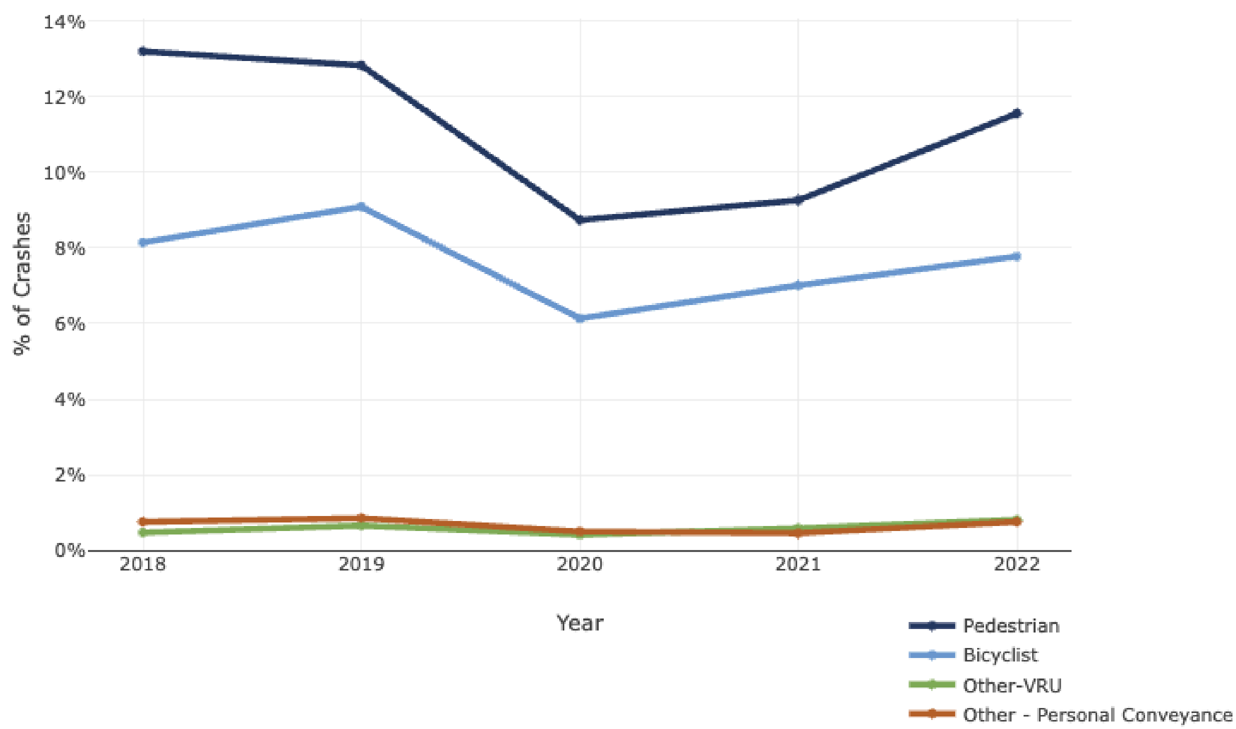

Figure 2: Crashes Over Time by Mode, 2018-2022

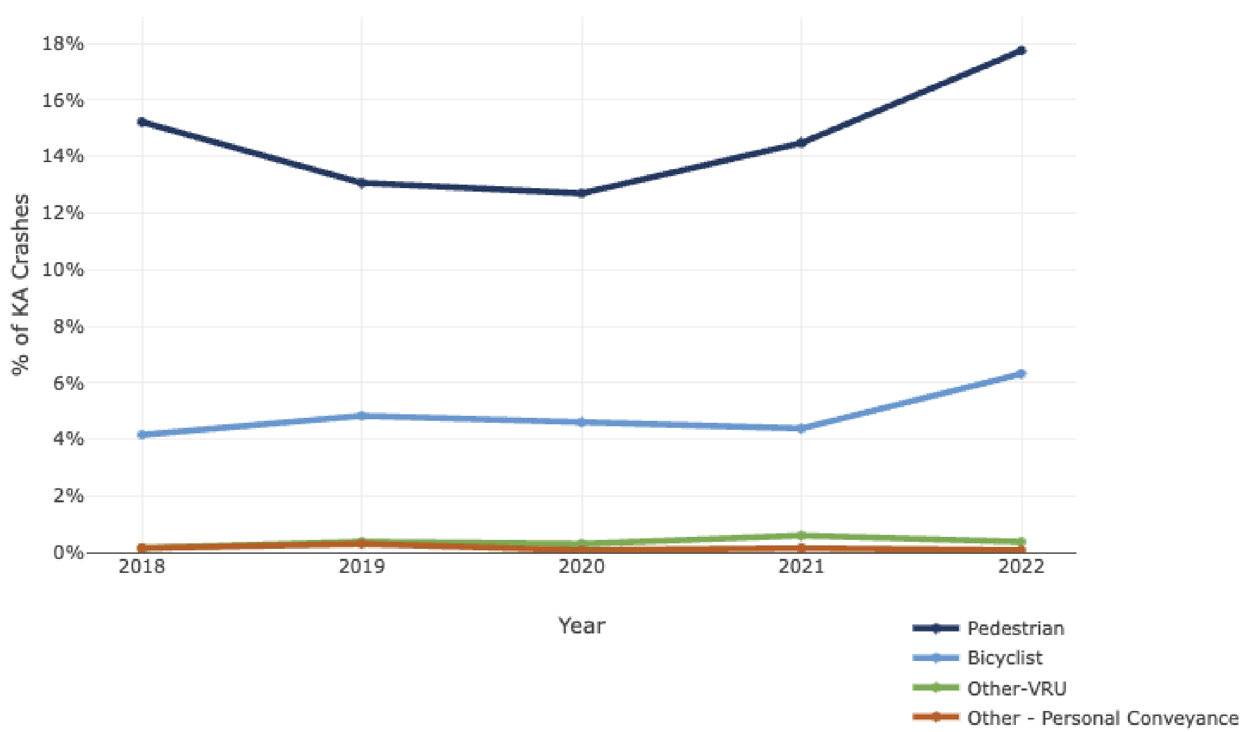

Figure 3: KA Crashes Over Time by Mode, 2018-2022

3.2 Injury Severity

Figure 4 shows the distribution of all bike-related and pedestrian- and other-VRU-related crashes, respectively, by injury severity. Most of the reported crashes for these VRU groups resulted in a possible or confirmed injury, an expected result due to the overall vulnerability of people walking, bicycling, or rolling within space shared with motorists. In total, there were 2,694 reported bicycle crashes during 2018–2022; roughly 12% of those crashes were reported to be fatal or result in a serious injury. During the same period, there were 4,131 reported pedestrian and other VRU crashes, with 24% resulting in a fatal or serious injury – twice the percentage of KA crashes as for bicyclist crashes.

There were far fewer property damage only (PDO) crashes than minor injury crashes, which may reflect underreporting[10] of these types of crashes or that these crashes do not meet the minimum cost threshold ($1,000)[11]. Injury severities in Figure 4 other than fatal also likely include some degree of both underreporting and misclassification – previous research has documented significant underreporting of crashes, particularly for bicyclists, in police crash data[12], and the San Francisco Department of Public Health has found miscoding between a non-trivial percentage of serious and minor injuries[13]. Future efforts to link police crash data with hospital or other public health data may help provide a more accurate assessment of bicyclist crash severity across the state.

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10 Stutts, J., & Hunter, W. (1998). Police reporting of pedestrians and bicyclists treated in hospital emergency rooms. Transportation Research Record: Journal of the Transportation Research Board, (1635), 88-92.

11 This $1,000 minimum changed in 2022, the underreporting is still present in the data being analyzed as the study period covers crashes that occurred between 2018-2022.

12 https://safetrec.berkeley.edu/publications/evaluating-research-data-linkage-assess-underreporting-pedestrian-and-bicyclist-injury

13 San Francisco Department of Public Health-Program on Health, Equity and Sustainability. 2017. Vision Zero High Injury Network: 2017 Update – A Methodology for San Francisco, California. San Francisco, CA. Available at: https://www.sfdph.org/dph/files/EHSdocs/PHES/VisionZero/Vision_Zero_High_Injury_Network_Update.pdf

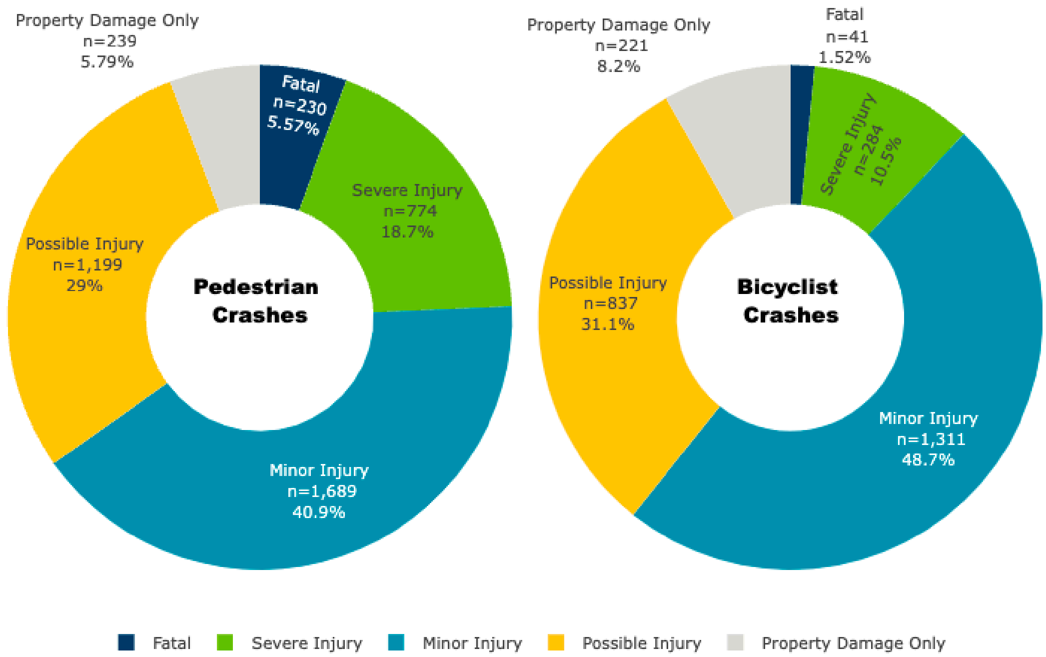

Figure 4: Crashes by Injury Severity, 2018-2022

3.3 Area Land Development Intensity

Table 5 shows the distribution of bicyclist crashes by the land development intensity recorded in MnDOT SPACE data surrounding the facility where the crash occurred. Twin Cities Metropolitan Areas (TCMA) have been subdivided to analyze crashes that occurred within Minneapolis and St. Paul separate from other cities within the metro area. The land development intensities referenced in this section are defined as follows:[14]

- **TCMA - Minneapolis and St. Paul**: The urban areas of Minneapolis and St. Paul.
- **TCMA - Other Cities**: All urban areas other than Minneapolis and St. Paul within the seven-county Twin Cities metropolitan area.
- **Greater MN Metro**: Urban areas with populations greater than 30,000 that are outside of the seven-county Twin Cities metropolitan area.
- **Small Urban Communities**: Areas of concentrated development outside of the seven-county Twin Cities metropolitan area and outside of urban areas with populations greater than 30,000.
- **Rural Areas**: Any area not included in one of the above categories.

Most bicyclist crashes (37.4%) and KA crashes (36.6%) occurred within the TCMA - Other Cities areas, followed by TCMA - Minneapolis and St. Paul areas (36.8% of all crashes; 30.2% of KA crashes). When looking at crashes that occurred within both of those subdivisions of the TCMA (Minneapolis and St. Paul; Other Cities), most crashes (74.2%) and KA crashes (66.8%) occurred in the TCMA, which is likely confounded by the number of people riding bikes; urban areas

[14] Department of Agriculture. "Urban Areas, Minnesota." March 12, 2016. Distributed by MnGEO.

often have higher volumes of people riding bikes, so it follows that there would be more crashes.

Small urban communities (defined as rural downtown in SPACE) had the third largest share of crashes (13.1%) and KA crashes (12.9%). While bicycle riding is less frequent (lower levels of exposure) in small urban areas relative to denser metro areas, this may be an indication of high crash risk in these areas of the state. Future efforts to collect bicyclist exposure data and to add installation dates to bike facility data will improve our understanding of crash risk in small urban areas.

Only 3.4% of all crashes occurred in rural areas, but 10.8% of KA crashes occurred in rural areas, and more than a third (38.0%) of all crashes that occurred in rural areas resulted in a KA crash. This finding likely results from a combination of underreporting of non-KA bicyclist crashes in rural areas and greater injury risk due to higher speeds and less robust bicycle facilities in rural areas relative to more urban areas.

Table 5: Crashes by Land Development (SPACE), Bicyclists, 2018-2022

Area Land Development Intensity	# of Crashes	% of Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA	# Crashes per 100 Hex	# KA Crashes per 100 Hex	% Square Mileage
TCMA - Minneapolis and St. Paul	991	36.8%	98	30.2%	9.9%	126.4	12.5	0.2%
TCMA - Other cities	1,008	37.4%	119	36.6%	11.8%	12.6	1.5	1.5%
Greater MN metro	249	9.2%	31	9.5%	12.4%	18.3	2.3	0.3%
Small urban communities	354	13.1%	42	12.9%	11.9%	3.8	0.5	1.8%
Rural	92	3.4%	35	10.8%	38.0%	0.0	0.0	96.3%
Bike Total	2,694	100.0%	325	100.0%	12.1%	161.1	16.7	100.0%

Table 6 shows the distribution of pedestrian and other VRU crashes by the SPACE land development intensity. Unlike bicyclist crashes, most pedestrian and other VRU crashes (46.9%) and KA crashes (34.9%) occurred within the TCMA - Minneapolis and St. Paul areas, which is likely related to the walkability of those communities and generally higher levels of pedestrian exposure. Additionally, the density of crashes per 100 hex cells shows that crashes (247.2 crashes per 100 hex cells) and KA crashes (44.6 crashes per 100 hex cells) are heavily concentrated in these two cities. TCMA - Other Cities had the second highest share of crashes (27.7%) and KA crashes (31.4%). Both communities accounted for 74.7% of all crashes and 66.2%, which mirrors the bicyclist findings.

Small urban communities and rural communities had similar proportions of crashes and KA crashes to bicyclist crashes. While a high proportion of bicyclist crashes in rural areas resulted in a KA outcome (38.0%), over half (52.5%) of reported pedestrian crashes in these areas resulted in a KA outcome. Like bicyclists, this finding is likely related to underreporting of pedestrian crashes in rural areas, as well as a combination of high-speeds and inadequate pedestrian facilities that lead to increased risk of severe injury relative to other communities.

Table 6: Crashes by Land Development (SPACE), Pedestrians and Other VRUs, 2018-2022

Area Land Development Intensity	# of Crashes	% of Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA	# Crashes per 100 Hex	# KA Crashes per 100 Hex	% Square Mileage
TCMA - Minneapolis and St. Paul	1,938	46.9%	350	34.9%	18.1%	247.2	44.6	0.2%
TCMA - Other cities	1,146	27.7%	315	31.4%	27.5%	14.3	3.9	1.5%
Greater MN metro	334	8.1%	73	7.3%	21.9%	24.5	5.4	0.3%
Small urban communities	509	12.3%	159	15.8%	31.2%	5.5	1.7	1.8%
Rural	204	4.9%	107	10.7%	52.5%	0.0	0.0	96.3%
Pedestrian or Other VRU Total	4,131	100.0%	1,004	100.0%	24.3%	291.5	55.7	100.0%

3.4 Month

Table 7 reviews the distribution of bicycle crashes by month of the year. In general, there were more bike crashes during warmer months (June through September). This finding aligns with our understanding of bicyclist volume seasonality: bicyclist volumes are highest during warmer months and lowest during colder and snowier months. As such, we can expect months with higher bicyclist volumes (exposure) to have the highest bicyclist crash frequencies.

The share of KA crashes follows the same trend - there are more KA crashes in warmer months than in colder months. March had the largest share of crashes that resulted in a KA outcome (15.9%), followed by October, which may indicate environmental risks from ice or snow posed to road users (narrower roadways, reduced traction, longer braking distances, etc.), darker lighting conditions (both of these months hosting daylight savings time changes), and/or visibility challenges related to snowfall or other inclement weather. Better bicyclist exposure data would allow us to further explore the relationship between crashes, these factors, and increasing (March) or declining (October) bicycling volumes in these transitional months.

Table 7: Crashes by Month, Bicyclists, 2018-2022

Month	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
January	43	1.6%	5	1.5%	11.6%
February	18	0.7%	1	0.3%	5.6%
March	69	2.6%	11	3.4%	15.9%
April	113	4.2%	13	4.0%	11.5%
May	264	9.8%	28	8.6%	10.6%
June	443	16.4%	59	18.2%	13.3%
July	435	16.1%	54	16.6%	12.4%
August	496	18.4%	51	15.7%	10.3%
September	411	15.3%	48	14.8%	11.7%
October	269	10.0%	41	12.6%	15.2%
November	100	3.7%	12	3.7%	12.0%
December	33	1.2%	2	0.6%	6.1%
Bike Total	2,694	100.0%	325	100.0%	12.1%

Table 8 summarizes the distribution of pedestrian crashes by month of the year. Like bicyclist crashes, most crashes occurred during warmer months. However, the distribution of crashes is not as heavily concentrated during summer months for pedestrians as it is for bicyclist crashes, likely because more people continue walking through the winter than biking. Pedestrian crashes and KA crashes instead appear slightly more concentrated in the early fall. Additionally, summer crashes are the least likely to result in a KA outcome, which, similar to bicyclist crashes, likely relates to the role of lighting and inclement weather in pedestrian injury severity outcomes.

Table 8: Crashes by Month, Pedestrians and Other VRUs, 2018-2022

Month	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
January	283	6.9%	61	6.1%	21.6%
February	271	6.6%	75	7.5%	27.7%
March	279	6.8%	73	7.3%	26.2%
April	229	5.5%	63	6.3%	27.5%
May	327	7.9%	76	7.6%	23.2%
June	334	8.1%	89	8.9%	26.6%
July	394	9.5%	91	9.1%	23.1%
August	371	9.0%	78	7.8%	21.0%
September	467	11.3%	95	9.5%	20.3%
October	449	10.9%	109	10.9%	24.3%
November	379	9.2%	103	10.3%	27.2%
December	348	8.4%	91	9.1%	26.1%
Pedestrian or Other VRU Total	4,131	100.0%	1,004	100.0%	24.3%

3.5 Lighting Condition

Table 9 shows how bicycle crashes and crash severity vary by lighting condition. Compared to dark and low-light conditions, most of the crashes happened in well-lit (i.e., daylight) conditions, although fatal and serious injury crashes are slightly overrepresented in dark and low-light conditions relative to non-severe crashes. Both findings align with expectations, as there are more people biking during daylight hours, but low lighting impairs both the visibility of people biking and drivers' and bicyclists' vision.

Over 40 percent (41.4%) of bicycle crashes that occurred in darkness where there were no streetlights resulted in a serious injury or fatality. Similarly, 60.0% of all crashes that occurred in dark hours at locations where streetlights were turned off resulted in serious injuries or fatalities (note small sample size). Crashes occurring in dark, lit conditions were still more likely to result in a severe outcome than those occurring in daylight or low-light (sunset and sunrise) conditions, but the difference was far smaller than compared to unlit conditions.

Table 9: Crashes by Lighting Condition, Bicyclists, 2018-2022

Lighting Condition	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Daylight	2,118	78.6%	225	69.2%	10.6%
Dark (Street Lights On)	361	13.4%	63	19.4%	17.5%
Dark (No Street Lights)	29	1.1%	12	3.7%	41.4%
Sunset	101	3.7%	12	3.7%	11.9%
Sunrise	49	1.8%	6	1.8%	12.2%
Dark (Street Lights Off)	5	0.2%	3	0.9%	60.0%
Dark (Unknown Lighting)	15	0.6%	3	0.9%	20.0%
Unknown	15	0.6%	1	0.3%	6.7%
Other	1	0.0%	0	0.0%	0.0%
Bike Total	2,694	100.0%	325	100.0%	12.1%

These trends are further investigated in Table 10, which separates crashes by lighting and urban or rural and small towns context. Most bike crashes occurred in urban areas (83.4%). Within urban areas, most crashes occurred during daylight hours (77.8%), as did most KA crashes (68.5%). Dark conditions without streetlights appear to be the riskiest: 33.3% of crashes that occurred in these conditions resulted in a KA outcome, compared to 7.5% and 11.5% for sunrise/sunset, respectively, and 17.2% for dark conditions with streetlights.

Of the crashes that occurred in rural and small town areas, 83.0% occurred during daylight hours, as did most KA crashes (71.4%). In contrast to urban areas, however, sunset and particularly sunrise times appear to be a much more prevalent risk factor, with 21.7% of those crashes resulting in a KA outcome (note small sample size). In contrast, just 20.0% of the crashes that occurred in darkness with streetlights resulted in a KA outcome, which may reflect where those crashes occurred (e.g., downtown main streets or in neighborhoods) as much as the impact of street lighting on crash severity.

