CONNECTICUT

VRU SA

VULNERABLE ROAD USER SAFETY ASSESSMENT

2022-2026

CONNECTICUT
ROAD TO SAVING LIVES

CONNECTICUT DEPARTMENT OF TRANSPORTATION

Table of Contents

Letter from the Commissioner

Bluebeam:

- Insert Letter
- Delete Cover Page on next Page

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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 concern, the Infrastructure Investment and Job Act (IIJA), enacted on November 15, 2021, implemented regulations that require all states to develop a VRU 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 safe and efficient transportation access for all roadway users.

A pedestrian crosses the intersection of Summer Street and Hoyt Street, Stamford, Connecticut.

The VRU SA was developed by the Connecticut Department of Transportation (CTDOT) Traffic Engineering – Safety Unit. The purpose of this document is to identify VRU safety concerns within Connecticut by conducting a data-driven analysis using historic VRU involved crash data and other relevant information to help the CTDOT understand the contributing factors in VRU fatal and serious injury crashes. 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 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 to identify higher-risk areas for VRU 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 fatalities and suspected serious injuries 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 SA enables CTDOT 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 Connecticut'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 CTDOT's relevant policies, goals, and statewide plans to make sure the VRU SA aligns with and reflects CTDOT'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 Connecticut. Table 1.1 summarizes each document as it relates to VRU safety or VRU-specific infrastructure.

Table 1.1: Previous Efforts Related to VRU SA

Plans and Programs	Year
Highway Safety Improvement Program (HSIP) Implementation Plan	2020 / Annual
COGs Unified Planning Work Program (UPWP)	2020 / Annual
Statewide Transportation Improvement Program (STIP)	2021
Comprehensive Pedestrian Safety Strategy	2021
Regional Transportation Safety Plan (RTSP)	2021
Strategic Highways Safety Plan (SHSP)	2022
Transportation Rural Improvement Program (TRIP)	2022
Complete Streets Controlling Design Criteria	2023

1.4 Stakeholder Engagement

As part of the VRU SA, CTDOT engaged stakeholders through meetings with all nine of the State's councils of government, representatives of local governments, Tribal agencies, and advocacy groups, including Connecticut's Bicycle and Pedestrian Advisory Board. During the initial meetings, CTDOT unveiled the VRU topic that would become the focal point of future meetings. This initial encounter served as the genesis, where stakeholders were familiarized with the objectives and the data associated with VRUs, and the challenges and limitations faced throughout collecting key strategies. The stakeholders were given an opportunity to reflect on what was discussed at the conclusion of the introductory meeting. The second meeting took place a month later, providing for collaborative discussion that not only showcased various approaches and insights to mitigate fatal and serious injury VRU crashes, but several of the discussed strategies were ultimately incorporated into the Key Strategies list illustrated in Section 7.0.

2.0 Crash Records

For this effort, CTDOT's Division of Traffic Engineering – Safety Engineering unit provided crash data for the five-year period from January 1, 2018, to December 31, 2022. The data included all VRU crashes occurring within Connecticut over the five-year analysis period. This information includes data from crash reports submitted to the Connecticut State Police from their officers and from local city, tribal, and federal law enforcement officials. The crash reports are a summation of information collected 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, typically 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 crashes within Connecticut to identify trends and contributing factors in these crashes so that CTDOT, in coordination with local stakeholders, can address these concerns and improve VRU safety on all roadways within the state.

2.1 CCRSMS VRU Analysis Tool

To automate the process of VRU SA, a research team from the Connecticut Transportation Institute (CTI) at the University of Connecticut (UConn) partnered with the CTDOT to develop an analysis tool incorporating the safe system approach as part of the VRU SA. The VRU analysis tool incorporates three major modules: network screening, diagnosis, and countermeasure selection. The Network Screening module allows CTDOT to automatically identify locations that are associated with higher risk for VRUs. The diagnosis module helps CTDOT investigate the temporal and spatial patterns of VRU safety, including but not limited to roadway functional classification, posted speed, weather and roadway conditions, time of day, etc. The diagnosis module also incorporates demographics and socioeconomics, including race, ethnicity, income, and age to account for equity of VRUs. The Countermeasure Selection module assists the user in identifying countermeasures that may be appropriate for the crash experience, based on a comprehensive literature review. The module assists CTDOT in identifying and implementing cost-effective solutions to improve safety for all VRUs.

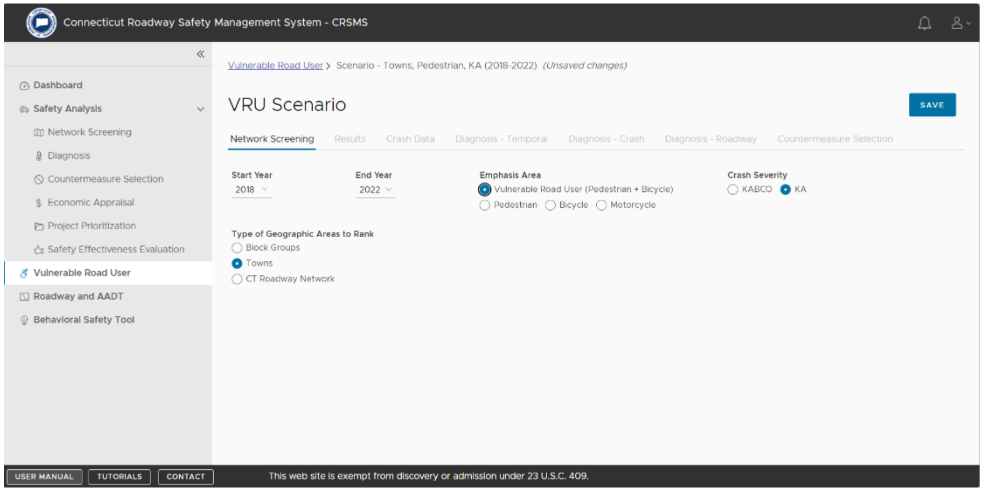
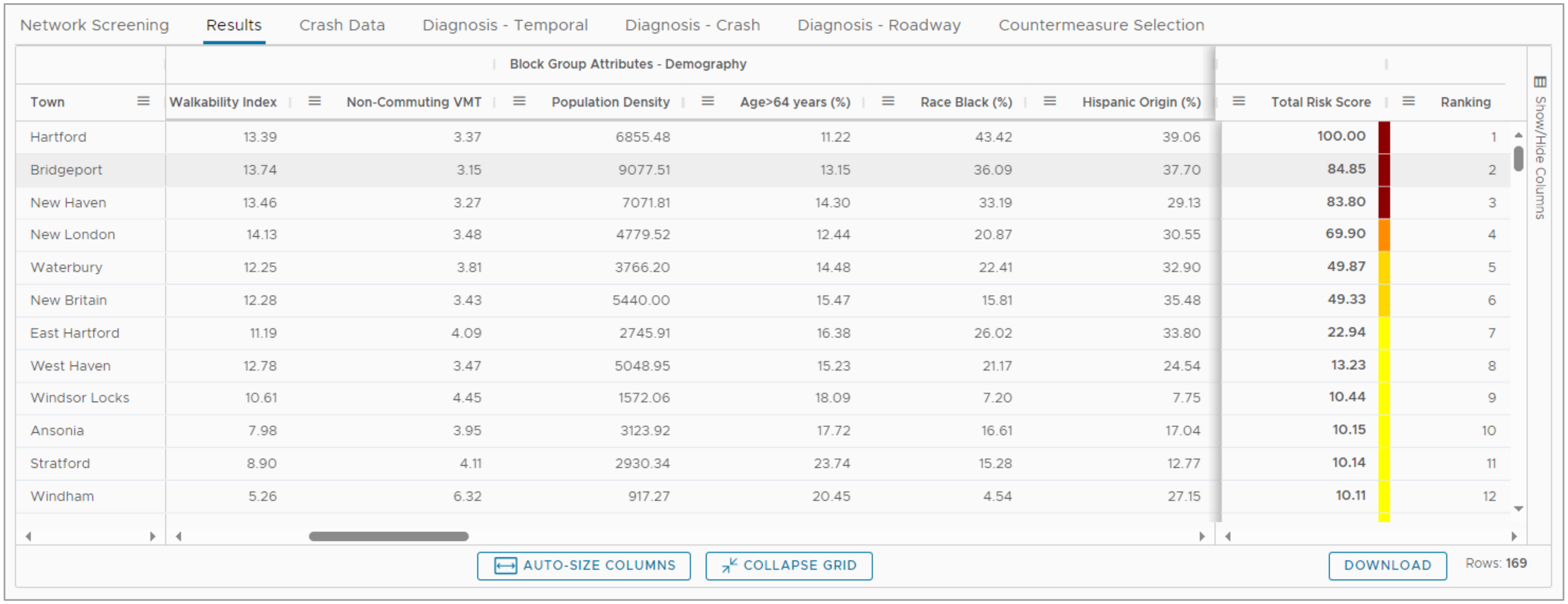


Figure 2.1: CRSMS VRU Network Screening Input



Network Screening | Results | Crash Data | Diagnosis - Temporal | Diagnosis - Crash | Diagnosis - Roadway | Countermeasure Selection

	Block Group Attributes - Demography							
Town	Walkability Index	Non-Commuting VMT	Population Density	Age>64 years (%)	Race Black (%)	Hispanic Origin (%)	Total Risk Score	Ranking
Hartford	13.39	3.37	6855.48	11.22	43.42	39.06	100.00	1
Bridgeport	13.74	3.15	9077.51	13.15	36.09	37.70	84.85	2
New Haven	13.46	3.27	7071.81	14.30	33.19	29.13	83.80	3
New London	14.13	3.48	4779.52	12.44	20.87	30.55	69.90	4
Waterbury	12.25	3.81	3766.20	14.48	22.41	32.90	49.87	5
New Britain	12.28	3.43	5440.00	15.47	15.81	35.48	49.33	6
East Hartford	11.19	4.09	2745.91	16.38	26.02	33.80	22.94	7
West Haven	12.78	3.47	5048.95	15.23	21.17	24.54	13.23	8
Windsor Locks	10.61	4.45	1572.06	18.09	7.20	7.75	10.44	9
Ansonia	7.98	3.95	3123.92	17.72	16.61	17.04	10.15	10
Stratford	8.90	4.11	2930.34	23.74	15.28	12.77	10.14	11
Windham	5.26	6.32	917.27	20.45	4.54	27.15	10.11	12

Figure 2.2: CRSMS VRU Network Screening Results Output

2.2 Challenges and Limitations

Several limitations exist when analyzing bicyclist and pedestrian crashes that creates challenges for the traditional safety analysis approach. Some of these are highlighted below:

- **Frequency of Crashes:** Bicyclist and pedestrian crashes are less frequent than other classifications of traffic incidents. 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 corridors or locations.

Currently, CTDOT does not collect statewide non-motorist usage data, although some Connecticut localities have begun implementing jurisdiction-wide count programs.

- **Underreported Data:** Traditionally, crashes involving pedestrians and bicyclists have been underreported, especially if no immediately apparent 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 crash report will have "unknown" listed or a field left blank. Without this information, it may be difficult to capture a complete record of what happened before, during, and after a crash event.
- **Inconsistent Data:** Inconsistencies in reporting, either by the reporting officer or by the individual entering data into the database, can 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 the cause of the collision. However, since it would be time prohibitive to review narratives for the nearly 8,000 VRU crashes that occurred in Connecticut over the past five years, the data analysis in this report focuses on the data contained in simplified crash record fields. For fatal and suspected serious injury crashes, the detailed narratives were reviewed to understand contributing circumstances to further identify underlying trends. Separate from the global dataset of all VRU crashes, efforts were made to update fatal and serious injury crash records for consistency. The effort included a spatial review of the crashes and the location stated in the report, 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

During the five-year analysis period from January 1, 2018, to December 31, 2022, there were 7,851 reported crashes in Connecticut involving VRUs. This section provides an overview of crash details and associated characteristics for these VRU incidents that took place within Connecticut during the analysis period.

It is important to note that the characteristics presented in this section are based on the information provided by responding officers, and no attempts have been made to rectify discrepancies or complete missing information.

3.1 Severity

Crash severity is categorized based on the most severe injury resulting from the incident. For Example, if a crash leads to both a possible and a suspected serious injury, it is categorized as a suspected serious injury crash. In this context, a suspected serious injury is defined as an observed injury, excluding fatalities, that would impede the injured person from walking, driving, or resuming their usual activities as before the injury occurred. The term “suspected” signifies that the officer’s assessment at the crash scene serves as the basis, without subsequent confirmation of the nature of the injury.

