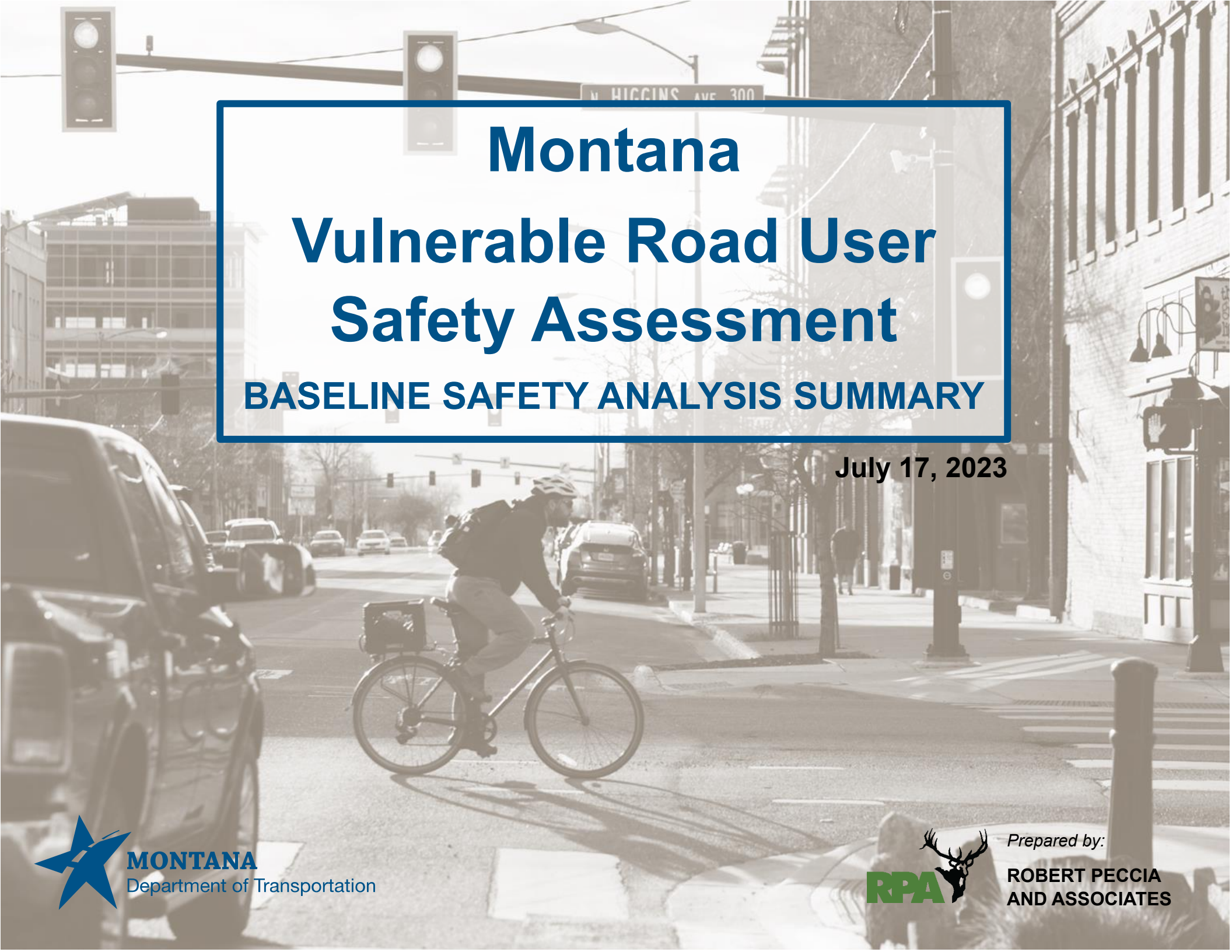

Montana Vulnerable Road User Safety Assessment

BASELINE SAFETY ANALYSIS SUMMARY

July 17, 2023

MONTANA
Department of Transportation

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Baseline Safety Analysis Summary

1.0. INTRODUCTION

Nationally, the number of vulnerable road user (VRU) roadway fatalities and serious injuries has been growing, with bicyclist and pedestrian fatalities increasing from 2019 to 2021. To address this growing safety issue, the Infrastructure Investment and Job Act (IIJA), enacted on November 15, 2021, implemented regulations that require all states to develop a Vulnerable Road User Safety Assessment (VRU SA) as part of their Highway Safety Improvement Program (HSIP) in accordance with 23 United States Code (U.S.C) 148(l). The VRU SA is intended to evaluate VRU safety performance and outline specific improvement projects or strategies through a comprehensive, collaborative approach to allow full and safe transportation access for all roadway users.

Without the protection of an outside shield, such as a vehicle, vulnerable road users are at higher risk to sustain a severe injury when involved in a collision with a vehicle.

The purpose of this document is to identify VRU safety problems within Montana by conducting a data-driven analysis using historic VRU-involved crash data and other relevant information to help MDT understand the contributing factors in VRU fatalities and serious injuries. An important component of the crash data analysis process includes consideration of VRU demographics in terms of both the location of VRU fatalities and serious injuries and the characteristics of individuals involved in crashes including race, disability, and economic status. In addition to assessing where VRU-involved crashes have occurred in the past, a systemic analysis was also performed to proactively consider indicators of where VRU fatalities and serious injuries are likely to occur in the future in order to identify areas at high-risk for VRU-involved crashes.

1.1. Definition of a Vulnerable Road User

A VRU is defined under 23 U.S.C 148 as a non-motorist. This category includes pedestrians, bicyclists, other cyclists, persons on motorized and non-motorized personal conveyances, persons in or on buildings, and other types of non-motorists as defined under National Highway Traffic Safety Administration (NHTSA) Fatality Analysis Reporting System (FARS) code attributes. A VRU may be walking, cycling, rolling, or stationary. Highway workers on foot in a work zone and anyone ejected from a transport vehicle and subsequently struck are considered a pedestrian in this category. Persons using personal conveyance devices for personal mobility assistance or recreation are considered pedestrians as well. These devices can be motorized or human powered but are not propelled by pedaling, such as roller skates, skateboards, scooters, wheelchairs, segways, and motorized rideable toys. Bicyclists include all persons riding a non-motorized vehicle propelled by pedaling such as a bicycle, tricycle, unicycle, or pedal car. Cyclists on e-bikes and motorcyclists are not considered VRUs.

In general, this report uses the term “non-motorist” interchangeably with “VRU” and is intended to encompass all categories of VRUs. Crashes involving VRUs are broadly categorized into pedestrian- and bicycle-involved crashes, which include all the applicable definitions described previously.

1.2. National Guidance

The National Road Safety Strategy (NRSS) outlines the United States Department of Transportation (US DOT) commitment to reduce serious injuries and fatalities of all road users on public roadways in pursuit of the goal of achieving zero highway deaths. A key component of the NRSS is the Safe System Approach (SSA) addressing the safety of all road users, with specific focus on improving safety culture, increasing stakeholder collaboration, and considering the human element in crash severity reduction. Other potential methods for reducing VRU fatalities and serious injuries include consideration of safe speeds, application of Americans with Disabilities Act (ADA) provisions, and use of Complete Streets Design principles to accommodate safety needs of all users. Through application of these methods, the VRU Safety Assessment enables MDT to use data-driven analysis to fully consider and prioritize safety for all road users in support of its collaborative Vision Zero campaign which strives for the goal of zero deaths and zero serious injuries on Montana's roadways in alignment with national US DOT goals.

1.3. Relevant Supporting Documents

As an initial step in the planning process, it is important to understand MDT's relevant policies, goals, and statewide plans to make sure the VRU SA aligns with and reflects MDT's overall safety program and strategic framework. It is also prudent to ensure the VRU SA considers historic safety performance and safety goals outlined in local Community Transportation Safety Plans (CTSP). These documents help establish a background understanding of previously identified safety performance concerns and VRU risk areas in Montana. **Table 1.1** summarizes each document as it relates to VRU safety or VRU-specific infrastructure. A detailed review of each document is contained in **Appendix A**, including a summary of how each document is relevant to the VRU SA.

Table 1.1: Previous Efforts Related to VRU SA

Plans and Programs		Year	Vulnerable Road User	
			Safety	Infrastructure
TranPlanMT		2017	✓	✓
Comprehensive Highway Safety Plan (CHSP)/Highway Safety Improvement Program (HSIP)		2020 / Annual	✓	✓
Statewide Transportation Improvement Program		2022	✓	✓
Highway Safety Plan and Annual Report		2022 / 2023	✓	
Montana Pedestrian and Bicycle Plan		2019	✓	✓
ADA Transition Plan		2021	✓	✓
Local Community Transportation Safety Plans	**Billings CTSP**	2022	✓	✓
	Missoula CTSP	2019	✓	✓
	Bozeman CTSP	2013	✓	✓
	Greater Helena Area CTSP	2013	✓	✓
	Butte-Silver Bow CTSP	2012	✓	✓
	Hamilton	2011	✓	✓
	Shelby-Toole County	2011	✓	✓

2.0. CRASH RECORD OVERVIEW

For this effort, the MDT Traffic and Safety Bureau provided crash data for the five-year period from January 1st, 2017, to December 31st, 2021. The data included all VRU-involved crashes occurring within Montana over the five-year analysis period. This information includes data from crash reports submitted to the Montana Highway Patrol (MHP) from their patrol officers and from local city, county, tribal, and federal law enforcement officials. The crash reports are a summation of information from the scene of the crash provided by the responding officer. Some of the information contained in the crash reports may be subjective. Furthermore, only reported crashes are included. Many crashes, especially those where individuals and vehicles are unharmed, do not get reported to law enforcement.

Crash records were analyzed to determine contributing factors, high-risk areas, and behavioral characteristics. User behavior, such as the use of proper safety equipment (i.e., helmets), impairment, and adherence to bicycling and pedestrian laws, is analyzed only when a crash occurs. There are likely many other instances in which these and other improper behaviors occur without resulting in a crash. The purpose of this analysis is only to analyze the circumstances of the VRU-involved crashes within Montana to identify trends and contributing factors in these crashes so that MDT, in coordination with local entities, can address these issues and improve VRU safety on the state's roadways.

2.1. Challenges and Limitations

Several challenges and limitations with analyzing bicyclist and pedestrian crashes makes a traditional safety analysis approach difficult. Below are some examples of the challenges and data limitations faced when analyzing bicyclist and pedestrian crash data.

- **Frequency of Crashes:** Unlike vehicle crashes, bicyclist and pedestrian crashes typically occur much less often. In performing a traditional safety analysis, the frequency of crashes is typically used to identify hot spots, or geographic locations with high frequencies of crashes, and statistically significant trends. Consequently, when traditional approaches are applied to bicyclist and pedestrian crashes, misleading conclusions or locations with variable safety performance may be identified.
- **Exposure Data:** Exposure data for vehicle traffic is common and is typically expressed in terms of Vehicle Miles Traveled (VMT) or Average Annual Daily Traffic (AADT). Pedestrian and bicyclist travel is less commonly counted and typically only for certain projects or locations. Currently, MDT does not collect statewide non-motorist usage data, however, some Montana localities have begun implementing jurisdiction-wide count programs.
- **Underreported Data:** Traditionally, crashes involving pedestrians and bicyclists have been underreported, especially if no injuries occurred. In general crashes on tribal lands, especially pedestrian- and bicycle-involved crashes, are also severely underreported. This underreporting can skew the available data more heavily towards higher severity crashes.
- **Unknown Data:** For many crash records, various fields are left blank by the reporting officer. Occasionally, a report will have "unknown" listed rather than a blank field. Without this information, it may be difficult to capture a complete understanding of what happened before, during, and after a crash.
- **Inconsistent Data:** Inconsistencies in reporting, either by the reporting officer or by the individual entering data into the MHP database, can also lead to misrepresentation of crash details. Although protocols have been established and training for filling out crash reports is provided to law enforcement, there may still be inconsistencies or errors in the reporting.

Crash reports by the investigating officer contain narratives of the crash occurrence, statements from the individuals involved and witnesses, crash diagrams, citations, and officer opinions as to cause of the collision, which can provide a fuller understanding of the crash. However, since it would be time prohibitive to review narratives for the nearly 1,500 VRU-involved crashes that occurred in Montana over the past five years, the data analysis in this report primarily considers only the data contained in simplified crash records.

Separately, the crash narratives for fatal and suspected serious injury crashes were reviewed to understand contributing circumstances in severe crashes and identify underlying trends. Separate from the global dataset of all VRU-involved crashes, efforts were made to update severe crash records for consistency and thoroughness. The effort included a review of the spatial relationship between crashes and their location as well as an analysis of road characteristics that may not be otherwise available in the simplified crash records. The information obtained from these reports is presented separately in **Section 6.0**. For the remainder of the analysis contained herein, the original crash records remained unchanged and are reported as received.

3.0. CRASH CHARACTERISTICS

A total of 1,484 VRU-involved crashes were reported in Montana over the five-year analysis period extending from January 1, 2017, to December 31, 2021. The following sections summarize crash details and other characteristics associated with these VRU crashes that occurred within Montana over the analysis period. The characteristics summarized in this section were evaluated as reported by the responding officer, and no efforts have been made to correct inconsistencies or fill in missing fields.

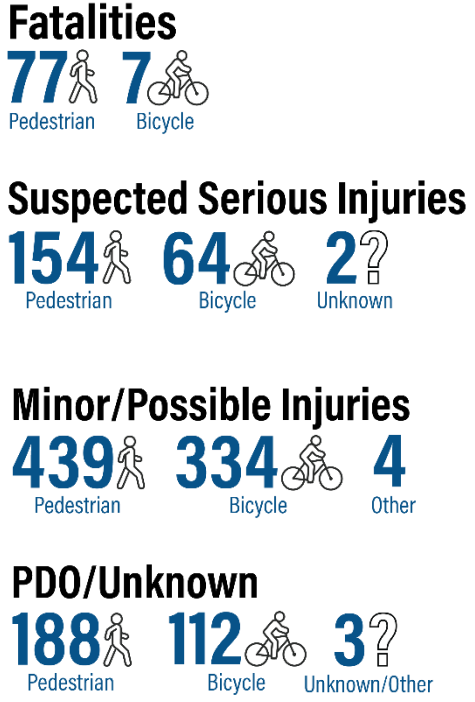
3.1. Severity

Crash severity is categorized based on the most severe injury resulting from the crash. For example, if a crash results in a possible injury and a suspected serious injury, the crash is reported as a suspected serious injury crash. A suspected serious injury is defined as an observed injury, other than a fatality, which would prevent the injured individual from walking, driving, or normally continuing the activities they were capable of performing before the injury. The term "suspected" references an officer's observation at the time of the crash without follow-up confirmation of the nature of the person's injury. The term "severe injuries" is used to refer to the combined total of fatal and serious injuries.

During the five-year analysis period, a total of 1,484 crashes occurred involving 1,384 non-motorists. Of those crashes, about 72 percent resulted in some level of injury and about 20 percent were severe. There were 84 fatal crashes, resulting in 84 total non-motorist fatalities, and 220 suspected serious injury crashes, resulting in 220 total serious injuries. A total of 1,081 of the 1,384 non-motorists involved in crashes, about 78 percent, were injured to some degree as a result of a crash. As noted previously, VRU-involved crashes may skew more heavily towards higher severity crashes due to underreporting of non-injury crashes. Approximately 28 percent of VRU crashes were reported as causing property damage only (PDO) or as unknown severity.