Table 10: Crashes by Lighting Condition, Rural and Small Towns vs. Urban Context, Bicyclists, 2018-2022

Urban/ Rural (SPACE)	Lighting Condition	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Urban	Daylight	1,748	77.8%	170	68.5%	9.7%
	Dark (Street Lights On)	326	14.5%	56	22.6%	17.2%
	Sunset	87	3.9%	10	4.0%	11.5%
	Dark (No Street Lights)	15	0.7%	5	2.0%	33.3%
	Sunrise	40	1.8%	3	1.2%	7.5%
	Dark (Unknown Lighting)	14	0.6%	2	0.8%	14.3%
	Dark (Street Lights Off)	3	0.1%	1	0.4%	33.3%
	Unknown	14	0.6%	1	0.4%	7.1%
	Other	1	0.0%	0	0.0%	0.0%
	Bike Urban Total	***2,248***	***100.0%***	***248***	***100.0%***	***11.0%***
Rural	Daylight	370	83.0%	55	71.4%	14.9%
	Dark (No Street Lights)	14	3.1%	7	9.1%	50.0%
	Dark (Street Lights On)	35	7.8%	7	9.1%	20.0%
	Sunrise	9	2.0%	3	3.9%	33.3%
	Sunset	14	3.1%	2	2.6%	14.3%
	Dark (Street Lights Off)	2	0.4%	2	2.6%	100.0%
	Dark (Unknown Lighting)	1	0.2%	1	1.3%	100.0%
	Unknown	1	0.2%	0	0.0%	0.0%
	Bike Rural Total	***446***	***100.0%***	***77***	***100.0%***	***17.3%***

Table 11 reviews the distribution of pedestrian crashes by reported lighting condition. Like bicyclist crashes, the majority of pedestrian crashes occurred during daylight conditions (54.2%). However, KA crashes were disproportionately more common (54.3%) and severe (34.2%) during dark lighting conditions. Lighting conditions clearly play an important role in pedestrian safety. The presence of a street light during dark lighting conditions appears to have a positive effect on safety, as highlighted by the percentage of crashes that resulted in a KA outcome when the lighting conditions are dark with no street lights (54.5%) or with the street lights off (44.1%). The role of darkness as a risk factor for pedestrian safety is even more alarming when accounting for much higher pedestrian activity during daylight hours compared to darkness. These trends and pedestrian overrepresentation in KA crashes during darkness are consistent with national patterns of pedestrian deaths in darkness[15], currently being researched as part of NCHPR 17-97[16].

Table 11: Crashes by Lighting Condition, Pedestrians and Other VRUs, 2018-2022

Lighting Condition	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Dark (Street Lights On)	1,321	32.0%	403	40.1%	30.5%
Daylight	2,239	54.2%	398	39.6%	17.8%
Dark (No Street Lights)	209	5.1%	114	11.4%	54.5%
Sunset	149	3.6%	32	3.2%	21.5%
Sunrise	105	2.5%	26	2.6%	24.8%
Dark (Street Lights Off)	34	0.8%	15	1.5%	44.1%
Dark (Unknown Lighting)	31	0.8%	13	1.3%	41.9%
Other	11	0.3%	2	0.2%	18.2%
Unknown	32	0.8%	1	0.1%	3.1%
Pedestrian or Other VRU Total	4,131	100.0%	1,004	100.0%	24.3%

Table 12 summarizes the distribution of pedestrian crashes by reported lighting condition and geography type. Regardless of geography type, the proportion of crashes that resulted in a KA during darkness is substantially larger than the proportion during daylight conditions. Similar to the regional trends in Table 11, the presence of a street light during dark conditions is associated with a lower percentage of crashes resulting in a KA outcome.

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15 National Highway Traffic Safety Administration (NHTSA). Traffic safety facts, 2021 data: Pedestrians, link
16 See the 17-97 project webpage at: https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4973

Table 12: Crashes by Lighting Condition, Rural and Small Towns vs. Urban Context, Pedestrians or Other VRU, 2018-2022

Urban/ Rural (SPACE)	Lighting Condition	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Urban	Dark (Street Lights On)	1,176	34.4%	344	46.6%	29.3%
	Daylight	1,846	54.0%	294	39.8%	15.9%
	Dark (No Street Lights)	96	2.8%	39	5.3%	40.6%
	Sunset	119	3.5%	21	2.8%	17.6%
	Sunrise	88	2.6%	18	2.4%	20.5%
	Dark (Street Lights Off)	32	0.9%	14	1.9%	43.8%
	Dark (Unknown Lighting)	22	0.6%	6	0.8%	27.3%
	Other	9	0.3%	1	0.1%	11.1%
	Unknown	30	0.9%	1	0.1%	3.3%
	Pedestrian or Other VRU Urban Total	***3,418***	***100.0%***	***738***	***100.0%***	***21.6%***
Rural	Daylight	393	55.1%	104	39.1%	26.5%
	Dark (No Street Lights)	113	15.8%	75	28.2%	66.4%
	Dark (Street Lights On)	145	20.3%	59	22.2%	40.7%
	Sunset	30	4.2%	11	4.1%	36.7%
	Sunrise	17	2.4%	8	3.0%	47.1%
	Dark (Unknown Lighting)	9	1.3%	7	2.6%	77.8%
	Dark (Street Lights Off)	2	0.3%	1	0.4%	50.0%
	Other	2	0.3%	1	0.4%	50.0%
	Unknown	2	0.3%	0	0.0%	0.0%
	Pedestrian or Other VRU Rural Total	***713***	***100.0%***	***266***	***100.0%***	***37.3%***

3.6 Age

This section reports on the ages of people involved in vulnerable road user crashes. Since nearly all reported crashes involve more than one person and more than one party, the numbers do not identically match the numbers of *crashes* presented in other sections. Data in this section are summarized by the number of parties involved, focusing on the main road users/vehicles involved in the crash, such as drivers, pedestrians, bicyclists, and parked vehicles. Nearly all of the crash records summarized in this memo contain more than one party, except for a small number of hit-and-run crashes.

Analyzing the party-level data provides additional insight into these crashes and the people affected by them. This analysis compared the distribution of parties involved in crashes to the population distribution of the state. For each comparison category, a ratio of bicyclist or driver proportion to population proportion is calculated. Values greater than one suggest that a certain segment of the population is overrepresented among crash parties on a per capita basis, while values less than one suggest that that segment of the population is underrepresented on the same basis.

It is important to note that this comparison is imperfect in two ways. First, if more or fewer people from a segment of the population bicycle or drive, we would expect that to be reflected in crash rates, all else equal – and this proportion of people who bicycle or drive may not reflect their per capita proportion. We likely see this, for example, in trends related to age and sex. In the absence of more nuanced exposure data, however, a per capita understanding is still valuable to help us understand how crashes are distributed among various segments of the population.

Second, the home zip code is not readily available for all parties involved in the crash, so we cannot rule out that some people riding a bicycle or driving a motor vehicle live outside of the state and their inclusion will therefore marginally affect the accuracy of the party-to-population ratio. This effect is more likely to apply to drivers than to bicyclists, and the effect is expected to be very small.

Table 13 and Figure 5 summarize the distribution of bicyclist parties and Table 14 driver parties by age and injury severity.[17] Table 13 shows that most crashes and the most severe bicycle crashes involved younger cyclists. People riding bikes aged between 10-14 accounted for the largest share of bicyclist parties (13.5%), and bicyclists aged between 15-19 accounted for the largest share of KA bicyclist parties (12.1%).

The distribution of driver ages was slightly more dispersed than that of bicyclist ages, though drivers aged 25-34 were most frequently involved in a crash with a bicyclist. Drivers aged 25-39 were most frequently involved in KA crashes with a bicyclist.

When comparing the distribution of parties by age to the state's population by age, younger bicyclists are much more likely to be involved in a crash and a KA crash compared to older populations. Bicyclists aged 10-19 were the most overrepresented in crashes and bicyclists aged 15-19 were the most overrepresented in KA crashes. This finding may reflect a higher percentage of bicyclists within these age groups, as well as a need to ensure that Minnesota's

17 Remember that there are multiple parties involved in each crash, so the party-scale totals in this section do not match crash-scale totals reported in other sections.

youth have access to safe bicycle facilities to meet their travel needs. At the same time, there still was some level of overrepresentation of older bicyclists ages 60 to 69 in KA but not all crashes, reinforcing the data showing that crashes among this age group are disproportionately severe.

Driver representation relative to the state's population was less skewed than bicyclist representation, however, drivers aged 25-34 were more overrepresented than other age cohorts.

Table 13: Bicyclist by Age, 2018-2022

Bicyclist Age	Total Bicyclists	% of Bicyclists	# of KA Bicyclists	% of KA Bicyclists	% of Crashes That Are Severe	% of Population	Bike:Pop Ratio	KA Bike:Pop Ratio
Under 5 years	38	1.4%	2	0.6%	5.3%	6.2%	**0.2**	**0.1**
5 to 9 years	98	3.6%	9	2.7%	9.2%	6.4%	**0.6**	**0.4**
10 to 14 years	371	13.5%	31	9.4%	8.4%	6.6%	**2.0**	**1.4**
15 to 19 years	359	13.0%	40	12.1%	11.1%	6.4%	**2.0**	**1.9**
20 to 24 years	223	8.1%	24	7.3%	10.8%	6.1%	**1.3**	**1.2**
25 to 29 years	221	8.0%	25	7.6%	11.3%	6.8%	**1.2**	**1.1**
30 to 34 years	238	8.7%	27	8.2%	11.3%	6.8%	**1.3**	**1.2**
35 to 39 years	157	5.7%	19	5.8%	12.1%	6.8%	**0.8**	**0.8**
40 to 44 years	146	5.3%	14	4.2%	9.6%	6.1%	**0.9**	**0.7**
45 to 49 years	133	4.8%	19	5.8%	14.3%	5.8%	**0.8**	**1.0**
50 to 54 years	159	5.8%	22	6.7%	13.8%	6.1%	**0.9**	**1.1**
55 to 59 years	175	6.4%	25	7.6%	14.3%	6.9%	**0.9**	**1.1**
60 to 64 years	141	5.1%	26	7.9%	18.4%	6.6%	**0.8**	**1.2**
65 to 69 years	111	4.0%	21	6.4%	18.9%	5.4%	**0.7**	**1.2**
70 to 74 years	52	1.9%	13	3.9%	25.0%	4.1%	**0.5**	**1.0**
75 to 79 years	29	1.1%	4	1.2%	13.8%	2.9%	**0.4**	**0.4**
80 to 84 years	13	0.5%	5	1.5%	38.5%	2.0%	**0.2**	**0.8**
85 years and over	5	0.2%	1	0.3%	20.0%	2.0%	**0.1**	**0.2**
Unknown	82	3.0%	3	0.9%	3.7%	NA	**NA**	**NA**
Total	2,751	100.0%	330	100.0%	12.0%	NA	**NA**	**NA**

Table 14: Drivers Involved in Bicyclist Crashes by Driver by Age, 2018-2022

Driver Age	# of Drivers	% of Drivers	# of KA Drivers	% of KA Drivers	% of Crashes That Are Severe	% of Population	Driver:Pop Ratio	KA Driver:Pop Ratio
Under 5 years	1	0.0%	1	0.3%	5.3%	6.2%	0.0	0.1
5 to 9 years	0	0.0%	0	0.0%	9.2%	6.4%	0.0	0.0
10 to 14 years	0	0.0%	0	0.0%	8.4%	6.6%	0.0	0.0
15 to 19 years	176	7.1%	24	7.6%	11.1%	6.4%	1.1	1.2
20 to 24 years	216	8.7%	26	8.3%	10.8%	6.1%	1.4	1.3
25 to 29 years	249	10.1%	30	9.5%	11.3%	6.8%	1.5	1.4
30 to 34 years	245	9.9%	30	9.5%	11.3%	6.8%	1.5	1.4
35 to 39 years	231	9.3%	30	9.5%	12.1%	6.8%	1.4	1.4
40 to 44 years	208	8.4%	22	7.0%	9.6%	6.1%	1.4	1.1
45 to 49 years	174	7.0%	21	6.7%	14.3%	5.8%	1.2	1.1
50 to 54 years	185	7.5%	24	7.6%	13.8%	6.1%	1.2	1.2
55 to 59 years	184	7.4%	26	8.3%	14.3%	6.9%	1.1	1.2
60 to 64 years	191	7.7%	25	7.9%	18.4%	6.6%	1.2	1.2
65 to 69 years	138	5.6%	16	5.1%	18.9%	5.4%	1.0	0.9
70 to 74 years	112	4.5%	14	4.4%	25.0%	4.1%	1.1	1.1
75 to 79 years	73	3.0%	13	4.1%	13.8%	2.9%	1.0	1.4
80 to 84 years	48	1.9%	5	1.6%	38.5%	2.0%	1.0	0.8
85 years and over	38	1.5%	7	2.2%	20.0%	2.0%	0.8	1.1
Unknown	2	0.1%	1	0.3%	3.7%	NA	NA	NA
Total	2,471	100.0%	315	100.0%	12.0%	NA	NA	NA

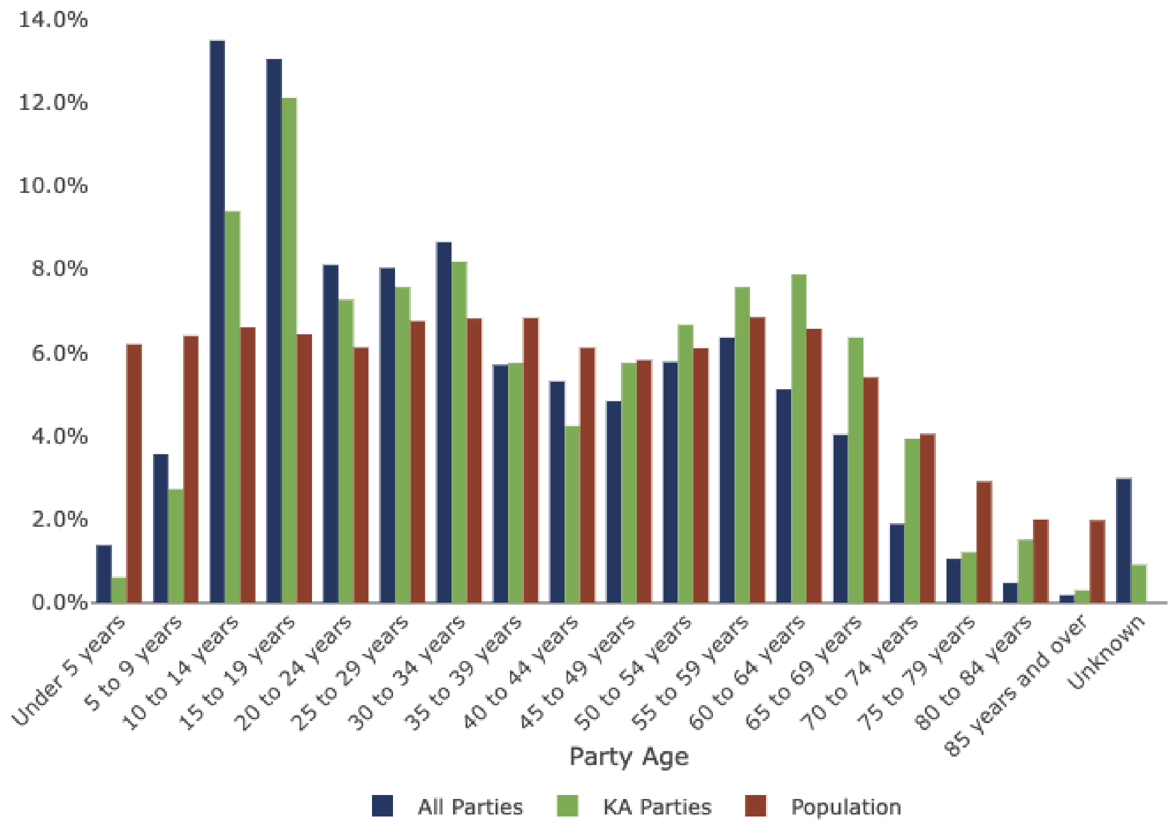

Figure 5: Bicyclist by Age, 2018-2022

Table 15 and Figure 6 summarizes the distribution of pedestrian parties and Table 16 summarizes driver parties by age and injury severity.[18] Pedestrians aged between 15 through 34 generally had the highest share of victims involved in a crash. Pedestrians aged between 20-24 accounted for the largest share of victims (10.5%). Pedestrians aged 10 and younger or age 74 and older had the lowest share of involvement (less than 3% for each age cohort). The distribution of KA parties is similar to that of all pedestrian parties, and pedestrians aged between 55-59 years of age accounted for the largest share of KA parties (9.5%). Pedestrians aged 15-29 and 55-59 were the most overrepresented among KA pedestrians, and pedestrians under 15 years of age were the most underrepresented KA parties

The distribution of drivers involved in a crash with a pedestrian had a similar distribution as drivers involved in a crash with a bicyclist. Drivers aged 20-29 were most frequently involved in a crash with a pedestrian. Drivers aged 20-29 and 45-49 were most frequently involved in KA crashes with a pedestrian. Drivers aged between 70-74 and drivers under 50 years of age were all overrepresented in pedestrian KA crashes.

18 Remember that there are multiple parties involved in each crash, so the party-scale totals in this section do not match crash-scale totals reported in other sections.

Table 15: Pedestrian/Other VRU and Drivers by Age, 2018-2022

Pedestrian Age	Total Pedestrians	% of Pedestrians	# of KA Pedestrians	% of KA Pedestrians	% of Crashes Resulting in KA	% of Population	Ped:Pop Ratio	KA Ped:Pop Ratio
Under 5 years	101	2.3%	27	2.6%	26.7%	6.2%	**0.4**	**0.4**
5 to 9 years	116	2.7%	23	2.2%	19.8%	6.4%	**0.4**	**0.3**
10 to 14 years	257	5.9%	40	3.9%	15.6%	6.6%	**0.9**	**0.6**
15 to 19 years	401	9.2%	80	7.7%	20.0%	6.4%	**1.4**	**1.2**
20 to 24 years	455	10.5%	93	9.0%	20.4%	6.1%	**1.7**	**1.5**
25 to 29 years	431	9.9%	95	9.2%	22.0%	6.8%	**1.5**	**1.4**
30 to 34 years	363	8.4%	81	7.8%	22.3%	6.8%	**1.2**	**1.1**
35 to 39 years	300	6.9%	65	6.3%	21.7%	6.8%	**1.0**	**0.9**
40 to 44 years	281	6.5%	54	5.2%	19.2%	6.1%	**1.1**	**0.9**
45 to 49 years	238	5.5%	64	6.2%	26.9%	5.8%	**0.9**	**1.1**
50 to 54 years	263	6.1%	69	6.7%	26.2%	6.1%	**1.0**	**1.1**
55 to 59 years	319	7.3%	98	9.5%	30.7%	6.9%	**1.1**	**1.4**
60 to 64 years	231	5.3%	71	6.9%	30.7%	6.6%	**0.8**	**1.0**
65 to 69 years	204	4.7%	61	5.9%	29.9%	5.4%	**0.9**	**1.1**
70 to 74 years	137	3.2%	36	3.5%	26.3%	4.1%	**0.8**	**0.9**
75 to 79 years	79	1.8%	28	2.7%	35.4%	2.9%	**0.6**	**0.9**
80 to 84 years	51	1.2%	20	1.9%	39.2%	2.0%	**0.6**	**1.0**
85 years and over	44	1.0%	18	1.7%	40.9%	2.0%	**0.5**	**0.9**
Unknown	73	1.7%	11	1.1%	15.1%	NA	**NA**	**NA**
Total	4,344	100.0%	1,034	100.0%	23.8%	NA	**NA**	**NA**

Table 16: Drivers Involved in Pedestrian or Other VRU Crashes by Driver by Age, 2018-2022

Driver Age	# of Drivers	% of Drivers	# of KA Drivers	% of KA Drivers	% of Crashes Resulting in KA	% of Population	Driver:Pop Ratio	KA Driver:Pop Ratio
Under 5 years	0	0.0%	0	0.0%	26.7%	6.2%	**0.0**	**0.0**
5 to 9 years	0	0.0%	0	0.0%	19.8%	6.4%	**0.0**	**0.0**
10 to 14 years	3	0.1%	1	0.1%	15.6%	6.6%	**0.0**	**0.0**
15 to 19 years	280	7.7%	74	8.5%	20.0%	6.4%	**1.2**	**1.3**
20 to 24 years	401	11.0%	110	12.6%	20.4%	6.1%	**1.8**	**2.1**
25 to 29 years	387	10.6%	102	11.7%	22.0%	6.8%	**1.6**	**1.7**
30 to 34 years	355	9.7%	83	9.5%	22.3%	6.8%	**1.4**	**1.4**
35 to 39 years	354	9.7%	74	8.5%	21.7%	6.8%	**1.4**	**1.2**
40 to 44 years	292	8.0%	64	7.3%	19.2%	6.1%	**1.3**	**1.2**
45 to 49 years	279	7.6%	92	10.5%	26.9%	5.8%	**1.3**	**1.8**
50 to 54 years	249	6.8%	52	5.9%	26.2%	6.1%	**1.1**	**1.0**
55 to 59 years	260	7.1%	61	7.0%	30.7%	6.9%	**1.0**	**1.0**
60 to 64 years	236	6.5%	51	5.8%	30.7%	6.6%	**1.0**	**0.9**
65 to 69 years	183	5.0%	37	4.2%	29.9%	5.4%	**0.9**	**0.8**
70 to 74 years	175	4.8%	36	4.1%	26.3%	4.1%	**1.2**	**1.0**
75 to 79 years	73	2.0%	13	1.5%	35.4%	2.9%	**0.7**	**0.5**
80 to 84 years	62	1.7%	12	1.4%	39.2%	2.0%	**0.8**	**0.7**
85 years and over	62	1.7%	12	1.4%	40.9%	2.0%	**0.9**	**0.7**
Unknown	5	0.1%	1	0.1%	15.1%	NA	**NA**	**NA**
Total	3,656	100.0%	875	100.0%	23.8%	NA	**NA**	**NA**

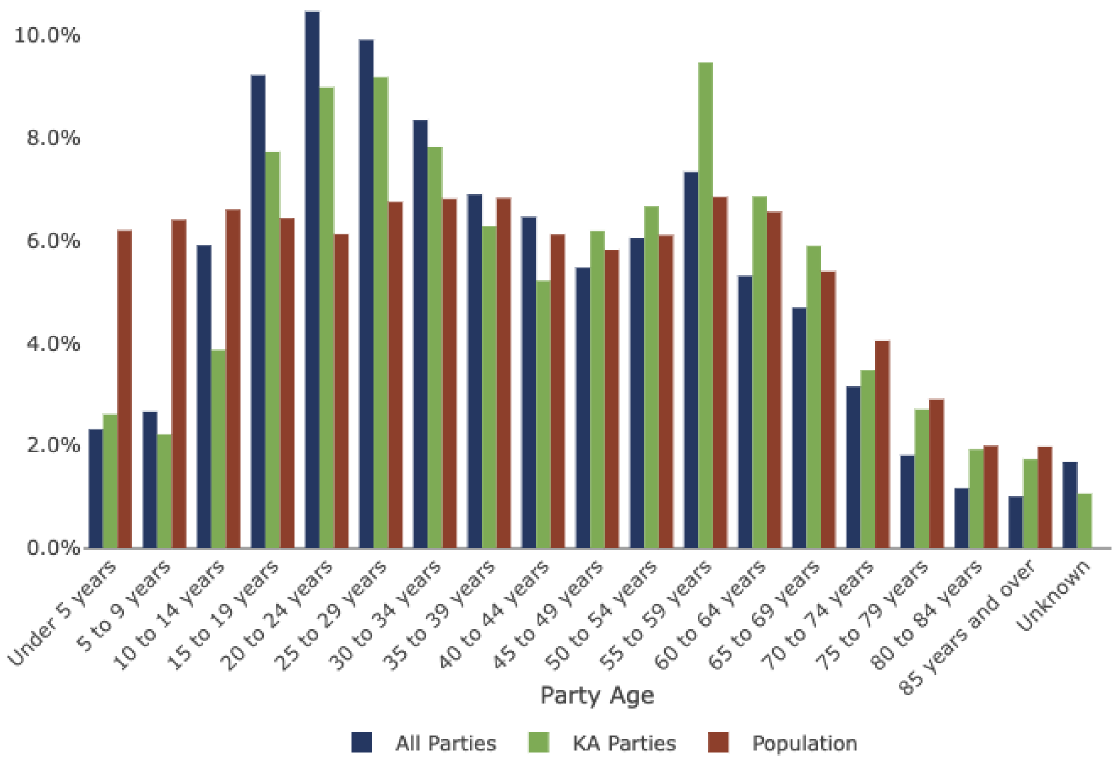

Figure 6: Pedestrian/Other VRU and Drivers by Age, 2018-2022

3.7 Crash Location Type

Table 17 summarizes bicyclist crashes by crash location type. The table shows that nearly three-quarters of crashes occurred at an intersection. Following the MnDOT Statewide Pedestrian Safety Analysis methodology, crashes were considered intersection-related if the crash occurred within 100 feet of the center of an intersection. Crashes not flagged as intersection-related were coded as segment crashes.