Over the course of the five-year analysis period, there were a total of 7,851 crashes involving 7,956 non-motorists. During the same period, there were a total of 1,344 crashes with a crash severity of fatal (K) or serious injury (A) involving 1,432 non-motorists. Among these incidents, roughly 77% resulted in fatal and serious injuries, while approximately 22% were fatal. Specifically, there were 299 fatal crashes with 326 non-motorists involved, and 1,069 suspected serious injury crashes. It's worth noting that, as mentioned previously, VRU crashes may exhibit a higher proportion of fatal and serious injury outcomes due to potential underreporting of non-injury crashes. Approximately 14.1% of VRU crashes were reported as either causing property damage only (PDO) or of unknown severity.

To assess the severity of crashes across various characteristics, a severity index was computed by assigning weightings based on the number of crashes or injuries within specific regions or linked to particular crash features. These weighting factors were established by CTDOT's Division of Traffic Engineering Unit, using typical crash costs applicable to Connecticut. The severity index can be calculated on an individual or crash level and serves as a tool for comparing the severity of crashes

BY THE NUMBERS

2018–2022

Total Fatalities

275 Pedestrian

24 Bicyclist

Total Serious Injuries

847 Pedestrian

198 Bicyclist

Highlights:

- **74% and 60% of pedestrian fatalities and serious injuries do not occur at intersections, respectively.**
- **Pedestrian fatalities and serious injuries are most likely to occur along locally owned roads and have a high incidence of aggressive driving (26%).**

SHSP Performance Objective:

- **Reduce the five-year rolling average of pedestrian fatalities and serious injuries to less than 263 by 2026.**

within specific geographic areas or associated with specific characteristics. There is no predefined threshold for determining abnormal or extreme severity. The equation utilized for computing the severity index for the purposes of this report is provided below.

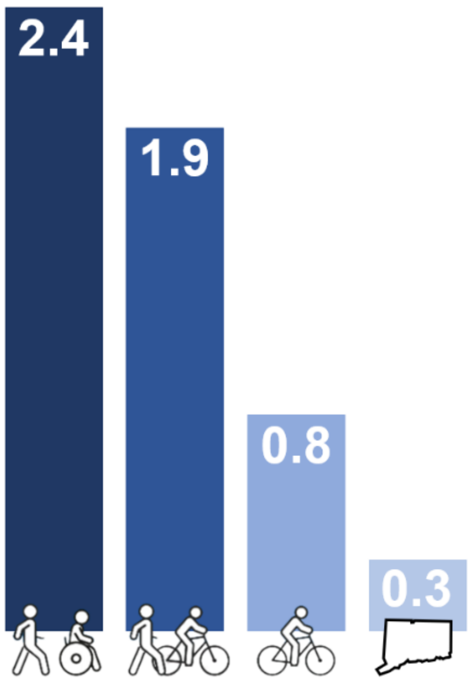
$$\boldsymbol{Severity\ Index} = \frac{(\mathbf{66.7} \times \boldsymbol{Fatal}) + (\mathbf{3.53} \times \boldsymbol{Serious\ Injury}) + (\mathbf{1.29} \times \boldsymbol{Minor\ Injury}) + (\mathbf{0.73} \times \boldsymbol{Possible\ Injury}) + (\mathbf{0.12} \times (\boldsymbol{PDO} + \boldsymbol{Unknown}))}{\boldsymbol{Total\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

The crash severity index for pedestrian-involved crashes was 2.4, and it was 0.8 for bicyclist-involved crashes. When considering all VRU crashes, including both pedestrians and bicyclists, the collective crash severity index reached 1.9.

In comparison to the broader dataset of 484,355 crashes in Connecticut spanning from 2018 to 2022, the overall crash severity index stood at 0.3. These findings emphasize that reported VRU crashes tend to exhibit substantially higher severity levels than the average crash in Connecticut.

According to the US Census Bureau, urban areas are defined as regions with a population of at least 5,000 people or at least 2,000 housing units. Consequently, the US Census Bureau recognizes 17 urban areas in Connecticut shown in Figure 3.1 All 17 Census-designated urban areas were taken into consideration during the development of the VRU SA. Figure 3.2 presents the VRU fatal crashes depicted in the municipality where the crash occurred. Comparing Figures 3.1 and 3.2, urban areas exhibit higher numbers of fatal VRU crashes.

Under 23 U.S.C. 148(l)(4)(B), states must engage in consultations with local governments, Metropolitan Planning Organizations (MPOs), Tribal agencies, and advocacy groups that represent underserved communities during the development of the VRU SA. In line with this requirement, specific emphasis was placed on Connecticut's MPOs and Tribal Reservations. The classification of MPOs by the US Census Bureau is based on a population threshold of 50,000. Connecticut hosts nine Councils of Governments (COGs); Capitol Region, Metropolitan, Lower CT River Valley, Naugatuck Valley, Northeastern, Northwest Hills, South Central Regional, Southeastern, and Western. Furthermore, Connecticut is home to two federal land-based Tribal Reservations, including the Mashantucket Pequot and Mohegan.



Non-Motorist Crash Severity Index

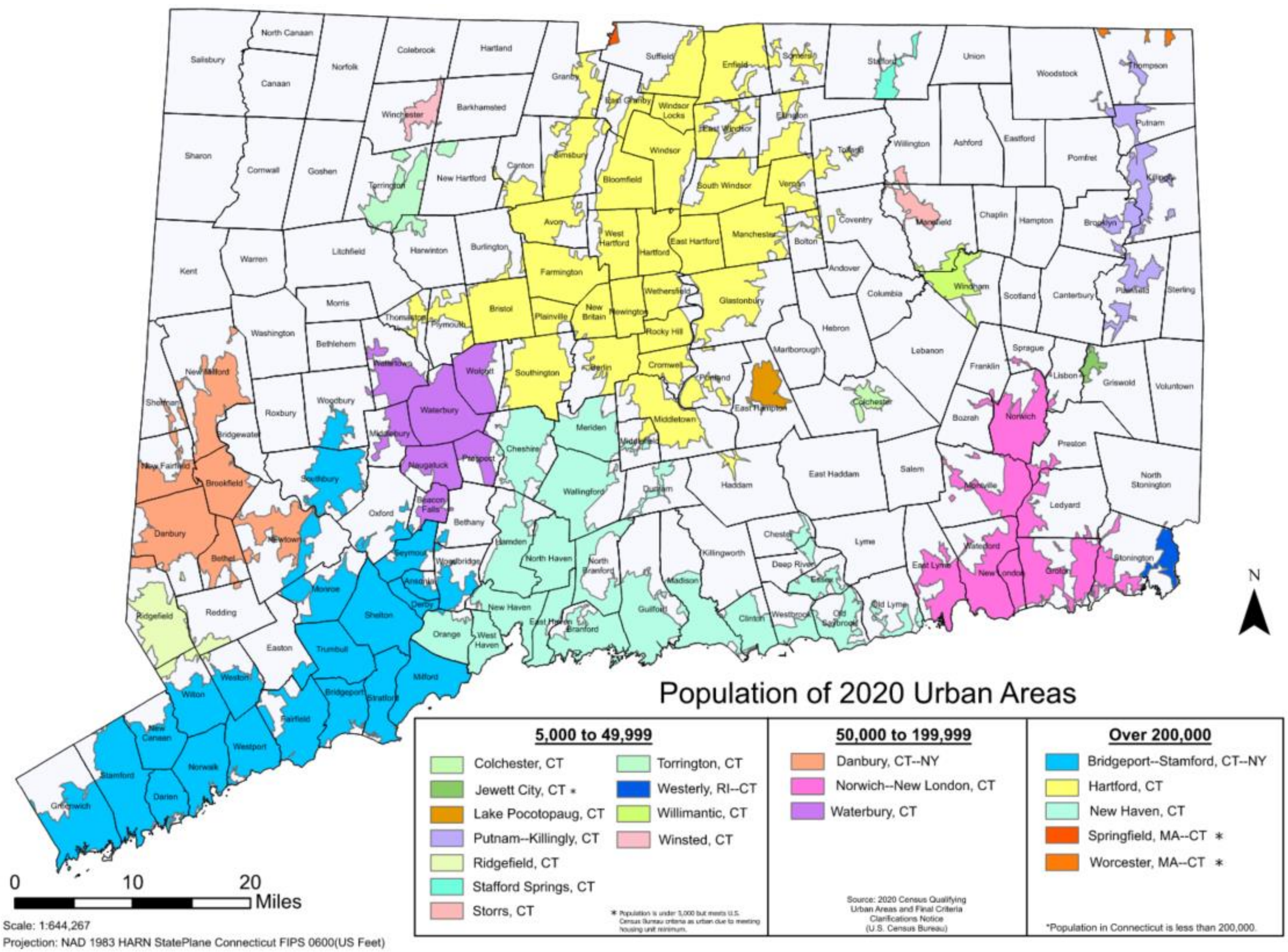


Figure 3.1: 2020 Connecticut Urbanized Areas

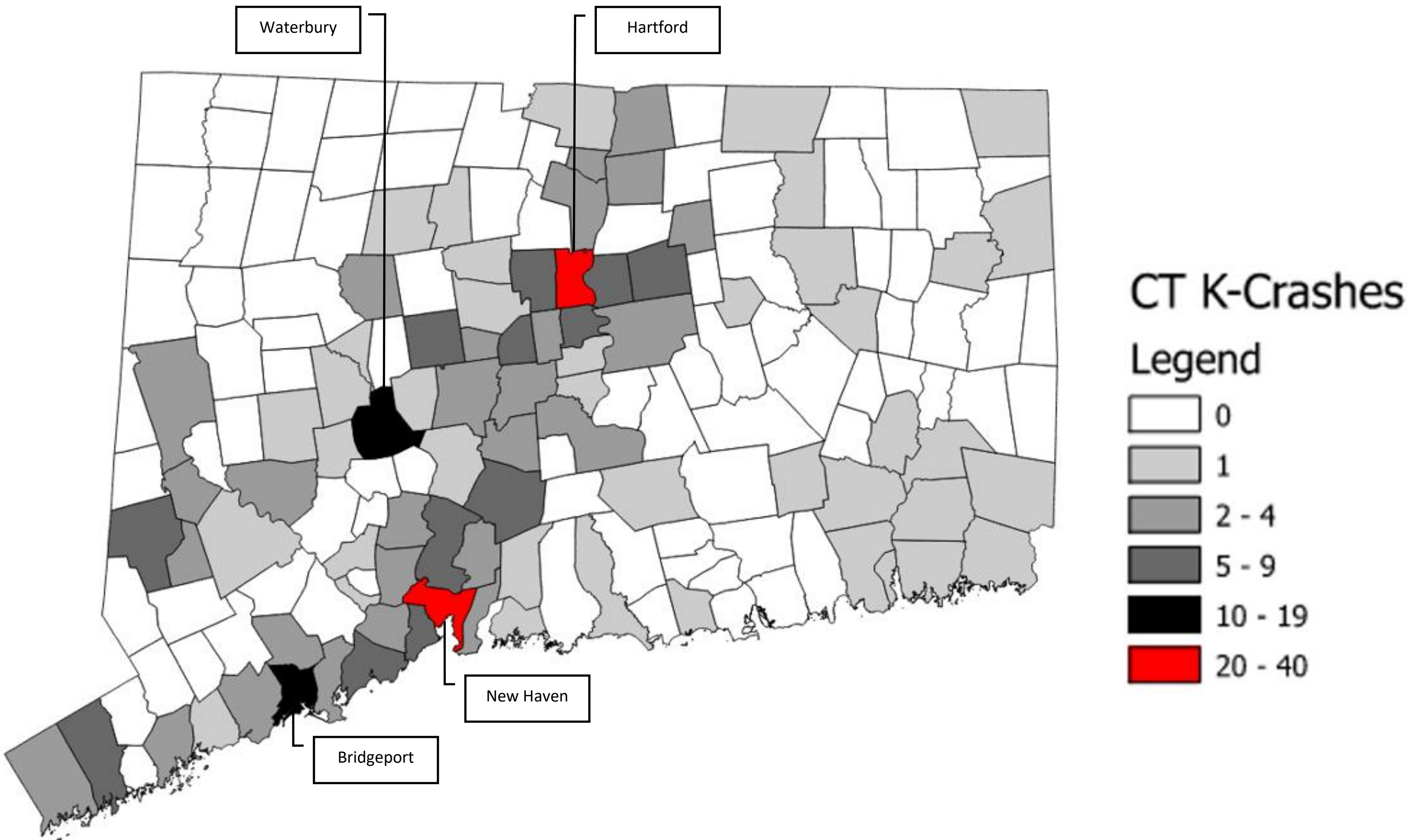


Figure 3.2: VRU Fatal Crashes Per Municipality

3.2 Crash Period

The crash data was analyzed with a focus on the temporal breakdown of each crash as outlined in the ensuing sections. This analysis serves the dual purpose of reviewing trends, including day of the week, month, and hour of the day, while also facilitating year-to-year comparisons.