To compare the severity of crashes across several different characteristics, a severity index was calculated by assigning weighting factors to the number of crashes or injuries that occurred within a specific area or by a specific crash characteristic. The weighting factors used for this calculation were derived by MDT's Traffic and Safety Bureau from typical crash costs in Montana. The severity index can be calculated on a person basis or on a crash basis. This index is used as a means for comparing the severity of crashes that occurred within specific geographic areas or with certain

Of the 1,384 Non-Motorists Involved in Crashes…



$$Severity\ Index = \frac{(66.7 * Fatal) + (3.53 * Serious\ Injury) + (1.29 * Minor\ Injury) + (0.73 * Possible\ Injury) + (0.12 * (PDO + Unknown))}{Total\ Crashes\ or\ Injuries}$$

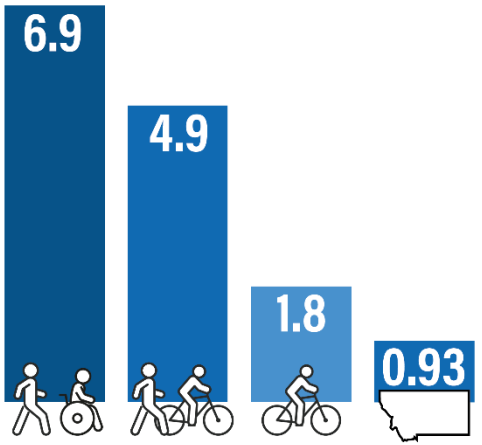
characteristics. No defined threshold is used to identify abnormal or extreme severity. The equation used to calculate severity index for the purposes of this report is presented below.

The crash severity index for pedestrian-involved crashes was 6.9, compared to a crash severity index of 1.8 for bicycle-involved crashes. Combined, all VRU-involved crashes (including both pedestrians and bicyclists) had a crash severity index of 4.9. When evaluated on a person basis, rather than on a crash basis, the injury severity index for non-motorists involved in pedestrian-involved crashes was 7.3 compared to 2.0 for bicyclist involved crashes. Combined, all VRU-involved crashes had an injury severity index of 5.2. These values account for multiple non-motorists involved in a single crash. For motor vehicle occupants involved in the 1,384 VRU crashes, including drivers and passengers, the injury severity index was 0.2, which indicates that the majority of motor vehicle occupants involved in these crashes experienced minor, if any injuries.

For all 113,190 crashes that occurred in Montana over the same five-year period, the overall crash severity index was 0.93 and the overall injury severity index was 0.58. This indicates that reported VRU-involved crashes tend to be much more severe than the average crash in Montana.

The VRU injury severity index by Montana county is presented in **Figure 3.1**. The total number of severe VRU injuries that occurred in each urban area is also identified on the map. The map indicates that while the urban areas have higher numbers of severe VRU injuries, there are higher concentrations of severe injuries occurring in rural counties, especially within Tribal Reservations.

The US Census Bureau defines urban areas as those encompassing at least 5,000 people or at least 2,000 housing units. Per state statute (Montana Code Annotated [MCA] Title 60), MDT defines urban areas only as those encompassing at least 5,000 people. Accordingly, the US Census Bureau identifies 22 urban areas in Montana, while MDT only recognizes 20, which excludes Libby and Dillon. All 22 Census-designated urban areas were considered during the development of the VRU SA.



Non-Motorist Crash Severity Index

Under 23 U.S.C. 148(l)(4)(B), states are required to consult with local governments, Metropolitan Planning Organizations (MPOs), Tribal agencies, and advocacy groups representing underserved communities during the VRU SA development process. Accordingly, particular attention was paid to Montana's MPOs and Tribal Reservations. The US Census Bureau defines MPOs based on a population threshold of 50,000. Results of the 2020 Census indicate that there are now five MPOs in Montana, including Great Falls, Billings, Missoula, Bozeman, and Helena. Prior to the 2020 Census, the three MPOs in the state were Great Falls, Billings, and Missoula. Since Bozeman and Helena did not yet have their MPOs established at the time of this assessment, only the three previous MPOs were considered and consulted for the development of the VRU SA. Additionally, there are seven land-based Tribal Reservations in Montana including the Blackfeet, Crow, Flathead, Fort Belknap, Fort Peck, Northern Cheyenne, and Rocky Boy's-Chippewa Cree, which are home to several Native American tribes.

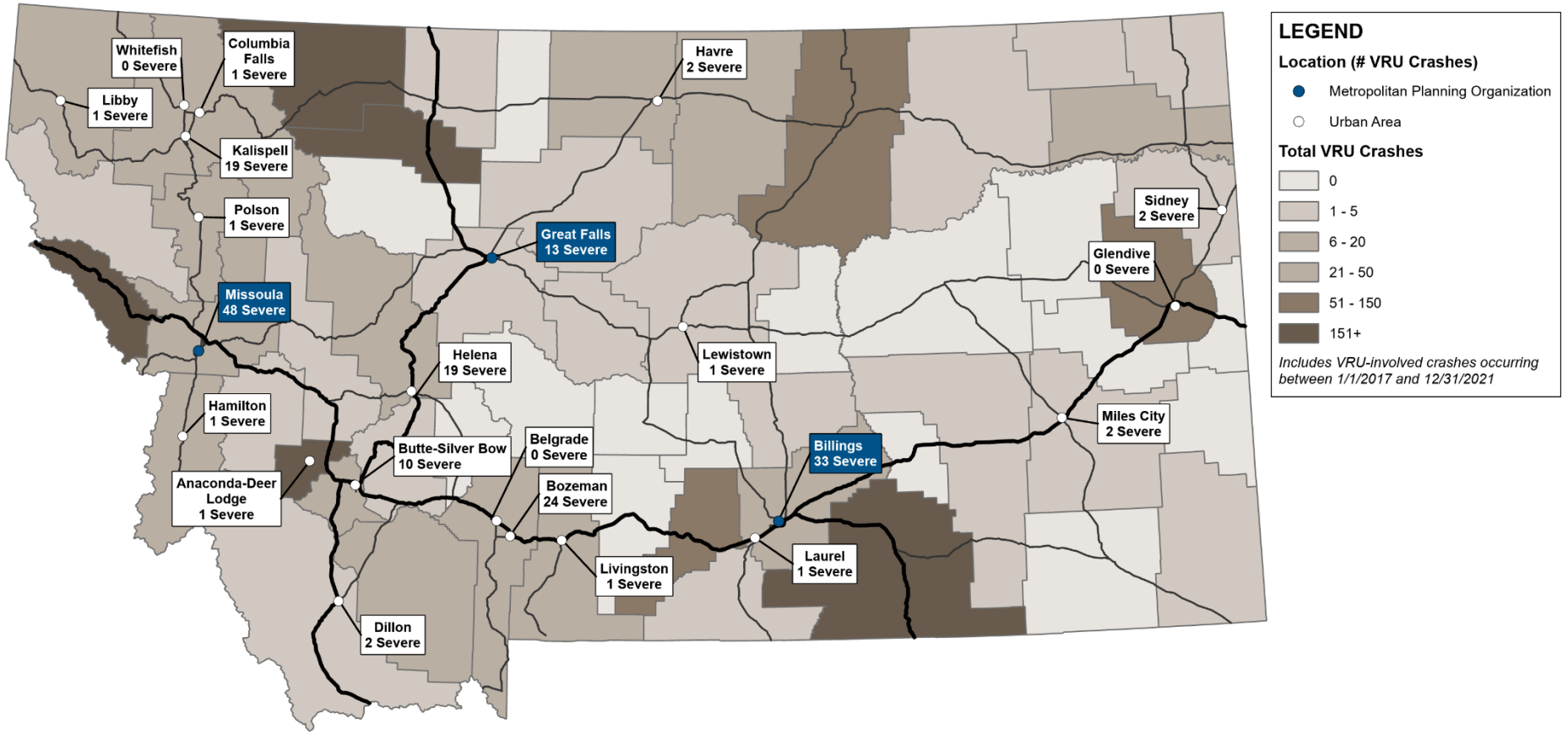


Figure 3.1: VRU Injury Severity Index

3.2. Crash Period

Crash data were evaluated based on the period of time when the crash occurred, as summarized in the following sections. This analysis helps identify temporal trends such as day of the week, month, or hour of the day as well as providing a comparison year over year.

YEAR

The number of non-motorist-involved crashes and severe injuries per year is presented in **Figure 3.2**. Overall, the number of VRU-involved crashes has generally been declining, with the exception of pedestrian crashes, which increased between 2020 and 2021. The non-motorist fatalities chart indicates the number of pedestrians and bicyclists who died in crashes. Pedestrian deaths increased from 2017 to 2020 but dropped to 2017 levels in 2021. There were relatively few bicyclist fatalities, with three or less per year over the analysis period. The number of pedestrians that sustained serious injuries increased from 2017 to 2018, then declined through 2021. The total number of bicyclists who sustained serious injuries remained relatively steady between 2017 and 2020 but experienced a sharp decline in 2021.

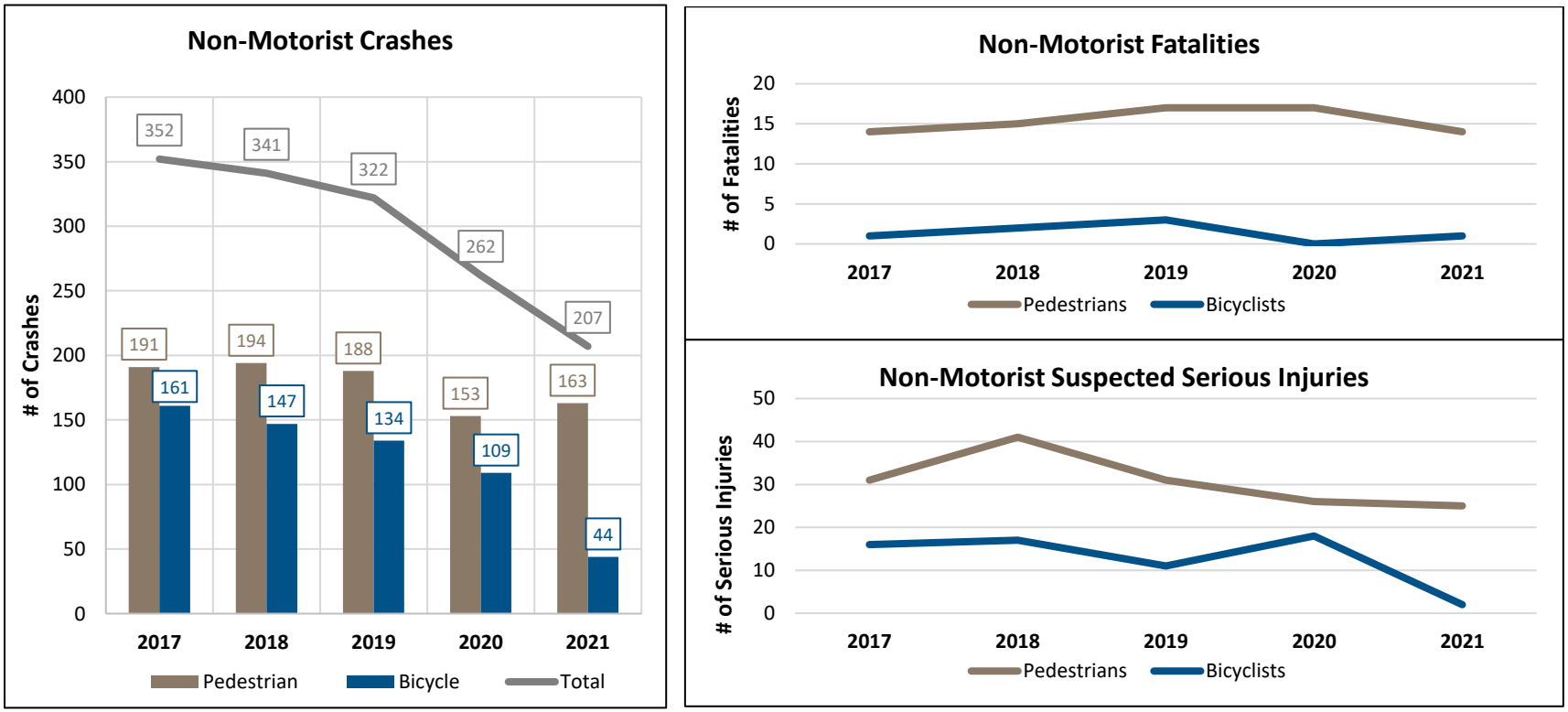


Figure 3.2: Non-Motorist Crashes and Severe Injuries by Year

DAY OF THE WEEK

With respect to the day of the week in which non-motorist-involved crashes occurred, a higher number of crashes occurred on weekdays (80 percent) compared to weekends. This suggests a possible trend with regular commuting patterns and generally higher traffic exposure on weekdays. The highest number of reported pedestrian fatalities occurred on Tuesdays (13), while Saturdays and Sundays accounted for the most bicyclist fatalities (5 total). Again, Tuesdays were the highest for pedestrian suspected serious injuries (29), while Fridays were the highest for bicyclist serious injuries (17) with generally lower numbers on weekends (14 total). The distribution of crashes and severe injuries based on the day of the week in which the crash occurred is presented in **Figure 3.3**.

Urban crashes exhibited these patterns more clearly, with a higher percentage of crashes during weekdays. Rural crashes remained steady throughout the week.