Overall crashes and KA crashes occurred most frequently at stop-controlled intersections (40.2% of all crashes; 34.5% of KA crashes). Detailed information related to the type of stop control (all-way or two-way) is not available for all crashes and intersections. There may be several factors that contribute to stop-controlled intersections accounting for the largest share of all crashes and KA crashes. First, stop-controlled intersections likely account for the largest share of intersections across the state, leading to a much higher rate of system-wide "exposure" at these locations.

Perhaps more importantly, there may be a systemic issue related to two-way stop signs where bicyclists ride along lower-intensity (often residential) streets and need to cross uncontrolled major streets. Without protected crossing accommodations, bicyclists attempting to cross the major street are exposed to oncoming motorists who are not required to stop and who may be traveling at higher speeds, resulting in a high-risk context.

The crash data support this theory: 47.5% of all bicyclist crashes and 47.5% of bicyclist KA crashes at stop-controlled intersections report the cyclist as crossing traffic/roadway. Furthermore, nearly all of those crashes are at an intersection where the lowest functional classification was a residential street.

Signalized intersections accounted for the largest share of overall crashes (34.3%) and tied for the largest share of KA crashes (34.5%). Crashes at this location type were more likely to result in a KA outcome (12.1%) than at stop-controlled intersections (10.3%), but less likely to do so than at segment locations (15.0%).

Table 17: Crashes by Location and Traffic Control Type, Bicyclists, 2018-2022

Crash Location	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Intersection with Signal	924	34.3%	112	34.5%	12.1%
Intersection with Stop Sign	1,084	40.2%	112	34.5%	10.3%
Segment	526	19.5%	79	24.3%	15.0%
Intersection with Other/Unknown Control	160	5.9%	22	6.8%	13.8%
Bike Total	2,694	100.0%	325	100.0%	12.1%

Table 18 summarizes bicyclist crashes by location type and urban/rural context. Examining crashes by context provides insight into how safety issues differ between urban and rural areas across Minnesota. For example, urban areas tend to have more signalized intersections than rural areas; correspondingly, only 9.0% of signalized intersection crashes occurred in rural areas.

Additionally, rural areas often have more lane miles of higher-speed roads as a proportion of the total area, which may help explain why 35.0% of rural segment crashes result in a KA outcome, compared to 8.9% of segment locations in urban areas. Crashes that occurred at stop-controlled intersections were also more likely to be severe in rural areas than in urban areas.

Table 18: Crashes by Location and Traffic Control Type, Rural vs. Urban Context, Bicyclists, 2018-2022

Urban/ Rural (SPACE)	Crash Location	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Urban	Intersection with Signal	841	37.4%	101	40.7%	12.0%
	Intersection with Stop Sign	870	38.7%	90	36.3%	10.3%
	Segment	403	17.9%	36	14.5%	8.9%
	Intersection with Other/Unknown Control	134	6.0%	21	8.5%	15.7%
	Bike Urban Total	2,248	100.0%	248	100.0%	11.0%
Rural	Segment	123	27.6%	43	55.8%	35.0%
	Intersection with Stop Sign	214	48.0%	22	28.6%	10.3%
	Intersection with Signal	83	18.6%	11	14.3%	13.3%
	Intersection with Other/Unknown Control	26	5.8%	1	1.3%	3.8%
	Bike Rural Total	446	100.0%	77	100.0%	17.3%

Table 19 summarizes pedestrian crashes by crash location type. Roughly two-thirds of pedestrian crashes occurred at or near intersections, regardless of intersection control. While more crashes occurred at signalized intersection locations than at stop-controlled locations (34.7% v. 27.7%, respectively) crashes at stop-controlled intersections were more likely to be severe. Segment (i.e., midblock) locations accounted for just less than one-third of all crashes (31.3%), but over 40 percent of KA crashes (41.5%), making them the most severe crashes for pedestrians overall. Motorist speeds are often higher midblock than at intersections, resulting in higher kinetic energy and limited reaction time, both of which may contribute to greater injury severity from segment crashes.

Table 19: Crashes by Location and Traffic Control Type, Pedestrians and Other VRUs, 2018-2022

Crash Location	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Segment	1,295	31.3%	417	41.5%	32.2%
Intersection with Stop Sign	1,146	27.7%	278	27.7%	24.3%
Intersection with Signal	1,433	34.7%	262	26.1%	18.3%
Intersection with Other/Unknown Control	257	6.2%	47	4.7%	18.3%
Pedestrian or Other VRU Total	4,131	100.0%	1,004	100.0%	24.3%

Table 20 shows how pedestrian crashes and crash severity vary by crash location and geography type. A key difference between urban and rural crashes by location type is which location type accounted for the most KA crashes. For rural areas, the majority of crashes (47.0%) and KA crashes (59.0%) occurred at segment locations, with very few crashes and KA crashes occurring at signalized intersections. In urban areas, KA crashes also occurred most frequently at segment locations (35.2%), but signalized intersections had the largest share of all crashes and the second largest share of KA crashes. While these statistics reflect pedestrian risk along segments in both area types, the percentage of segment crashes in rural areas highlights particular pedestrian vulnerability along higher-speed roadways with few pedestrian safety countermeasures. Indeed, roughly half of all rural segment crashes resulted in a KA outcome, underscoring this pedestrian vulnerability and the need for systemic countermeasures to ensure safe pedestrian travel in rural areas.

Table 20: Crashes by Location and Traffic Control Type, Rural vs. Urban Context, Pedestrians or Other VRU, 2018-2022

Urban/ Rural (SPACE)	Crash Location	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Urban	Segment	960	28.1%	260	35.2%	27.1%
	Intersection with Signal	1,351	39.5%	244	33.1%	18.1%
	Intersection with Stop Sign	890	26.0%	197	26.7%	22.1%
	Intersection with Other/Unknown Control	217	6.3%	37	5.0%	17.1%
	Pedestrian or Other VRU Urban Total	3,418	100.0%	738	100.0%	21.6%
Rural	Segment	335	47.0%	157	59.0%	46.9%
	Intersection with Stop Sign	256	35.9%	81	30.5%	31.6%
	Intersection with Signal	82	11.5%	18	6.8%	22.0%
	Intersection with Other/Unknown Control	40	5.6%	10	3.8%	25.0%
	Pedestrian or Other VRU Rural Total	713	100.0%	266	100.0%	37.3%

3.8 MnDOT Trunk Highways

In addition to functional classification, the project team also reviewed crash distribution by the network of trunk highways within the state, as shown in Table 21 and Table 23. Trunk highways are state-operated roadways that range from freeways and interstates to urban arterials and small-town main streets. Most bicyclist crashes and severe crashes occur off the trunk network (85.9% and 83.4%, respectively), likely because local roadways tend to be more attractive roadways for cyclists and thus have higher levels of ridership (exposure) than the trunk network. Because trunk highway mileage represents a relatively small percentage of all roadway network mileage (8%, or 11,694 miles out of 141,956 miles), there are comparatively fewer locations where deployment of safety countermeasures would be under MnDOT's purview, and future VRU analyses focusing on non-trunk roadways are needed to further investigate these patterns. However, crashes on the trunk network are disproportionately severe compared to non-trunk crashes (14.2% v. 11.7%, respectively). MnDOT controls the design of trunk highways, and it is important to consider these safety trends and investigate the trunk highways for possible countermeasures.

Table 21: Trunk vs Non-Trunk Crashes, Bicyclists, 2018-2022

Trunk Highway	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Non-Trunk Highway	2,315	85.9%	271	83.4%	11.7%
Trunk Highway	379	14.1%	54	16.6%	14.2%
Bike Total	2,694	100.0%	325	100.0%	12.1%

Table 22 shows bicycle crash trends on the trunk highway network in urban and rural contexts. A larger share of crashes occurred on the trunk network in small urban communities (33.1%) compared to TCMA and greater MN metro areas (9.8% - 14.1%), and more of these crashes were severe (37.0% in rural areas compared to 11.8% to 12.2% in TCMA locations). Most of the trunk highway network by mileage is in rural areas (80.4%), whereas only 10.9% of the network is within small urban communities, 7.4% percent in the TCMA, and 1.2% percent in the greater MN metro.

Controlling for mileage, we see that bicyclist crashes along the trunk highway network were concentrated in more urban areas, with the TMCA Minneapolis & St. Paul location having 58 crashes per 100 miles, followed by Greater MN Metros (23 crashes per 100 miles) and TCMA Other Cities (13 crashes per 100 miles). Crashes along the trunk network in rural and small urban communities could be in places where the trunk network becomes a central roadway within smaller urban areas or rural towns. In urban areas, crashes that occurred on the trunk highway network were more likely to be severe, underscoring the injury burden associated with these facilities.

Table 22: Trunk vs Non-Trunk Crashes and Urban/Rural Context, Bicyclists, 2018-2022

Urban/ Rural (SPACE)	Trunk Highway	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
TCMA - Minneapolis and St. Paul	Non-Trunk Highway	864	89.8%	84	87.5%	9.7%
	Trunk Highway	98	10.2%	12	12.5%	12.2%
	Bike TCMA - Minneapolis and St. Paul Total	***962***	***100.0%***	***96***	***100.0%***	***10.0%***
TCMA - Other cities	Non-Trunk Highway	935	90.2%	109	90.1%	11.7%
	Trunk Highway	102	9.8%	12	9.9%	11.8%
	Bike TCMA - Other cities Total	***1,037***	***100.0%***	***121***	***100.0%***	***11.7%***
Greater MN metro	Non-Trunk Highway	214	85.9%	24	77.4%	11.2%
	Trunk Highway	35	14.1%	7	22.6%	20.0%
	Bike Greater MN metro Total	***249***	***100.0%***	***31***	***100.0%***	***12.4%***
Small urban communities	Non-Trunk Highway	237	66.9%	29	69.0%	12.2%
	Trunk Highway	117	33.1%	13	31.0%	11.1%
	Bike Small urban communities Total	***354***	***100.0%***	***42***	***100.0%***	***11.9%***
Rural	Non-Trunk Highway	65	70.7%	25	71.4%	38.5%
	Trunk Highway	27	29.3%	10	28.6%	37.0%
	Bike Rural Total	***92***	***100.0%***	***35***	***100.0%***	***38.0%***

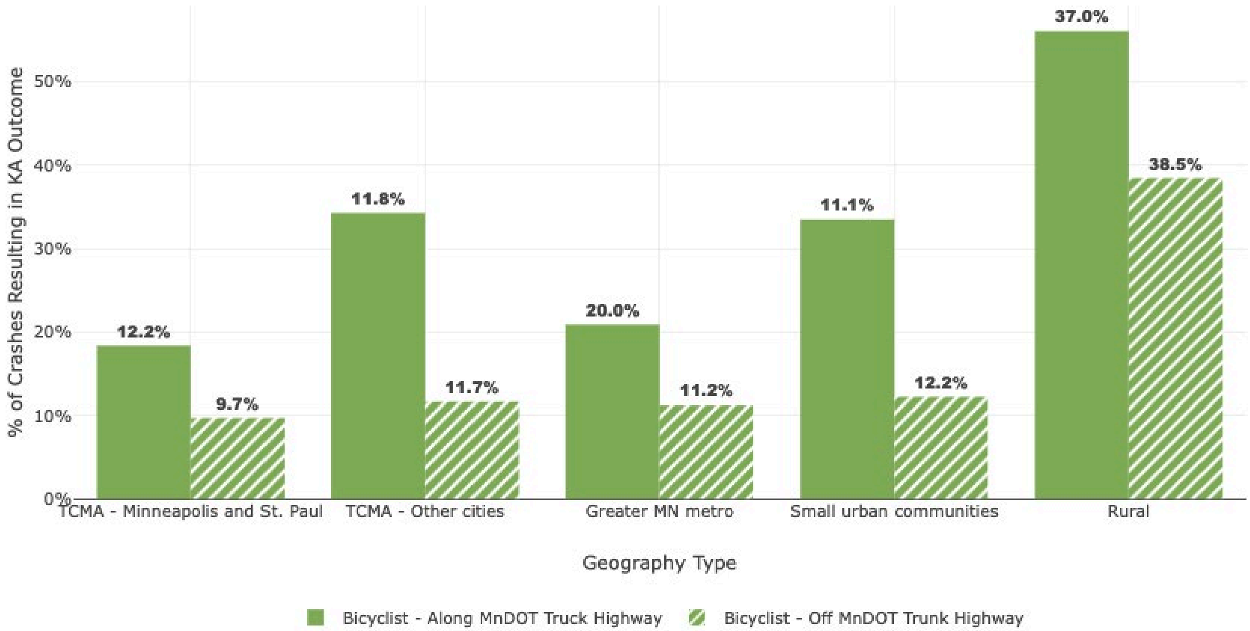

Figure 7: Percentage of Crashes Resulting in a KA Outcome by Trunk vs Non-Trunk and Geography Type, Bicyclist, 2018-2022

Table 23 shows the distribution of pedestrian crash trends on the trunk highway. The results are similar to bicyclist crash trends, with most crashes having occurred off the trunk highway system (81.5%), though there was a slightly larger percentage of pedestrian crashes and KA crashes that occurred along trunk highways compared to bicyclist crashes. Additionally, crashes that occurred along the trunk highway system were disproportionately severe compared to crashes that were not along the trunk highway system (30.5% v. 22.9%, respectively).

Table 23: Trunk vs Non-Trunk Crashes, Pedestrian or Other VRU, 2018-2022

Trunk Highway	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Non-Trunk Highway	3,367	81.5%	771	76.8%	22.9%
Trunk Highway	764	18.5%	233	23.2%	30.5%
Pedestrian or Other VRU Total	4,131	100.0%	1,004	100.0%	24.3%

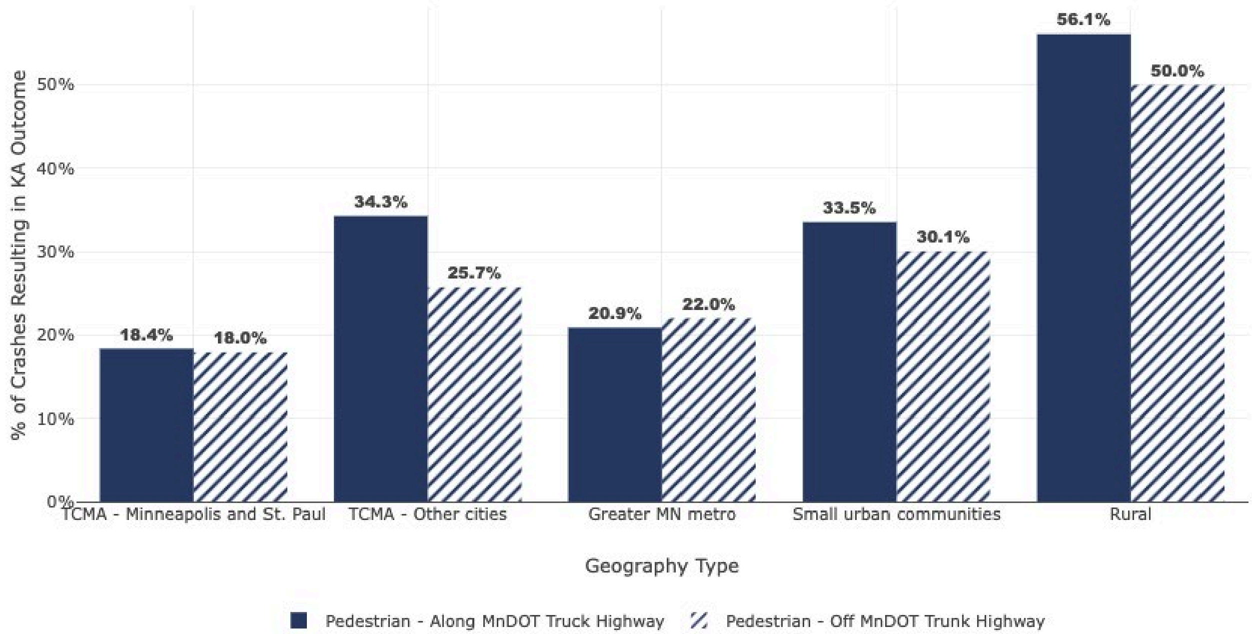

Figure 8: Percentage of Crashes Resulting in a KA Outcome by Trunk vs Non-Trunk and Geography Type, Pedestrian or Other VRU, 2018-2022

Table 24 shows how pedestrian crash trends on the trunk highway network differ between urban and rural contexts. Like bicyclist crashes, a larger share of pedestrian crashes occurred along the trunk network in small urban communities (34.0%) compared to TCMA and greater MN metro areas (12.9% - 18.3%). More than half of the pedestrian crashes (56.1%) that occurred along the trunk highway network resulted in a KA outcome within the rural context – nearly three times the rate for pedestrian crashes in the TCMA Minneapolis and St. Paul area (18.4%).

Like bicyclist crashes, once mileage is controlled for, pedestrian crashes along the trunk highway network were heavily concentrated in more urban areas, with the TMCA Minneapolis & St. Paul location having 148 crashes per 100 miles, followed by Greater MN Metros (28 crashes per 100 miles) and TCMA Other Cities (27 crashes per 100 miles). This concentration of pedestrian crashes on a per mile basis within the TCMA - Minneapolis and St. Paul area is likely correlated both with higher pedestrian volumes at these locations and with risk factors common along trunk highways (higher speeds, larger streets, and fewer pedestrian safety countermeasures). Furthermore, while only 1.3% of the trunk highway network mileage is within the TCMA - Minneapolis and St. Paul area, these streets accounted for a disproportionate 13.1% of pedestrian crashes and 13.4% of pedestrian KA crashes that occurred along the trunk highway statewide.

Table 24: Trunk vs Non-Trunk Crashes and Urban/Rural Context, Pedestrian or Other VRU, 2018-2022

Urban/ Rural (SPACE)	Trunk Highway	Total Crashes	% of Total Crashes	# of Severe Crashes	% of Severe Crashes	% of Crashes That Are Severe
TCMA - Minneapolis and St. Paul	Non-Trunk Highway	1,654	86.9%	297	86.6%	18.0%
	Trunk Highway	250	13.1%	46	13.4%	18.4%
	Pedestrian or Other VRU TCMA - Minneapolis and St. Paul Total	***1,904***	***100.0%***	***343***	***100.0%***	***18.0%***
TCMA - Other cities	Non-Trunk Highway	964	81.7%	248	77.0%	25.7%
	Trunk Highway	216	18.3%	74	23.0%	34.3%
	Pedestrian or Other VRU TCMA - Other cities Total	***1,180***	***100.0%***	***322***	***100.0%***	***27.3%***
Greater MN metro	Non-Trunk Highway	291	87.1%	64	87.7%	22.0%
	Trunk Highway	43	12.9%	9	12.3%	20.9%
	Pedestrian or Other VRU Greater MN metro Total	***334***	***100.0%***	***73***	***100.0%***	***21.9%***
Small urban communities	Non-Trunk Highway	336	66.0%	101	63.5%	30.1%
	Trunk Highway	173	34.0%	58	36.5%	33.5%
	Pedestrian or Other VRU Small urban communities Total	***509***	***100.0%***	***159***	***100.0%***	***31.2%***
Rural	Non-Trunk Highway	122	59.8%	61	57.0%	50.0%
	Trunk Highway	82	40.2%	46	43.0%	56.1%
	Pedestrian or Other VRU Rural Total	***204***	***100.0%***	***107***	***100.0%***	***52.5%***

3.8.1 Trunk Highways – Sidewalk

Sidewalk data are only available for locations along MnDOT trunk highways or overpasses that cross trunk highways. The sidewalk data do not represent separated bike lanes or shared use paths. Table 25 summarizes crashes that occurred at or along trunk highways by the presence of a sidewalk. Most bicyclist crashes occurred along trunk highways where a sidewalk was present. However, trunk highways that lack a sidewalk had more than twice the percentage of bicyclist crashes resulting in a KA outcome (24.0%) compared to trunk highways with a sidewalk (9.7%).