YEAR

Figure 3.3 depicts the annual statistics for pedestrian and bicycle involved fatal and serious injury crashes. Overall, the number of crashes involving VRUs has shown an overall upward trend from 2018 to 2022. Bicycle and pedestrian fatalities have fluctuated from 57 to 70 fatalities per year between 2018 and 2021, with bicycle fatalities contributing to nine or fewer cases per year throughout the analysis period. The count of pedestrians sustaining serious injuries decreased from 2018 to 2020, then began to rise through 2022. Meanwhile, the total number of bicyclists with serious injuries remained fairly consistent over the 5-year period.

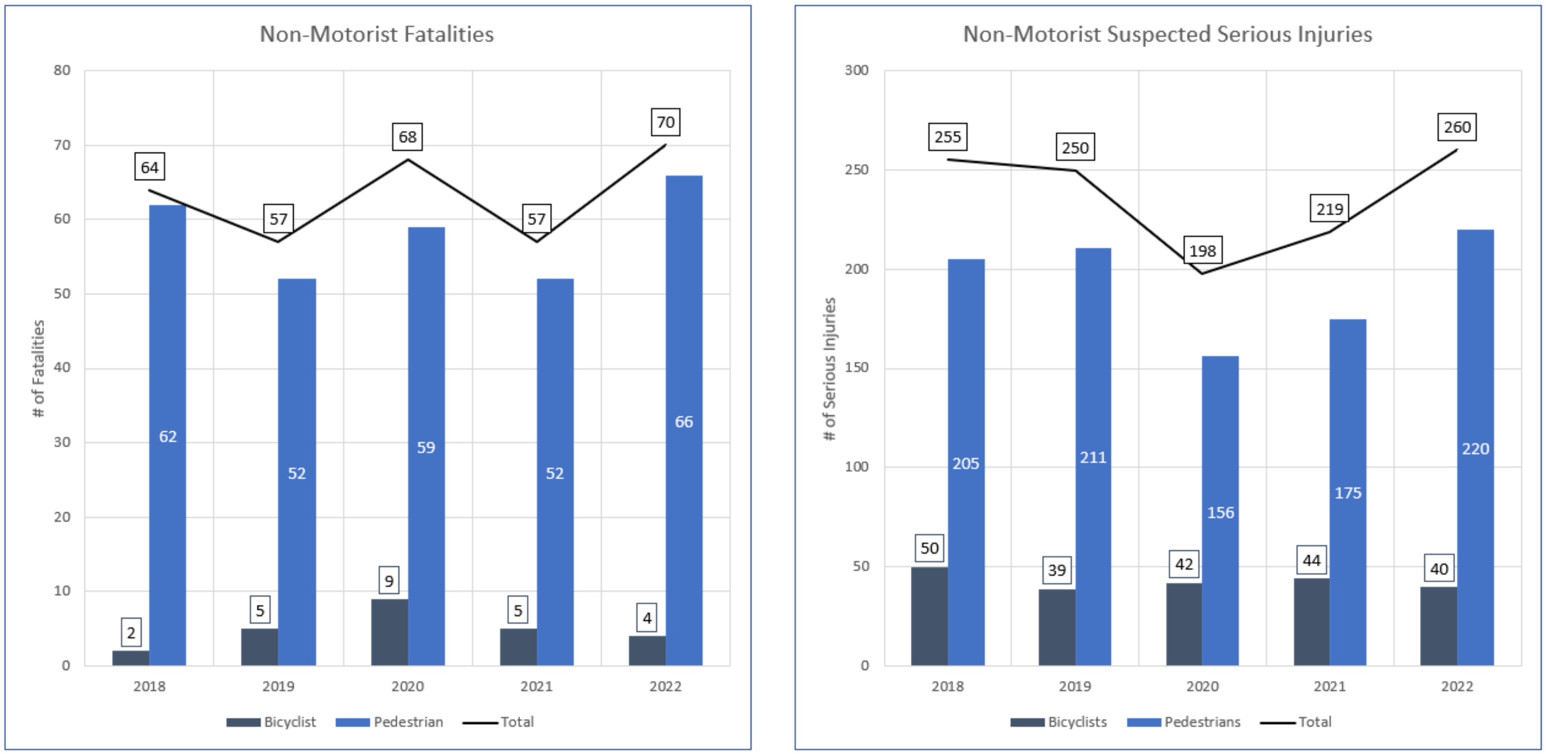


Figure 3.3: Non-Motorist Fatal and Serious Injury Crashes by Year

MONTH

Figure 3.4 depicts the breakdown of reported non-motorist-involved crashes based on the month of the year when they occurred. Approximately 56% of fatal crashes took place during the summer and fall months, spanning from June through November, while 55% of serious injury crashes occurred during the fall and winter months, from September through February. The total number of crashes involving VRUs peaked in the fall months (September through November), accounting for 30% of all crashes, and hit a low point during the spring months (March through May), representing only 18% of crashes.

Urban areas exhibited these patterns more prominently, with a distinct peak in the Fall months (August through October), whereas rural areas remained relatively even throughout the year, with only a slight increase in the summer months (June and July).

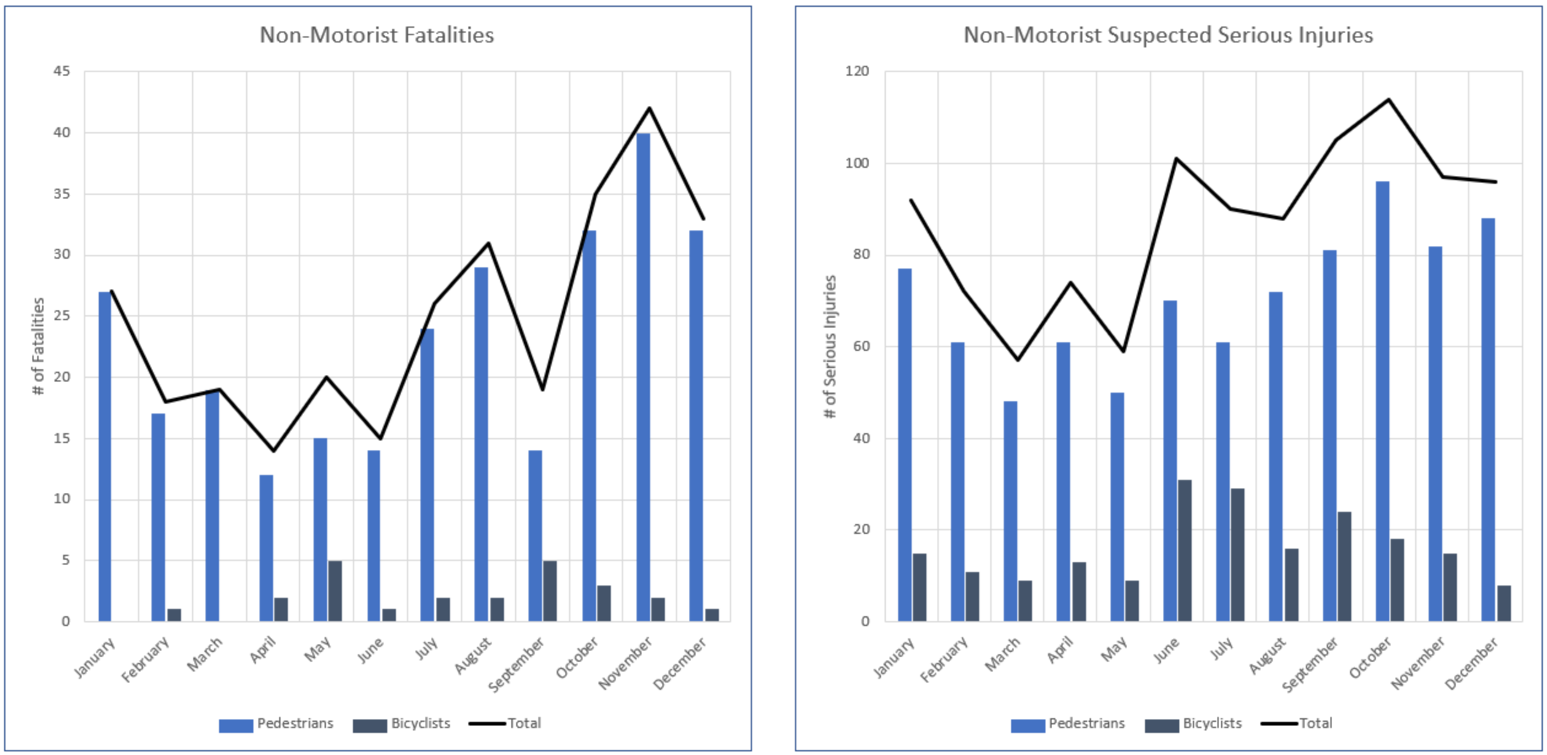


Figure 3.4: Non-Motorist Fatal and Serious Injury Crashes by Month

DAY OF THE WEEK

Regarding the day of the week when non-motorist-involved crashes occurred, most of these incidents took place on weekdays (74%). This observation hints at a potential correlation with regular commuting patterns and the typically heightened traffic volume on weekdays. Notably, the highest count of reported pedestrian KA (Fatal and Suspected Serious Injury) Crashes was recorded on Thursdays and Fridays (32%), while Fridays and Saturdays accounted for the most bicyclist KA Crashes (34%).

These patterns were more pronounced in urban areas, where a greater percentage of crashes occurred on weekdays, whereas rural areas exhibited a more consistent distribution throughout the week.

TIME OF DAY

Figure 3.5 provides an overview of the time-of-day distribution for fatal and suspected serious injury crashes. There is one noticeable peak in the data at 5:00 PM for the suspected serious injury crashes, likely associated with evening commutes. Another, though less pronounced, peak occurs at around 8:00 AM. This peak is likely associated with morning commutes, as well as school drop-off times.

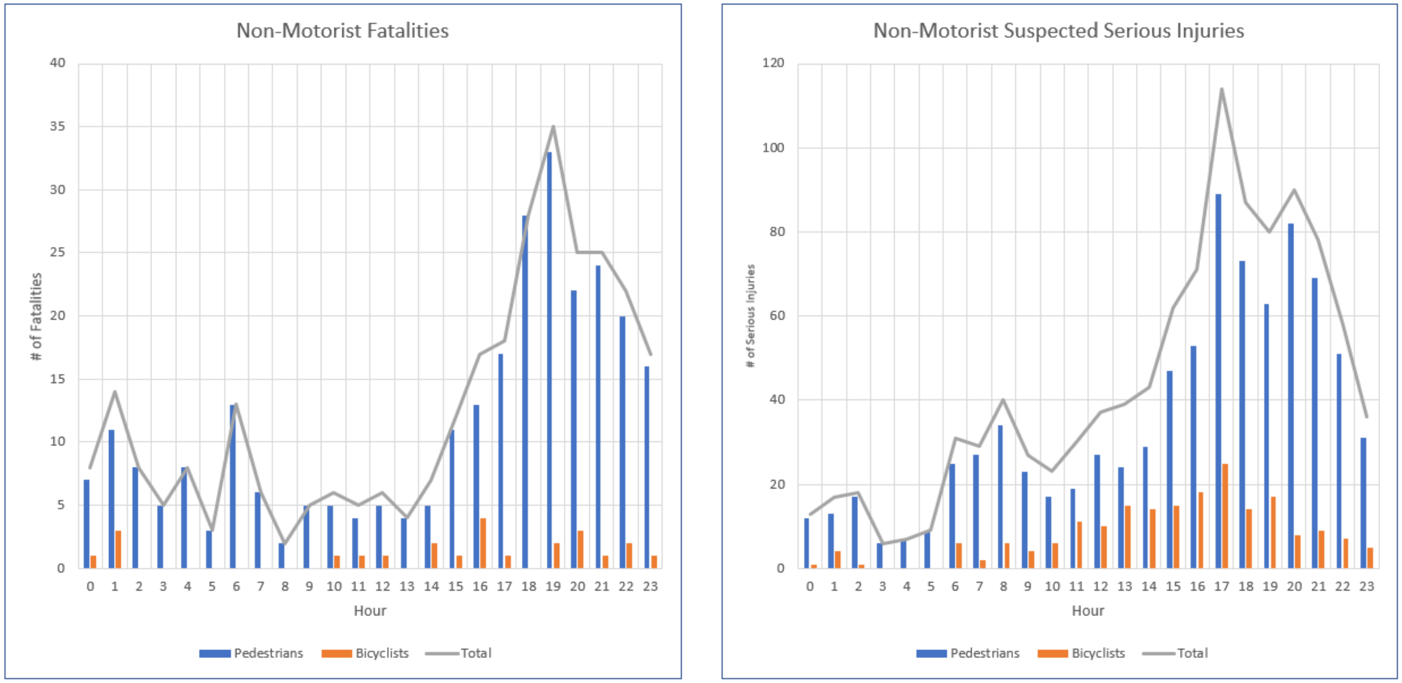


Figure 3.5: Non-Motorist Fatal and Serious Injury Crashes by Time of Day

Fatalities were most prevalent during the evening hours, spanning from approximately 6:00 PM to 11:00 AM. Similarly, non-motorist suspected serious injuries appeared to also be most prevalent during the evening hours from approximately 5:00 PM to 10:00 PM. Another less pronounced peak occurs at around 6:00 AM for VRU fatal crashes.