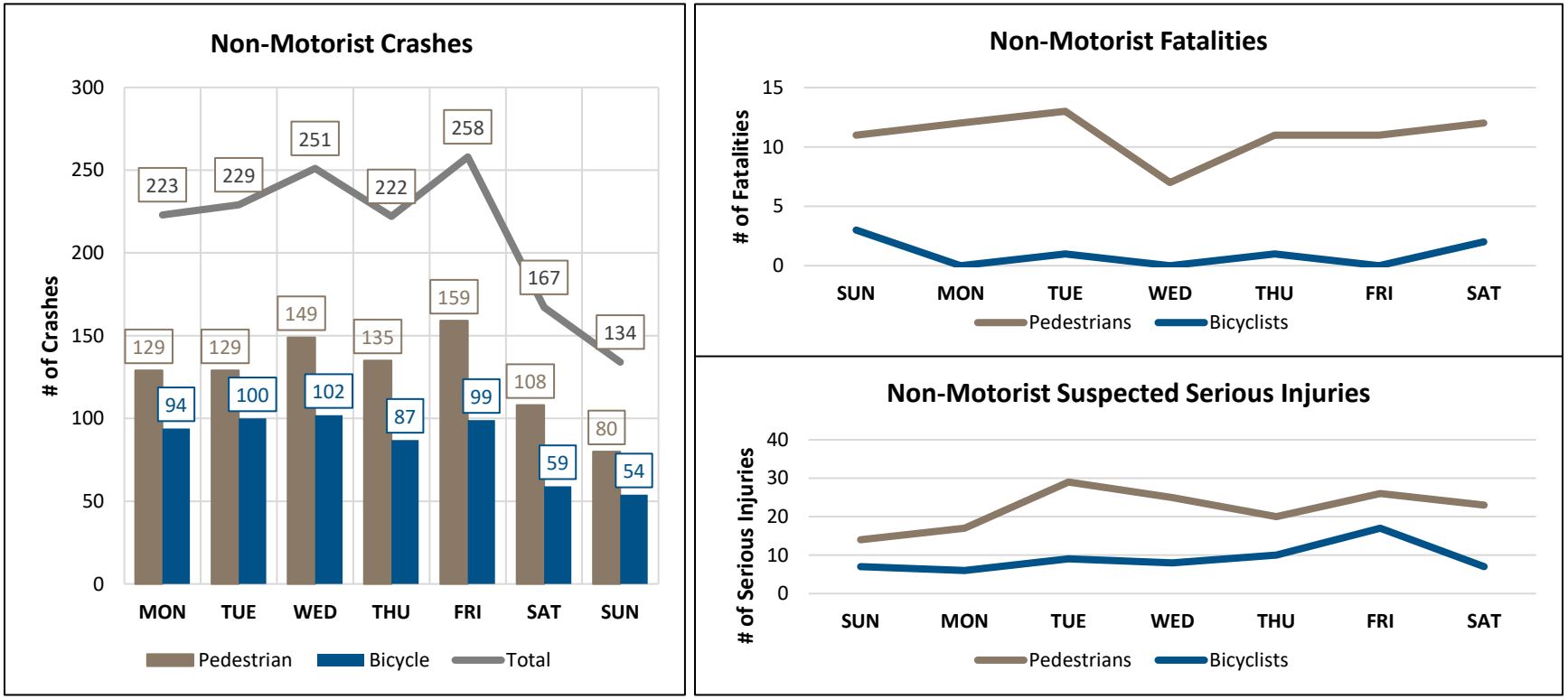


Figure 3.3: Non-Motorist Crashes and Severe Injuries by Day of the Week

MONTH

Figure 3.4 shows the distribution of reported non-motorist-involved crashes based on the month of the year in which the crash occurred. Approximately 68% of bicycle-involved crashes occurred in the summer and fall months (June through October) while 57 percent of pedestrian-involved crashes occurred in the fall and winter months (September through February). Total VRU-involved crashes were highest in the summer months (June through September, 45 percent of crashes) and lowest in the winter months (December through April, 29 percent of crashes). Pedestrian fatalities peaked in December while pedestrian suspected serious injuries were highest in October, February, and July. Bicyclist fatalities and serious injuries both peaked in July. These findings may suggest more bicyclist activity during warmer months as well as higher traffic volumes due to increased travel and tourism. The higher frequency of pedestrian-related crashes during winter months may point to issues with winter maintenance of pedestrian facilities and consideration of daylight savings time.

Urban crashes exhibited these patterns more clearly, with a pronounced peak occurring in summer months (June through September). Rural crashes remained relatively steady throughout the year, with only a slight increase in summer months.

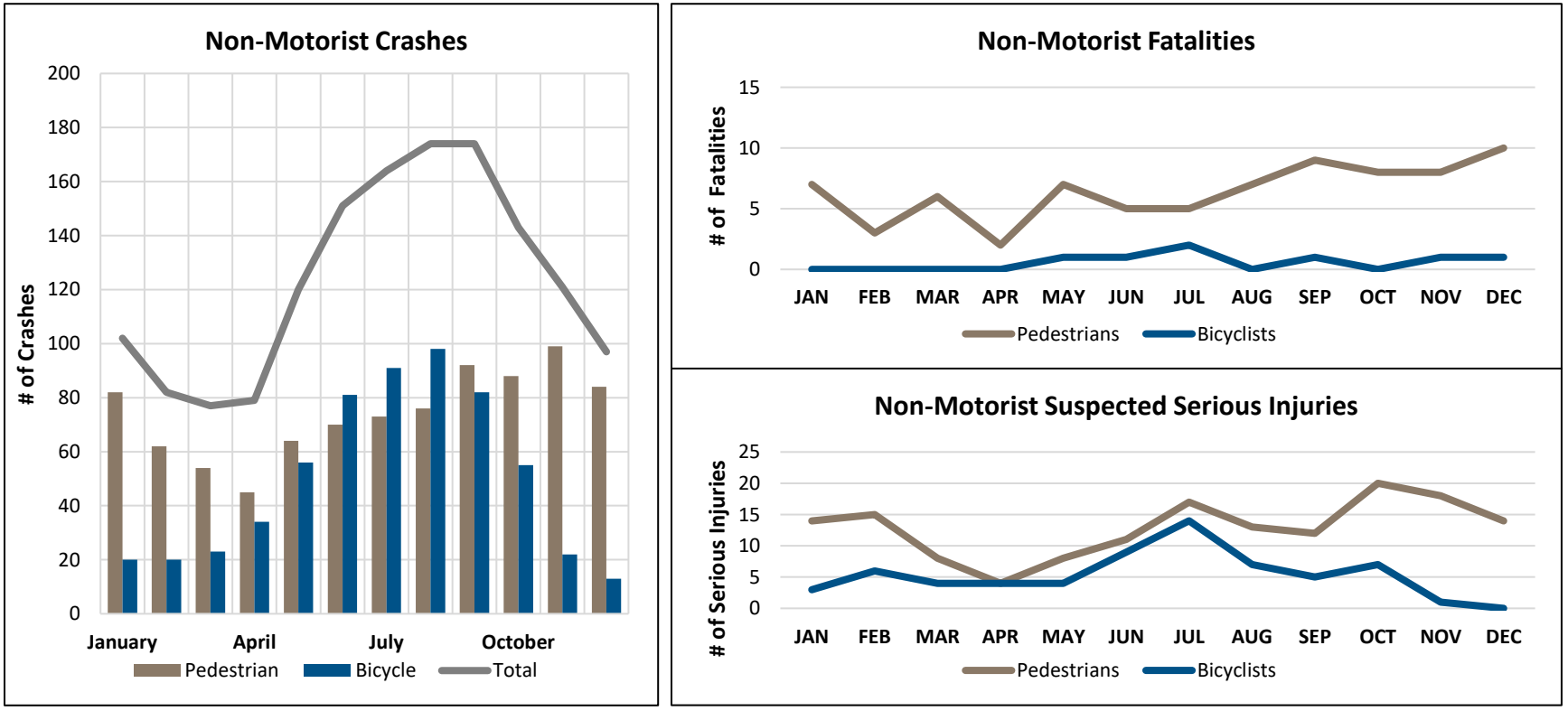


Figure 3.4: Non-Motorist Crashes and Severe Injuries by Month

TIME OF DAY

The time-of-day distribution for crashes and severe injuries is presented in **Figure 3.5**. Two prominent peaks can be seen, with one around 7:00 AM and the other between 3:00 PM and 6:00 PM, likely corresponding to morning and evening commutes as well as school start and release times. Another less drastic peak is observed at night around 10:00 PM. Pedestrian fatalities were highest in the evening and early morning hours, from approximately 6:00 PM to 12:00 AM. Small peaks in bicyclist fatalities were observed at 7:00 AM, 2:00 PM, and 11:00 PM. Non-motorist suspected serious injuries occurred more randomly throughout the day, with the greatest number of pedestrian serious injuries at 1:00 PM, between 5:00 and 6:00 PM, and at 9:00 PM. Bicyclist suspected serious injuries peaked between 11:00 AM and 4:00 PM.

Urban crashes exhibited these patterns more clearly, with pronounced peaks at 7:00 AM and between 3:00 PM and 6:00 PM. Rural crashes remained relatively steady throughout the day, with only slight increases at 4:00 PM and 7:00 PM.

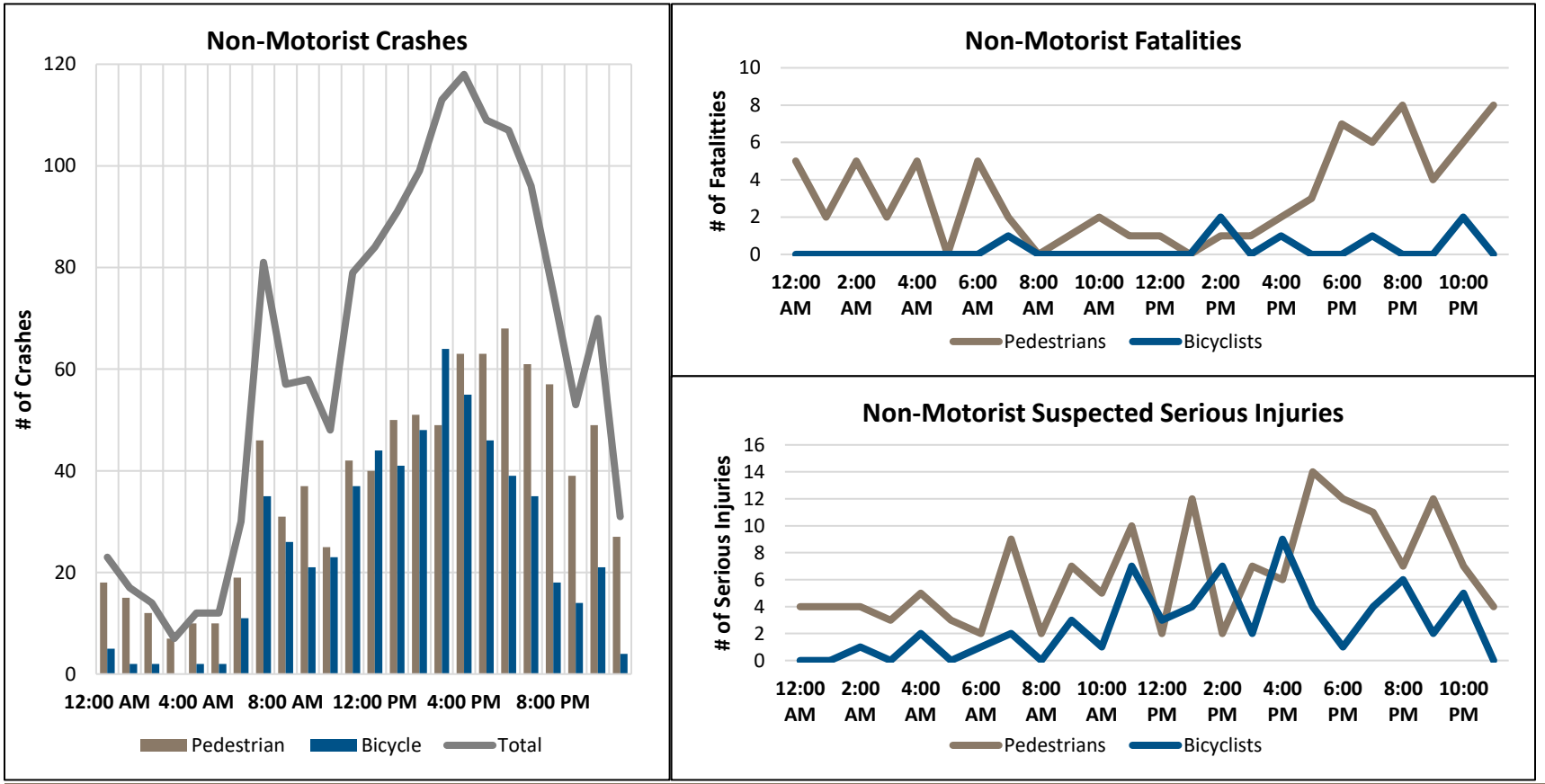


Figure 3.5: Non-Motorist Crashes and Severe Injuries by Time of Day

3.3. Location

When analyzing VRU-involved crashes, it is important to understand where they are occurring to identify any concentrations or areas with a higher risk of occurrence. **Figure 3.6** indicates the total number of VRU-involved crashes that occurred in each county and notes the number of VRU crashes within each urban area. This map shows higher concentrations of VRU crashes in counties with large urban areas and MPOs. These areas have higher population densities, greater traffic volumes, and are also typically more condensed, offering greater opportunities for walking and bicycling as transportation modes. These circumstances can lead to greater traffic exposure and a higher risk of collisions.

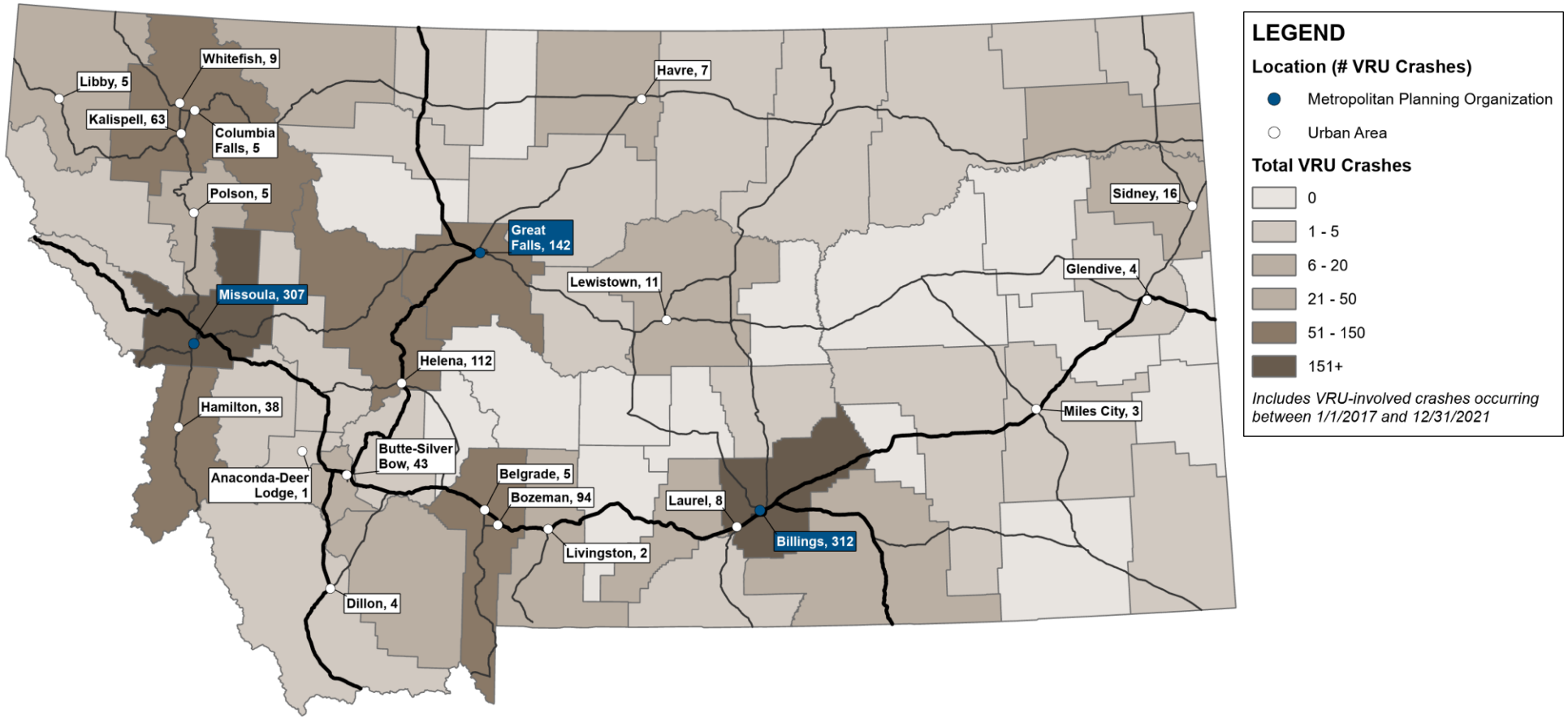
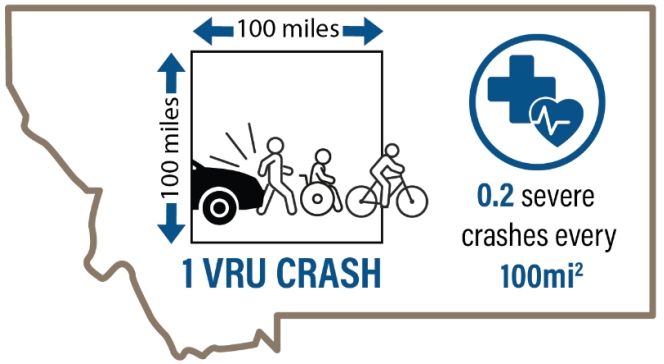


Figure 3.6: VRU Crashes by Montana County and Urban Area

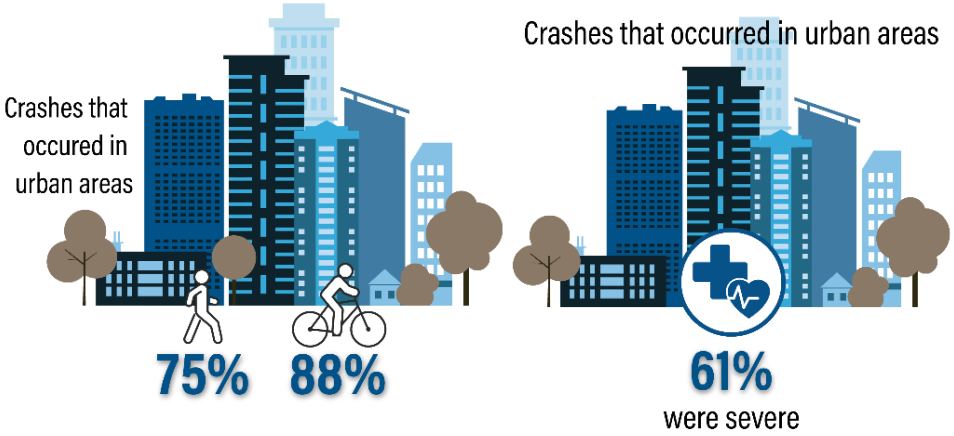
URBAN VS. RURAL

Montana is a large state with a relatively low population density. Accordingly, the number of VRU crashes within Montana is also relatively low compared to more populous states. When translated to a statewide crash density, approximately one VRU-involved crash occurred per 100 square miles over the five-year analysis period. Approximately 0.2 severe VRU crashes occurred per 100 square miles over the same period.