Table 25: Bicyclist crashes at/along trunk highways by presence of sidewalk (excludes crashes off trunk highways), 2018-2022

Presence of sidewalk (trunk highways only)	Total Crashes	% of Total Crashes	# of Severe Crashes	% of Severe Crashes	% of Crashes That Are Severe
No Sidewalk	121	31.9%	29	53.7%	24.0%
Sidewalk	258	68.1%	25	46.3%	9.7%
Bike Total	379	100.0%	54	100.0%	14.2%

To better understand the relationship between bicyclist crashes, trunk highways, and sidewalks, there are two important attributes in the crash records: nmloctn and nmaction. The nmloctn field has information about where the non-motorized roadway user location was located, and the nmaction field has information about the non-motorized roadway user action. While these variables include information that can provide additional insight into the bicyclists' relationship to sidewalks at the time of the crash, neither of these attributes consistently or accurately conveys whether the bicyclist was riding their bike along a sidewalk before the crash occurred.

- The non-motorized roadway user location attribute records where the bicyclist was located at the time of the crash. Of the 379 crashes along trunk highways, 43 crashes were coded as the bicyclist at/along a sidewalk.
- The non-motorized roadway user action attribute reflects how the bicyclist was traveling leading up to the crash. This attribute better captures if the bicyclist was riding along a sidewalk or within the street, but still does not catch all crashes in which the bicyclist was using the sidewalk rather than the street, particularly when the bicyclist was crossing the street at an intersection.

Note that the non-motorized roadway user location field also allows officers to report a bicyclist's pre-crash location as a shared use path, bicycle lane, or shoulder/roadside, so findings from this field should represent true sidewalk locations, not merely any sidewalk-level VRU facility. The non-motorized roadway user action field, however, does not have options to classify non-sidewalk dedicated facilities (e.g., sidepath, shared use path, cycle track, etc.). These two fields are limited in that they require an officer to choose one response for each, even if multiple responses are accurate. For example, it is possible for a driver to hit a bicyclist while the bicyclist is on the sidewalk at a driveway access ramp, but a reporting officer must choose either sidewalk or driveway access as the pre-crash location – not both.

To increase the chance of capturing sidewalk crashes along trunk highways, all crash narratives were systematically scanned for the word "sidewalk" (or some other spelling of sidewalk). The following criteria were used to code crashes as the bicyclist possibly using the sidewalk:

- Narrative suggests the bicyclist used the sidewalk prior to the crash
- Narrative suggests the bicyclist was using the crosswalk AND the crash occurred along a trunk sidewalk WITH a sidewalk
- non-motorized roadway user location (nmloctn) = 'sidewalk'
- non-motorized roadway user action (nmaction) = 'Walk/cycle on Sidewalk'

Table 26: Bicyclist crashes at/along trunk highways by presence of sidewalk (excludes crashes off trunk highways), 2018-2022

Presence of sidewalks (trunk highways only)	Possible sidewalk usage flag	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
No Sidewalk	Possible Sidewalk	6	1.6%	0	0.0%	0.0%
No Sidewalk	Sidewalk Not Likely	115	30.3%	29	53.7%	25.2%
Sidewalk	Possible Sidewalk	154	40.6%	12	22.2%	7.8%
Sidewalk	Sidewalk Not Likely	104	27.4%	13	24.1%	12.5%
Bike Total	-	379	100.0%	54	100.0%	14.2%

Table 26 shows bicyclist crashes along/at trunk highways using the flag that indicates if the bicyclist possibly used the sidewalk or a sidewalk-level facility before the crash. Interestingly, bicyclist crashes that occurred along trunk highways most frequently occurred if the bicyclist was using the sidewalk or a crosswalk connected to a sidewalk (40.6%) rather than riding within the road for overall crashes. This is not surprising given that most trunk highways lack low-stress on-street bicycle facilities designed to encourage bicyclists of all ages and abilities to ride within the road or in dedicated facilities rather than on the sidewalk.

Furthermore, the need for these low-stress facilities is not just preference-based: most KA crashes occurred along trunk highways that lacked a sidewalk and where there was no indication that the bicyclist was riding along the sidewalk (53.7% of KA crashes). Many of these crashes would likely have been prevented if the cyclist had been separated from vehicular traffic.

Table 27: Possibly Sidewalk Related Bicyclist Crashes by Reported Location and Action, 2018-2022

Police Reported Location	Police Reported Action	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
NULL	Other	8	1.1%	0	0.0%	0.0%
Bicycle Lane	Walk/Cycle With Traffic	3	0.4%	0	0.0%	0.0%
Driveway Access	Walk/Cycle on Sidewalk	43	5.7%	3	5.5%	7.0%
	Other	2	0.3%	0	0.0%	0.0%
Intersection – Marked Crosswalk	Walk/Cycle Across Traffic/Roadway	212	28.2%	14	25.5%	6.6%
	Walk/Cycle on Sidewalk	109	14.5%	7	12.7%	6.4%
	Walk/Cycle With Traffic	12	1.6%	1	1.8%	8.3%
	Other	8	1.1%	2	3.6%	25.0%
	Walk/Cycle Against Traffic	8	1.1%	0	0.0%	0.0%
	In Roadway - Other (working playing etc.)	4	0.5%	0	0.0%	0.0%
	Adjacent to Roadway (shoulder median etc.)	1	0.1%	0	0.0%	0.0%
Intersection – Other	Walk/Cycle Across Traffic/Roadway	17	2.3%	2	3.6%	11.8%
	Walk/Cycle on Sidewalk	11	1.5%	1	1.8%	9.1%
	Walk/Cycle Against Traffic	4	0.5%	1	1.8%	25.0%
	Other	2	0.3%	0	0.0%	0.0%
	In Roadway - Other (working playing etc.)	1	0.1%	0	0.0%	0.0%

Police Reported Location	Police Reported Action	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Intersection – Unmarked Crosswalk	Walk/Cycle on Sidewalk	70	9.3%	4	7.3%	5.7%
	Walk/Cycle Across Traffic/Roadway	67	8.9%	7	12.7%	10.4%
	Other	4	0.5%	1	1.8%	25.0%
	Walk/Cycle Against Traffic	3	0.4%	0	0.0%	0.0%
	Walk/Cycle With Traffic	3	0.4%	2	3.6%	66.7%
	In Roadway - Other (working playing etc.)	2	0.3%	1	1.8%	50.0%
Median/Crossing Island	Walk/Cycle Across Traffic/Roadway	1	0.1%	0	0.0%	0.0%
Midblock – Marked Crosswalk	Walk/Cycle Across Traffic/Roadway	7	0.9%	1	1.8%	14.3%
	Walk/Cycle on Sidewalk	1	0.1%	0	0.0%	0.0%
Other	Walk/Cycle Across Traffic/Roadway	2	0.3%	0	0.0%	0.0%
	Walk/Cycle on Sidewalk	2	0.3%	0	0.0%	0.0%
Shared-Use Path or Trail	Walk/Cycle on Sidewalk	2	0.3%	0	0.0%	0.0%
Shoulder/Roadside	Walk/Cycle With Traffic	7	0.9%	1	1.8%	14.3%
	Walk/Cycle Against Traffic	3	0.4%	0	0.0%	0.0%
	Walk/Cycle on Sidewalk	2	0.3%	0	0.0%	0.0%
	Adjacent to Roadway (shoulder median etc.)	1	0.1%	0	0.0%	0.0%

Police Reported Location	Police Reported Action	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
	Walk/Cycle Across Traffic/Roadway	1	0.1%	1	1.8%	100.0%
Sidewalk	Walk/Cycle on Sidewalk	78	10.4%	2	3.6%	2.6%
	Other	11	1.5%	0	0.0%	0.0%
	Walk/Cycle Across Traffic/Roadway	7	0.9%	1	1.8%	14.3%
	Adjacent to Roadway (shoulder median etc.)	5	0.7%	0	0.0%	0.0%
	Walk/Cycle Against Traffic	2	0.3%	0	0.0%	0.0%
	Walk/Cycle With Traffic	2	0.3%	0	0.0%	0.0%
Travel Lane – Other Location	Walk/Cycle Across Traffic/Roadway	7	0.9%	0	0.0%	0.0%
	Walk/Cycle With Traffic	5	0.7%	0	0.0%	0.0%
	Other	2	0.3%	1	1.8%	50.0%
	In Roadway - Other (working playing etc.)	1	0.1%	0	0.0%	0.0%
Unknown	Walk/Cycle Across Traffic/Roadway	4	0.5%	0	0.0%	0.0%
	Walk/Cycle on Sidewalk	2	0.3%	1	1.8%	50.0%
	Other	1	0.1%	0	0.0%	0.0%
	Walk/Cycle Against Traffic	1	0.1%	1	1.8%	100.0%
Bike Total	-	751	100.0%	55	100.0%	7.3%

Table 27 summarizes all crashes (statewide) that were flagged as possibly being related to a sidewalk using the method described above; 751 crashes (27.9% of all crashes) and 55 KA crashes (16.9% all KA crashes) fit the criteria. This table illustrates the need for an attribute to be added to the crash report that specifies whether the bicyclist was riding along the sidewalk before/during the crash. Currently, the crash report only includes the location of the crash and the reported action, which do not consistently capture sidewalk riding. In fact, only 42.6% of crashes (320/751) and 32.7% of KA crashes (18/55) that were flagged using the above screening process reported the crash as having occurred at a sidewalk or the bicyclist as cycling on the sidewalk. Our understanding of bicyclist riding on the sidewalk versus on the street and the associated crash risk is limited without specific and reliable data to analyze. We strongly recommend including a sidewalk riding attribute in future crash report revisions.

3.9 Hit and Run

The project team also reviewed the frequency of hit and run bicycle crashes, shown in Table 28. Most bicycle crashes (86.9%) and KA crashes (91.1%) did not involve a hit and run. Non-hit and run crashes involving bicyclists were slightly more severe on average than hit and run crashes (12.6% v. 8.2%, respectively).

Table 28: Hit and Run vs Non-hit and Run Crashes, Bicyclists, 2018-2022

Crash Response	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Not Hit and Run	2,341	86.9%	296	91.1%	12.6%
Hit and Run	353	13.1%	29	8.9%	8.2%
Bike Total	2,694	100.0%	325	100.0%	12.1%

Table 29 summarizes bicyclist hit and run crash status by urban/rural context. Hit and run crashes comprised less than 10 percent of all crashes and KA crashes in most urban and rural areas. In contrast, hit and run crashes in TCMA Minneapolis and St. Paul comprised a much greater percentage of all crashes (24.1%) and KA crashes (18.8%). In all cases, rural crashes were far more likely to be severe than crashes in other areas.

Table 29: Hit and Run vs Non-hit and Run Crashes and Urban/Rural Context, Bicyclists, 2018-2022

Urban/ Rural (SPACE)	Crash Response	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
TCMA - Minneapolis and St. Paul	Not Hit and Run	730	75.9%	78	81.2%	10.7%
	Hit and Run	232	24.1%	18	18.8%	7.8%
	Bike TCMA - Minneapolis and St. Paul Total	***962***	***100.0%***	***96***	***100.0%***	***10.0%***
TCMA - Other cities	Not Hit and Run	968	93.3%	117	96.7%	12.1%
	Hit and Run	69	6.7%	4	3.3%	5.8%
	Bike TCMA - Other cities Total	***1,037***	***100.0%***	***121***	***100.0%***	***11.7%***
Greater MN metro	Not Hit and Run	229	92.0%	28	90.3%	12.2%
	Hit and Run	20	8.0%	3	9.7%	15.0%
	Bike Greater MN metro Total	***249***	***100.0%***	***31***	***100.0%***	***12.4%***
Small urban communities	Not Hit and Run	327	92.4%	40	95.2%	12.2%
	Hit and Run	27	7.6%	2	4.8%	7.4%
	Bike Small urban communities Total	***354***	***100.0%***	***42***	***100.0%***	***11.9%***
Rural	Not Hit and Run	87	94.6%	33	94.3%	37.9%
	Hit and Run	5	5.4%	2	5.7%	40.0%
	Bike Rural Total	***92***	***100.0%***	***35***	***100.0%***	***38.0%***

Table 30 summarizes the frequency of hit and run pedestrian crashes. Like bicyclist crashes, most pedestrian crashes (79.7%) and KA crashes (82.2%) were not hit and run. Additionally, non-hit and run crashes for pedestrians were slightly more severe than hit and run crashes on average.

Table 30: Hit and Run vs Non-hit and Run Crashes, Pedestrian or Other VRU, 2018-2022

Crash Response	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Not Hit and Run	3,294	79.7%	825	82.2%	25.0%
Hit and Run	837	20.3%	179	17.8%	21.4%
Pedestrian or Other VRU Total	4,131	100.0%	1,004	100.0%	24.3%

Table 31 shows pedestrian crash frequencies by hit and run status and geography type. The relative share of crashes and KA crashes that were a hit and run was lowest in rural and small urban communities. In contrast, TCMA Minneapolis and St. Paul had an alarmingly high relative share of hit and run crashes (31.0%) and KA crashes (32.7%). As with bicyclists, pedestrian crashes in rural areas were disproportionately likely to result in a severe outcome.

Table 31: Hit and Run vs Non-hit and Run Crashes and Urban/Rural Context, Pedestrian or Other VRU, 2018-2022

Urban/ Rural (SPACE)	Crash Response	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
TCMA - Minneapolis and St. Paul	Not Hit and Run	1,314	69.0%	231	67.3%	17.6%
	Hit and Run	590	31.0%	112	32.7%	19.0%
	Pedestrian or Other VRU TCMA - Minneapolis and St. Paul Total	***1,904***	***100.0%***	***343***	***100.0%***	***18.0%***
TCMA - Other cities	Not Hit and Run	1,041	88.2%	285	88.5%	27.4%
	Hit and Run	139	11.8%	37	11.5%	26.6%
	Pedestrian or Other VRU TCMA - Other cities Total	***1,180***	***100.0%***	***322***	***100.0%***	***27.3%***
Greater MN metro	Not Hit and Run	285	85.3%	61	83.6%	21.4%
	Hit and Run	49	14.7%	12	16.4%	24.5%
	Pedestrian or Other VRU Greater MN metro Total	***334***	***100.0%***	***73***	***100.0%***	***21.9%***
Small urban communities	Not Hit and Run	470	92.3%	149	93.7%	31.7%
	Hit and Run	39	7.7%	10	6.3%	25.6%
	Pedestrian or Other VRU Small urban communities Total	***509***	***100.0%***	***159***	***100.0%***	***31.2%***
Rural	Not Hit and Run	184	90.2%	99	92.5%	53.8%
	Hit and Run	20	9.8%	8	7.5%	40.0%
	Pedestrian or Other VRU Rural Total	***204***	***100.0%***	***107***	***100.0%***	***52.5%***

3.10 Functional Classification

More than half of all bicyclist crashes (52.1%) and KA crashes (50.5%) occurred on minor arterials (see Table 32), indicating a serious safety issue with these roadways. Local roadways and major collectors had the next two largest shares of crashes and KA crashes. Minor arterials also have the highest number of crashes per mile for both all crashes (7.6 crashes per 100 miles) and KA crashes (0.9 KA crashes per 100 miles), followed by principal arterials (2.8 crashes per 100 miles; 0.4 KA crashes per 100 miles). In terms of the percentage of crashes that resulted in a KA outcome, crashes on minor collectors were the most likely to be severe (22.2%), followed by those on principal arterials and local roads.

Table 32: Bicyclist Crashes by Functional Classification, 2018-2022

Functional Classification	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA	% Roadway Mileage	Crashes per 100 Miles	KA Crashes per 100 Miles
Principal Arterial	312	11.6%	45	13.8%	14.4%	3.8%	2.8	0.4
Minor Arterial	1,403	52.1%	164	50.5%	11.7%	6.3%	7.6	0.9
Major Collector	478	17.7%	47	14.5%	9.8%	12.1%	1.3	0.1
Minor Collector	45	1.7%	10	3.1%	22.2%	8.7%	0.2	0.0
Local	455	16.9%	58	17.8%	12.7%	69.1%	0.2	0.0
Total	2,694	100.0%	325	100.0%	12.1%	100.0%	0.9	0.1

Table 33 summarizes bicyclist crashes by functional classification and urban/rural context. These findings are similar to statewide trends, with crashes concentrated along minor arterials in all larger urban areas. In rural and small urban communities, crashes are still most likely along minor arterials, but are also substantially present along local roads and principal arterials (small urban communities) and major collectors (rural areas).

Table 33: Bicyclist Crashes by Functional Classification and Urban/Rural Context, 2018-2022

Urban/ Rural (SPACE)	Functional Classification	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
TCMA - Minneapolis and St. Paul	Minor Arterial	592	61.5%	58	60.4%	9.8%
	Local	147	15.3%	16	16.7%	10.9%
	Principal Arterial	41	4.3%	11	11.5%	26.8%
	Major Collector	182	18.9%	11	11.5%	6.0%
	Bike TCMA - Minneapolis and St. Paul Total	***962***	***100.0%***	***96***	***100.0%***	***10.0%***
TCMA - Other cities	Minor Arterial	534	51.5%	67	55.4%	12.5%
	Local	181	17.5%	22	18.2%	12.2%
	Major Collector	164	15.8%	16	13.2%	9.8%
	Principal Arterial	151	14.6%	14	11.6%	9.3%
	Minor Collector	7	0.7%	2	1.7%	28.6%
	Bike TCMA - Other cities Total	***1,037***	***100.0%***	***121***	***100.0%***	***11.7%***
Greater MN metro	Minor Arterial	123	49.4%	11	35.5%	8.9%
	Principal Arterial	31	12.4%	7	22.6%	22.6%
	Major Collector	47	18.9%	5	16.1%	10.6%
	Local	37	14.9%	4	12.9%	10.8%
	Minor Collector	10	4.0%	3	9.7%	30.0%
	NA	1	0.4%	1	3.2%	100.0%
	Bike Greater MN metro Total	***249***	***100.0%***	***31***	***100.0%***	***12.4%***
Small urban communities	Minor Arterial	124	35.0%	13	31.0%	10.5%
	Local	77	21.8%	13	31.0%	16.9%
	Principal Arterial	76	21.5%	9	21.4%	11.8%
	Major Collector	59	16.7%	5	11.9%	8.5%
	Minor Collector	18	5.1%	2	4.8%	11.1%
	Bike Small urban communities Total	***354***	***100.0%***	***42***	***100.0%***	***11.9%***

Urban/ Rural (SPACE)	Functional Classification	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Rural	Minor Arterial	30	32.6%	15	42.9%	50.0%
	Major Collector	26	28.3%	10	28.6%	38.5%
	Principal Arterial	13	14.1%	4	11.4%	30.8%
	Minor Collector	10	10.9%	3	8.6%	30.0%
	Local	13	14.1%	3	8.6%	23.1%
	Bike Rural Total	***92***	***100.0%***	***35***	***100.0%***	***38.0%***

Table 34 summarizes intersection bicyclists crashes by the highest and lowest functional classification at the intersection. Most crashes (30.2%) and KA crashes (29.7%) occurred at intersections between minor arterials and local streets, followed by minor arterials and minor arterials (13.9% of all intersection crashes), major collectors and local roads (13.2% of all intersection crashes), and local roads with local roads (12.4% of all intersection crashes).

Exploring the pre-crash action of the bicyclist at intersections between a minor arterial and a local road, half of all crashes (50.2%) and KA crashes (49.3%) indicate that the bicyclist was cycling across traffic/roadway. Looking only at crashes with this crossing pre-crash action at these locations, 50.0% of crashes and 44.4% of KA crashes were at an intersection with some type of stop control (most likely two-way stop signs; data not shown). This finding indicates serious safety issues at locations where bicyclists are attempting to cross a major street but do not have a traffic control or crossing enhancement to facilitate a safe crossing.

Our data also suggest safety concerns at larger intersections where a minor arterial meets another minor arterial or major collector. These combinations contribute 24.3% of all bicyclist crashes and 25.2% of severe bicyclist crashes. Even at signalized intersections, careful attention to design and operations is needed to ensure safe passage for bicyclists.

Table 34: Bicyclist Intersection Crashes by Highest and Lowest Functional Classification at the Intersection, 2018-2022

Functional Classification	Lowest Functional Classification	Total Crashes	% of Total Crashes	# of Severe Crashes	% of Severe Crashes	% of Crashes That Are Severe
Principal Arterial	Principal Arterial	29	1.3%	7	2.8%	24.1%
	Minor Arterial	87	4.0%	10	4.1%	11.5%
	Major Collector	45	2.1%	7	2.8%	15.6%
	Minor Collector	10	0.5%	0	0.0%	0.0%
	Local	117	5.4%	14	5.7%	12.0%
Minor Arterial	Minor Arterial	302	13.9%	36	14.6%	11.9%
	Major Collector	225	10.4%	26	10.6%	11.6%
	Minor Collector	30	1.4%	2	0.8%	6.7%
	Local	654	30.2%	73	29.7%	11.2%
Major Collector	Major Collector	84	3.9%	6	2.4%	7.1%
	Local	287	13.2%	28	11.4%	9.8%
Minor Collector	Minor Collector	3	0.1%	0	0.0%	0.0%
	Local	27	1.2%	5	2.0%	18.5%
Local	Local	268	12.4%	32	13.0%	11.9%
Bike Total	-	2,168	100.0%	246	100.0%	11.3%

Table 35 shows the distribution of pedestrian crashes by functional classification. Like bicyclist crashes, pedestrian crashes (52.7%) and KA crashes (49.0%) occurred most frequently along minor arterials, followed by local roadways and major collectors. Minor arterials also had the highest rate of crashes per 100 miles for all crashes (11.8 crashes per 100 miles) and KA crashes (2.7 KA crashes per 100 miles), followed by principal arterials (3.5 crashes per 100 miles; 1.1 KA crashes per 100 miles). For pedestrians, crashes along principal arterials and minor collectors had an alarmingly high likelihood of resulting in a KA outcome (32.2% and 30.8%, respectively).