Urban areas exhibited these patterns more prominently, with distinct peaks at 1:00 AM, 6:00 AM, and between 6:00 PM and 9:00 PM. In contrast, rural areas showed a relatively steady distribution throughout the day, with only a slight increase at 7:00 PM.

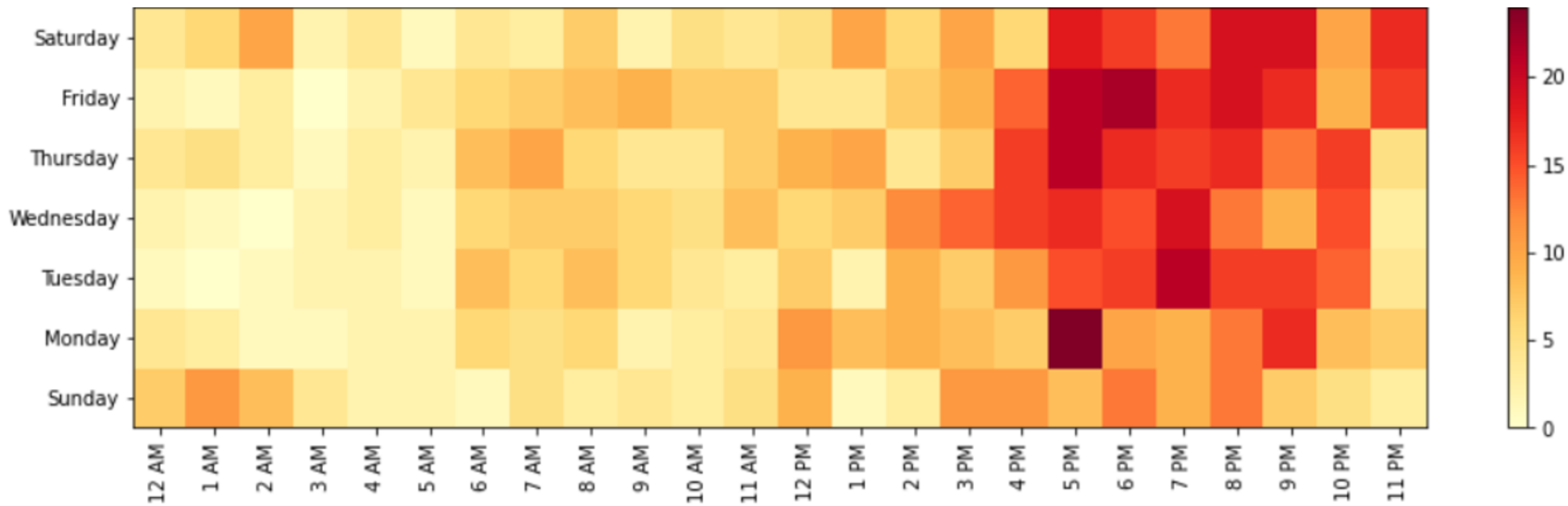


Figure 3.6: Pedestrian Fatal and Serious Injury Crashes by Day and Hour

Figures 3.6 and 3.7 provide a heat map of time of hour and day of week for pedestrians and bicyclists, respectively. Pedestrian fatal and suspected serious injury crashes occurred most on Monday at 5:00 PM and Friday and 6:00 PM (21 crashes each). These findings suggest increased activity in the evening and potentially higher traffic volumes due to evening commutes. Similarly, bicyclist fatal and suspected serious injury crashes appeared to also occur during evening hours, specifically on Tuesday at 5 PM, Wednesday at 7 PM, and Friday at 4 PM (7 crashes each).

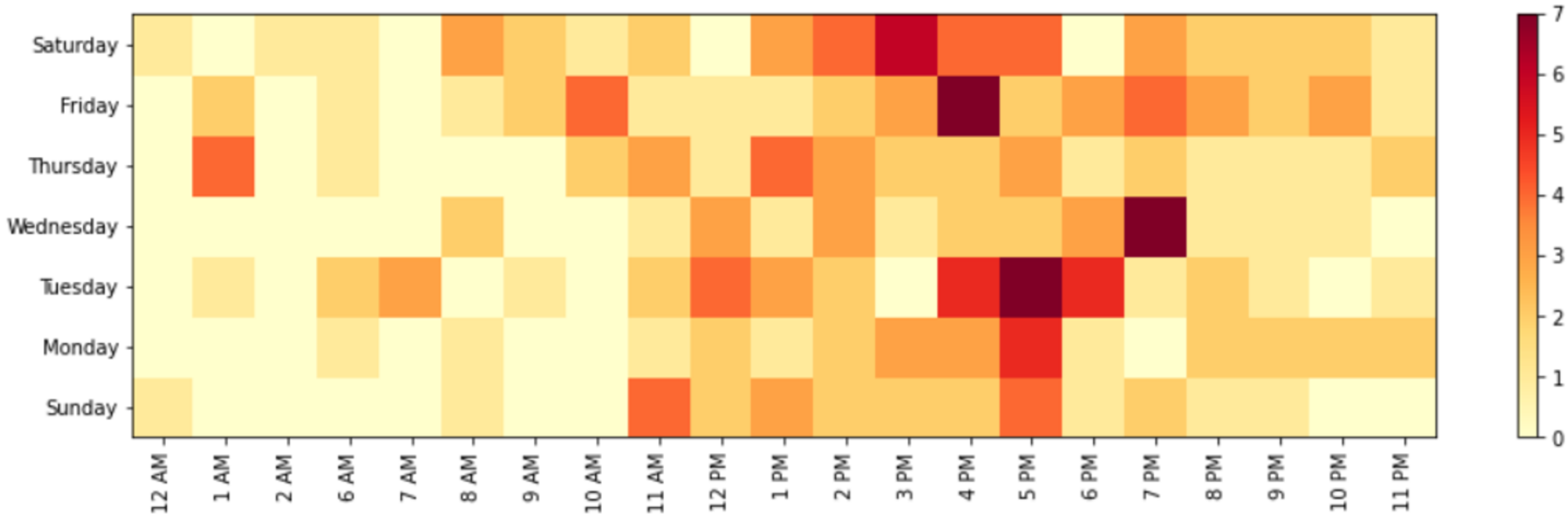


Figure 3.7: Bicyclist Fatal and Serious Injury Crashes by Day and Hour

3.3 Location

When examining crashes involving VRUs, it's crucial to gain insights into their geographical distribution to pinpoint any notable clusters or regions with an elevated likelihood of incidents. Figure 3.8 provides an overview of the cumulative KA VRU crash counts within each of Connecticut's 169 towns. This map underscores a pronounced concentration of VRU-related crashes in urban areas. These municipalities tend to boast higher population densities and increased traffic flow, often characterized by compactness, correlating with higher likelihoods of walking and bicycling as modes of transportation. Such circumstances can expose VRUs to greater traffic interactions and heighten the risk of collisions.

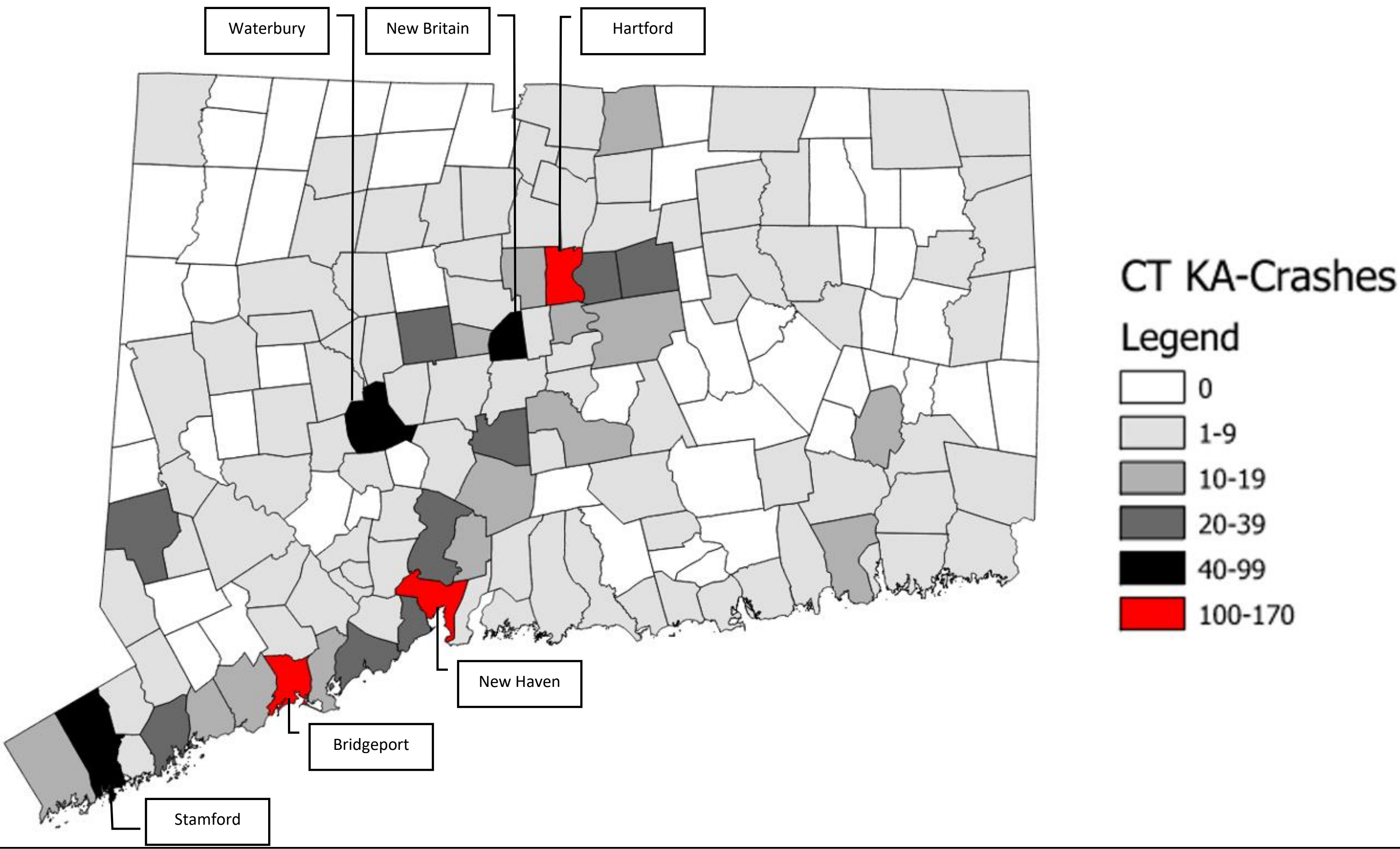
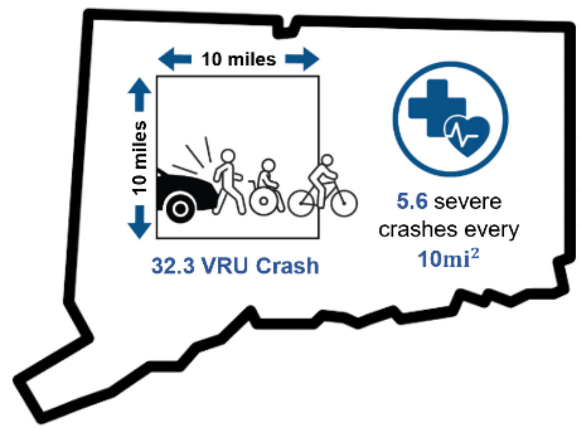


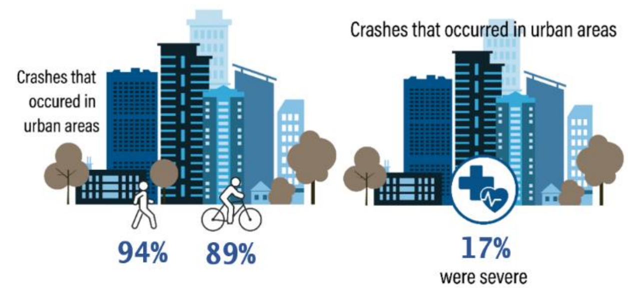
Figure 3.8: VRU Fatal and Serious Injury Crashes

URBAN VS. RURAL

Connecticut is a smaller state with a relatively high population density (744.7 persons per square mile by Census Tract, 2020). More than 92% of all crashes involving VRUs took place within urban areas. When examining the 7,851 VRU crashes within Connecticut's 4,842 square miles of land area designated by the US. Census Bureau, the data reveals an approximate rate of 32.3 VRU crashes per 10 square miles. Furthermore, within Connecticut's land area there were 5.6 fatal and serious injury VRU crashes per 10 square miles.