Over 80 percent of all VRU-involved crashes occurred in urban areas. When considering the 1,196 VRU crashes that occurred in the 292 square miles constituting Montana's 22 urban areas identified by the U.S Census Bureau, approximately 410 VRU crashes occurred per 100 square urban miles. Furthermore, there were approximately 590 VRU crashes per 100 square miles in Montana's three MPOs (Billings, Great Falls, and Missoula). Conversely, there were approximately 0.2 VRU crashes per 100 square miles in rural areas of Montana.

Of the 889 pedestrian-involved crashes that occurred over the five-year analysis period, 670 (or 75 percent) occurred in an urban area. Of the 595 bicyclist-involved crashes, 526 (or 88 percent) occurred in an urban area. Of those urban area VRU crashes, 61 percent were severe. Interestingly, the crash severity index for urban areas was 3.1 while the crash severity index for rural areas was 12.3 over the five-year period. This indicates that although there were fewer VRU-involved crashes in rural areas, these crashes tended to be more severe.

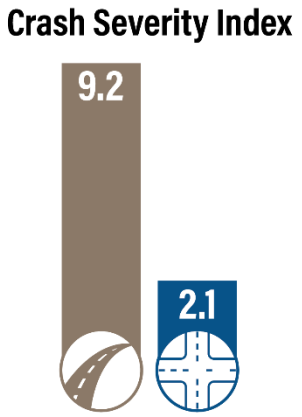


In terms of individual injuries, 60 percent of all non-motorist fatalities and 33 percent of serious injuries occurred in rural areas of Montana, compared to 40 percent of fatalities and 67 percent of serious injuries that occurred in urban areas. This reinforces the observation that rural crashes were more severe in terms of personal injury.

INTERSECTION RELATION

With respect to physical location, approximately 54 percent of all VRU-involved crashes occurred at an intersection or were related to an intersection. In all, 46 percent of pedestrian-involved crashes and 67 percent of bicyclist-involved crashes occurred at intersections. In urban areas, 63 percent of crashes occurred at intersections while only 18 percent of crashes in rural areas occurred at intersections.

In terms of severity, approximately 13 percent of intersection crashes were severe while 31 percent of non-junction crashes were severe. Furthermore, 34 percent of severe injuries occurred at intersections and 55 percent occurred at non-junction locations. Overall, the crash severity index at intersections was calculated to be 2.1 while the severity index at non-junction locations was 9.2. By comparison, the overall VRU-involved crash severity index was 4.3.



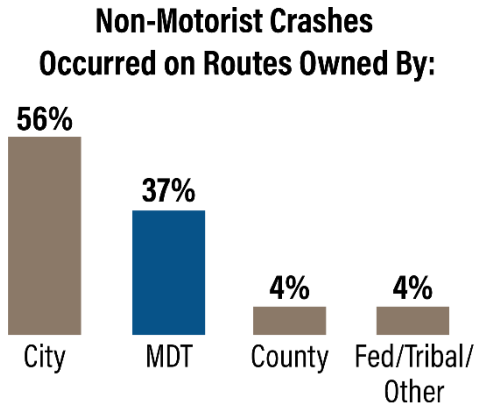
Although more VRU-involved crashes occurred at intersections, they tended to be less severe than those that occurred at non-junction locations. Typically, non-junction locations, such as highways, have higher speeds which increases the risk of injury when a crash occurs.

3.4. Road Characteristics

At the location of a crash, the data point is matched spatially to the roadway on which the crash occurred and select characteristics of the route are drawn from various MDT databases and tied to each crash record. A summary of the route characteristics for each crash is provided in the following sections.

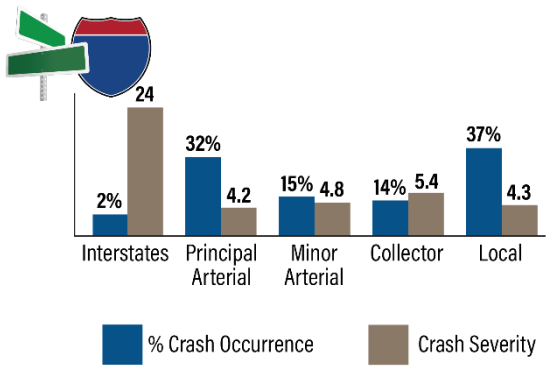
ROUTE OWNERSHIP

Understanding the owner of the roadway on which a crash occurs can help identify jurisdictions that are responsible for the maintenance and improvement of the route. Approximately 37 percent of VRU-involved crashes occurred on MDT-owned roadways, while 56 percent occurred on routes owned and maintained by cities or other municipal agencies, and 4 percent occurred on county-owned routes. The remaining 4 percent of crashes occurred on routes owned by Tribal agencies, the US Forest Service, or other state and federal agencies. Pedestrian and bicycle-involved crashes were similarly distributed among these route ownership types with slightly more pedestrian-involved crashes occurring on state-owned routes and slightly more bicycle-involved crashes occurring on city-owned routes. These findings point out the importance of inter-agency coordination since it is not just one agency that is responsible for the roadways where VRU crashes are occurring. This data also has a strong correlation to the urban nature of many VRU-involved crashes where routes are primarily city owned.



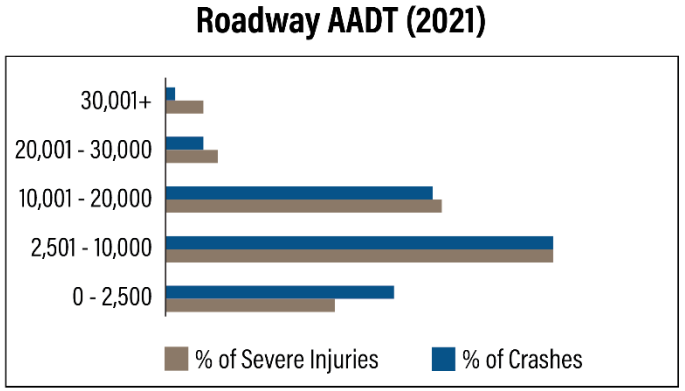
FUNCTIONAL CLASSIFICATION

The transportation system is made up of a hierarchy of roadways classified by parameters such as geometric configuration, traffic volumes, spacing in the community's transportation grid, speed, and adjacent land uses. The method by which these roles are defined is widely known as functional classification, which classifies roadways as interstates, principal arterials, minor arterials, collector streets, and local streets. The majority of crashes occurred on local streets (37 percent) and principal arterials (32 percent). The fewest number of crashes (2 percent) occurred on interstates, although the crash severity on interstates was the highest (24 percent). While crashes most frequently occurred on local roads and principal arterials, the overall crash severity on these systems was comparatively lower (4.3 and 4.2, respectively). Still, 57 percent of all fatalities and 67 percent of all suspected serious injuries occurred on local roads and principal arterials. Minor arterials and collectors each had approximately 15 percent of total crashes with crashes occurring on collectors being slightly more severe.



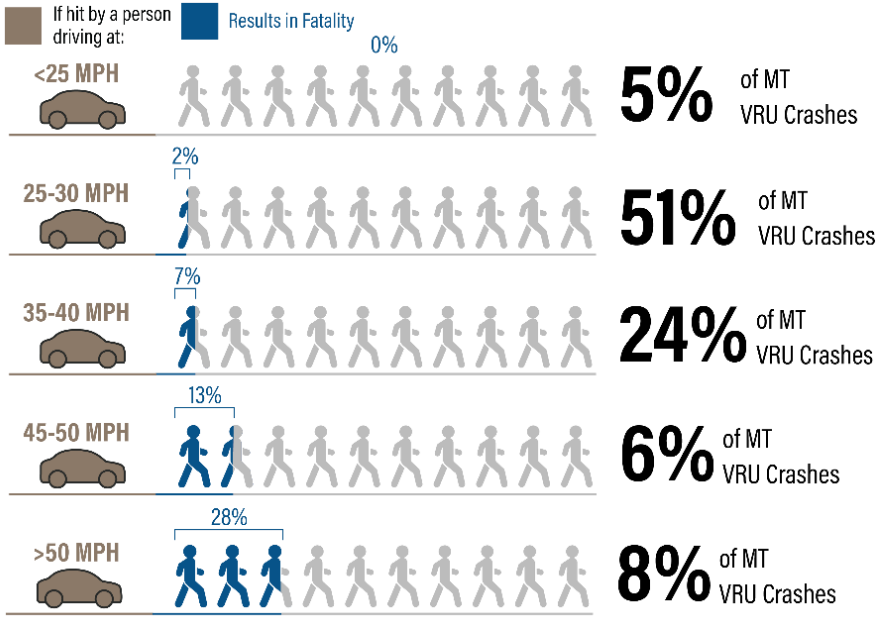
TRAFFIC VOLUMES

Traffic volumes of the roadway on which a crash occurred can point to the level of exposure to vehicle traffic. For vehicle crashes, higher traffic volumes typically indicate a heightened risk of conflict and therefore a higher frequency of crashes. This isn't always the case for VRU-involved crashes since non-motorists and vehicles typically occupy separate spaces, such as sidewalks or paths versus the roadway. Overall, the highest percentage of crashes and the highest percentage of severe injuries occurred on roadways with 2,500 to 10,000 vehicles per day. Lower percentages of crashes occurred on higher volume roadways, although higher percentages of severe injuries, comparatively, occurred on higher volume roadways.



SPEED

The speed limit on the roadway on which the crash occurred is also provided in crash data. While the posted speed limit doesn't necessarily indicate the speed at which a vehicle was traveling at the time of the crash, it is generally a good indication. Approximately 56 percent of VRU-involved crashes occurred on roadways with a posted speed limit of 30 miles per hour (mph) or less, which is a standard speed limit for local and collector streets. Approximately 8 percent of crashes occurred on roadways with speed limits greater than 50 mph which is typical of rural principal arterials and interstates. Pedestrian and bicycle-involved crashes were similarly distributed among roadways with these speed limits, with slightly higher percentages of pedestrian crashes occurring on higher speed roadways. Rural crashes were more likely to occur on roadways with speed limits greater than 50 mph (37 percent) compared to only 2 percent in urban areas. In urban areas, 83 percent of crashes occurred on roadways with posted speeds between 25 and 35 mph. In general, crashes occurring at higher speeds have a greater likelihood of resulting in a fatality. In Montana, 28 percent of VRU-involved crashes occurring on roadways with posted speeds in excess of 50 mph resulted in one or more fatalities while only 2 percent of crashes on roadways with posted speeds of 25 or 30 mph resulted in fatalities.



3.5. Other Factors

In addition to the time and location of the crash, other factors contribute to the occurrence and severity of a crash. These factors may include weather conditions, road surface conditions, lighting conditions, or the type of vehicle involved in the crash. The following sections summarize these circumstances for VRU-involved crashes over the five-year analysis period.

ENVIRONMENTAL CONDITIONS

The majority of VRU-involved crashes occurred when the weather was clear or cloudy (73 percent). Approximately 3 percent of crashes occurred when it was either snowing or raining, respectively. Pedestrian-involved crashes were slightly more frequent during severe weather conditions compared to bicyclist involved crashes. This is interesting to consider since many of the pedestrian-involved crashes occurred during winter months when weather is typically variable in Montana. Since VRUs do not have the protection of a vehicle, they are typically less likely to be active when the weather is poor, which may explain the lower frequency of crashes during poor weather conditions. Poor

weather also didn't appear to be correlated to severe crashes, with 82 percent of fatal and 75 percent of suspected serious injury crashes occurring under clear or cloudy conditions.

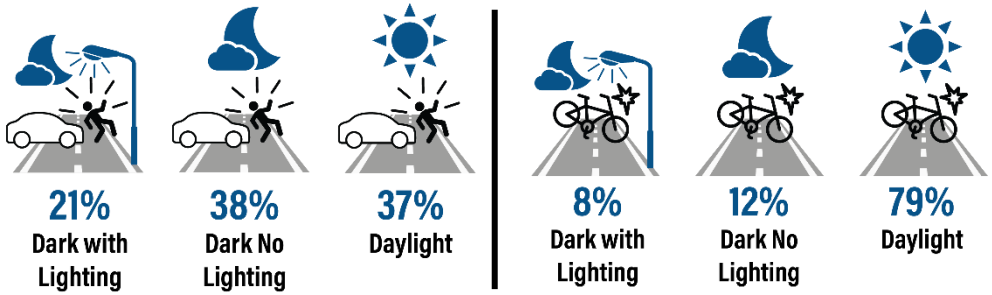
Likewise, most VRU-involved crashes occurred when the road surface was dry (80 percent). Nearly all bicyclist-related crashes occurred on dry roads (91 percent) with 6 percent occurring on wet roads and only 2 percent occurring on snow, ice, or frost-covered roads. Pedestrian-involved crashes were more likely to occur under adverse road conditions, with 12 percent occurring on snow, ice, or frost-covered roads and 13 percent occurring on wet roads. Approximately 78 percent of fatal crashes and 80 percent of suspected serious crashes occurred on dry roads. Crashes occurring under adverse road or weather conditions could indicate a lack of maintenance of non-motorized facilities, forcing pedestrians or bicyclists into the travel way, however, this finding is inconclusive.