Table 35: Pedestrian or Other VRU Crashes by Functional Classification, 2018-2022

Functional Classification	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA	% Roadway Mileage	Crashes per 100 Miles	KA Crashes per 100 Miles
Principal Arterial	398	9.6%	128	12.7%	32.2%	3.8%	3.5	1.1
Minor Arterial	2,175	52.7%	492	49.0%	22.6%	6.3%	11.8	2.7
Major Collector	660	16.0%	172	17.1%	26.1%	12.1%	1.9	0.5
Minor Collector	78	1.9%	24	2.4%	30.8%	8.7%	0.3	0.1
Local	815	19.7%	187	18.6%	22.9%	69.1%	0.4	0.1
Total	4,131	100.0%	1,004	100.0%	24.3%	100.0%	1.4	0.3

Table 36 summarizes pedestrian crashes by functional classification and urban/rural context. As with bicyclists, crashes in larger urban areas are concentrated along minor arterials. In smaller urban communities, crashes along minor arterials still comprise the highest share of crashes, but they are closely followed by crashes on local roads and principal arterials. In rural areas, crashes are fairly evenly split between minor and principal arterials, major collectors, and local roadways.

Table 36: Pedestrian or Other VRU Crashes by Functional Classification and Urban/Rural Context, 2018-2022

Urban/ Rural (SPACE)	Functional Classification	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
TCMA - Minneapolis and St. Paul	Minor Arterial	1,260	66.2%	223	65.0%	17.7%
	Major Collector	285	15.0%	55	16.0%	19.3%
	Local	285	15.0%	46	13.4%	16.1%
	Principal Arterial	74	3.9%	19	5.5%	25.7%
	Pedestrian or Other VRU TCMA - Minneapolis and St. Paul Total	***1,904***	***100.0%***	***343***	***100.0%***	***18.0%***
TCMA - Other cities	Minor Arterial	563	47.7%	156	48.4%	27.7%
	Local	316	26.8%	79	24.5%	25.0%
	Major Collector	163	13.8%	46	14.3%	28.2%
	Principal Arterial	129	10.9%	41	12.7%	31.8%
	Minor Collector	8	0.7%	0	0.0%	0.0%
	NA	1	0.1%	0	0.0%	0.0%
	Pedestrian or Other VRU TCMA - Other cities Total	***1,180***	***100.0%***	***322***	***100.0%***	***27.3%***
Greater MN metro	Minor Arterial	151	45.2%	38	52.1%	25.2%
	Major Collector	67	20.1%	13	17.8%	19.4%
	Local	56	16.8%	13	17.8%	23.2%
	Principal Arterial	40	12.0%	6	8.2%	15.0%
	Minor Collector	16	4.8%	2	2.7%	12.5%
	NA	4	1.2%	1	1.4%	25.0%
	Pedestrian or Other VRU Greater MN metro Total	***334***	***100.0%***	***73***	***100.0%***	***21.9%***
Small urban communities	Minor Arterial	154	30.3%	45	28.3%	29.2%
	Principal Arterial	110	21.6%	37	23.3%	33.6%
	Major Collector	95	18.7%	33	20.8%	34.7%

	Local	111	21.8%	29	18.2%	26.1%
	Minor Collector	39	7.7%	15	9.4%	38.5%
	Pedestrian or Other VRU Small urban communities Total	***509***	***100.0%***	***159***	***100.0%***	***31.2%***
Rural	Minor Arterial	47	23.0%	30	28.0%	63.8%
	Principal Arterial	45	22.1%	25	23.4%	55.6%
	Major Collector	50	24.5%	25	23.4%	50.0%
	Local	47	23.0%	20	18.7%	42.6%
	Minor Collector	15	7.4%	7	6.5%	46.7%
	Pedestrian or Other VRU Rural Total	***204***	***100.0%***	***107***	***100.0%***	***52.5%***

Table 37 summarizes intersection pedestrian crashes by the highest and lowest functional classification at the intersection. Similar to bicyclists, most crashes (30.8%) and KA crashes (30.3%) occurred at intersections between minor arterials and local streets, followed by minor arterials and minor arterials (15.2% of all intersection crashes) and minor arterials and major collectors (14.4% of all intersection crashes). Crashes that occurred at intersections between minor arterials and local streets most frequently occurred at marked crosswalks (46.7% of all crashes and 36.0% of KA crashes; data not shown).

Table 37: Pedestrian or Other VRU Intersection Crashes by Highest and Lowest Functional Classification at the Intersection, 2018-2022

Functional Classification	Lowest Functional Classification	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Principal Arterial	Principal Arterial	31	1.1%	11	1.9%	35.5%
	Minor Arterial	81	2.9%	12	2.0%	14.8%
	Major Collector	40	1.4%	14	2.4%	35.0%
	Minor Collector	6	0.2%	1	0.2%	16.7%
	Local	132	4.7%	37	6.3%	28.0%
Minor Arterial	Minor Arterial	432	15.2%	78	13.3%	18.1%
	Major Collector	408	14.4%	75	12.8%	18.4%
	Minor Collector	19	0.7%	6	1.0%	31.6%
	Local	874	30.8%	178	30.3%	20.4%
Major Collector	Major Collector	126	4.4%	20	3.4%	15.9%
	Local	331	11.7%	84	14.3%	25.4%
Minor Collector	Minor Collector	3	0.1%	0	0.0%	0.0%
	Local	29	1.0%	8	1.4%	27.6%
Local	Local	323	11.4%	63	10.7%	19.5%
NA	NA	1	0.0%	0	0.0%	0.0%
Pedestrian or Other VRU Total	-	2,836	100.0%	587	100.0%	20.7%

3.11 Number of Through Lanes

Table 38 shows the distribution of bicyclist crashes and crash severity by the number of vehicle through lanes. Several trends emerge. First, most crashes and KA crashes occurred along two- and four-lane roadways. Not counting the very small sample of one-lane roadways, those with five or more lanes had the most severe crashes, with 13.8% crashes resulting in a KA outcome. Two-lane roadways followed close behind (13.0%), while four-lane roadways were slightly less severe on average (10.5%). These results likely reflect both safety issues associated with many of these roadways and the reality that two- and four-lane roadways comprise the largest shares of the network. Statewide data needed to parse this difference, such as centerline mileage by number of through lanes and statewide roadway characteristics to better understand the configuration of the street along these two- and four- lane roads, was not available to the project team at the time of the analysis.

Table 38: Crashes by Number of Through Lanes, Bicyclists, 2018-2022

# Through Lanes	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
1	35	1.3%	5	1.5%	14.3%
2	1,498	55.6%	194	59.7%	13.0%
3	174	6.5%	15	4.6%	8.6%
4	769	28.5%	81	24.9%	10.5%
5+	218	8.1%	30	9.2%	13.8%
Bike Total	2,694	100.0%	325	100.0%	12.1%

Similar trends emerge when examining bicyclist crashes by urban and rural context, albeit with some nuance, as shown Table 39. In general, crashes and KA crashes occurred on roadways with two or four lanes. TCMA - Minneapolis and St. Paul saw the largest share of KA crashes along roads with 5+ lanes compared to other locations. Interestingly, a minority of severe crashes occurred on two-lane roadways within TCMA - Minneapolis and St. Paul, whereas a clear majority of severe crashes occurred along two-lane roads in other areas. These patterns likely reflect the interaction of roadway design, vehicle speed, and countermeasure presence in each area. Complete and accurate statewide data on the presence of bike facilities do not currently exist; future analyses using these data would allow us to explore and provide insights related to the impact of bicycle facilities on bicyclist crashes and crash severity – particularly along two-lane roads outside of TCMA - Minneapolis and St. Paul.

Table 39: Crashes by Number of Through Lanes and Urban/Rural Context, Bicyclists, 2018-2022

Urban/ Rural (SPACE)	# Through Lanes	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
TCMA - Minneapolis and St. Paul	1	15	1.6%	3	3.1%	20.0%
	2	443	46.0%	36	37.5%	8.1%
	3	92	9.6%	8	8.3%	8.7%
	4	322	33.5%	36	37.5%	11.2%
	5+	90	9.4%	13	13.5%	14.4%
	Bike TCMA - Minneapolis and St. Paul Total	***962***	***100.0%***	***96***	***100.0%***	***10.0%***
TCMA - Other cities	1	14	1.4%	0	0.0%	0.0%
	2	575	55.4%	75	62.0%	13.0%
	3	67	6.5%	7	5.8%	10.4%
	4	286	27.6%	28	23.1%	9.8%
	5+	95	9.2%	11	9.1%	11.6%
	Bike TCMA - Other cities Total	***1,037***	***100.0%***	***121***	***100.0%***	***11.7%***
Greater MN metro	1	3	1.2%	1	3.2%	33.3%
	2	147	59.0%	23	74.2%	15.6%
	3	9	3.6%	0	0.0%	0.0%
	4	74	29.7%	5	16.1%	6.8%
	5+	16	6.4%	2	6.5%	12.5%
	Bike Greater MN metro Total	***249***	***100.0%***	***31***	***100.0%***	***12.4%***
Small urban communities	1	2	0.6%	1	2.4%	50.0%
	2	253	71.5%	29	69.0%	11.5%
	3	5	1.4%	0	0.0%	0.0%
	4	78	22.0%	8	19.0%	10.3%
	5+	16	4.5%	4	9.5%	25.0%

	Bike Small urban communities Total	***354***	***100.0%***	***42***	***100.0%***	***11.9%***
Rural	1	1	1.1%	0	0.0%	0.0%
	2	80	87.0%	31	88.6%	38.8%
	3	1	1.1%	0	0.0%	0.0%
	4	9	9.8%	4	11.4%	44.4%
	5+	1	1.1%	0	0.0%	0.0%
	Bike Rural Total	***92***	***100.0%***	***35***	***100.0%***	***38.0%***

Table 40 shows the distribution of pedestrian crashes and crash severity by the number of vehicle through lanes. Like bicyclist crashes, most crashes occurred along two- and four-lane roads. One- and three-lane roads had the lowest share of crashes and KA crashes, which likely relates to there being fewer streets with one or three lanes; however, crashes at these locations also had the lowest proportion of crashes that resulted in a KA outcome. Detailed crossing characteristics (crossing island, rectangular rapid flashing beacons, marked crosswalk type, etc.) are not available to better understand if certain crossing elements are associated with the lower average injury severity observed in the crash data at these locations.

Table 40: Crashes by Number of Through Lanes, Pedestrian or Other VRU, 2018-2022

# Through Lanes	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
1	85	2.1%	15	1.5%	17.6%
2	2,140	51.8%	581	57.9%	27.1%
3	291	7.0%	56	5.6%	19.2%
4	1,293	31.3%	278	27.7%	21.5%
5+	322	7.8%	74	7.4%	23.0%
Pedestrian or Other VRU Total	4,131	100.0%	1,004	100.0%	24.3%

Table 41 shows how pedestrian crashes and crash severity vary by number of vehicle through lanes and geography type. For all location types except for TCMA - Minneapolis and St. Paul, two-lane roads accounted for the highest frequency of KA crashes. In TCMA - Minneapolis and St. Paul, in contrast, four-lane roads had the highest frequency of KA crashes. These findings likely relate to a combination of factors that vary by jurisdiction type, such as pedestrian exposure, concentrations of pedestrian trip attracting land uses, and risk factors. In less urban locations, most of the street network is comprised of two-lane streets. For suburban and urban areas, four-lane roadways often make up a larger share of the network and experience higher pedestrian crossing and walking volumes.

Table 41: Crashes by Number of Through Lanes and Urban/Rural Context, Pedestrian or Other VRU, 2018-2022

Urban/ Rural (SPACE)	# Through Lanes	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
TCMA - Minneapolis and St. Paul	1	24	1.3%	4	1.2%	16.7%
	2	781	41.0%	135	39.4%	17.3%
	3	208	10.9%	32	9.3%	15.4%
	4	723	38.0%	145	42.3%	20.1%
	5+	168	8.8%	27	7.9%	16.1%
	Pedestrian or Other VRU TCMA - Minneapolis and St. Paul Total	***1,904***	***100.0%***	***343***	***100.0%***	***18.0%***
TCMA - Other cities	1	40	3.4%	8	2.5%	20.0%
	2	628	53.2%	184	57.1%	29.3%
	3	63	5.3%	19	5.9%	30.2%
	4	337	28.6%	78	24.2%	23.1%
	5+	112	9.5%	33	10.2%	29.5%
	Pedestrian or Other VRU TCMA - Other cities Total	***1,180***	***100.0%***	***322***	***100.0%***	***27.3%***
Greater MN metro	1	8	2.4%	2	2.7%	25.0%
	2	180	53.9%	42	57.5%	23.3%
	3	11	3.3%	2	2.7%	18.2%
	4	111	33.2%	18	24.7%	16.2%
	5+	24	7.2%	9	12.3%	37.5%
	Pedestrian or Other VRU Greater MN metro Total	***334***	***100.0%***	***73***	***100.0%***	***21.9%***
Small urban communities	1	13	2.6%	1	0.6%	7.7%
	2	380	74.7%	131	82.4%	34.5%
	3	7	1.4%	1	0.6%	14.3%

Urban/ Rural (SPACE)	# Through Lanes	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
	4	93	18.3%	23	14.5%	24.7%
	5+	16	3.1%	3	1.9%	18.8%
	Pedestrian or Other VRU Small urban communities Total	***509***	***100.0%***	***159***	***100.0%***	***31.2%***
Rural	2	171	83.8%	89	83.2%	52.0%
	3	2	1.0%	2	1.9%	100.0%
	4	29	14.2%	14	13.1%	48.3%
	5+	2	1.0%	2	1.9%	100.0%
	Pedestrian or Other VRU Rural Total	***204***	***100.0%***	***107***	***100.0%***	***52.5%***

3.12 Speed Limit

Vehicle speed is a common risk factor for bicycle crashes and crash severity. Table 42 shows crashes segmented by posted speed limit. While posted speed limit is not always indicative of prevailing vehicle speed, it is used as a proxy in this analysis. Most crashes (52.1%) and KA crashes (45.8%) occurred in places where there are 30 mph speed limits. This could be because there are many roadways where the posted speed limit is 30 mph, because roadways where vehicle speeds are 30 mph are perceived by cyclists as "low enough" stress roadways, or other reasons; however, there are notably fewer crashes and KA crashes on roadways signed at 25 mph or lower.

Crashes were more likely to be severe on higher speed roadways, with the likelihood of a severe crash increasing as posted speed increased. For example, 8.0% of crashes were severe at 35mph, compared to 16.2% at 45 mph and 20.6% at 50 mph or more. While this finding is expected, as higher speed crashes release more energy during the crash, resulting in more serious injuries – it also underscores the safety benefits of lower speeds.

Table 42: Crashes by Posted Speed Limit, Bicyclists, 2018-2022

Posted Speed Limit	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
<25	52	1.9%	4	1.2%	7.7%
25	86	3.2%	9	2.8%	10.5%
30	1,403	52.1%	149	45.8%	10.6%
35	300	11.1%	24	7.4%	8.0%
40	235	8.7%	25	7.7%	10.6%
45	185	6.9%	30	9.2%	16.2%
50+	373	13.8%	77	23.7%	20.6%
Unknown	60	2.2%	7	2.2%	11.7%
Bike Total	2,694	100.0%	325	100.0%	12.1%

In general, the same trends are present across the urban—rural spectrum, as shown in Table 43, with some differences. First, compared to TCMA, more of the crashes that occur on high-speed segments in rural areas are likely to result in a serious injury or death. This differential should be further investigated to understand its cause. For example, many non-highway (non-trunk) rural roads have speed limits above 50 mph and are very narrow with no shoulders, affording no space for safe or comfortable passing when bicycling with traffic on these roads. If people are more likely to drive above the posted speed limit in rural areas due to lack of enforcement or environmental cues to slow down, such that a crash in a 50-mph zone actually occurs at 60 mph, this crash would be even more likely to be severe. Difficulties accessing timely post-crash care may also contribute to a higher likelihood of a serious injury or fatality. These and other factors need to be investigated and understood in order to be adequately addressed by the state.

Table 43: Crashes by Posted Speed Limit and Urban/Rural Context, Bicyclists, 2018-2022

Urban/ Rural (SPACE)	Posted Speed Limit	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
TCMA - Minneapolis and St. Paul	<25	26	2.7%	3	3.1%	11.5%
	25	69	7.2%	7	7.3%	10.1%
	30	733	76.2%	70	72.9%	9.5%
	35	56	5.8%	1	1.0%	1.8%
	40	24	2.5%	6	6.2%	25.0%
	45	4	0.4%	1	1.0%	25.0%
	50+	27	2.8%	4	4.2%	14.8%
	Unknown	23	2.4%	4	4.2%	17.4%
	Bike TCMA - Minneapolis and St. Paul Total	***962***	***100.0%***	***96***	***100.0%***	***10.0%***
TCMA - Other cities	<25	13	1.3%	0	0.0%	0.0%
	25	9	0.9%	1	0.8%	11.1%
	30	274	26.4%	33	27.3%	12.0%
	35	193	18.6%	17	14.0%	8.8%
	40	159	15.3%	15	12.4%	9.4%
	45	141	13.6%	25	20.7%	17.7%
	50+	229	22.1%	29	24.0%	12.7%
	Unknown	19	1.8%	1	0.8%	5.3%
	Bike TCMA - Other cities Total	***1,037***	***100.0%***	***121***	***100.0%***	***11.7%***
Greater MN metro	<25	3	1.2%	0	0.0%	0.0%
	25	7	2.8%	1	3.2%	14.3%
	30	150	60.2%	18	58.1%	12.0%
	35	23	9.2%	1	3.2%	4.3%
	40	31	12.4%	3	9.7%	9.7%
	45	19	7.6%	1	3.2%	5.3%

Urban/ Rural (SPACE)	Posted Speed Limit	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
	50+	13	5.2%	6	19.4%	46.2%
	Unknown	3	1.2%	1	3.2%	33.3%
	Bike Greater MN metro Total	***249***	***100.0%***	***31***	***100.0%***	***12.4%***
Small urban communities	<25	9	2.5%	1	2.4%	11.1%
	25	1	0.3%	0	0.0%	0.0%
	30	240	67.8%	27	64.3%	11.2%
	35	26	7.3%	4	9.5%	15.4%
	40	20	5.6%	1	2.4%	5.0%
	45	20	5.6%	3	7.1%	15.0%
	50+	25	7.1%	6	14.3%	24.0%
	Unknown	13	3.7%	0	0.0%	0.0%
	Bike Small urban communities Total	***354***	***100.0%***	***42***	***100.0%***	***11.9%***
Rural	<25	1	1.1%	0	0.0%	0.0%
	30	6	6.5%	1	2.9%	16.7%
	35	2	2.2%	1	2.9%	50.0%
	40	1	1.1%	0	0.0%	0.0%
	45	1	1.1%	0	0.0%	0.0%
	50+	79	85.9%	32	91.4%	40.5%
	Unknown	2	2.2%	1	2.9%	50.0%
	Bike Rural Total	***92***	***100.0%***	***35***	***100.0%***	***38.0%***

Table 44 summarizes pedestrian crashes segmented by posted speed limit. Streets with a posted speed limit of 30 mph had the largest share of all crashes (59.9%) and KA crashes (51.6%), followed by streets with a speed limit of 50+ (10.9% and 18.5% of all crashes and ka crashes, respectively). The data follow expected injury severity patterns: as the posted speed limit increases, the proportion of crashes that resulted in a KA also generally increases, particularly beginning at 35 mph. The slightly lower percentage severe for 45 mph compared to

40 mph may reflect a combination of roadway characteristics and land use cues that merit further investigation.

Table 44: Crashes by Posted Speed Limit, Pedestrian or Other VRU, 2018-2022

Posted Speed Limit	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
<25	140	3.4%	28	2.8%	20.0%
25	79	1.9%	15	1.5%	19.0%
30	2,473	59.9%	518	51.6%	20.9%
35	346	8.4%	88	8.8%	25.4%
40	309	7.5%	98	9.8%	31.7%
45	144	3.5%	42	4.2%	29.2%
50+	452	10.9%	186	18.5%	41.2%
Unknown	188	4.6%	29	2.9%	15.4%
Pedestrian or Other VRU Total	4,131	100.0%	1,004	100.0%	24.3%

Table 45 shows how pedestrian crashes and crash severity vary by posted speed limit and geography type. For all location types except for rural, the majority of crashes and KA crashes occurred along 30 mph streets, while roadways signed at 50+ mph in rural areas had the largest share of crashes and KA crashes. Within the TCMA, streets with a speed limit of at least 35 mph generally had a higher proportion of crashes that resulted in a KA outcome compared to streets with a lower posted speed limit. KA crashes within the greater MN metro and small urban communities were heavily concentrated along 30 mph streets, which may relate to those locations having more streets with that posted speed limit and/or higher pedestrian exposure along those streets. Detailed crossing characteristics data could help provide insights into possible contributing factors within these location types.