Of the 5,648 pedestrian-involved crashes documented during the five-year analysis, 94% occurred within urban areas. Similarly, out of the 2,203 bicyclist-involved crashes, 89% occurred in urban areas. Within these urban VRU incidents, 17% were categorized as fatal and serious injury. An observation arises when comparing crash severity indices: urban areas registered a severity index of 1.9, while rural areas exhibited a higher index of 2.2 over the five-year period. This highlights that although rural areas had fewer VRU crashes, these incidents tended to result in more fatal and serious injury outcomes.

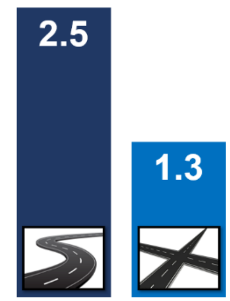


In terms of fatal and serious injuries for non-motorists, rural areas accounted for 73% of suspected serious injuries, while urban areas accounted for 78%. Rural areas have 27% of the State’s fatalities, while urban areas have 22% of them.

INTERSECTION RELATION

Regarding the physical locations of VRU crashes, approximately 50% of these incidents were concentrated at intersections or had a direct association with them. Of the 1,344 fatal and serious injury crashes, only 40% occurred at intersections. Digging deeper, it was noted that 82% of pedestrian-involved crashes and 18% of bicyclist-involved crashes transpired at intersections. In urban areas, 42% of crashes took place at intersections, in stark contrast to rural areas, where 25% of crashes took place at intersections.

When analyzing crash severity, it was found that roughly 2.1% of crashes at intersections were classified as fatal, while 5.5% of crashes occurring away from intersections were fatal. Additionally, 11.9% of fatal and serious injuries were linked to intersection crashes, with 14.7% occurring at not-at-intersection locations. The calculated crash severity index at intersections stood at 1.3, whereas not-at-intersection locations exhibited a significantly higher severity index of 2.5. In comparison, the overall VRU crash severity index averaged at 1.9.



Crash Severity Index

Despite a higher frequency of VRU crashes at intersections, they tended to result in less fatal and serious injury outcomes compared to those at non- intersection locations. Typically, non- intersection sites, such as highways, are characterized by higher speeds, which inherently heightens the risk of injury when crashes occur.

3.4 Road Characteristics

For each crash location, the data point is spatially matched to the specific roadway where the incident took place, and pertinent attributes of the route are extracted from a range of CTDOT databases. These extracted route characteristics are then linked to each individual crash record. The subsequent sections will present a comprehensive summary of the roadway characteristics associated with each crash.

ROADWAY CLASSIFICATION

The transportation system comprises a hierarchy of roadways classified based on various criteria, including geometric configuration, traffic volumes, community grid layout, speed, and adjacent land uses. This classification method is commonly referred to as functional classification, which categorizes roadways into different types such as interstates, principal arterials, minor arterials, collector streets, and local streets. To note, 42% of crashes had inconclusive data for functional classification. Most crashes took place on minor arterials (26%) and principal arterials (20%). Interstates, on the other hand, accounted for the fewest number of crashes (1%), although they had the highest crash severity (4.2). While minor arterial and principal arterials had the highest crash frequency, their overall crash severity was comparatively lower, at 1.5 and 2.1, respectively. It's important to note that 78% of all fatalities and 74% of all suspected serious injuries occurred on minor arterials and principal arterials, while local streets and collector streets only accounted for a combined 14% fatal crashes and 24% suspected serious injury crashes. Minor arterials and principal arterials contributed a combined 68% of total crashes, with slightly more fatal and serious injury crashes occurring on minor arterials.

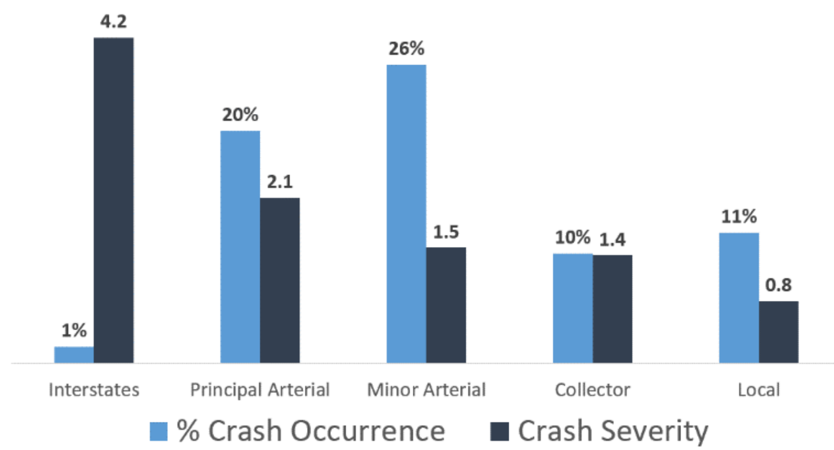


Figure 3.9: Roadway Classification

TRAFFIC VOLUMES

The traffic volumes on the roadway where a crash occurred can provide insights into the level of exposure to vehicular traffic. In cases of vehicle crashes, higher traffic volumes typically signify an increased risk of conflicts and, therefore, a higher frequency of crashes. However, this doesn't always hold true for VRU crashes, as non-motorists and vehicles often occupy separate spaces, such as sidewalks or paths versus the roadway. Overall, the highest percentage of crashes and fatal and serious injuries occurred on roadways with daily traffic volumes ranging from 2,500 to 10,000 vehicles. On higher volume roadways, the percentage of crashes was lower, but comparatively, a higher percentage of fatal and serious injuries occurred on these higher volume routes.

SPEED

The crash data also includes information about the speed limit of the roadway where the crash occurred. Although the posted speed limit may not always precisely reflect the actual vehicle speeds at the time of a crash, it generally serves as a reliable indicator. Approximately 57% of VRU crashes transpired on roadways with a posted speed limit of 25 miles per hour (mph) or less, which is a standard speed limit for local and collector streets. About 7% of crashes took place on roadways with speed limits exceeding 50 mph, typical of rural principal arterials and interstates. Pedestrian and bicycle-involved crashes exhibited a similar distribution across roadways with these speed limits, although there were more pedestrian crashes on higher-speed roadways.

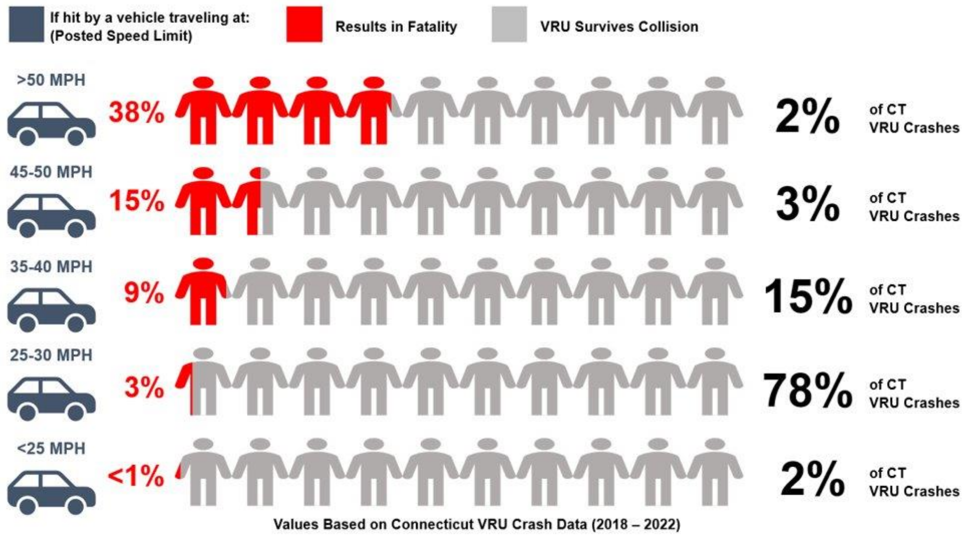


Figure 3.10: Posted Speed VRU Fatality Percentages

Rural areas were more prone to crashes on roadways with speed limits greater than 50 mph (10%), in contrast to urban areas where only 5% of crashes occurred on such roads. Within urban areas, a significant 72% of crashes took place on roadways with posted speeds ranging from 25 to 35 mph. Generally, crashes that occur at higher speeds are more likely to result in fatalities. In Connecticut, 38% of VRU crashes on roadways with posted speeds exceeding 50 mph resulted in one or more fatalities, whereas only 3% of crashes on roadways with posted speeds of 25 or 30 mph led to fatalities.

3.5 Other Factors

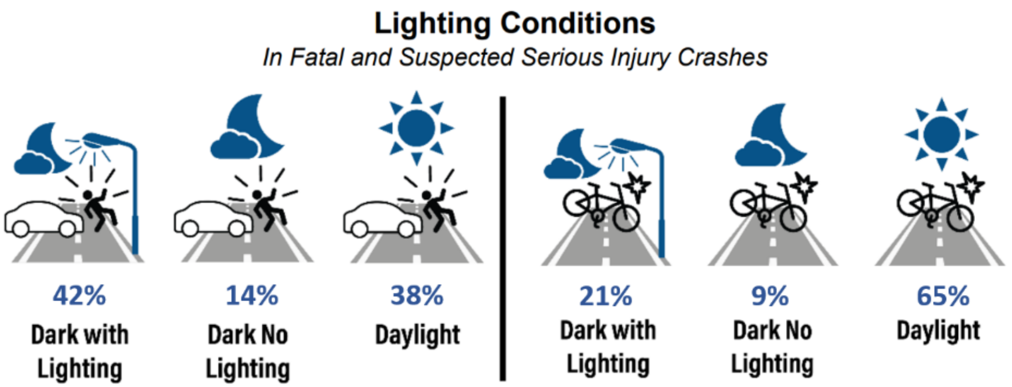
Beyond the time and location of the crash, various other factors play a role in both the likelihood and severity of a crash. These factors encompass elements such as weather conditions, road surface conditions, lighting conditions, or the type of vehicle involved in the incident. The subsequent sections will provide an overview of these contextual factors as they relate to VRU crashes throughout the five-year analysis period.

ENVIRONMENTAL CONDITIONS

The majority of VRU crashes took place under clear or cloudy weather conditions, constituting 85% of incidents. Approximately 14% of crashes occurred during either snowy or rainy conditions. Pedestrian-involved crashes exhibited a slightly higher frequency during severe weather conditions compared to bicyclist-involved crashes. This observation is notable, especially considering that many pedestrian-involved crashes occurred during Connecticut's variable winter months. It's worth noting that poor weather conditions did not appear to be significantly correlated with fatal and serious injury crashes.

LIGHTING CONDITIONS

Lighting conditions are another crucial factor in VRU crashes since non-motorists are typically smaller and harder to see, especially in low light or darkness. Overall, 42% of VRU KA crashes occurred during daylight hours, with more bicyclist-involved crashes (65%) than pedestrian-involved crashes (38%) occurring under these conditions. Approximately 60% of pedestrian-involved crashes occurred in darkness, with 42% happening in areas with some level of street lighting. In contrast, only about 33% of bicyclist-involved crashes occurred in the dark, with 21% in areas with some level of lighting. Fatal pedestrian-involved crashes were more likely to occur at night (73%), especially in areas without street lighting (19%). While most fatal bicyclist-involved crashes still occurred during daylight hours (50%), 8% of fatal bicyclist-involved crashes took place in the dark with no street lighting, and 33% happened at night with street lighting. These trends may suggest a need for increased street lighting in areas with high VRU activity or enhanced education for pedestrians and bicyclists on using proper equipment to improve their visibility.



VEHICLE TYPE

When a crash is reported, the responding officer records information about the types of vehicles involved in each incident. Bicycles are typically, though not always, categorized as low-speed vehicles. In total, there were 1,538 vehicles involved in the 1,344 VRU crashes, accounting for instances where multiple vehicles were part of a single crash.

4.0 Demographics

A crucial aspect of the analysis of crash data related to VRUs involves the examination of VRU demographics. This examination encompasses not only the demographics of the geographical areas where VRU fatal and serious injuries take place, but also the attributes of the individuals involved in these crashes. The following sections will delve into an analysis of demographic information extracted from crash data, along with an analysis of demographic data obtained through the US DOT Justice40 Initiative.