LIGHTING CONDITIONS

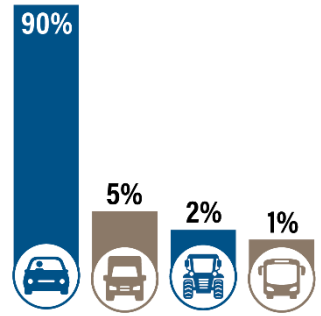
Lighting conditions are another important factor in VRU-involved crashes since non-motorists are typically much smaller and more difficult to see, especially in low light or darkness. Overall, 66 percent of VRU-involved crashes occurred during daylight with more bicyclist-involved crashes (84 percent) than pedestrian-involved crashes (55%) occurring under these conditions. Over 40 percent of pedestrian-involved crashes occurred when it was dark outside, with 21 percent occurring when there was street lighting present. Conversely, only about 13 percent of bicyclist-involved crashes occurred when it was dark, with 9 percent occurring where lighting was available.

Lighting Conditions

In Fatal and Suspected Serious Injury Crashes



Severe pedestrian-involved crashes were more likely to occur at night (59 percent), especially in areas without street lighting (38 percent). The majority of severe bicyclist-involved crashes still occurred during daylight hours, however, 12 percent occurred under dark lighting conditions with no street lighting and 8 percent occurred at dark with street lighting. These trends may point to a need for more street lighting in areas with heavy VRU activity, or the need for education for pedestrians and bicyclists on the use proper equipment to enhance visibility of their person.



Vehicles Involved in Severe Non-Motorist Crashes

VEHICLE TYPE

When a crash is reported, the responding officer documents details about the types of vehicles involved in each crash. Bicycles are typically, but not always, coded as a low-speed vehicle. In total, 2,215 vehicles were involved in the 1,484 VRU-involved crashes, accounting for multiple vehicles involved in a single crash. A total of 584 bicyclists involved in the 595 bicycle crashes were classified as low-speed vehicles. Excluding low-speed vehicles from the dataset, 86 percent of vehicles involved in all VRU crashes and 90 percent of vehicles involved in severe VRU crashes were passenger cars, which includes SUVs and pickup trucks. Large trucks accounted for 3 percent of vehicles involved in all crashes and about 5 percent of vehicles involved in severe crashes. Machinery, such as farm equipment and snowplows, were involved in 5 percent of all crashes and 2 percent of severe crashes. Buses and motorhomes were involved in less than 1 percent of all crashes and approximately 1 percent of severe crashes.

4.0. DEMOGRAPHICS

An important component of the VRU SA crash data analysis process includes consideration of VRU demographics in terms of both the demographics of the location where VRU fatalities and serious injuries occurred as well as the characteristics of the individuals involved in crashes. The following sections include an analysis of demographic details provided in crash data as well as an analysis of demographics sourced by the US DOT Justice40 Initiative.

4.1. Demographics of Location

The Justice40 Initiative was created to confront and address decades of underinvestment in disadvantaged communities. The initiative allows US DOT to identify and prioritize projects that benefit rural, suburban, tribal, and urban communities facing barriers to affordable, equitable, reliable, and safe transportation. The US DOT has compiled a mapping tool to help identify disadvantaged communities. Version 2.0, released in May 2022, includes data for 22 indicators collected at the Census tract level and grouped into six categories of transportation disadvantage.[1] The data is sourced from the Center for Disease Control's Social Vulnerability Index, the US Census Bureau's American Community Survey, the Environmental Protection Agency's Smart Location Map and Environmental Justice Screen, the United States Department of Housing and Urban Development's Location Affordability Index, and the Federal Emergency Management Agency's Resilience Analysis & Planning Tool and National Risk Index. The six categories of transportation disadvantage are listed below with the numbers in parentheses showing how many of the 22 indicators fall within each category:

1. **TRANSPORTATION ACCESS DISADVANTAGE**: identifies communities and places that spend more, and take longer, to get where they need to go. (4)
2. **HEALTH DISADVANTAGE**: identifies communities based on variables associated with adverse health outcomes, disability, as well as environmental exposures. (3)
3. **ENVIRONMENTAL DISADVANTAGE:** identifies communities with disproportionately high levels of certain air pollutants and high potential presence of lead-based paint in housing units. (6)
4. **ECONOMIC DISADVANTAGE:** identifies areas and populations with high poverty, low wealth, lack of local jobs, low homeownership, low educational attainment, and high inequality. (7)
5. **RESILIENCE DISADVANTAGE:** identifies communities vulnerable to hazards caused by climate change. (1)
6. **EQUITY DISADVANTAGE:** identifies communities with a high percentile of persons (age 5+) who speak English "less than well." (1)

Within each Census tract, the percentile value was calculated for each of the 22 indicators, where the 99th percentile represents the most disadvantaged. Within each category, the average percentile for each tract was calculated. For each category, a tract is assigned a value of one (1) if it is in the 50th percentile or higher and zero (0) otherwise. For the resilience category only, a tract is assigned a value of one (1) if it is in the top 75th percentile of disadvantage. A Census tract is considered transportation disadvantaged if it exceeds these thresholds in at least four of the six categories. The resulting analysis for Montana is provided in **Figure 4.1**.

[1] *US DOT, Transportation Disadvantaged Census Tracts (Historically Disadvantaged Communities) Interim Definition Methodology, Updated April 27, 2023,* https://www.transportation.gov/priorities/equity/justice40/transportation-disadvantaged-census-tracts-historically-disadvantaged

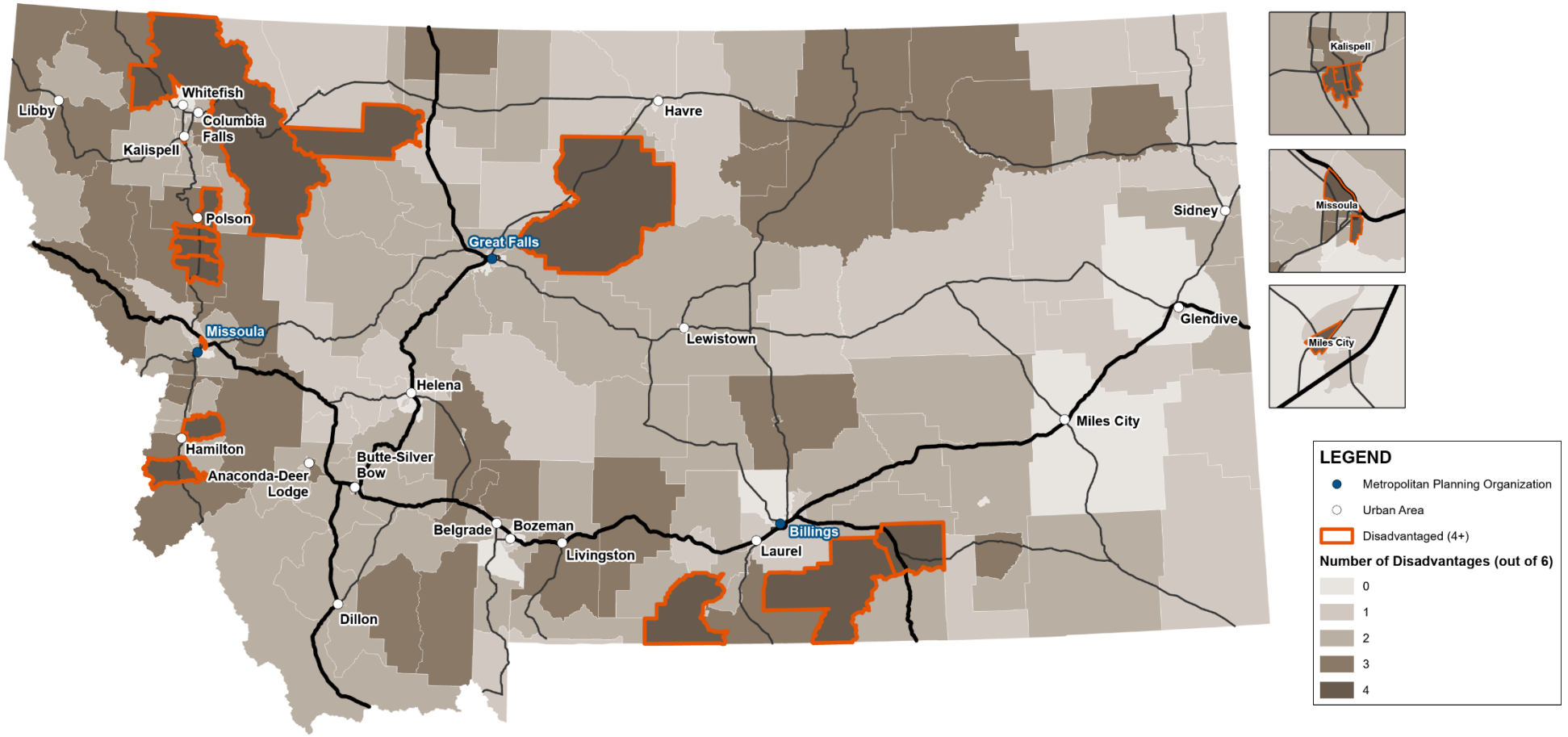


Figure 4.1: Transportation Disadvantages (US DOT Justice 40)

The mapping in **Figure 4.1** shows that there are 17 Census tracts that were identified as having 4 or more disadvantages. Interestingly, none of the Census tracts exceeded 4 disadvantages. The disadvantaged Census tracts are located primarily in areas where there are Tribal Reservations, including the Blackfeet, Crow, Flathead, Rocky Boy's-Chippewa Cree, and Northern Cheyenne. Several areas of Montana were identified as having no disadvantages including Custer, Dawson, and parts of Yellowstone and Gallatin Counties.

17 highly disadvantaged communities identified in MT (out of 271)

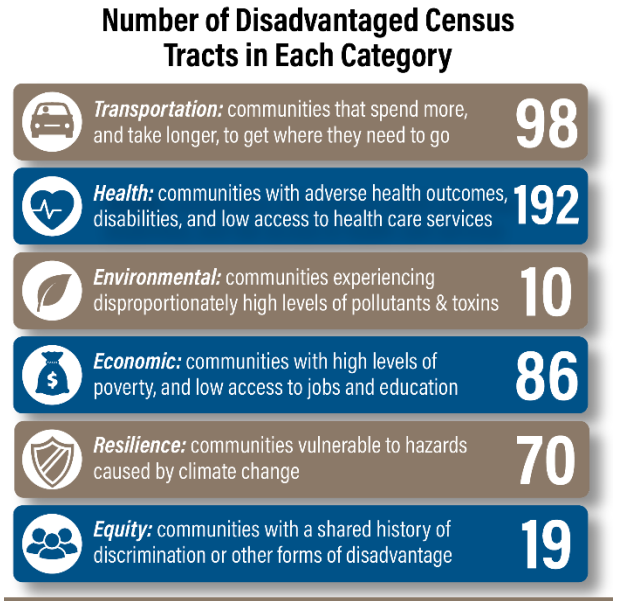


Figure 4.2: Number of Disadvantaged Census Tracts by Category

Figure 4.2 indicates the number of Census tracts, out of 271 total Census tracts in the state, which were identified as exceeding the 50th percentile (75th percentile for Resilience) in each category. Of note, over 70 percent of Montana Census tracts are identified as being health disadvantaged. These Census tracts are primarily in rural parts of the state with low access to health care services and don't necessarily indicate high concentrations of people with disease or disabilities. Census tracts identified as being economically disadvantaged or transportation disadvantaged may be areas where there are large populations of low-income earners who may rely on walking and bicycling as their primary transportation modes.

Figure 4.4 on the following page maps the number of VRU severe injuries per 2,500 people within each Census tract and compares the severe injury per capita rate to the Justice40 Disadvantaged Communities information. Below, **Figure 4.3** indicates the number of disadvantages associated with the 10 Census tracts with the highest VRU severity per capita rates. In general, more crashes and many of the higher-severity crashes are occurring in urban areas, which are generally not considered disadvantaged. The two Census tracts with the highest VRU severe injury per capita rate are located on the western border of the Blackfeet Reservation and on the eastern half of the Fort Peck Reservation, both of which are not considered disadvantaged.

Figure 4.3 indicates that the majority of Census tracts where high rates of VRU severe injuries are occurring are considered health and economic disadvantaged (9 and 8 Census tracts, respectively). Two of the Census tracts are considered highly disadvantaged, meaning they exceed the minimum thresholds in four or more disadvantage categories. These tracts are located northeast of Colombia Falls and south of Polson. This information may indicate a need to focus efforts in areas with either or both health and economic disadvantages as these areas may have populations at higher risk of involvement in a crash as a VRU due to health or economic circumstances.

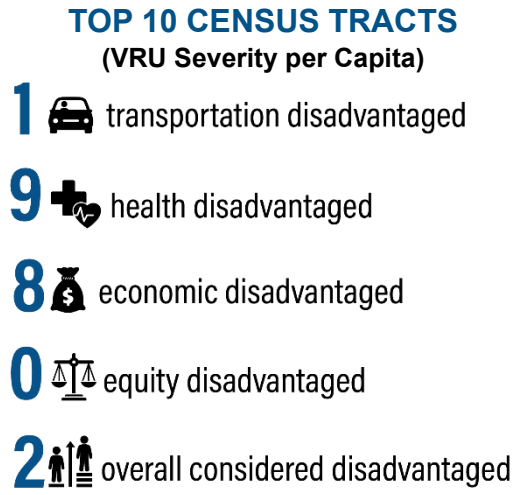


Figure 4.3: Disadvantages in Areas with High Severity Rates

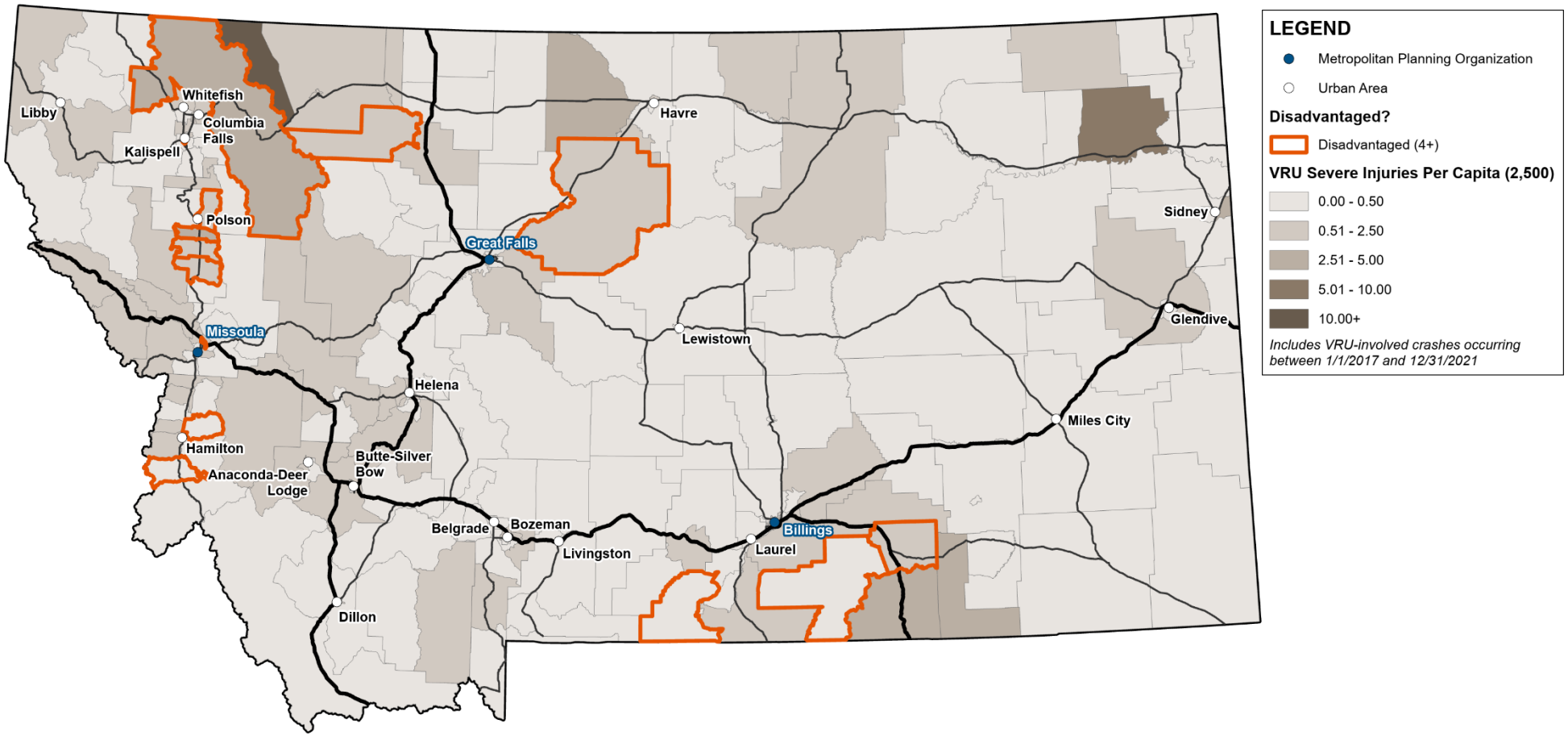


Figure 4.4: VRU Severe Injuries by Capita and Disadvantaged Status

4.2. Tribal Areas

Tribal Reservations in the United States are disproportionately poverty stricken. Nationwide, low-income residents use walking and bicycling as primary transportation modes. In Montana, 76 percent of the Census tracts overlapping the seven land-based Tribal Reservations are considered economically disadvantaged and 68 percent are considered transportation disadvantaged. These disadvantages are indicators that walking and bicycling for transportation on Tribal Reservations is likely prevalent. Anecdotally, MDT has observed that residents often use these modes to travel within their respective communities as well as for travel between neighboring communities, often on high-speed rural highways lacking dedicated pedestrian and bicycle facilities.