Table 45: Crashes by Posted Speed Limit and Urban/Rural Context, Pedestrian or Other VRU, 2018-2022

Urban/ Rural (SPACE)	Posted Speed Limit	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
TCMA - Minneapolis and St. Paul	<25	83	4.4%	17	5.0%	20.5%
	25	66	3.5%	12	3.5%	18.2%
	30	1,521	79.9%	264	77.0%	17.4%
	35	66	3.5%	17	5.0%	25.8%
	40	52	2.7%	17	5.0%	32.7%
	45	4	0.2%	0	0.0%	0.0%
	50+	48	2.5%	9	2.6%	18.8%
	Unknown	64	3.4%	7	2.0%	10.9%
	Pedestrian or Other VRU TCMA - Minneapolis and St. Paul Total	***1,904***	***100.0%***	***343***	***100.0%***	***18.0%***
TCMA - Other cities	<25	31	2.6%	4	1.2%	12.9%
	25	8	0.7%	2	0.6%	25.0%
	30	364	30.8%	91	28.3%	25.0%
	35	224	19.0%	56	17.4%	25.0%
	40	201	17.0%	67	20.8%	33.3%
	45	95	8.1%	24	7.5%	25.3%
	50+	199	16.9%	68	21.1%	34.2%
	Unknown	58	4.9%	10	3.1%	17.2%
	Pedestrian or Other VRU TCMA - Other cities Total	***1,180***	***100.0%***	***322***	***100.0%***	***27.3%***
Greater MN metro	<25	10	3.0%	3	4.1%	30.0%
	25	1	0.3%	1	1.4%	100.0%
	30	214	64.1%	46	63.0%	21.5%
	35	31	9.3%	5	6.8%	16.1%
	40	27	8.1%	9	12.3%	33.3%

Urban/ Rural (SPACE)	Posted Speed Limit	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
	45	11	3.3%	1	1.4%	9.1%
	50+	18	5.4%	5	6.8%	27.8%
	Unknown	22	6.6%	3	4.1%	13.6%
	Pedestrian or Other VRU Greater MN metro Total	***334***	***100.0%***	***73***	***100.0%***	***21.9%***
Small urban communities	<25	9	1.8%	1	0.6%	11.1%
	25	4	0.8%	0	0.0%	0.0%
	30	356	69.9%	109	68.6%	30.6%
	35	19	3.7%	7	4.4%	36.8%
	40	23	4.5%	4	2.5%	17.4%
	45	28	5.5%	14	8.8%	50.0%
	50+	34	6.7%	17	10.7%	50.0%
	Unknown	36	7.1%	7	4.4%	19.4%
	Pedestrian or Other VRU Small urban communities Total	***509***	***100.0%***	***159***	***100.0%***	***31.2%***
Rural	<25	7	3.4%	3	2.8%	42.9%
	30	18	8.8%	8	7.5%	44.4%
	35	6	2.9%	3	2.8%	50.0%
	40	6	2.9%	1	0.9%	16.7%
	45	6	2.9%	3	2.8%	50.0%
	50+	153	75.0%	87	81.3%	56.9%
	Unknown	8	3.9%	2	1.9%	25.0%
	Pedestrian or Other VRU Rural Total	***204***	***100.0%***	***107***	***100.0%***	***52.5%***

3.13 Traffic Volume

Table 46 summarizes bicyclist crashes by vehicle annual average daily traffic (AADT). AADT is not available for all streets across the state; as such, 17.4% of all bicycle crashes and 16.3% of KA crashes occurred along streets that lack documented AADT. The vast majority of the street network with available AADT is comprised of streets with an AADT less than 3,000 vehicles per day (VPD), accounting for 83.9% of the network mileage but only 8.7% of crashes. Even if we assume all crashes that do not have available AADT data occurred along streets with less than 3,000 VPD, that will still result in a lower crash per mile rate (1.4 crashes per 100 miles) and KA crashes per mile (0.2 KA crashes per 100 miles) than most other AADT categories.

However, the AADT findings also appear to corroborate the findings about functional classification above (see Section 4.10) – crashes that occurred along streets with an AADT less than 3,000 were nearly equally likely to result in a KA outcome (17.4%) as crashes that occurred along streets with an AADT between 30,000-34,999 (16.0%). This finding suggests safety issues along what are commonly considered lower-stress streets (lower volume and often lower speed) that should be further investigated. Differences between urban and rural areas are examined below.

Furthermore, lower-volume streets throughout the state had a larger share of bicyclist crashes that involved a bicyclist who was less than 18 years of age. Of crashes that occurred along a street with less than 5,000 VPD, 21.6% involved a youth bicyclist compared to 17.0% for streets with an AADT greater than 15,000 (data not shown). When looking at these lower volume streets (less than 5,000 AADT) more than half of all crashes (55.6%, n=55) of all crashes in small urban communities involved a youth bicyclist, followed by TCMA - Other Cities (35.5%, n=60), Metro Greater MN (26.2%, n=11), rural (25.5%, n=14), and TCMA Minneapolis and St. Paul (13.4%, n=16). Most crashes occurred along streets with an AADT between 5,000-9,999 VPD (23.2%) and 10,000- 14,999 VPD (18.0%), although these categories had among the lowest rates of severe crashes on a per-crash basis.

Table 46: Crashes by Vehicle AADT, Bicyclists, 2018-2022

AADT	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA	Total Crashes per 100 Mile	KA Crashes per 100 Mile	Approximate # of Mile	Approximate % of Mile
0-2,999	235	8.7%	41	12.6%	17.4%	0.5	0.1	50,832	83.9%
3,000-4,999	249	9.2%	26	8.0%	10.4%	7.3	0.8	3,400	5.6%
5,000-9,999	625	23.2%	70	21.5%	11.2%	19.5	2.2	3,201	5.3%
10,000-14,999	486	18.0%	51	15.7%	10.5%	40.3	4.2	1,205	2.0%
15,000-19,999	345	12.8%	50	15.4%	14.5%	49.0	7.1	704	1.2%
20,000-24,999	142	5.3%	16	4.9%	11.3%	40.2	4.5	353	0.6%
25,000-29,999	61	2.3%	6	1.8%	9.8%	34.0	3.3	179	0.3%
30,000-34,999	50	1.9%	8	2.5%	16.0%	36.5	5.8	137	0.2%
35,000+	33	1.2%	4	1.2%	12.1%	5.8	0.7	566	0.9%
Unknown	468	17.4%	53	16.3%	11.3%	NA	NA	NA	NA
Bike Total	2,694	100.0%	325	100.0%	12.1%	4.4	0.5	60,577	100.0%

Table 47 summarizes bicyclist crashes by vehicle AADT and urban/rural context, highlighting differences between urban and rural roadway operations as they relate to bicyclist crashes. Here we see that crashes along lower-volume streets (less than 3,000 VPD) in rural areas are over twice as likely to be severe as in urban areas. In urban areas, all crashes and KA crashes (56.6% and 57.3%, respectively) were concentrated along streets with an AADT between 5,000-20,000 VPD. Streets with an AADT between 15,000-19,1999 and 30,000+ had the largest proportion of crashes that resulted in a KA outcome. Reliable statewide bicycle facility data are not available to determine what type of bicycle facility (if any) was located along these higher vehicle volume streets.

Table 47: Crashes by Vehicle AADT and Urban/Rural Context, Bicyclists, 2018-2022

Urban/ Rural (SPACE)	Vehicle AADT	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Urban	0-2,999	144	6.4%	17	6.9%	11.8%
	3,000-4,999	186	8.3%	15	6.0%	8.1%
	5,000-9,999	511	22.7%	53	21.4%	10.4%
	10,000-14,999	437	19.4%	44	17.7%	10.1%
	15,000-19,999	324	14.4%	45	18.1%	13.9%
	20,000-24,999	132	5.9%	14	5.6%	10.6%
	25,000-29,999	56	2.5%	5	2.0%	8.9%
	30,000-34,999	49	2.2%	8	3.2%	16.3%
	35,000+	33	1.5%	4	1.6%	12.1%
	Unknown	376	16.7%	43	17.3%	11.4%
	Bike Urban Total	***2,248***	***100.0%***	***248***	***100.0%***	***11.0%***
Rural	0-2,999	91	20.4%	24	31.2%	26.4%
	3,000-4,999	63	14.1%	11	14.3%	17.5%
	5,000-9,999	114	25.6%	17	22.1%	14.9%
	10,000-14,999	49	11.0%	7	9.1%	14.3%
	15,000-19,999	21	4.7%	5	6.5%	23.8%
	20,000-24,999	10	2.2%	2	2.6%	20.0%
	25,000-29,999	5	1.1%	1	1.3%	20.0%
	30,000-34,999	1	0.2%	0	0.0%	0.0%
	Unknown	92	20.6%	10	13.0%	10.9%
	Bike Rural Total	***446***	***100.0%***	***77***	***100.0%***	***17.3%***

Table 48 reviews the distribution of pedestrian crashes by vehicle AADT. As with bicyclist crashes, AADT data are not available for all streets, resulting in 19.5% of all pedestrian crashes and 18.5% of KA crashes having occurred along streets that lack documented AADT. With 83.9% of the network with known AADT data, but only 8.9% of crashes, again, if we assume all crashes without AADT data occurred along streets with less than 3,000 VPD, that will still result in a lower crash per mile rate (2.3 crashes per 100 miles) and KA crashes per mile (0.6 KA crashes per 100 miles) than most other AADT categories. Interestingly, pedestrian crashes that occurred along streets with an AADT less than 3,000 had generally the same proportion of crashes that resulted in a KA outcome as many of the higher volume streets. This finding underscores safety issues along these commonly considered lower-stress streets (lower volume and often lower speed) that should be further investigated.

Like bicyclist crashes, pedestrian crashes occurred most frequently along streets with an AADT between 5,000-9,999 VPD (19.8%) and 10,000- 14,999 VPD (18.1%), with both AADT categories having the lowest proportion of crashes resulting in a KA outcome. These roadways may have existing safety countermeasures and/or higher pedestrian volumes that increase driver expectations of pedestrians along these streets (i.e. safety in numbers). Statewide data on pedestrian safety countermeasures would facilitate deeper exploration of pedestrian safety in the future.

Table 48: Crashes by Vehicle AADT, Pedestrian or Other VRU, 2018-2022

AADT	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA	Total Crashes per 100 Mile	KA Crashes per 100 Mile	Approximate # of Mile	Approximate % of Mile
0-2,999	366	8.9%	127	12.6%	34.7%	0.7	0.2	50,832	83.9%
3,000-4,999	272	6.6%	78	7.8%	28.7%	8.0	2.3	3,400	5.6%
5,000-9,999	820	19.8%	196	19.5%	23.9%	25.6	6.1	3,201	5.3%
10,000-14,999	747	18.1%	146	14.5%	19.5%	62.0	12.1	1,205	2.0%
15,000-19,999	598	14.5%	122	12.2%	20.4%	84.9	17.3	704	1.2%
20,000-24,999	261	6.3%	66	6.6%	25.3%	73.9	18.7	353	0.6%
25,000-29,999	88	2.1%	22	2.2%	25.0%	49.1	12.3	179	0.3%
30,000-34,999	79	1.9%	24	2.4%	30.4%	57.7	17.5	137	0.2%
35,000+	93	2.3%	37	3.7%	39.8%	16.4	6.5	566	0.9%
Unknown	807	19.5%	186	18.5%	23.0%	NA	NA	NA	NA
Pedestrian or Other VRU Total	4,131	100.0%	1,004	100.0%	24.3%	6.8	1.7	60,577	100.0%

Table 49 shows how pedestrian crashes by vehicle AADT and urban/rural context. Nearly two-thirds of crashes and KA crashes occurred along roadways with an AADT less than 10,000 in rural areas, and crashes were particularly severe for the lowest-volume roadways (less than 3,000 VPD). Regardless of AADT, the proportion of crashes that resulted in a KA outcome was fairly high for each AADT category in rural areas. For crashes that occurred in urban areas, the majority of all crashes (55.8%) and KA crashes (51.4%) occurred along streets with an AADT between 5,000-20,000 VPD. Interestingly, these roadways had the lowest percentage of crashes that resulted in a KA outcome. Conversely, streets with an AADT of at least 20,000, and particularly those with an AADT of at least 30,000, had the largest proportions of crashes that resulted in a KA outcome.

Table 49: Crashes by Vehicle AADT and Urban/Rural Context, Pedestrian or Other VRU, 2018-2022

Urban/ Rural (SPACE)	Vehicle AADT	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
Urban	0-2,999	183	5.4%	44	6.0%	24.0%
	3,000-4,999	195	5.7%	48	6.5%	24.6%
	5,000-9,999	652	19.1%	137	18.6%	21.0%
	10,000-14,999	685	20.0%	128	17.3%	18.7%
	15,000-19,999	569	16.6%	114	15.4%	20.0%
	20,000-24,999	249	7.3%	59	8.0%	23.7%
	25,000-29,999	84	2.5%	20	2.7%	23.8%
	30,000-34,999	77	2.3%	24	3.3%	31.2%
	35,000+	88	2.6%	34	4.6%	38.6%
	Unknown	636	18.6%	130	17.6%	20.4%
	Pedestrian or Other VRU Rural Total	***3,418***	***100.0%***	***738***	***100.0%***	***21.6%***
Rural	0-2,999	183	25.7%	83	31.2%	45.4%
	3,000-4,999	77	10.8%	30	11.3%	39.0%
	5,000-9,999	168	23.6%	59	22.2%	35.1%
	10,000-14,999	62	8.7%	18	6.8%	29.0%
	15,000-19,999	29	4.1%	8	3.0%	27.6%
	20,000-24,999	12	1.7%	7	2.6%	58.3%
	25,000-29,999	4	0.6%	2	0.8%	50.0%
	30,000-34,999	2	0.3%	0	0.0%	0.0%
	35,000+	5	0.7%	3	1.1%	60.0%
	Unknown	171	24.0%	56	21.1%	32.7%
	Pedestrian or Other VRU Rural Total	***713***	***100.0%***	***266***	***100.0%***	***37.3%***

3.14 Land Use - Entertainment, retail, restaurants

The 2019 Pedestrian Safety Analysis crash tree analysis found that pedestrian crashes were highly associated with pedestrian trip attracting destinations such as entertainment establishments, retail, and restaurants. Table 50 summarizes bicyclist crashes that are within 328 feet[19] of any of those destinations. These destinations appear to be correlated with bicyclist crashes, as well: 40.3% of all crashes were within 328 feet of one of the target destinations. The correlation between destinations and crash severity is still present, but slightly weaker, as only 35.4% of KA crashes were within this buffer.

Table 50: Bicyclist Crashes Within 328 feet of an Entertainment, Retail, or Restaurant Establishment, 2018-2022

Within 100m of entertainment, retail, or restaurant	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
No	1,607	59.7%	210	64.6%	13.1%
Yes	1,087	40.3%	115	35.4%	10.6%
Bike Total	2,694	100.0%	325	100.0%	12.1%

Table 51 summarizes bicyclist crashes by entertainment, retail, and restaurant locations by urban/rural context. As expected given land use patterns, more urban areas had a substantially higher percentage of crashes (ranging from 32.8% to 48.6%) and KA crashes (ranging from 28.1% to 54.8%) near these target destinations compared to rural area crashes (4.3%) and KA crashes (5.7%).

19 328 feet (or 100 meters) is the same distance threshold used in the 2019 Pedestrian Safety Analysis.

Table 51: Bicyclist Crashes Within 328 feet of an Entertainment, Retail, or Restaurant Establishment and Urban/Rural Context, 2018-2022

Urban/ Rural (SPACE)	Within 100m of entertainment, retail, or restaurant	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
TCMA - Minneapolis and St. Paul	No	494	51.4%	49	51.0%	9.9%
	Yes	468	48.6%	47	49.0%	10.0%
	Bike TCMA - Minneapolis and St. Paul Total	***962***	***100.0%***	***96***	***100.0%***	***10.0%***
TCMA - Other cities	No	697	67.2%	87	71.9%	12.5%
	Yes	340	32.8%	34	28.1%	10.0%
	Bike TCMA - Other cities Total	***1,037***	***100.0%***	***121***	***100.0%***	***11.7%***
Greater MN metro	Yes	109	43.8%	17	54.8%	15.6%
	No	140	56.2%	14	45.2%	10.0%
	Bike Greater MN metro Total	***249***	***100.0%***	***31***	***100.0%***	***12.4%***
Small urban communities	No	188	53.1%	27	64.3%	14.4%
	Yes	166	46.9%	15	35.7%	9.0%
	Bike Small urban communities Total	***354***	***100.0%***	***42***	***100.0%***	***11.9%***
Rural	No	88	95.7%	33	94.3%	37.5%
	Yes	4	4.3%	2	5.7%	50.0%
	Bike Rural Total	***92***	***100.0%***	***35***	***100.0%***	***38.0%***

Table 52 summarizes pedestrian crashes that are within 328 feet of a retail, entertainment, or restaurant land use. Like bicyclist crashes, destinations appear to have some correlation with crashes, though the relationship appears to be slightly stronger for pedestrians, with 48.3% of all crashes and 40.4% KA crashes within 328 feet of one of the target destinations.

Table 52: Pedestrian or Other VRU Crashes Within 328 feet of an Entertainment, Retail, or Restaurant Establishment, 2018-2022

Within 100m of entertainment, retail, or restaurant	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
No	2,137	51.7%	598	59.6%	28.0%
Yes	1,994	48.3%	406	40.4%	20.4%
Pedestrian or Other VRU Total	4,131	100.0%	1,004	100.0%	24.3%

Table 53 summarizes pedestrian crashes by entertainment, retail, and restaurant locations by urban/rural context. Pedestrian crashes followed the same pattern as bicyclist crashes, with all urban areas having a substantial percentage of crashes and KA crashes within 328 feet of these land uses. The pattern was even more pronounced for the TCMA - Minneapolis and St. Paul area, in which a clear majority of crashes (59.8%) and KA crashes (56.3%) occurred near one of the target destination types.

Table 53: Pedestrian or Other VRU Crashes Within 328 feet of an Entertainment, Retail, or Restaurant Establishment and Urban/Rural Context, 2018-2022

Urban/ Rural (SPACE)	Within 100m of entertainment, retail, or restaurant	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
TCMA - Minneapolis and St. Paul	Yes	1,139	59.8%	193	56.3%	16.9%
	No	765	40.2%	150	43.7%	19.6%
	Pedestrian or Other VRU TCMA - Minneapolis and St. Paul Total	***1,904***	***100.0%***	***343***	***100.0%***	***18.0%***
TCMA - Other cities	No	716	60.7%	214	66.5%	29.9%
	Yes	464	39.3%	108	33.5%	23.3%
	Pedestrian or Other VRU TCMA - Other cities Total	***1,180***	***100.0%***	***322***	***100.0%***	***27.3%***
Greater MN metro	No	170	50.9%	38	52.1%	22.4%
	Yes	164	49.1%	35	47.9%	21.3%
	Pedestrian or Other VRU Greater MN metro Total	***334***	***100.0%***	***73***	***100.0%***	***21.9%***
Small urban communities	No	295	58.0%	96	60.4%	32.5%
	Yes	214	42.0%	63	39.6%	29.4%
	Pedestrian or Other VRU Small urban communities Total	***509***	***100.0%***	***159***	***100.0%***	***31.2%***
Rural	No	191	93.6%	100	93.5%	52.4%
	Yes	13	6.4%	7	6.5%	53.8%
	Pedestrian or Other VRU Rural Total	***204***	***100.0%***	***107***	***100.0%***	***52.5%***

3.15 Transit

Transit serving intersections may create additional conflict points for cyclists, so the project team reviewed bicycle crashes by the presence of nearby transit stops, as shown in Table 54. There were no transit stops in the data in the small urban communities or rural contexts, as shown in Table 55, so Table 54 only applies to bicycle crashes in TCMA and Greater MN Metro locations. Even in these areas, most crashes and severe crashes did not occur near transit stops. While this is encouraging given the important role of both bicycling and transit in a healthy transportation system, still 95 KA crashes occurred in proximity to transit, and this was more likely within the TCMA Minneapolis and St. Paul areas. These findings suggest a need for attention to bicyclists where they interact with transit in the TCMA areas.

Table 54: Crashes by Proximity to Transit, Bicyclists, 2018-2022

Proximity to Transit Stop	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
No	1,740	64.6%	230	70.8%	13.2%
Yes	954	35.4%	95	29.2%	10.0%
Bike Total	2,694	100.0%	325	100.0%	12.1%

Table 55: Crashes by Proximity to Transit and Urban/Rural Context, Bicyclists, 2018-2022

Urban/ Rural (SPACE)	Proximity to Transit Stop	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
TCMA - Minneapolis and St. Paul	Yes	577	60.0%	59	61.5%	10.2%
	No	385	40.0%	37	38.5%	9.6%
	Bike TCMA - Minneapolis and St. Paul Total	***962***	***100.0%***	***96***	***100.0%***	***10.0%***
TCMA - Other cities	No	661	63.7%	85	70.2%	12.9%
	Yes	376	36.3%	36	29.8%	9.6%
	Bike TCMA - Other cities Total	***1,037***	***100.0%***	***121***	***100.0%***	***11.7%***
Greater MN metro	No	248	99.6%	31	100.0%	12.5%
	Yes	1	0.4%	0	0.0%	0.0%
	Bike Greater MN metro Total	***249***	***100.0%***	***31***	***100.0%***	***12.4%***
Small urban communities	No	354	100.0%	42	100.0%	11.9%
	Bike Small urban communities Total	***354***	***100.0%***	***42***	***100.0%***	***11.9%***
Rural	No	92	100.0%	35	100.0%	38.0%
	Bike Rural Total	***92***	***100.0%***	***35***	***100.0%***	***38.0%***

Table 56 reviews the distribution of pedestrian crashes by proximity to transit stops.[20] The percentage of crashes and KA crashes that occurred near a transit stop is much higher for pedestrians than for bicyclists. This difference between modes is likely associated with higher pedestrian volumes and a higher frequency of pedestrians crossing the street to access a bus stop compared to bicyclists. This finding does not mean that bus stops inherently have a higher crash risk, but the placement, crossing characteristics, proximity to activity generators, and other roadway characteristics associated with bus stops may be contributing to increased pedestrian crash risk. Future analysis with more detailed roadway information may be able to home in on correlations between crash potential and severity and road user actions and roadway and operational characteristics, such as boarding/alighting operations, multiple threat scenarios, roadway users crossing the primary street, number of lanes, speed, etc. Interestingly, the proportion of crashes that resulted in a KA outcome near a transit stop was lower than that proportion among crashes that were not near a transit stop.