4.1 Demographics of Locations

The Justice40 Initiative was established to confront and rectify decades of insufficient investment in disadvantaged communities. This initiative empowers the US DOT to pinpoint and prioritize projects that enhance transportation access, affordability, equity, reliability, and safety for rural, suburban, tribal, and urban communities facing various obstacles. To aid in the identification of these disadvantaged communities, the US DOT has developed a mapping tool, Version 2.0 of which was released in May 2022. This tool incorporates data from 22 indicators gathered at the Census tract level, categorized into six transportation disadvantage areas. These indicators draw from sources like 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 27 municipalities in Connecticut with Justice40 tracts are shown in Figure 4.1. Notably, the four major cities of Hartford, Waterbury, New Haven, and Bridgeport are the top four cities with the highest incidents of fatalities and serious injuries for VRU crashes.

1)	**Ansonia (2)**	**8)**	**Enfield (10)**	**15)**	**New Britain (45)**	**22)**	**Stamford (65)**
2)	**Bridgeport (117)**	**9)**	**Fairfield (15)**	**16)**	**New Haven (164)**	**23)**	**Torrington (7)**
3)	**Bristol (27)**	**10)**	**Groton (4)**	**17)**	**New London (9)**	**24)**	**Vernon (7)**
4)	**Byram** (Community in Greenwich) **(18)***	**11)**	**Hartford (124)**	**18)**	**New Milford (7)**	**25)**	**Waterbury (82)**
5)	**Danbury (39)**	**12)**	**Manchester (22)**	**19)**	**Norwalk (37)**	**26)**	**West Haven (31)**
6)	**Derby (3)**	**13)**	**Meriden (39)**	**20)**	**Norwich (18)**	**27)**	**Windham (7)**
7)	**East Hartford (22)**	**14)**	**Middletown (18)**	**21)**	**Shelton (5)**		**(#) = Total Number of KA VRU Crashes** *** = Total Number of KA VRU Crashes Associated with Town**

Figure 4.1: Connecticut's Justice40 Towns (listed alphabetically)

The six categories of transportation disadvantage are as follows, with the numbers in parentheses indicating how many of the 22 indicators fall within each category:

1. **Transportation Access Disadvantage:** Identifies communities and areas where residents spend more time and resources on transportation. (4)
2. **Health Disadvantage:** Identifies communities based on factors related to adverse health outcomes, disability, and environmental exposures. (3)
3. **Environmental Disadvantage:** Identifies communities with disproportionately high levels of certain air pollutants and a high potential for lead-based paint presence in housing units. (6)
4. **Economic Disadvantage:** Identifies areas and populations characterized by high poverty rates, low wealth, limited local job opportunities, low homeownership rates, low educational attainment, and high-income inequality. (7)
5. **Resilience Disadvantage:** Identifies communities vulnerable to climate change-related hazards. (1)
6. **Equity Disadvantage:** Identifies communities where a significant proportion of individuals (aged 5+) have limited proficiency in English. (1)

For each Census tract, percentile values were calculated for each of the 22 indicators, with the 99th percentile representing the most disadvantaged. Within each category, the average percentile for each tract was computed. A tract received a value of one (1) if it ranked in the 50th percentile or higher in a particular category and zero (0) otherwise. For the resilience category only, a tract received a value of one (1) if it ranked in the top 75th percentile of disadvantage. A Census tract is considered transportation disadvantaged if it surpasses these thresholds in at least four of the six categories. The results of this analysis for Connecticut are presented in Figure 4.2.

Figure 4.3 illustrates that 32 Census tracts were identified with 4 or more transportation disadvantages. Two of these Census tracts recorded having 5 disadvantages, both Census tracts located in Bridgeport. Interestingly, only 2 Census tracts out of the 830 were categorized as being disadvantaged in resilience. Of note, over 50% of Connecticut's Census tracts are categorized as being equity disadvantaged. These Census tracts are primarily in urban areas of the state.

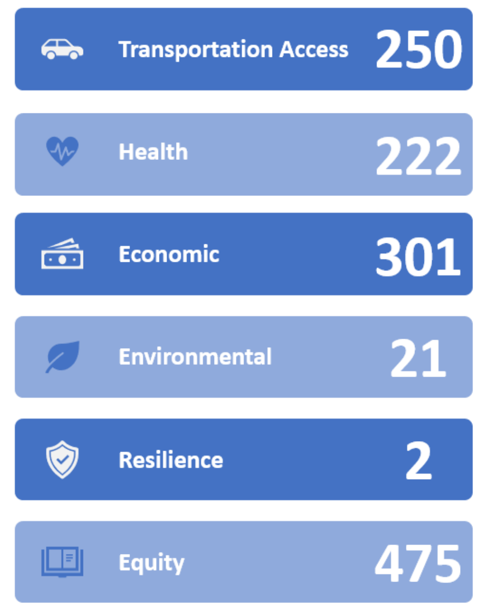


Figure 4.2: Number of Disadvantaged Census Tracts in Each Category

Figure 4.3: Transportation Disadvantage Map of CT (US DOT Justice40)

4.2 Tribal Areas

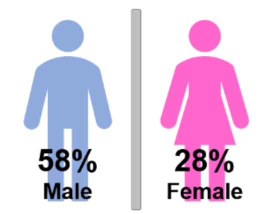
Connecticut law recognizes five Indian tribes: (1) Golden Hill Paugussett, (2) Mashantucket Pequot, (3) Mohegan, (4) Paucatuck Eastern Pequot, and (5) Schaghticoke. These five tribes have six reservations in the state of Connecticut. The Mashantucket Pequot and Mohegan tribes are both recognized by the federal government and are considered federal reservations. These reservations did not have any reported incidents involving VRUs during the analysis period.

4.3 Demographics of Individuals

Examining the traits of individuals implicated in crashes can aid in pinpointing specific demographics for targeted educational initiatives or recognizing groups consistently linked to non-motorist crashes, warranting special attention. Subsequent sections delve into the person demographics accessible from the crash data.

GENDER

In total, approximately 28% of crash-involved non-motorists were females. Males constituted the majority at 58% of the non-motorists involved in suspected serious injuries or fatal VRU crashes. Gender classification was listed as unknown for roughly 15% of those involved in these crashes. Among non-motorist fatalities, 68% were males, and males also accounted for 66% of non-motorist suspected serious injuries.



Non-Motorists Involved in Crashes

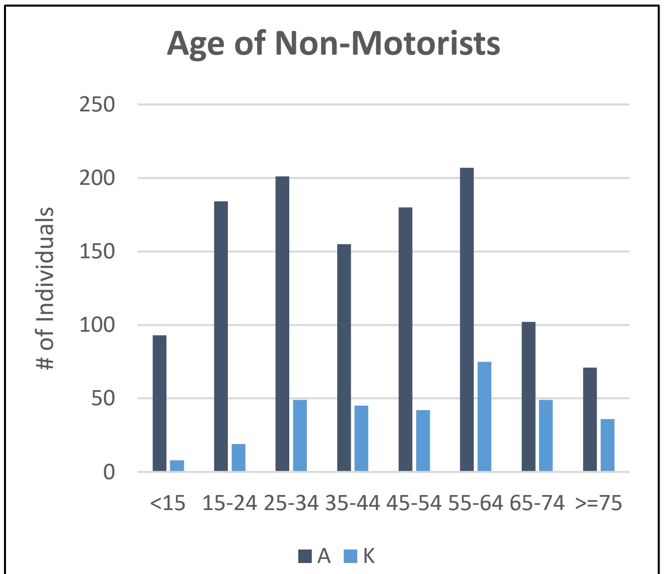
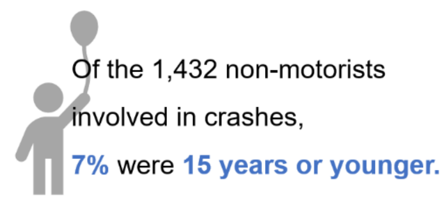


Figure 4.4: Age of Individuals Involved in Crashes

AGE

The age distribution for non-motorists involved in crashes is illustrated in Figure 4.4, with the highest concentration of individuals involved falling in the 25-34 and 55-64-year age brackets. Approximately 20% of non-motorists were aged 24 years or younger. Roughly 7% of all non-motorists were under the age of 15, representing those who typically lack the ability to operate a vehicle for transportation. About 17% of non-motorists were aged over 65.



Roughly 41% of drivers involved in VRU crashes fell within the young-to-middle-aged adult category, spanning from 25 to 44 years of age. Approximately 12% of drivers involved in crashes with VRUs were 65 years or older, while approximately 16% were 24 years or younger.

OTHER FACTORS

Race and ethnicity data presents challenges due to its significant underreporting and frequent incompleteness, primarily relying on officer observations at the scene and lacking verification. Using the US Census Tract, data was obtained to show the relationship between percentage of race and ethnicity. Among the KA VRU crash data reported between the 5-year period, approximately 30% of crashes occurred in Census tract areas with black populations of 30% or more. For Hispanic populations of 30% of more, 28% of incidents occurred.

Within the analysis period of 2018-2022, Connecticut recorded 38% of fatal or suspected serious injury crashes in Census tracts with 50% or greater of households only having 1 or no vehicle. Furthermore, the Census tract also identified that areas with 20% or more of people living below the poverty line were involved in 20% of the incidents recorded.

5.0 High-Risk Areas

Federal regulations mandate that the state's VRU SA must pinpoint areas of elevated risk for VRUs. Federal guidelines emphasize the use of various data-driven safety analysis methods to identify these areas. These approaches include the development of high injury network (HIN), the predictive safety analysis to highlight locations with the most potential for improvement and to quantify the expected safety performance of different project options, and systemic safety analysis to pinpoint high-risk roadway features that are associated with specific types of crashes and identify locations prone to fatal and serious injury crashes, even if the frequency of crashes at these spots is not high. Subsequent sections will delve into the methodologies considered for analyzing high-risk VRU locations in Connecticut.

Children walking home from school at a crosswalk.

METHOD 1: SPATIAL MAPPING ANALYSIS

Figure 5.1, presented on the next page, illustrates the distribution of fatal and suspected serious injury crashes across the state during the five-year analysis period. The map depicts that most fatal and serious injury crashes occurred in urban areas.

Since Connecticut is such a densely populated state, and fatal and serious VRU injuries occur throughout the state, it is difficult to draw conclusions about high-risk areas for VRU crashes from this type of mapping analysis. The 3 towns illustrated in Figure 5.1 represent the most fatal and serious injury VRU crashes in the state and help reveal specific areas of emphasis. While each of these areas have similarities in the population density and VRU crashes, they have considerably different characteristics in terms of roadway infrastructure, surrounding land uses, and crash circumstances, making it difficult to assess risk factors. Consequently, further analysis based on spatial mapping of past VRU crash occurrences was not pursued.

METHOD 2: CRASH RATE ANALYSIS

Another approach under consideration for identifying high-risk areas involved calculating crash rates along segments of the transportation network, accounting for traffic exposure. However, this method encountered challenges due to inconsistencies in the segmentation of the roadway network, which led to crash rates being disproportionately influenced by the length of individual segments, rather than the actual number of crashes on each segment. Moreover, basing crash rates on traffic exposure, or vehicle miles traveled, could distort VRU-crash rates, particularly on high-volume roads. This approach also failed to consider non-motorist traffic activity and did not provide a comprehensive perspective on interactions between vehicles and non-motorists.