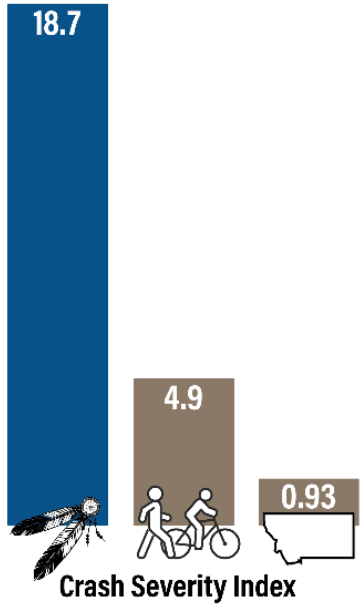
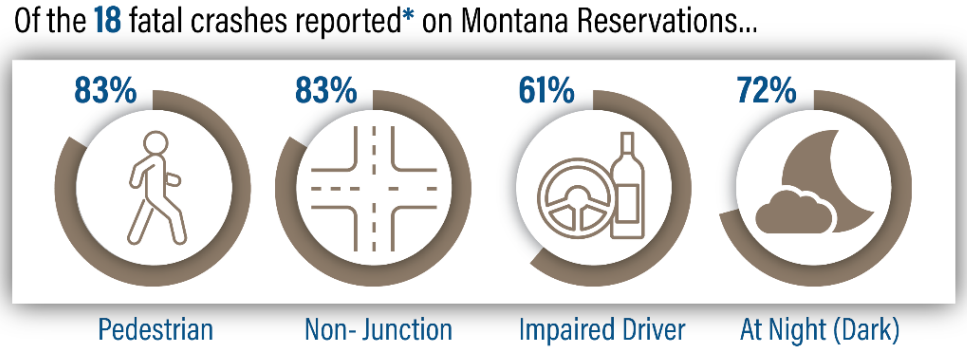


Figure 4.5 on the following page illustrates the boundaries of the seven land-based Tribal Reservations in Montana and indicates the VRU injury severity index for each. The Census tracts identified by Justice40 as being disadvantaged are also shown on the map, 8 of which overlap with the boundaries of the Blackfeet, Crow, Flathead, and Rocky Boy's. Combined, the Tribal Reservations have an injury severity index of 18.4 and a crash severity index of 18.7, which are both much higher than the statewide VRU injury and crash severity indices of 5.2 and 4.9, respectively. Approximately 21.4 percent of all fatal crashes and 23.8 percent of all fatal injuries occurred on Tribal Reservations. The higher proportion of severe injuries on Tribal Reservations contributes to these higher indices. **Figure 4.5** shows that the Crow and Rocky Boy's Reservations both had an injury severity index of 66.7, which is a result of only fatalities occurring on each (4 VRU fatalities on Crow and 1 on Rocky Boy's). No VRU-involved crashes occurred on the Fort Belknap Reservation during the five-year analysis period.

Of the 70 VRU-involved crashes reported on Montana Tribal Reservations, 18 were fatal. Historically, non-fatal crashes have been chronically underreported on Montana Tribal Reservations. Fatal crashes are regularly reported to the Coroner's Office. Therefore, fatal crash data is considered the most reliable dataset to understand crashes on Montana's Tribal Reservations. Of the 18 fatal crashes, 83 percent were pedestrian-involved crashes and 83 percent occurred at a non-junction location. About 61 percent of the crashes involved an impaired driver. Anecdotally, the overwhelming majority of these crashes involved either or both impaired drivers and VRUs. Furthermore, 72 percent of fatal VRU crashes on Tribal Reservations occurred at night when it was dark outside, both with (17 percent) and without (55 percent) street lighting.



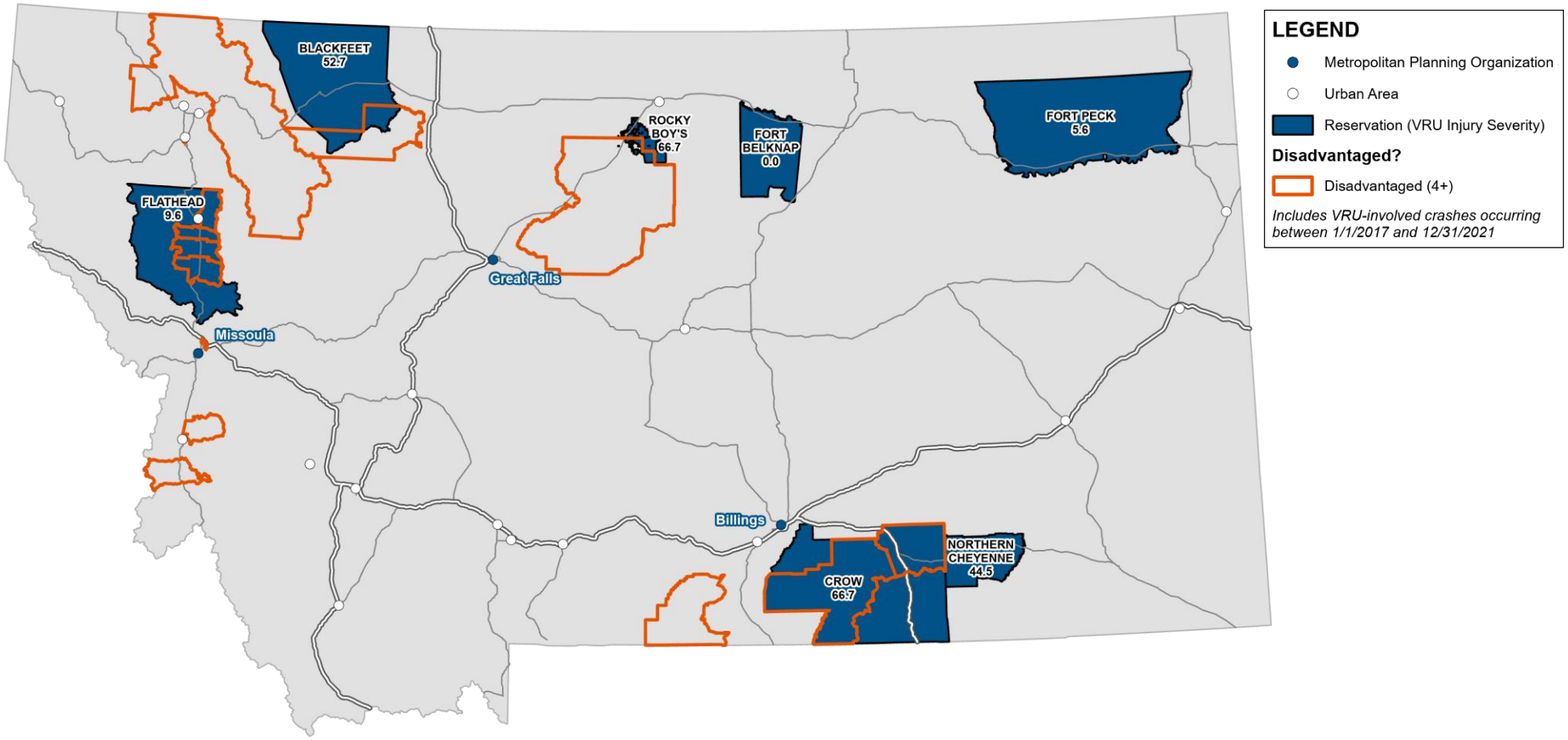


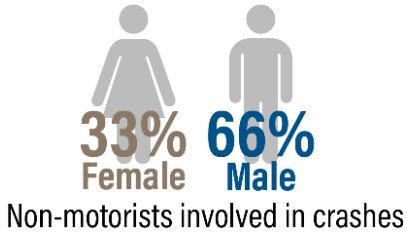
Figure 4.5: VRU Injury Severity by Tribal Reservation

4.3. Demographics of Individuals

Understanding the characteristics of individuals involved in crashes may help identify populations to focus for education campaigns or identify groups that are chronically involved in non-motorist crashes that may need special consideration during design phases. The following sections discuss the available person demographics reported in the crash data.

GENDER

Overall, about 37 percent of individuals involved in crashes were female including 33 percent of non-motorists, and 40 percent of drivers. Males accounted for 53 percent of all individuals involved in crashes, including 66 percent of non-motorists and 49 percent of drivers. For approximately 10 percent of people involved in crashes, the gender type was listed as unknown. Males also accounted for 66 percent of all non-motorist fatalities and 69 percent of non-motorist suspected serious injuries.



Non-motorists involved in crashes

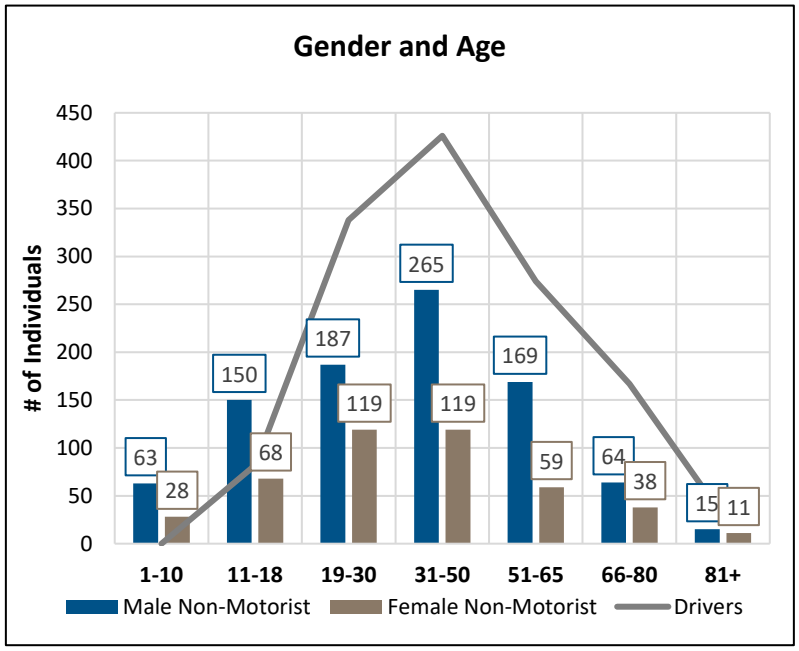
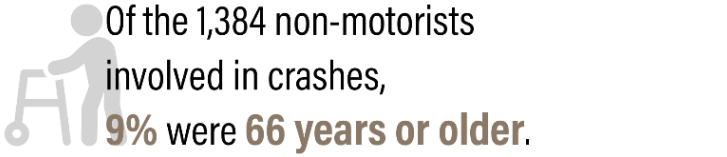


Figure 4.6: Age of Individuals Involved in Crashes

AGE

The age distribution for non-motorists involved in crashes follows a typical bell curve, as shown in **Figure 4.6**, with the highest proportion of involved individuals in the 31- to 50-year age range. About 23 percent of male non-motorists were aged 18 years and younger while only about 10 percent of female non-motorists were minors. About 14 percent of all non-motorists were under the age of 15, representing the population of individuals who typically do not have the ability to drive a vehicle for transportation. Approximately 8.6 percent of male and 10.9 percent of female non-motorists were over the age of 65.



About 51 percent of drivers involved in crashes were young- to middle-aged adults (19 – 50 years). Approximately 13 percent of drivers involved in VRU crashes were aged 66 or older and about 5 percent were aged 18 or younger. Additionally, 5 drivers were under the legal driving age of 14.5 in Montana.

RACE/ETHNICITY

Race and ethnicity data is severely underreported and often incomplete as it is based on officer observations at the scene and is not always verified. Race was only reported for about 36 percent of drivers and 41 percent of VRUs. Of those reported, about 87 percent of VRUs were identified as White, 12 percent were identified as Indian, and a combined 1 percent were identified as Asian or Black. For drivers, 92 percent were identified as White, 7 percent Indian, and a combined 1 percent were identified as Asian or Black. For VRUs who died in crashes, the race is indicated for 68 percent. Of those, 39 percent were identified as Indian and the remaining 61 percent were identified as White.

The Fatality Analysis Reporting System (FARS) is a nationwide census of data regarding fatal injuries suffered in motor vehicle traffic crashes. The FARS database obtains race information from death certificates and is considered the most reliable source of this information. For the 2017-2021 data analysis period, 27 pedestrians and 3 bicyclists killed in VRU crashes in Montana were American Indian or Alaska Native. This equates to approximately 36 percent of all fatalities in the state over the five-year period. Based on results of the 2020 Census, American Indian or Alaska Natives make up approximately 6.6 percent of the state's population. This means Native Americans are disproportionately represented in VRU fatalities.

Of the 84 non-motorists who died in crashes, **36%** were **Native American.**

Of the Native American VRU fatalities, 17 pedestrian and 2 bicyclist fatalities occurred on one of seven of the Tribal Reservations in Montana. This means that 63 percent of Native American VRU fatalities occurred on Tribal Reservations.

5.0. HIGH-RISK AREAS

Federal regulations require the state's VRU SA to identify high-risk areas for vulnerable road users. Federal guidance notes multiple data-driven safety analysis approaches may be used to identify these locations, including development of a high injury network (HIN), predictive analysis to identify locations with the greatest potential for improvement and quantify the expected safety performance of different project alternatives, and systemic safety analysis to identify high-risk roadway features that correlate with particular crash types and determine locations at risk for severe crashes even if there is not a high crash frequency at these locations. The following sections describe the methods considered for the analysis of high-risk VRU locations in Montana.