Table 56: Crashes by Proximity to Transit, Pedestrian or Other VRU, 2018-2022

Proximity to Transit Stop	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
No	2,356	57.0%	646	64.3%	27.4%
Yes	1,775	43.0%	358	35.7%	20.2%
Pedestrian or Other VRU Total	4,131	100.0%	1,004	100.0%	24.3%

When looking at pedestrian crashes by proximity to transit stratified by geography type, there is a clear relationship between transit stops and pedestrian crashes within the TCMA - Minneapolis and St. Paul geography compared to the other geography types (see Table 57). Within the TCMA - Minneapolis and St. Paul area, two-thirds of all crashes and nearly three-quarters of KA crashes occurred near a transit stop, whereas 42.1% of all crashes and 36.3% KA crashes occurred near a transit stop in the TCMA - Other Cities area.

20 Like Table 54, Table 56 only applies to pedestrian crashes in TCMA and Greater MN Metro locations as there are no transit stops in the data outside of these geographic contexts.

Table 57: Crashes by Proximity to Transit and Urban/Rural Context, Pedestrian or Other VRU, 2018-2022

Urban/ Rural (SPACE)	Proximity to Transit Stop	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
TCMA - Minneapolis and St. Paul	Yes	1,278	67.1%	241	70.3%	18.9%
	No	626	32.9%	102	29.7%	16.3%
	Pedestrian or Other VRU TCMA - Minneapolis and St. Paul Total	***1,904***	***100.0%***	***343***	***100.0%***	***18.0%***
TCMA - Other cities	No	683	57.9%	205	63.7%	30.0%
	Yes	497	42.1%	117	36.3%	23.5%
	Pedestrian or Other VRU TCMA - Other cities Total	***1,180***	***100.0%***	***322***	***100.0%***	***27.3%***
Greater MN metro	No	334	100.0%	73	100.0%	21.9%
	Pedestrian or Other VRU Greater MN metro Total	***334***	***100.0%***	***73***	***100.0%***	***21.9%***
Small urban communities	No	509	100.0%	159	100.0%	31.2%
	Pedestrian or Other VRU Small urban communities Total	***509***	***100.0%***	***159***	***100.0%***	***31.2%***
Rural	No	204	100.0%	107	100.0%	52.5%
	Pedestrian or Other VRU Rural Total	***204***	***100.0%***	***107***	***100.0%***	***52.5%***

3.16 SPACE Score

Figure 9 displays the distribution of bicyclist, pedestrian, and other VRU crashes by severity and SPACE score. MnDOT developed the Pedestrian and Cycling Environment (SPACE) tool. This tool and corresponding output dataset score half-mile hexagons across the entire state based on 19 variables describing demographic, economic, and transportation characteristics. The full method is documented in an MnDOT internal memo titled "Statewide Bicycle/Pedestrian Suitability Analysis."[21]

21 Eric Devoe, Statewide Bicycle/Pedestrian Suitability Analysis, 2019-06-25.

The research team examined the distribution of crashes by SPACE score and found that higher numbers of crashes (for all modes) occurred in areas with mid-range SPACE scores, as shown in Figure 9. The percentage of high-severity crashes did not follow this pattern, and there appears to be an inverse correlation between the percentage of severe crashes and mileage by SPACE score (Figure 10). This apparent mismatch may be due to lower motor vehicle speeds (for example, due to congestion, existing roadway design, or lower posted speed limits) or greater motorist expectation of bicyclist presence in locations with higher SPACE scores. Further research is needed to understand the relationship between SPACE score and vulnerable road user safety in greater detail.

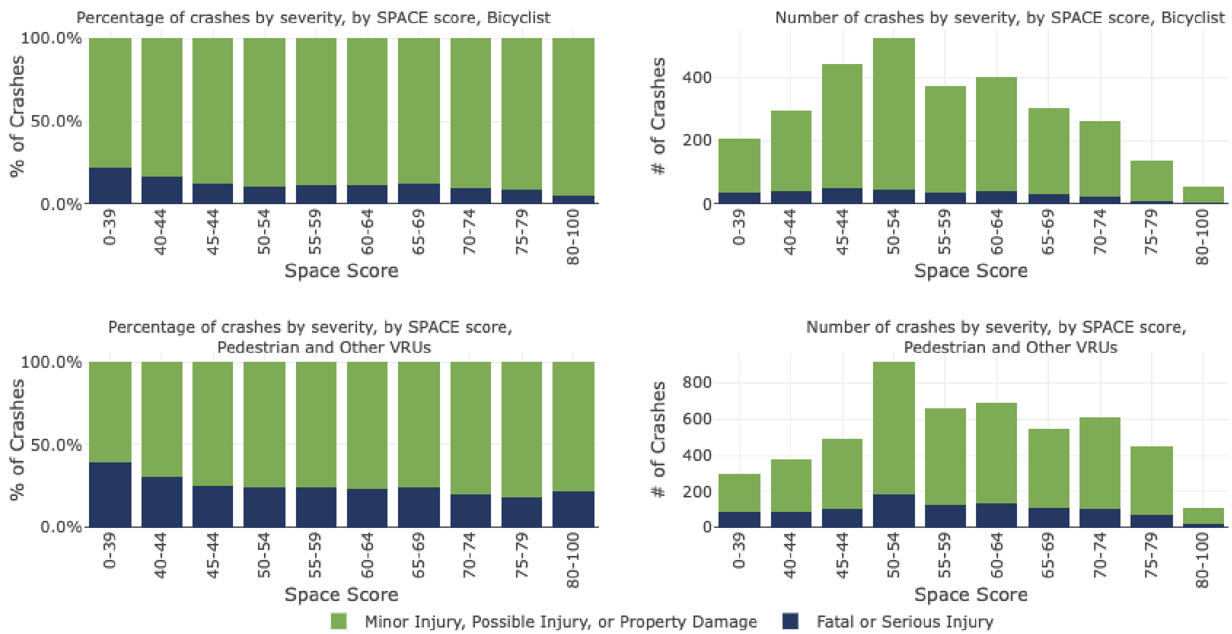

Figure 9: Distribution of Crashes by Severity and SPACE Score, Bicyclists, Pedestrians, and Other VRUs, 2018-2022

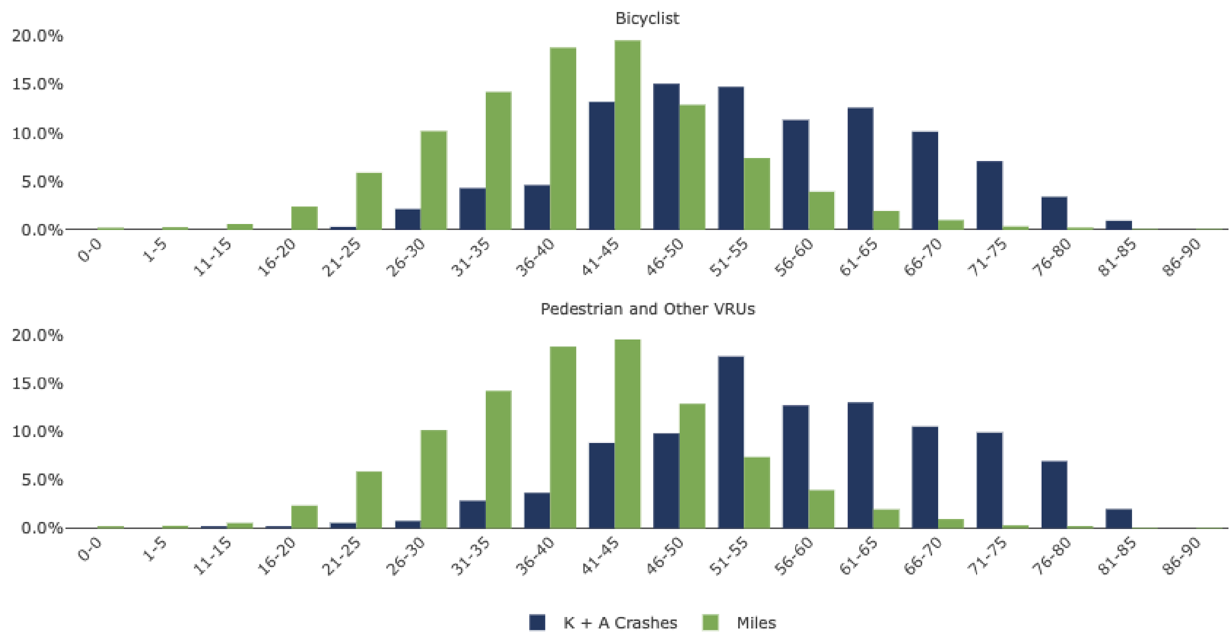

Figure 10: Distribution of KA Crashes and Roadway Mileage by SPACE Score, Bicyclists, Pedestrians, and Other VRUs, 2018-2022

MnDOT's Office of Traffic Engineering created a star rating system as part of the District Safety Plans (DSP) in 2016 to screen urban intersections for risk factors. These ratings were aggregated into the SPACE tool by MnDOT and summarized in Table 58 and Table 59. SPACE hexagons with three- or four-star ratings (out of seven stars), indicating greater presence of roadway and contextual risk factors from that study, had the highest number of fatal or serious injury and crashes for bicyclists and pedestrians/other vulnerable road users. Locations with similar star ratings may be useful to prioritize for improvements. Note that the screening was done for individual signalized intersections on trunk highways in urban areas and then aggregated to the SPACE hexagon surface. Therefore, this analysis represents crashes happening within hexagons that contain one or more higher-risk urban signalized intersections.

As described in the 2019 Pedestrian Safety Analysis, while the SPACE tool covers the whole state, the previous study that produced star ratings calculated them for trunk highway intersections in urbanized areas only. Only 994 of over 500,000 hexagons across the state contain a valid "dsp_risk" score. Therefore, the underlying data in Table 58 and Table 59 represent the subset of 398 crashes occurring within these 994 hexagons. This represents 14.4% of the state's 2,694 bicyclist crashes, and 17.6% of the state's 4,131 pedestrian crashes during the study period. For serious injury or fatal crashes, 29 of 325 bicyclist KA crashes (8.9%) and 84 of 1,004 pedestrian KA crashes (16.0%) occurred in a location with a valid star rating, and among these, most occurred in hexagons with 4 or more stars.

Table 58: Crashes by DSP STAR Rating (only crashes with valid STAR Rating), Bicyclists, 2018-2022

DSP STAR Rating	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
0	5	1.3%	0	0.0%	0.0%
1	9	2.3%	0	0.0%	0.0%
2	60	15.5%	8	27.6%	13.3%
3	139	35.9%	6	20.7%	4.3%
4	103	26.6%	9	31.0%	8.7%
5	48	12.4%	3	10.3%	6.2%
6	20	5.2%	3	10.3%	15.0%
7	3	0.8%	0	0.0%	0.0%
Bike Total	387	100.0%	29	100.0%	7.5%

Table 59: Crashes by DSP STAR Rating (only crashes with valid STAR Rating), Pedestrian or Other VRU, 2018-2022

DSP STAR Rating	Total Crashes	% of Total Crashes	# of KA Crashes	% of KA Crashes	% Crashes Resulting in KA
0	5	0.7%	1	0.6%	20.0%
1	12	1.7%	3	1.9%	25.0%
2	124	17.1%	22	13.7%	17.7%
3	278	38.2%	51	31.7%	18.3%
4	207	28.5%	57	35.4%	27.5%
5	78	10.7%	21	13.0%	26.9%
6	21	2.9%	6	3.7%	28.6%
7	2	0.3%	0	0.0%	0.0%
Pedestrian or Other VRU Total	727	100.0%	161	100.0%	22.1%

3.17 Equity

The distribution of fatal and serious injury crashes and demographic variables from the SPACE tool related to environmental justice22 were explored across geography types. Equity was explored using the same process as in the 2019 Pedestrian Safety Analysis, using the definitions of low-income populations and communities of color identified in the SPACE tool using the Minnesota Pollution Control Agency (MNPCA).[23]

Figure 11 shows the concentration of bicyclist and pedestrian crashes per hexagon in the SPACE data. In most geography groups, the concentrations of crashes are higher in hexagons with at least one of these risk factors present (blue, green, or gray bars) relative to hexagons with neither risk factor present (orange bars). In small urban communities, the concentration of severe bicyclist crashes among areas with high poverty rates and majority BIPOC residents is about 6 times higher than concentrations in areas where neither risk factor is present. When looking at all crash severities, both the dominance of Minneapolis and St. Paul in the data as well as the racial and socioeconomic disparities within these cities are evident. Put another way, even though smaller numbers of severe crashes are happening in these areas, people who live in these areas – who, by definition, are more likely to be low-income or people of color – are exposed to greater risk of crashes.

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22 For more information on environmental justice at MnDOT, see: http://www.dot.state.mn.us/environmentaljustice/

23 Low income is defined as incomes less than 185% of the federal poverty level, and hexagons are identified as low income if at least 40% of people meet this criterion. People of color are defined using Census data as anyone who is not white, non- Hispanic, and hexagons are identified for having at least 50% of people meeting this criterion.

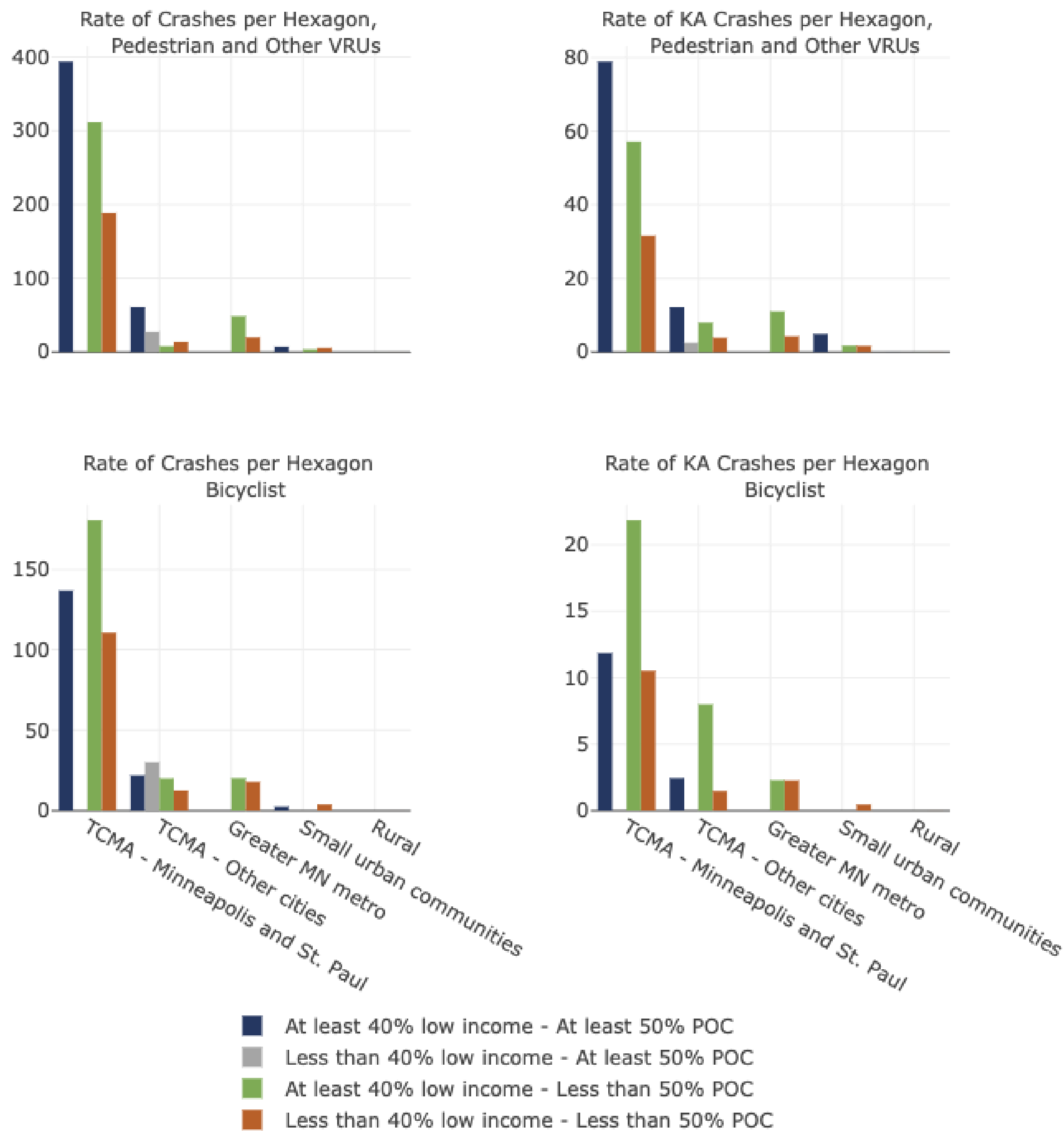

Figure 11: Rate of Crashes per Hexagon by Urban/Rural Geography and EJ Demographics in the SPACE Tool, Bicyclist, Pedestrians and Other VRUs, 2018-2022

4. High Injury Network

There are many established ways to examine crashes to better understand traffic safety patterns. Hotspot analyses have long been used to address high crash locations by retrospectively identifying the greatest concentrations of reported crashes over a determined period of time. Hotspot analysis is a valuable method to visualize locations with historic crash issues, but it is less effective at identifying locations with latent crash risk factors. In this way, it can be described as reactive. Additionally, hotspots may be less effective for analyzing bicyclist safety if crash frequencies are low due to geographic sparsity, which can exacerbate issues related to regression to the mean. Conversely, a systemic analysis is effective for identifying roadways with risk factors for crashes, independent from their crash history. For example, a wide arterial with a 45-mph posted speed limit, high traffic volumes, no bike facility, and few trip-attracting land uses may not have any reported bike crashes. However, the roadway and operational characteristics of that arterial are associated with higher bicycle crash risk. The absence of crashes is therefore not a reflection of low crash risk, but a reflection of lack of exposure that hotspot analyses cannot adequately convey. Systemic analysis is largely proactive; it allows planners and engineers to find locations that may warrant safety improvements before crashes have occurred there.

High injury networks strike a balance between entirely retrospective and entirely proactive methods. Using spatial patterns of crash history, a High Injury Network identifies areas on the road network where crashes have been concentrated in sequence. A stretch of arterial roadway with crashes occurring at every other intersection might not show up on a traditional hotspot analysis because no one location has multiple crashes happening in the same place. However, the pattern of crashes all along the corridor suggests a larger safety issue. Further, the entire corridor likely shares similar characteristics that could be addressed systemically – even the intersections along the corridor that have not yet had crashes.

This section describes the development of a statewide High Injury Network and the results of the related High Injury Network analysis. The High Injury Network was built from a standard sliding windows analysis, which measures severity-weighted crash density by mode along segments on the network.

4.1 Data Overview

4.2 Motorist-only (non-VRU) crashes

For the purpose of the VRUSA, FHWA defines VRU as a non-motorist with a person code attribute in the Fatality Analysis Reporting System (FARS) equivalent to pedestrian, bicyclist, other cyclist, or other personal conveyance. FHWA further clarifies that VRUs include highway workers on foot in a work zone and exclude motorcyclists.[24] Therefore, we removed crashes that only involved motorists (i.e., did not include person type 5, 6, or 8). Consistent with

24 FHWA Memorandum, "Vulnerable Road User Safety Assessment Guidance". https://highways.dot.gov/sites/fhwa.dot.gov/files/2022-10/VRU%20Safety%20Assessment%20Guidance%20FINAL_508.pdf

FHWA's definition, we did not remove highway worker or unintended pedestrian crashes (e.g., crashes involving a driver who has exited their vehicle after breaking down on the highway).

4.3 Inapplicable or missing geo-locations

As this study relied heavily on geospatial processing and analysis, crashes with missing geo-location data were excluded, with some exceptions. A small number of pedestrian crashes were missing geo-location data in MnDOT's main crash database but had previously been assigned corrected location data as part of MnDOT's Statewide Pedestrian Crash Analysis study. We migrated this corrected geo-location data to the current project dataset. This update only affected fatal and serious injury pedestrian crashes from 2016—2019 which had previously been assigned corrected geo-location information. Pedestrian crashes from 2020—2021 and all bicyclist crashes with missing geo-location information were excluded from the analysis.

Additional criteria for exclusion included:

- Crashes that were reported to have occurred in a parking lot, since this study focused on roadways,
- Crashes that occurred more than 300 feet from any street, or
- Crashes that occurred along private roadways.

4.4 Injury Severity Assignment

Crashes in the dataset were assigned a global severity variable that represented the most seriously injured (MSI) party (see Section 4.2 for more information about the injury severity assignment methodology used in this analysis). Usually, the most vulnerable road user is also the most seriously injured party; however, there are rare exceptions. We identified the most seriously injured VRU within each crash and assigned a VRU-specific crash severity to each crash. Since this study focuses exclusively on VRUs, using the victim-level severity helps improve accuracy of summarizing injury severities as they relate to VRU safety and risk factors. It should be noted that the San Francisco Department of Public Health has conducted extensive research and has documented reporting errors related to mis-coded injury severities, particularly for severe injuries[25], suggesting a need for some fluidity when discussing minor and serious injuries. This analysis does not have access to hospital records to verified injury severities stored in the crash data, so the results in this document reflect the best available data at the time.

4.5 Roadway and Contextual Data

High Injury Network analysis primarily relies on spatially processing crash history along a road network. Therefore, minimal – if any – roadway attributes are needed for this type of analysis. We joined High Injury Network analysis results to MnDOT's Trunk Highway network to be able to identify which segments of the HIN are on state-owned roadways. We also joined the HIN to MnDOT's Suitability of the Pedestrian and Cycling Environment (SPACE) dataset to be able to

25 https://www.visionzerosf.org/wp-content/uploads/2021/11/Severe-Injury-Trends 2011-2020 final report.pdf

evaluate the HIN through this lens. Crash and HIN segment data were joined to these layers spatially.