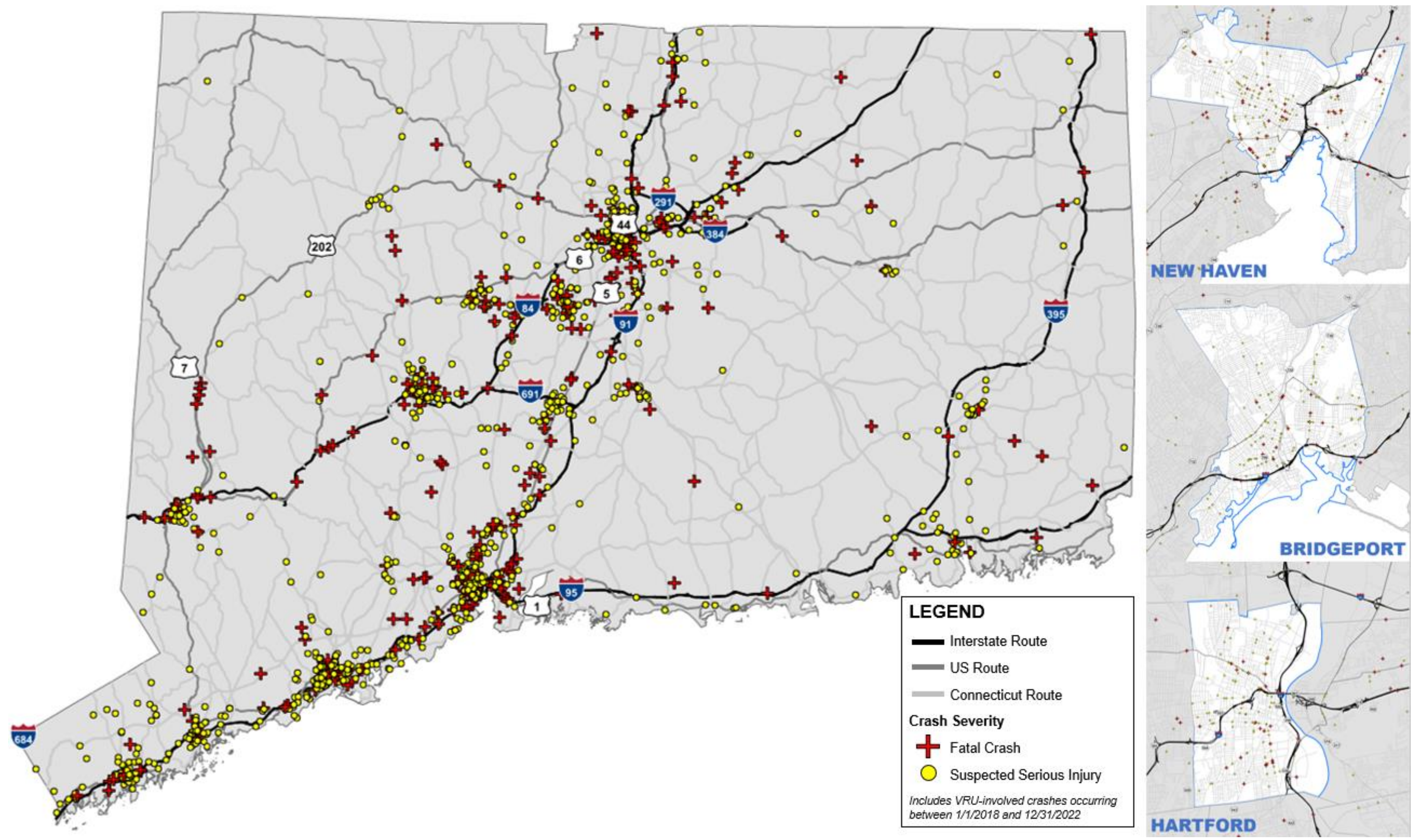


Figure 5.1: VRU Fatal and Serious Injury Locations

METHOD 3: INFRASTRUCTURE INDICATORS ANALYSIS

An analysis was conducted to explore common characteristics among the infrastructure elements in areas where VRU crashes have taken place. **This systemic safety analysis approach will be used to help identify VRU High-Risk Areas.** It aids the CTDOT in devising strategies to address specific design challenges and proactively identifying similar circumstances across the state where VRU crashes have not yet occurred but may exhibit future risk factors. Figure 5.2 provides insights into key infrastructure indicators for fatal and serious injury pedestrian and bicycle crashes including shoulder widths, functional classification, lane count, speed limits, street lighting, and behaviors of both vehicle operators and non-motorists.

Figure 5.2 illustrates that 92% of the fatal and serious injury VRU crashes occurred in urban areas, with the additional 8% happening in rural areas. 58% of urban area fatal and serious injury VRU involved crashes occurred at not-at-intersection locations with the other 42% occurring at intersections. Approximately 75% of fatal and serious injury VRU crashes in rural areas occurred at not-at-intersection locations. Key observations regarding fatal and serious injury VRU crashes include:

- With 77% of all fatal and serious injury VRU involved crashes occurring in Equity Disadvantage Areas, 567 crashes (46%) occurred at not-at-intersection urban area locations.
- The lack of streetlights in rural areas play a bigger role in crashes compared to urban areas.
- All intersections had a majority of their crashes occurring along roadway segments.
- A significant proportion of crashes occurred on roadway segments. Urban areas saw a higher percentage of crashes on roads with speed limits lower than or equal to 25mph, whereas rural areas recorded more crashes on roads with speed limits higher than or equal to 50mph.
- Aggressive driving related crashes was most prevalent at not-at-intersection rural areas.

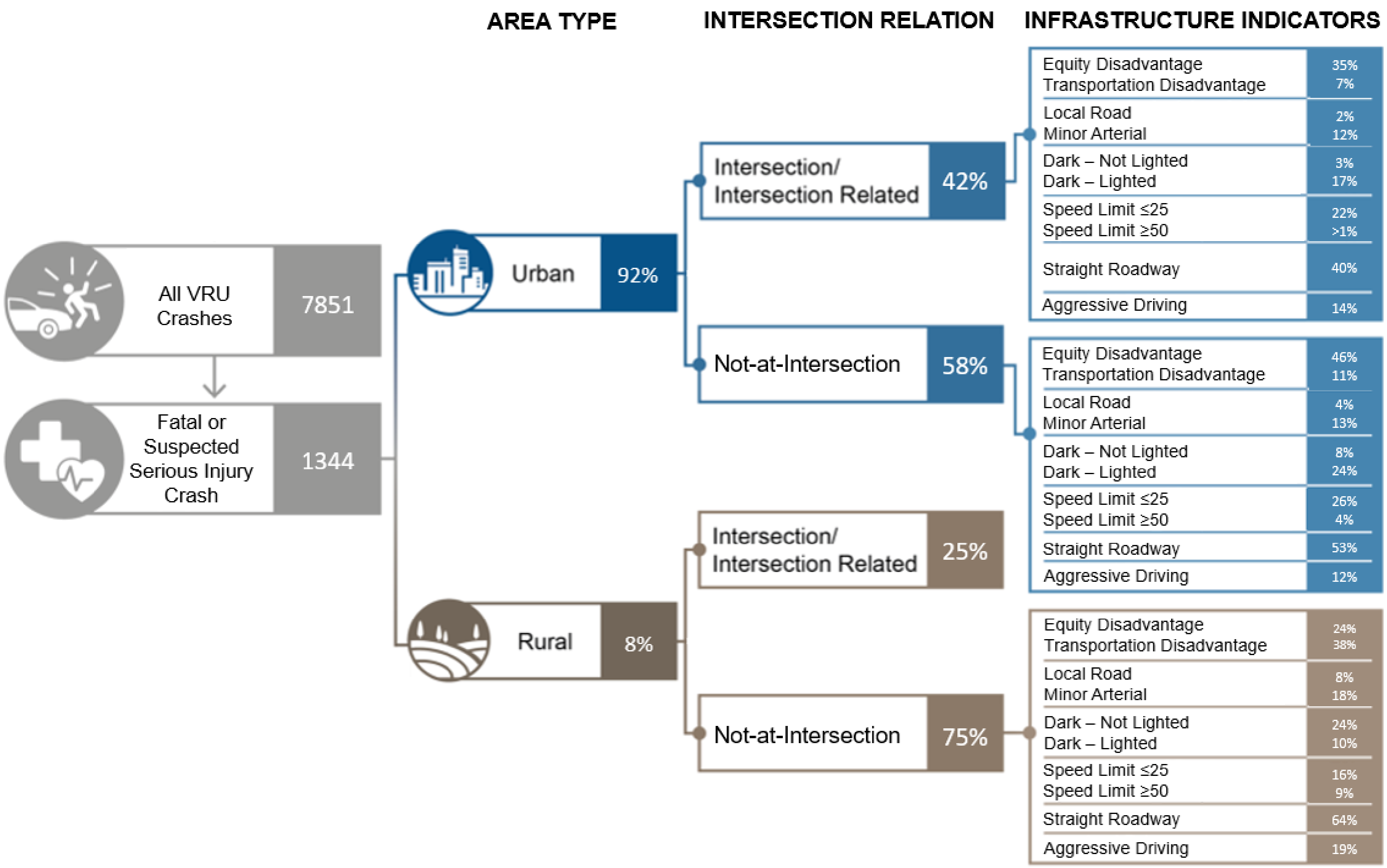


Figure 5.2: Infrastructure Indicators in VRU Fatal and Serious Injury Crashes

6.0 Crash Narrative Review

While examining the crash data discussed in the previous sections, it became evident that additional information was required to gain a comprehensive understanding of fatal and suspected serious injury incidents involving VRUs. This was essential for identifying commonalities and emerging trends. Consequently, crash narratives were reviewed, which included accounts from individuals involved in the crashes and reports from responding officers, particularly for fatal and serious injury VRU crashes. These narratives provided insight into behavioral patterns. Additionally, locations of fatal and serious injury crashes were reviewed using available Google Earth imagery to assess various infrastructure indicators at the crash sites. It's important to note that some of the aerial imagery might be outdated, and infrastructure conditions could have changed since the time of the crash.

6.1 Observed Trends Summary

The review of crash narratives revealed several noteworthy trends that appear to contribute to crashes involving VRUs. These trends have the potential to inform strategies aimed at addressing VRU crashes. These trends have been categorized into sections based on whether they pertain exclusively to non-motorists, exclusively to drivers, or are relevant to both groups. It's important to emphasize that these summaries are qualitative in nature, and no attempt has been made to quantify the frequency of these circumstances.

TRENDS RELATED TO NON-MOTORISTS ONLY

- Many non-motorists involved in nighttime crashes were found to be wearing dark clothing without reflective gear or personal lighting.
- In numerous instances, pedestrians were struck while crossing unmarked, midblock locations within roadways. In many cases, there was a nearby intersection with marked crosswalks, as confirmed though recent aerial reviews.
- Some pedestrians were struck while in marked crosswalks; however, in some instances, it was observed that the pedestrian failed to wait for a pedestrian signal to activate before entering the crosswalk. Similarly, a few bicyclists failed to stop before proceeding through intersections.
- Many bicyclists involved in crashes were riding on sidewalks and did not slow down or yield before entering intersections and crosswalks. In a handful of cases, bicyclists were riding in marked bike lanes but against the flow of traffic, resulting in collisions.
- Several non-motorists were observed to be in the roadway in an improper manner at the time of the crash. This included pedestrians, particularly impaired individuals, walking in travel lanes.
- Several pedestrians were noted as "darting" or "dashing" across streets just before a collision. In these cases, it appeared that pedestrians either did not check for oncoming traffic, misjudged the gaps between vehicles, or were attempting to beat oncoming vehicles.

High Visibility Safety

TRENDS RELATED TO DRIVERS ONLY

- Several flagged crashes involved vehicles backing up and striking pedestrians who were behind the vehicle. In some cases, the injured pedestrian was acquainted with the driver.
- In a few instances, drivers failed to provide adequate space when passing bicyclists, resulting in collisions.
- Some crashes involved drivers failing to yield to pedestrians in crosswalks. Often, these incidents occurred when turning vehicles did not give the right-of-way to pedestrians crossing on the street the vehicle was turning onto. There were also cases of turning vehicles taking shallow turning paths and clipping bicyclists waiting at intersections.
- Some drivers were found to be speeding at the time of the crash, resulting in insufficient reaction time to avoid a collision with a pedestrian or bicyclist in the roadway, or they lost control of the vehicle and collided with a nearby non-motorist. This speeding issue also applied to bicyclists who were riding too fast to stop before a collision. In a couple of instances, a driver lost control of the vehicle and crashed into a building, injuring an occupant of the building. These incidents were classified as pedestrian crashes.
- In certain crashes, drivers cited obstructed views as a contributing factor. This encompassed situations where pedestrians emerged into the roadway from between multiple vehicles and instances where glare from the sun or oncoming headlights affected visibility.

TRENDS RELATED TO NON-MOTORISTS AND DRIVERS

- Aerial reviews indicated that several crashes occurred in proximity to parks, schools, bus stops, and recreational areas.
- Many fatal and serious injury non-motorist-involved crashes involved impairment by either the non-motorist, driver, or both. Impaired crashes were particularly common in rural areas. Almost all impaired VRUs involved pedestrians.
- Several pedestrian-involved crashes resulted from disputes or displays of aggression, particularly between individuals who knew each other. In some cases, one party was outside the vehicle during the argument, and the driver either intentionally or recklessly set the car in motion, striking the other person involved in the altercation. In an extreme case, a driver intentionally veered off the road and hit a pedestrian on two separate occasions, leading to their apprehension. Other reports highlighted conflicts between drivers and pedestrians escalating into violent confrontations ending in collisions.
- Environmental factors played a role in several VRU crashes, such as low lighting conditions with insufficient or less than ideal street lighting, adverse weather conditions, and other visibility-related issues.
- Some drivers and non-motorists involved in crashes alleged faulty vehicles or equipment, though investigators rarely substantiated these claims for vehicles. Several bicyclists mentioned poor or absent brakes.
- Among the children involved in fatal and serious injury VRU crashes, some were unsupervised. These crashes often occurred when children darted into streets, ran after vehicles, stood behind vehicles, or inadvertently set vehicles in motion while playing inside them.