METHOD 1: MAPPING ANALYSIS

Figure 5.1 on the following page maps the fatal and suspected serious injuries that occurred throughout the state over the five-year analysis period. As shown in the map, the majority of severe injuries occurred in urban areas. For reference, severe injury densities for the three MPOs are also provided in the figure.

Since Montana is such a vast state, and the number of severe VRU injuries is relatively low in comparison to the geographic expanse, it is difficult to draw conclusions about high-risk areas for VRU-involved crashes from this type of mapping analysis. The densities in the MPO inset maps in **Figure 5.1** represent the number of severe VRU injuries in a 500-foot by 500-foot area, or the equivalent of 2 to 3 city blocks. One area in Bozeman had a concentration of 4 severe injuries and five areas in Billings, Great Falls, Missoula, and Poplar had one or more concentrations of 3 severe injuries resulting from one or multiple crashes. Each of these areas had considerably different characteristics in terms of roadway infrastructure, surrounding land uses, and crash circumstances making it difficult to draw broad conclusions about risk levels. For this reason, a high-risk analysis based on spatial mapping of past VRU crash occurrences was not pursued further.

METHOD 2: CRASH RATE ANALYSIS

Another method considered for identifying high-risk areas was to calculate crash rates along segments of the transportation network based on traffic exposure. However, due to inconsistencies in how the roadway network is segmented, crash rates were heavily influenced by the length of an individual segment rather than the number of crashes occurring on each segment in this analysis. Furthermore, basing a crash rate on traffic exposure, or vehicle miles traveled, can offset VRU-crash rates especially on high-volume roads. Vehicle traffic exposure also ignores non-motorist traffic activity and does not provide the full picture of vehicle and non-motorist interactions. For these reasons, an analysis based on crash rates was not pursued.

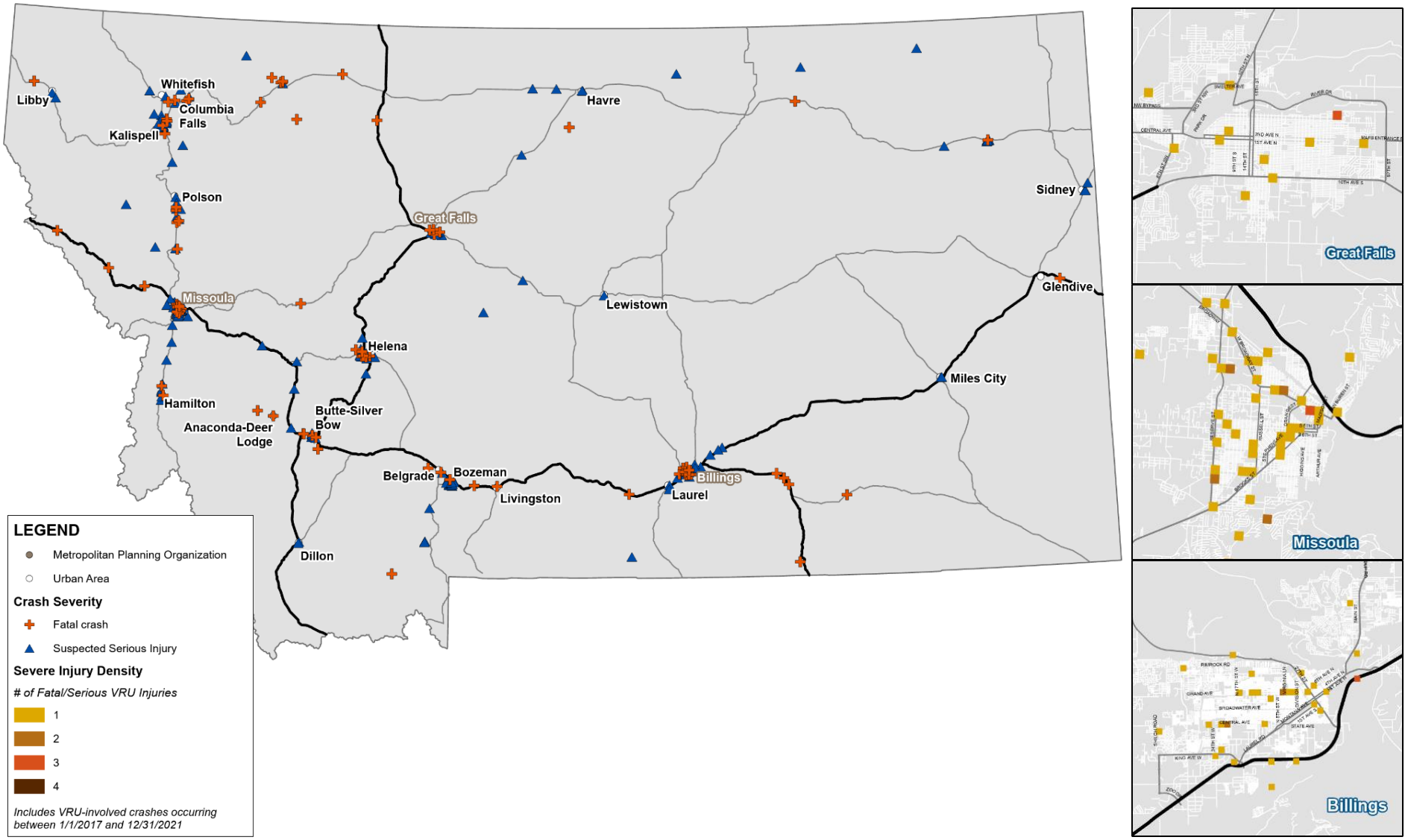


Figure 5.1: VRU Severe Injury Locations

METHOD 3: INFRASTRUCTURE INDICATORS ANALYSIS

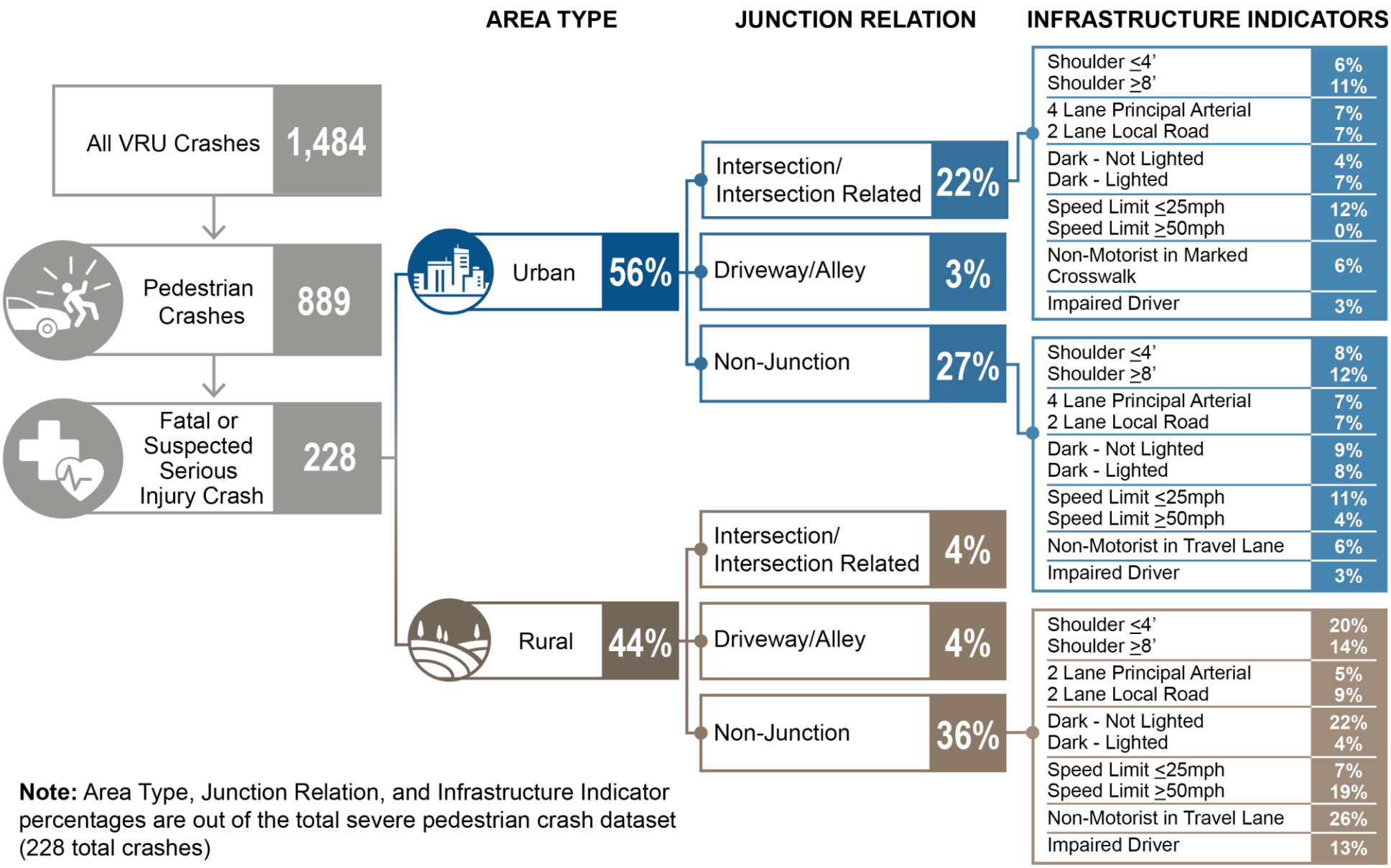
An analysis was performed to examine commonalities between the infrastructure attributes of areas where crashes have occurred. Using a systemic safety analysis approach, this analysis will help MDT define strategies addressing specific design challenges and proactively identify similar circumstances across the state where VRU-involved crashes have not occurred but may occur in the future. **Figures 5.2** and **5.3** illustrate key infrastructure indicators for severe pedestrian and bicycle crashes, respectively. These figures highlight characteristics of the roadways on which a severe crash occurred including shoulder widths, functional classification, number of lanes, speed limit, street lighting, and vehicle operator or non-motorist behaviors.

Figure 5.2 indicates 22 percent of severe pedestrian-involved crashes occurred at intersections in urban areas and 27 percent occurred at non-junction locations in urban areas. Approximately 36 percent of severe pedestrian-involved crashes occurred at rural non-junction locations. Key takeaways about pedestrian-involved crashes include the following:

- Intersection crashes in urban areas occurred at junctions of roadways with shoulders greater than or equal to 8 feet, indicating possible long crossing distances for pedestrians.
- In urban areas, crashes typically occurred on roadways with lower speed limits, whereas in rural areas crashes primarily occurred on high-speed roadways.
- Crashes occurred primarily on two-lane local roads. In urban areas, a higher percentage of crashes occurred on four-lane principal arterials, such as main streets, whereas in rural areas more crashes occurred on two-lane principal arterials, such as rural highways.
- At non-junction locations, a large percentage of pedestrians who suffered severe injuries were in the travel lane. Additionally, multiple rural non-junction crashes occurred on roadways with narrow or no shoulders indicating a lack of available space for pedestrians to walk outside the travel lane.

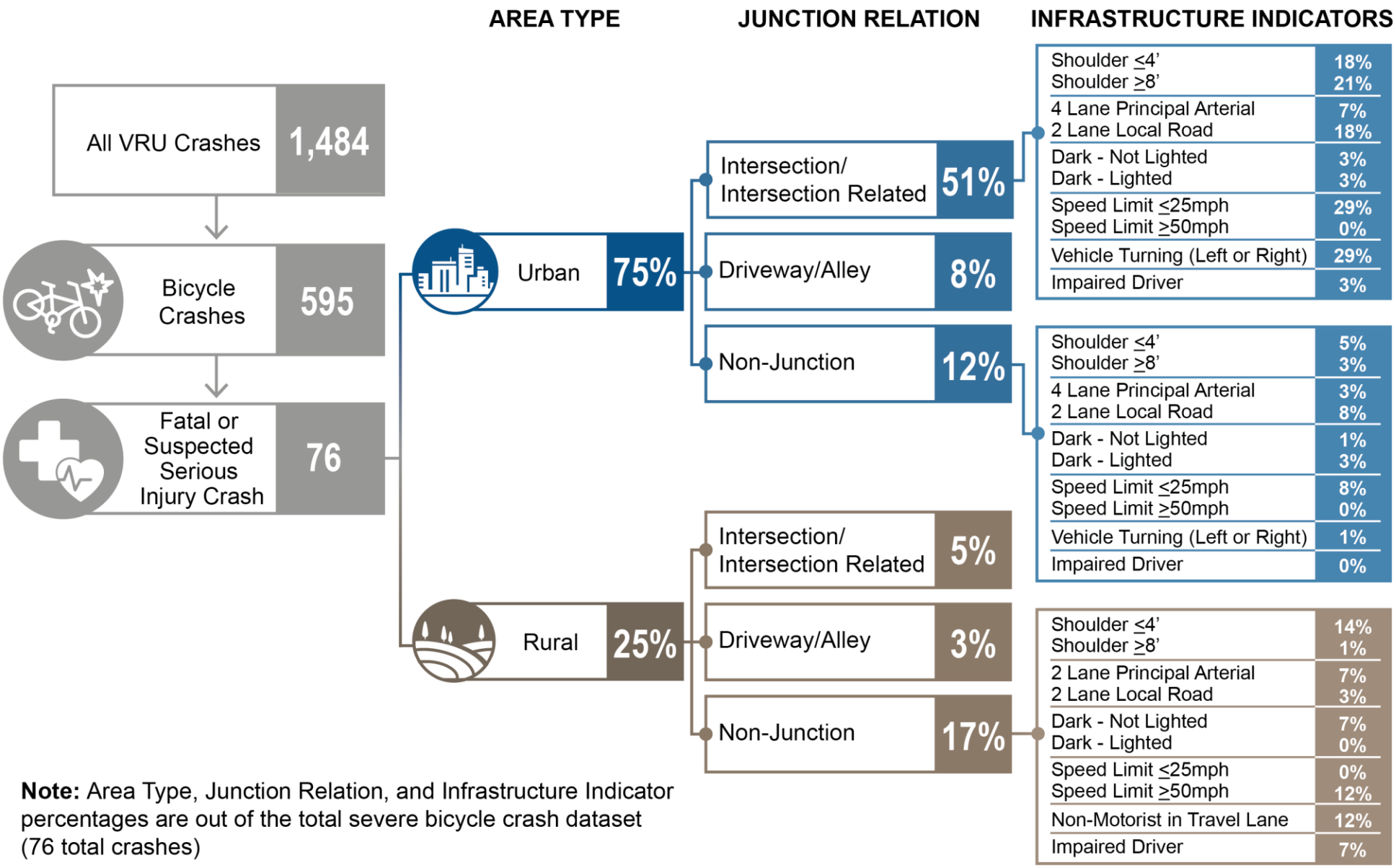
Figure 5.3 indicates 51 percent of severe bicycle-involved crashes occurred at intersections in urban areas and 12 percent occurred at non-junction locations in urban areas. Approximately 17 percent of severe bicycle crashes occurred at rural non-junction locations. Key takeaways bicycle-involved crashes include the following:

- Non-junction crashes were more likely to occur on roadways with narrow or no shoulders, indicating the bicyclist likely did not have adequate room to ride outside of the travel lane.
- In urban areas, severe bicycle-involved crashes were more likely to occur on low-speed roadways compared to crashes in rural areas, which occurred more often on higher-speed roadways. Spatially, it was observed that non-junction rural crashes typically occurred on roadways between communities rather than within rural communities.
- Street lighting was less of a factor in urban areas compared to rural areas.
- At urban intersections, bicycle-involved crashes tended to be a result of vehicles turning right or left.
- More severe bicycle-involved crashes occurred on two-lane local roads than multi-lane arterials, suggesting a possible preference to ride in roadways of this type.