4.6 High Injury Network Methodology

High Injury Networks are typically built using a process called sliding windows analysis, which helps detect patterns of crashes happening in sequence. A sliding windows analysis calculates linear crash densities (often weighted by injury severity) for each mode separately. The sliding windows analysis consists of a virtual window of a predetermined length that is moved along the street network at predetermined step lengths and aggregates the crashes that are within each window (see Figure 14).

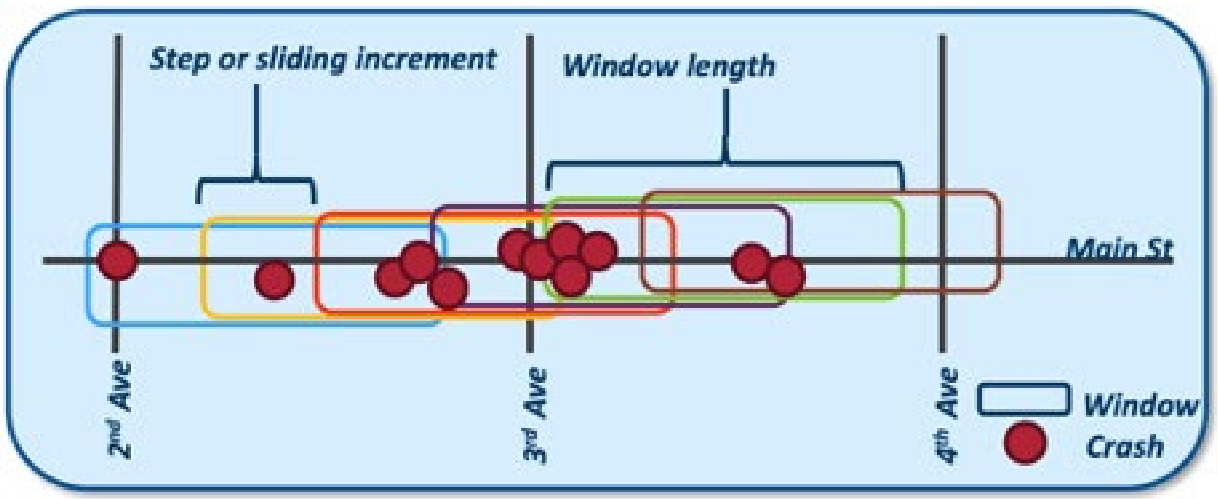

Figure 14: Sliding windows process to measure crash density along a network.

Two different window lengths were used based on the SPACE urban/rural designations as a means to account for different crash densities, roadway characteristics, and land use across the urban—rural gradient. For large metropolitan urban areas (e.g., Minneapolis—St. Paul, Rochester, Duluth, St. Cloud, Fargo-Moorehead, Mankato), one-mile window lengths and 1/10th-mile step increments were used in this analysis. For smaller urban communities (e.g., Bemidji, Brainerd, Alexandria, Willmar, Redwing, etc.) and rural areas, two-mile window lengths and 1⁄4-mile step increments were used.

Additionally, only fatal (K), serious injury (A), and minor injury (B) crashes were included in the sliding window analysis and HIN development process. This decision was made to prioritize locations that have a history and high concentration of crashes that resulted in death or injury. The Safe System Approach pushes us to prioritize fatal and serious injury crashes. We additionally included minor injury crashes for several reasons, including:

1. The geographic sparsity of vulnerable road user crashes, especially in smaller urban communities and rural areas, leads to sparse or patchy results in a High Injury Network.
2. Misclassification between serious injury and minor injury crashes in police reports is common.

3. Individual characteristics like age and frailty can influence injury severity.

To maintain an appropriate emphasis on life-altering crashes, we weighted fatal and serious injury crashes more heavily in the analysis (3:1 weighting).

4.7 Threshold Determination

HINs are a blend of art and science, needing to be large enough to be meaningful, but not so large as to be meaningless. This balance is even more pronounced for larger HINs, e.g., at the regional or statewide level, that cover vastly different land use patterns and geography types. To strike this balance, each mode-specific HIN is produced by an initial determination of a minimum threshold for the weighted crash value of segments to be included in the HIN, followed by a review of the distribution of crashes for each mode along the relevant HIN and the percentage of the network that is along that HIN. If necessary, the threshold is adjusted to achieve the sought-after balance described above. Since the purpose of a High Injury Network is to identify clusters or patterns of crashes, it is important to choose a threshold that is high enough to represent a true pattern.

Our experience with HIN development over the years has led to the following general rules of thumb:

- Using a high threshold will make a high injury network smaller (fewer miles), focusing only on the places that have had many fatal and injury crashes.
- Using a low threshold will make a high injury network larger (more miles), including places that may have only had one or two fatal and injury crashes.
- Using too low of a threshold produces networks that are not meaningfully targeted at fatal and injury crashes.

We recommend five as the lowest possible threshold for defining a High Injury Network because it implies a minimum of 2-3 fatal and injury crashes to meet or exceed it. In order to reach this minimum threshold in small urban areas and rural areas, we used a longer window length and also combined all VRU crashes into a single HIN category (i.e., bicyclists and pedestrians/other VRUs combined instead of separate). Generally speaking, with fatal and serious injury crashes weighted at 3 and minor injury crashes weighted at 1, the lowest possible threshold that may still reflect spatial patterns is 5. With a score of 5, a segment will have had at least 2-3 crashes within the window size (1-2 miles) over the previous 5 years, with at least 1-2 of them resulting in death or serious injury.

In addition to being tailored to each mode, thresholds may vary by geography. Denser, larger urbanized areas have more VRU crashes in general and have higher scores on average. Smaller urban areas and rural areas have fewer VRU crashes and lower scores on average. Choosing a single threshold to use across all geography types ("severe injury density" approach) results in a HIN that is heavily concentrated in denser, larger urbanized areas. It aggressively targets the highest concentrations of fatal and injury crashes. Choosing variable thresholds based on geography type ("geographic balance" approach) results in a HIN that has broad coverage across many contexts, though coverage may not be proportionate to the severity of safety problems. Ultimately, each project should select a HIN threshold for each mode that provides the most helpful information for informing future safety strategies and actions.

4.8 HIN Thresholds

Based on the distribution of scores by geography, conversations with MnDOT and stakeholders, review of draft HINs using various thresholds, and MnDOT's goals for the HIN, our team ultimately recommended the following thresholds for MnDOT's first HIN. These thresholds fit reasonably well for this VRUSA update, given that this HIN is built on overlapping data from the first one (2018–2022 vs. 2017–2021).

Table 60: HIN threshold by mode and geography group

Geography Group	Window Length	Pedestrian/Other VRU Threshold	Bicyclist Threshold	All (Combined) VRU Threshold
TCMA - Minneapolis and St. Paul	1 mile	12	7	N/A
TCMA - Other cities	1 mile	7	5	N/A
Greater MN metro areas	1 mile	7	5	N/A
Small urban communities	2 miles	N/A	N/A	5
Rural areas	2 miles	N/A	N/A	5

These thresholds yield the miles of HIN displayed in Table 61. Note that for small urban communities and rural areas, the HIN was defined using a threshold for bicyclist and ped/other crashes *combined* (i.e., all VRU). Therefore, no miles are shown for bike only or ped/other only modal HINs. In the larger metro categories (TCMA MSP, TCMA Other, and Greater MN Metro), modal HINs were defined for bike and ped/other separately. They are summarized based on network segments that appear on both modal networks (i.e., all VRU) and network segments that appear for only one mode or the other.

Table 61: Miles of HIN by geography group

HIN	TCMA - Minneapolis and St. Paul		TCMA - Other cities		Greater MN metro areas		Small urban communities		Rural areas		Statewide	
	#	%	#	%	#	%	#	%	#	%	#	%
HIN for all VRU	13.9	0.7	8.2	0.1	0.0	0.0	77.6	0.6	20.4	0.0	120.1	0.1
HIN for Bike only	24.9	1.2	42.5	0.3	4.8	0.2	0.0	0.0	0.0	0.0	72.2	0.0
HIN for Ped/Other only	65.8	3.2	65.5	0.5	11.8	0.5	0.0	0.0	0.0	0.0	143.2	0.1
Any HIN Subtotal	104.5	5.2	116.2	1.0	16.6	0.8	77.6	0.6	20.4	0.0	335.5	0.2
Non-HIN	1,919.9	94.8	12,039.2	99.0	2,197.3	99.2	12,322.1	99.4	119,785.7	100.0	148,269.1	99.8
Total	2,024.4	100.0	12,155.4	100.0	2,213.9	100.0	12,399.7	100.0	119,806.1	100.0	148,604.5	100.0

We see over 200 miles of HIN within the Twin Cities metro area alone, more than 15 miles in other large metro urban areas, nearly 78 miles in smaller urban areas, and 20 miles in rural areas. Note that crash data on Tribal lands are typically incomplete in MnDOT's dataset, so the rural HIN may underestimate crash concentrations in rural areas absent these data.

In the Twin Cities, there is a small amount of overlap between pedestrian/other VRU HIN and bicyclist HIN, whereas in other large metro urban areas around the state, we do not see any overlap. The fact that we see different spatial patterns here reinforces the decision to analyze pedestrian and bicyclist crashes separately where data allow.

4.9 HIN Descriptive Analysis

4.9.1 High Injury Network Patterns Over Time

Table 62 shows how many crashes are on any HIN-identified segments for any mode for each year of the study period. Table 63 shows these statistics filtered on fatal and serious injury (KA) crashes. On average, 30% of all VRU crashes and 33% of severe VRU crashes are on the HIN, though this varies year to year.

For the pre-pandemic HIN years 2018–2019, roughly 32% of VRU crashes and 35% of severe VRU crashes were on the HIN. During the pandemic years (2020–2021), the HIN covers a smaller share of crashes (26% of all severity and 30-31% of severe), indicating that crashes were more dispersed and less clustered than VRU crashes in earlier years. The 2022 data indicate a return to a comparable pre-pandemic capture rate of crashes and severe crashes on the HIN. Continuing to monitor these trends as more post-pandemic years of crash data become available will help MnDOT understand the latest evolving patterns.

Table 62: Number and percentage of VRU crashes on and off any HIN by year, 2018-2022

Year	Crashes on the HIN		Crashes off the HIN	
	#	%	#	%
2018	490	31.8%	1,050	68.2%
2019	512	32.1%	1,082	67.9%
2020	275	25.5%	804	74.5%
2021	313	26.3%	877	73.7%
2022	430	30.2%	992	69.8%
Total	2,020	29.6%	4,805	70.4%

Table 63: Number and percentage of VRU KA crashes on and off any HIN by year, 2018-2022

Year	KA Crashes on the HIN		KA Crashes off the HIN	
	#	%	#	%
2018	89	33.8%	174	66.2%
2019	87	35.4%	159	64.6%
2020	70	29.5%	167	70.5%
2021	82	31.3%	180	68.7%
2022	118	35.9%	211	64.1%
Total	446	33.4%	891	66.6%

4.9.2 HIN Status by Crash Mode and Severity

The HIN is defined by fatal, serious injury, and minor injury crashes, using weights to more heavily emphasize fatal and serious injury crashes. We see varying percentages of crashes on and off the HIN by crash severity, though the pattern is not very intuitive or meaningful. Serious injury crashes have the greatest representation on the HIN, with 35% of them falling on the HIN (Table 64).

Table 64: Number and percentage of VRU crashes on and off any HIN by crash severity

Injury Severity	Crashes on the HIN		Crashes off the HIN	
	#	%	#	%
Fatal	79	28.9%	194	71.1%
Serious Injury	367	34.5%	697	65.5%
Minor Injury	793	26.3%	2,224	73.7%
Possible Injury	646	31.5%	1,402	68.5%
Property Damage Only	135	31.9%	288	68.1%
Total	2,020	29.6%	4,805	70.4%

Pedestrian and other VRU crashes were more tightly clustered on the network, with nearly 33% of them being on the HIN compared to only 25% of bicyclist crashes (Table 65). Note that these statistics reflect the entire HIN, not limited by mode-specific HIN (e.g., bicyclist crashes on any part of the HIN, pedestrian crashes on any part of the HIN).

Table 65: Number and percentage of VRU crashes on and off any HIN by crash mode

Mode	Crashes on the HIN		Crashes off the HIN	
	#	%	#	%
Bicyclist	676	25.1%	2,018	74.9%
Pedestrian or other VRU	1,344	32.5%	2,787	67.5%
Total	2,020	29.6%	4,805	70.4%

4.9.3 HIN Status by Geography

Among bicyclist crashes in large urban areas, the bicycle HIN best represents the location of serious injury crashes (almost 38% on the network) but overall captures just under 27% of all urban bicyclist crashes (Table 66).

Table 66: Urban bike crashes on and off the urban bike HIN, by severity

Injury Severity	Crashes on the HIN		Crashes off the HIN	
	#	%	#	%
Fatal	3	12.5%	21	87.5%
Serious Injury	84	37.5%	140	62.5%
Minor Injury	265	24.7%	806	75.3%
Possible Injury	199	27.0%	539	73.0%
Property Damage Only	52	27.2%	139	72.8%
Total	603	26.8%	1,645	73.2%

The pedestrian/other VRU HIN in urban areas does a better job of capturing crashes than the bicyclist HIN, with nearly 37% of all crashes and nearly 41% of serious injury crashes on the HIN (Table 67).

Table 67: Urban ped and other VRU crashes on and off the urban ped and other VRU HIN, by severity

Injury Severity	Crashes on the HIN		Crashes off the HIN	
	#	%	#	%
Fatal	53	35.3%	97	64.7%
Serious Injury	238	40.5%	350	59.5%
Minor Injury	460	32.6%	952	67.4%
Possible Injury	419	39.2%	649	60.8%
Property Damage Only	82	41.0%	118	59.0%
Total	1,252	36.6%	2,166	63.4%

Only about 18% of small urban community and rural area crashes (all VRU modes) are on the small urban community and rural HIN, though the small urban and rural HIN does a better job of capturing fatal and serious injury crashes in these areas (48% and 25% respectively; Table 68). Fatal crashes in particular are much better captured than any of the other modal or geography HINs.

Table 68: Small urban community and rural VRU crashes on and off the small urban and rural HIN, by severity

Injury Severity	Crashes on the HIN		Crashes off the HIN	
	#	%	#	%
Fatal	19	47.5%	21	52.5%
Serious Injury	40	24.5%	123	75.5%
Minor Injury	65	15.4%	358	84.6%
Possible Injury	24	12.2%	172	87.8%
Property Damage Only	8	19.5%	33	80.5%
Total	156	18.1%	707	81.9%

Across all VRU modes, the Minneapolis and St. Paul HIN captures the greatest share of crashes. Table 69 shows nearly half of them falling on the network (which, as Table 61 showed, comprises only 5% of the network mileage). In the rest of the Twin Cities metro, other large metro urban areas, and small urban communities, 14-18% of VRU crashes are on the HIN. Only 3% of rural area crashes are on the rural HIN.

Table 69: Number and percentage of VRU crashes on and off any HIN by geography group

Geography Group	Crashes on the HIN		Crashes off the HIN	
	#	%	#	%
TCMA - Minneapolis and St. Paul	1,378	48.1%	1,488	51.9%
TCMA - Other cities	395	17.8%	1,822	82.2%
Greater MN metro	82	14.1%	501	85.9%
Small urban communities	156	18.1%	707	81.9%
Rural	9	3.0%	287	97.0%
Total	2,020	29.6%	4,805	70.4%

Among severe crashes, the HIN does a better job in all geography groups (Table 70). Over half of fatal and serious injury VRU crashes in Minneapolis and St. Paul are on the HIN in this area.

Table 70: Number and percentage of severe (K+A) VRU crashes on and off any HIN by geography group

Geography Group	KA Crashes on the HIN		KA Crashes off the HIN	
	#	%	#	%
TCMA - Minneapolis and St. Paul	245	55.3%	198	44.7%
TCMA - Other cities	107	24.2%	336	75.8%
Greater MN metro	27	26.0%	77	74.0%
Small urban communities	59	29.1%	144	70.9%
Rural	8	5.6%	136	94.4%
Total	446	33.4%	891	66.6%

4.9.4 HIN Status by Location Type

The HIN does a much better job of capturing signalized intersection VRU crashes than crashes at other location types, with 49.4% of all VRU crashes at signalized intersections and 58.6% of severe crashes at signalized intersections falling on the HIN (Table 71 and Table 72). This higher capture rate for signalized intersections likely relates to higher traffic volumes (and therefore more potential for conflict) at those locations, as well as lower numbers of signalized intersections overall. The other location types (e.g., midblock or segment locations, with 16.1% of VRU crashes, and unsignalized/stop-controlled intersections, with 29.5%) are vastly more numerous around the state than signalized intersections; without exposure data, we cannot normalize crashes per location or per VRU walking, biking, or rolling across these locations.

Table 71: Number and percentage of VRU crashes on and off any HIN by location type

Crash Location	Crashes on the HIN		Crashes off the HIN	
	#	%	#	%
Intersection with Other/Unknown Control	123	29.5%	294	70.5%
Intersection with Signal	1,165	49.4%	1,192	50.6%
Intersection with Stop Sign	438	19.6%	1,792	80.4%
Segment	294	16.1%	1,527	83.9%
Total	2,020	29.6%	4,805	70.4%

Table 72: Number and percentage of VRU severe (K+A) crashes on and off any HIN by location type

Crash Location	KA Crashes on the HIN		KA Crashes off the HIN	
	#	%	#	%
Intersection with Other/Unknown Control	22	31.9%	47	68.1%
Intersection with Signal	221	58.6%	156	41.4%
Intersection with Stop Sign	99	25.3%	293	74.7%
Segment	104	20.8%	395	79.2%
Total	446	33.4%	891	66.6%

4.9.5 HIN Status by SPACE Score and Variables

We joined the High Injury Network to the SPACE dataset by flagging any hexagon that intersects with any HIN segment. Overall, there were 849 hexagons out of 522,263 that contained any of the HIN, or about 0.2% of the state (Table 73). The HIN is concentrated in hexagons with medium and high SPACE suitability scores, with the greatest concentration in the 70-74 and 75-79 score range (28.8% and 35.0%, respectively).

Table 73: Presence of HIN by SPACE score

SPACE Suitability Score	Hexagons with 1+ HIN segments	Hexagons with no HIN segments	Percentage of hexagons with 1+ HIN segments
0-39	38	302,104	0.0%
40-44	71	110,951	0.1%
45-44	141	62,238	0.2%
50-54	131	32,226	0.4%
55-59	163	10,376	1.5%
60-64	113	2,663	4.1%
65-69	90	619	12.7%
70-74	57	141	28.8%
75-79	36	67	35.0%
80-100	9	29	23.7%
Total	849	521,414	0.2%

The HIN is overrepresented among hexagons where 50% or more of residents are BIPOC. Among hexagons where at least 40% of households are low income and a majority of residents are BIPOC, approximately 0.7% of hexagons contain HIN segments. Where residents are majority BIPOC but less than 40% are low income, about 2.5% of hexagons contain HIN. These represent a 4-fold and 15-fold overrepresentation, respectively, relative to the state at large (0.2% of hexagons with HIN segments).

Table 74: Presence of HIN by SPACE equity variables – areas of concentrated poverty and areas where 50% or more of residents are People of Color

SPACE Equity Variables (income and race/ethnicity)	Hexagons with 1+ HIN segments	Hexagons with no HIN segments	Percentage of hexagons with 1+ HIN segments
At least 40% low income - At least 50% BIPOC	69	10,089	0.7%
Less than 40% low income - At least 50% BIPOC	4	157	2.5%
At least 40% low income - Less than 50% BIPOC	66	35,628	0.2%
Less than 40% low income - Less than 50% BIPOC	710	475,540	0.1%
Total	849	521,414	0.2%

5. Conclusion and Next Steps

This report documents the methodology and findings from the descriptive and systemic safety analysis for vulnerable road users, which was largely an update to the MnDOT 2022 VRUSA. The findings from this analysis will be integrated into the development of the 2025-2029 MnDOT Strategic Highway Safety Plan.

Future Considerations

Future updates to this analysis (and the VRUSA) should explore patterns over time around the COVID-19 pandemic, once more years of post- pandemic crash data are available.

Additionally, to better understand bicyclist safety throughout the state, collecting additional existing conditions data are recommended. Many of these data are also recommended in the 2019 Pedestrian Safety Analysis:

- Operating Speed – Median and 85th percentile
- Non-MnDOT Sidewalks
- Non-MnDOT Signals, PHBs, and RRFBs
- Statewide bikeways and off-street paths
- Crosswalk markings
- Crossing Islands (Pedestrian Refuges)
- Non-MnDOT Turn Lanes (on cross streets approaching Trunk highways, or full network)
- Statewide bicyclist volumes/exposure estimates
- Evaluation of the types of vehicles (type, shape, and height) involved in VRU crashes.

Analyses where normalization by area, population, mileage, or another metric were conducted provided some of the most interesting insights in this analysis. For example, equity concerns might have been obscured by raw numbers, but being able to assess not only the total number but the concentration within the SPACE hexagon surface helped illuminate patterns.

Certain types of data structures make this type of normalization easier or harder; for example, evaluating roadway mileage can be problematic when datasets depict a mix of centerline miles, lane miles, and directional miles. Nonetheless, identifying other opportunities to normalize crash data by one of these denominators can help the state identify conditions under which bicyclist crashes are disproportionately concentrated – even if raw numbers do not appear clustered.

The results about sidewalk riding – both the large numbers of crashes happening under possible sidewalk riding conditions as well as the relatively lower severity rate of these possible sidewalk riding crashes – can inform decisions about education and enforcement as well as engineering. With data suggesting that sidewalk riding may be less dangerous than riding in a street that lacks adequate bicyclist facilities, greater emphasis should be placed on adding appropriate facilities. Enforcement and education against bicyclists for riding on the sidewalk are likely counterproductive.