Note: Area Type, Junction Relation, and Infrastructure Indicator percentages are out of the total severe pedestrian crash dataset (228 total crashes)

Figure 5.2: Infrastructure Indicators in Severe Pedestrian Crashes



Note: Area Type, Junction Relation, and Infrastructure Indicator percentages are out of the total severe bicycle crash dataset (76 total crashes)

Figure 5.3: Infrastructure Indicators in Severe Bicycle Crashes

6.0. CRASH NARRATIVE REVIEW

While analyzing and reporting the crash data contained in the previous sections, it was determined that more information was needed to understand the circumstances surrounding fatal and suspected serious injury VRU-involved crashes to determine commonalities and trends. Accordingly, the crash narratives, including descriptions from individuals involved and responding officers, were reviewed for the severe VRU-involved crashes. Based on these narratives, behavioral trends were identified. Additionally, a review of each severe injury crash location was performed using available Google Earth imagery to determine various infrastructure indicators at the scene of each crash. Some aerial imagery may be outdated, or some infrastructure conditions may have changed since the time when the crash occurred. The original crash records were systematically reviewed and updated as necessary to catalogue the information more precisely and consistently. As such, some of the information in this section may not match previously discussed trends. Furthermore, the updated information is still only as accurate as the details provided in the crash narratives, and some relevant circumstances may not have been recorded.

6.1. Flagged Crashes

Through a review of the crash narratives, it was observed that several of the crashes were correctly coded as pedestrian-involved crashes but were not reflective of individuals walking for transportation purposes. For example, some pedestrian-coded crashes involved emergency responders or individuals who had exited a disabled or crashed vehicle and were then hit by an oncoming vehicle. A total of 63 crashes were identified as involving individuals who were not involved in pedestrian transport. **Table 5.1** summarizes the number of crashes by each flagged crash type in addition to other characteristics such as resulting crash severity and location. As a result of some crashes being flagged in more than one category, there were a total of 71 flags raised during the crash narrative review. All flagged crashes were coded as pedestrian-involved crashes.

Table 6.1: Flagged Crash Types – Pedestrian Not In Transport

Flagged Crash / Type (Multiple Types)	Crash Severity		Location		On Reservation	Total
	Fatal	Serious	Urban	Rural		
Argument	2	4	1	5	3	**6**
Vehicle Backing	2	9	4	7	3	**11**
Building Occupant	2	2	3	1	0	**4**
Emergency Worker/Work Zone Flagger	1	3	1	3	1	**4**
Former Occupant of Crashed/Disabled/Other Vehicle	13	19	8	24	4	**32**
Faulty Equipment	1	0	0	1	0	**1**
Intentional (Non-Motorist or Driver)	3	2	0	5	2	**5**
Jumped from Vehicle	1	2	2	1	0	**3**
Fell in Roadway/Waving Down Vehicle	0	5	1	4	1	**5**
Total	**25**	**46**	**20**	**51**	**14**	**71**

6.2. Observed Trends Summary

Several trends were noted from the review of crash narratives. These trends appeared to be contributors to crashes and may help identify strategies to address VRU-involved crashes. The trends are summarized in the following sections based on whether they were related to only non-motorists or only drivers, respectively, or whether they were applicable to both person types. These summaries are qualitative only and no attempt was made to quantify the occurrence of such circumstances.

NON-MOTORISTS ONLY

- Several pedestrians were hit while crossing an unmarked, mid-block location within a roadway. Often, these pedestrians were cited with jaywalking. In many instances, there was a nearby intersection with marked crosswalks, according to a review of recent aerials.
- Many non-motorists involved in crashes during the night were wearing dark clothing with no reflective gear or personal lighting.
- Several non-motorists were observed to be in the roadway improperly at the time of the crash. This includes pedestrians, especially impaired individuals, walking in the travel lane. These instances primarily occurred in rural non-junction settings where other pedestrian facilities were unavailable, although in some cases an adjacent sidewalk was available but not used. A few disabled individuals using wheelchairs were also hit while riding in the roadway, despite an adjacent sidewalk being available. In these cases, the pedestrian cited poor sidewalk maintenance or lack of traversable curb ramps as reasons for riding in the roadway.
- Some pedestrians were hit while in marked crosswalks, however, in some cases it was noted that the pedestrian failed to wait for the pedestrian signal to be activated before entering the crosswalk. Similarly, some bicyclists failed to stop at a stop sign before proceeding through the intersection.
- Many bicyclists involved in crashes were riding on the sidewalk and did not slow down or yield before entering intersections and crosswalks. In a handful of instances, bicyclists were riding in marked bike lanes but were riding against traffic rather than with traffic when they were hit.
- Several pedestrians were noted as darting or dashing across a street prior to a collision. In these cases, it appeared that the pedestrians either did not look for oncoming traffic, misjudged the gaps between vehicles, or were attempting to beat an oncoming vehicle. Several children were hit as a result of darting into the travel path of a vehicle.
- A few crashes involving a pedestrian darting into traffic or standing in a roadway travel lane were flagged as intentional crashes and were assumed to be suicide attempts based on evidence at the scene. Additionally, several pedestrians were identified as having been diagnosed or treated for mental health, dementia, or other medical conditions affecting decision making.

DRIVERS ONLY

- Several flagged crashes involved a vehicle backing and hitting a pedestrian who was behind the vehicle. In some cases, the injured pedestrian was known to the driver and contact between the driver and pedestrian occurred just prior to the crash. Most drivers noted that they either did not look before backing up or that they could not see the pedestrian behind them.
- Some drivers were speeding at the time of the crash and either did not have enough time to react to a pedestrian or bicyclist in the roadway or lost control of the vehicle and hit a nearby non-motorist. This was also true of bicyclists riding too fast and not being able to stop before a collision. In a couple of instances, a driver lost control of the vehicle and crashed through a building, injuring a building occupant, which was coded as a pedestrian crash.

- In some crashes, the driver cited obstructed views as a contributor in the crash. This included pedestrians emerging into the roadway from between multiple vehicles as well as glare from the sun or oncoming headlights.
- Some crashes involved a driver failing to yield to a pedestrian in a crosswalk. Often these crashes occurred when turning vehicles did not yield to a pedestrian crossing on the street that the vehicle was turning onto. There were several instances of turning vehicles taking a shallow turning path and clipping a bicyclist who was waiting at an intersection. Additionally, there were instances on multi-lane roadways where some vehicles had stopped to yield to a pedestrian and an approaching vehicle swerved around the stopped cars and hit the crossing pedestrian.
- In a few instances, a bicyclist was hit due to a driver failing to give enough room to the cyclist when passing.

NON-MOTORISTS & DRIVERS

- Many of the severe injury non-motorist-involved crashes involved impairment by either the non-motorist, driver, or both. Impaired crashes were especially prevalent in rural areas and on Tribal Reservations. Nearly all impaired VRUs involved in crashes were pedestrians.
- Some VRUs and drivers involved in crashes admitted to being distracted at the time of the crash, including headphone/device usage and reaching for an object inside a vehicle.
- Environmental factors were contributors in several VRU crashes including dark lighting conditions with no or poor street lighting, poor weather conditions, and other visibility issues mentioned previously.
- Of the children who were involved in severe VRU crashes, many were left unattended. These crashes involved children darting into a street or running after a vehicle, standing behind a vehicle, or playing in a vehicle and accidentally shifting it into motion.
- Faulty vehicles or equipment were cited by some drivers and non-motorists involved in crashes, however, investigators rarely found these accusations to be true for vehicles. Several bicyclists cited poor or absent brakes.
- Several pedestrian-involved crashes were a result of an argument or displays of aggression, especially between known parties. In some cases, one party was outside the vehicle while the argument was taking place and the driver of the vehicle either intentionally or haphazardly put the car into motion, hitting the other person involved in the argument. In an extreme case, a driver intentionally ran off the road and hit a pedestrian on two separate instances and was later apprehended. Other reports of disputes between drivers and pedestrians turning violent and ending in a collision were also noted.
- Based on aerial reviews, several of the crashes occurred around parks, schools, bus stops, and recreation sites. A couple of crashes also involved transient individuals with at least one crash occurring outside of a food bank.

6.3. Infrastructure Indicators

For only the fatal and suspected serious injury VRU-involved crashes, a detailed review of infrastructure characteristics was conducted using aerial imagery and MDT GIS databases. The following analysis is based on information reviewed in the spring of 2023, recognizing that available aerial imagery may not fully match the conditions that were present at the time of a crash that occurred during the 2017 to 2021 period. Furthermore, in some instances aerial imagery was poor or unavailable. Various infrastructure details were catalogued according to observed conditions and the detailed crash narratives. These details may differ slightly compared to the analyses provided in previous chapters which relied solely on the information contained in the simplified crash records. All fatal and suspected serious injury VRU-involved crashes were included in the analysis, including those that were flagged (see **Section 6.1**).

JUNCTION CHARACTERISTICS

Approximately 35 percent of the severe VRU-involved crashes occurred at intersections or were intersection related. About 9 percent occurred at a driveway or alley while 54 percent occurred at non-junction locations. The intersections at which crashes occurred were primarily two-way stop controlled (51 percent) but were also often controlled by traffic signals (32 percent). About 7 percent of crashes occurred at an uncontrolled intersection. About 88 percent of crashes that occurred at a signalized intersection caused suspected serious injuries while 12 percent resulted in fatalities. Nearly all (86 percent) of crashes that occurred at driveways, either residential driveways or commercial access points, did not have any form of traffic control device. About 4 percent of severe crashes occurred at a skewed intersection and another 4 percent occurred at offset intersections; about 88 percent of these intersections were in urban areas. Overall, intersection crashes occurred primarily in an urban setting (90 percent) and involved a pedestrian (60 percent).

Non-junction crashes occurred more often in rural settings (58 percent) and involved primarily pedestrians (87 percent). Of all the VRU-involved fatal and severe injury crashes that occurred on Tribal Reservations, 78 percent occurred at a non-junction location. Approximately 74 percent of fatal crashes and 46 percent of suspected serious injury crashes occurred at non-junction locations.

ROADWAY CHARACTERISTICS

About 33 percent of severe VRU-involved crashes occurred on principal arterials while 26 percent occurred on local streets. Of the principal arterials where crashes occurred, 43 percent were undivided, 41 percent had a center two-way left-turn lane, and 17 percent had a concrete median or other physical divider. About 67 percent of principal arterials where crashes occurred had four lanes, and about 29 percent had two lanes. Almost all (90 percent) of local roads where crashes occurred were undivided and had two lanes. The majority of routes where crashes occurred were two-way streets; about 7 percent of roadways were one-way roadways.

About one-third of crashes occurred on roadways with a speed limit of 25 mph, including a mixture of local, collector, and arterial roadways. About 25 percent of crashes occurred on roadways with a 35 mph speed limit, of which about 41 percent were principal arterials. About 15 percent of severe VRU-involved crashes occurred on arterials and interstates with a speed limit of 65 mph or greater.

Nearly 29 percent of roadways where VRU-involved crashes occurred had no shoulder, including 21 percent of principal arterials and 42 percent of local roads. About 47 percent of principal arterials had 8-foot shoulders. Overall, 47 percent of roadways had shoulders of 4 feet or less while 39 percent had shoulders greater than or equal to 8 feet.

NON-MOTORIST FACILITY CHARACTERISTICS

At locations where a bicycle crash occurred, 36 percent of roadways had marked bicycle facilities including bike lanes, sharrows, or a separated path. In 4 percent of bicycle crashes, the bicycle facility ended (or started) at the location where the crash occurred. About 13 percent of bicyclists were riding on the sidewalk at the time of the crash, and in 60 percent of those crashes there was an on-street bicycle facility available.

At locations where a pedestrian-involved crash occurred, there was a sidewalk or separated path available 55 percent of the time, a crosswalk available 20 percent of the time, and a pedestrian signal about 7 percent of the time. In about 25 percent of locations where a crosswalk was available, the pedestrian crossed at a midblock location without a crosswalk. In about 13 percent of locations where a sidewalk was available, the pedestrian was walking in the roadway. In 75 percent of crashes when the pedestrian was walking in the roadway, there were no pedestrian facilities available. In about 10 percent of pedestrian-involved crashes the pedestrian was walking or standing in the roadway shoulder.

7.0. SUMMARY

This *Baseline Safety Analysis Summary* for the VRU SA identifies VRU safety problems within Montana through a data-driven analysis of historic VRU-involved crash data over the five-year period from January 1, 2017, to December 31, 2021. This analysis helps identify contributing factors in VRU fatalities and serious injuries including demographics, roadway characteristics, and behavioral trends to determine commonalities that put a location type or individual at a higher risk of being involved in a VRU crash.

Initial sections of this report summarize data from crash reports submitted to the MHP from their patrol officers and from local city, county, tribal, and federal law enforcement officials. The information from the crash reports is conveyed as recorded in the report, with no attempts to correct or modify the data. Separately, VRU-involved crash narratives for fatal and suspected serious injury crashes were reviewed to understand contributing circumstances in severe crashes and identify underlying trends. This effort included a review of the spatial relationship between crashes and their location as well as an analysis of road characteristics that may not be otherwise available in the simplified crash records. This analysis is contained in **Chapter 6**.

All of the analyses contained in this report will assist MDT in identifying projects or strategies to focus on the most high-risk pedestrian and bicycle safety issues. Findings will also help MDT tailor any potential strategies to specific areas and contextual situations. A summary of generalized takeaways from the baseline safety analysis is provided below.

- In general, pedestrian crashes were more common than bicycle crashes, and both crash types were more common in urban areas. A disproportionate number of VRU-involved crashes, especially severe crashes, occurred on Montana's Tribal Reservations. Native Americans were disproportionately represented in the fatal crash dataset, especially for pedestrian crashes.
- In urban areas, VRU-involved crashes at intersections were more common, while crashes at non-junction locations were more common in rural areas.
- Crashes in urban areas involving a VRU commonly occurred on two-lane, undivided, low-speed local roadways or on multi-lane principal arterials with two-way left-turn lanes and lower speed limits. In rural areas, crashes commonly occurred on local roadways, but were also common on high-speed, two-lane arterials.
- Many crashes occurred where there were no pedestrian or bicycle facilities available, especially in rural areas. However, when there were facilities available, they were not always used by non-motorists due in part to maintenance issues, accessibility issues, convenience, or general comfort level of the non-motorist. Many non-motorists chose to cross at mid-block locations, even if there was an adjacent crosswalk available.
- Drivers were often unaware of the pedestrian or bicyclist either because they were difficult to see, they did not expect a non-motorist, the non-motorist was in an improper position, or they failed to look for and yield to non-motorists.
- Many VRU-involved crashes occur at night when it is difficult to see individuals in the roadway. Street lighting and high visibility clothing or equipment can help drivers see non-motorists.
- Impairment puts drivers and non-motorists at a higher risk of being involved in a VRU crash.
- Pedestrians not in transport were involved in multiple VRU crashes, including former occupants of motor vehicles standing in the roadway, emergency service/work zone situations, building occupants, and other unusual circumstances.