Bicycle Symbol Sign

6.2 Infrastructure Indicators

A comprehensive examination of infrastructure characteristics was undertaken specifically for fatal and suspected serious injury incidents involving VRUs. This review utilized aerial imagery and data from CTDOT's Transportation Enterprise Dataset. It's important to note that the available aerial imagery may not precisely match the conditions at the time of crashes occurring between 2018 and 2022. Additionally, in certain cases, aerial imagery was of low quality or unavailable. Various infrastructure details were documented based on observed conditions and in-depth crash narratives. These details may exhibit slight variances when compared to the analyses presented in previous sections, which relied solely on information from simplified crash records. The analysis encompassed all fatal and suspected serious injury VRU crashes. To continue, the Office of Public Transportation is working on improving the transit data that will include transit routes, transit stops, and other public transportation infrastructure. Upon completion, this data will be incorporated into the analysis to further investigate infrastructure elements associated with high-risk areas for VRU fatal and serious injury crashes.

INTERSECTION CHARACTERISTICS

Approximately 42% of fatal and serious injury VRU injury crashes occurred at or were related to intersections, while 58% transpired at not-at-intersection locations. The intersections where these crashes occurred were mainly controlled by traffic control signals (49%) or stop signs (14%). Approximately 30% of crashes happened at intersections with no control devices. Around 85% of crashes at signalized intersections resulted in suspected serious injuries, with 15% resulting in fatalities. Overall, intersection-related crashes predominantly took place in urban settings (95%) and involved pedestrians (82%).

Rural areas had more frequent fatal and serious injury VRU incidents at not-at-intersection locations (10%) than at intersections (5%). Approximately 59% of fatal and serious injury VRU crashes occurred at not-at-intersection locations and involved pedestrians (90%). Around 27% of the crashes at not-at-intersection locations resulted in fatalities, with the other 73% resulting in suspected serious injuries.

ROADWAY CHARACTERISTICS

Approximately 25% of fatal and serious injury VRU crashes occurred on minor arterials, while only 7% occurred on local streets. Among the minor arterials involved in crashes, 64% of vehicles were traveling straight ahead, and 15% were turning left. 24% of the crashes were reported under the "aggressive driving" code. Nearly all (92%) of the minor arterial and local streets where crashes occurred were on straight roadways. Local streets encountered aggressive driving in 34% of crashes with 45% of those drivers driving straight ahead.

(orange)	1 – 5.75	Least walkable
(yellow)	5.76 – 10.5	Below average walkable
(light green)	10.51 – 15.25	Above average walkable
(green)	15.26 – 20	Most walkable

Figure 6.1: National Walkability Index Score

NON-MOTORIST FACILITY CHARACTERISTICS

The data for the National Walkability Index is accessible at the block group level, which is a Census geography unit smaller than a tract and larger than a block. Each block group in Connecticut is assigned a National Walkability Index score, determined by factors in the built environment influencing the likelihood of people choosing walking as a mode of transportation. These factors include street intersection density, proximity to transit stops, and diversity of land uses. While various elements impact walking, these specific measures were selected for the index due to their measurability using variables in the Smart Location Database, offering nationwide data consistency at the block group level. The intentional simplicity of this limited set of variables enhances the index's accessibility for a broad audience. The United States Environmental Protection Agency created a national walkability index score on a scale of 1 to 20 illustrated in Figure 6.1.

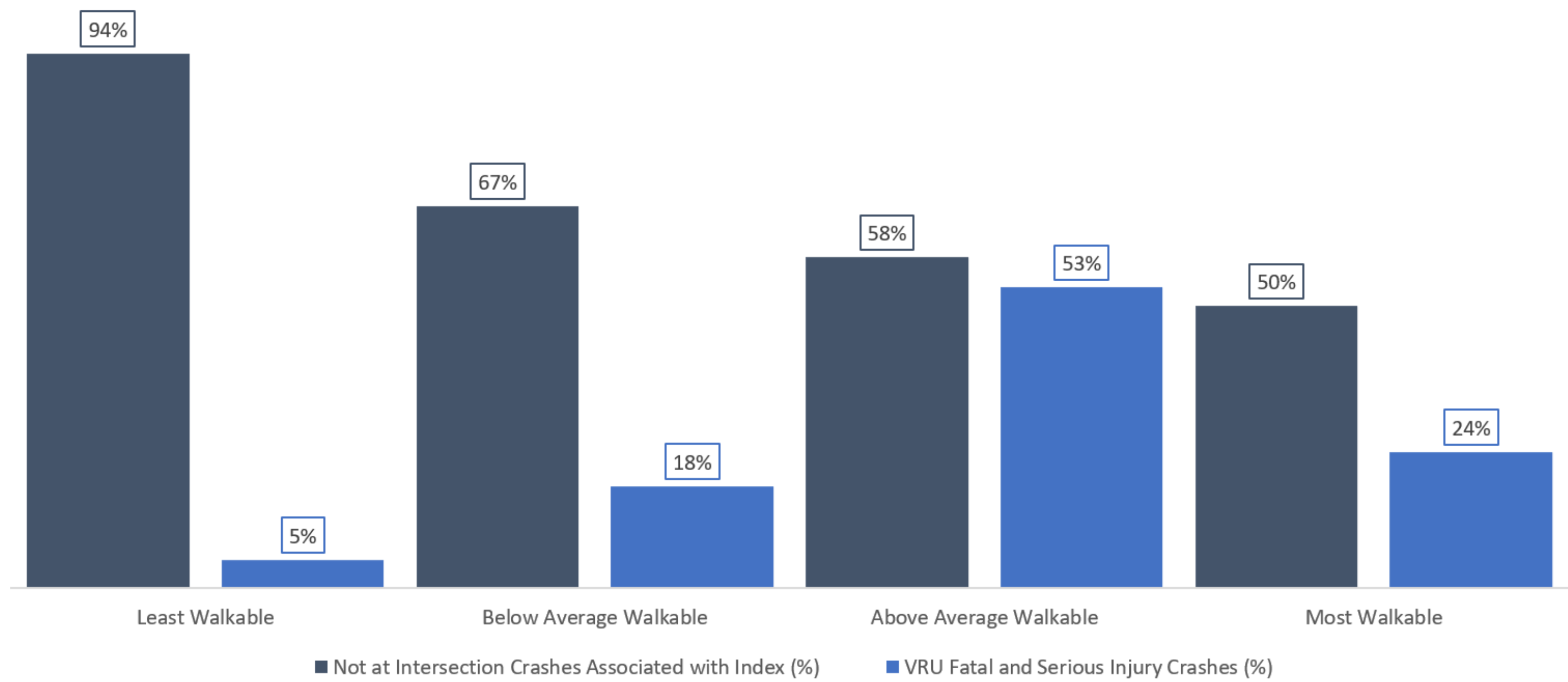


Figure 6.2: Walkability Index

Figure 6.2 illustrates that 18% of the fatal and serious injury VRU crashes occurred where the block groups were categorized as below average walkable, while areas categorized least walkable only had 5% of fatal and serious injury VRU crashes. Approximately half (53%) of the fatal and serious injury VRU crashes occurred in areas with a score within the above average walkable range. However, 58% of those crashes occurred at not-at-intersection locations. 24% of the fatal and serious injury VRU crashes occurred in areas most walkable with 50% of those incidents occuring at not-at-intersection locations.

7.0 VRU Proposed Key Strategies

There are several contributing factors influencing the increase of pedestrian fatalities or serious injuries while traveling. Some of the factors include more people walking for fitness or commuting, an increase in vehicle size from passenger cars to SUVs and pick-up trucks, additional pedestrian and driver distractions from smartphones and increased incidence of impaired driving and walking. CTDOT with input from stakeholders, identified current and proposed key strategies to improve VRU safety through improving exposure, visibility, and awareness as well as improvements to improve driver behavior and awareness.

7.1 Strategies To **Reduce VRU Exposure**:

- Sidewalks
- Accessible Pedestrian Signals
- Pedestrian Refuge Islands
- Bumpouts at crosswalks
- Curb Extensions
- Pedestrian Bridge/Tunnel Installation
- Pedestrian Signals with Countdown Indications
- Leading Pedestrian Interval (LPI)
- Assessment of VRU facilities within a 100-foot buffer of a Transit stop per the Complete Streets Design Controlling Design Criteria

7.2 Strategies That **Improve Visibility**:

- Crosswalk Enhancements
- Crosswalk Illumination
- Eliminate Screening by Physical Objects
- Pedestrian Hybrid Beacon (PHB)
- Rectangular Rapid Flashing Beacon Pedestrian Crosswalk Systems (RRFBS)
- Install Crosswalks at Roundabouts
- Evaluate And Improve Access at Transit Stops
- Adding Sidewalk Connectivity and Accessibility To/From Transit Stops
- Bumpouts at crosswalks
- Raised crosswalks

7.3 Strategies For **Improving Awareness**:

- Education, Outreach, And Training
- Increase Enforcement, including High Visibility Distracted Driving Enforcement Campaigns
- Education Campaign in High-Risk Communities
- Pedestrian Road Safety Audits
- Updating the Highway Design Manual to Reflect Complete Street methodologies and Target Speed
- Data Collection of Pedestrian Infrastructure Elements and Pedestrian Exposure

7.4 **Safe Speed or Slowing Vehicle** Strategies to Improve Safety for VRUs Include:

- Speed Humps
- Raised intersections and crosswalks
- Speed Feedback Signs
- Chicanes
- Semi-Diverter, where appropriate
- Full / Partial Diverters and Street Closure, where appropriate
- Reduce Statutory Speed Limits
- Continue To Allow Municipalities to Set Speed Limits and Allow Creation of Pedestrian Safety Zones
- Speed Management Training Program
- Speed and Red Light Safety Cameras

7.5 Strategies That Improve Safety Through **Protective Wear** Such As:

- Enact Universal Helmet-Use Law
- Conduct Targeted Media to Promote Helmet Use
- Promote Awareness of High-Visibility Clothing

7.6 The Below Strategies Improve **Driver Awareness** at Signalized Intersections:

- Signal Backplates
- 12-Inch Led Lenses
- Mast Arms with Street Names
- Educate The Public to Improve Understanding of Traffic Control Devices
- Improve Driver Training Content

- Promote Use of Smartphone Technology to Limit or Eliminate Calls or Texting While Driving

7.7 Strategies To Improve **Safety for Bicyclists** Include:

- Data Collection of Bicyclist Infrastructure Elements and Bicyclist Exposure.
- Red Signal as Stop Sign Law
- Education On Verbal and Non-Verbal Communication
- Bicycle Facilities Be Applied for Each Direction of Vehicular Travel.
    - Bicyclists Facilities:
        - Paved Outside Shoulders
        - Bicycle Lanes
        - Buffered Bicycle Lanes
        - Separated Bicycle Lanes
        - Side Paths
        - Shared Use Paths

8.0 Conclusion

This summary of the VRU Baseline Safety Assessment focuses on identifying safety issues for VRUs in Connecticut, employing a data-driven examination of VRU crash data spanning five years, from January 1, 2018, to December 31, 2022. The analysis delves into various factors contributing to VRU fatalities and serious injuries, encompassing demographics, roadway characteristics, and behavioral trends. The aim is to discern commonalities that elevate the risk of VRU crashes for specific locations or individuals.

The initial sections of the report synthesize data extracted from crash reports submitted by Connecticut State Police officers and various law enforcement entities, including local city, tribal, and federal officials. This information is presented exactly as recorded in the reports, without alterations. Additionally, narratives of VRU crashes, particularly fatal and suspected serious injury incidents, were reviewed to comprehend contributing circumstances, and identify overarching trends. This effort incorporates an analysis of the spatial relationships and road characteristics not readily available in simplified crash records, presented in Chapter 6 of the report.

The analyses compiled herein will aid CTDOT in pinpointing projects and strategies to address high-risk pedestrian and bicycle safety issues. Furthermore, the findings will enable CTDOT to tailor strategies to specific areas and contextual situations. A condensed summary of key takeaways from the baseline safety assessment is outlined below:

- Nighttime posed a higher risk for VRU crashes due to reduced visibility. Adequate street lighting and high-visibility clothing or equipment were identified as mitigating factors.
- Impairment heightened the risk of VRU crashes for both drivers and non-motorists.
- Pedestrians not in transport were involved in various VRU crashes, including former motor vehicle occupants standing in the roadway, emergency service/work zone situations, building occupants, and other unconventional circumstances.
- Generally, pedestrian crashes outnumbered bicycle crashes, with both being more prevalent in urban areas.
- In urban and rural areas, VRU crashes were more common at not-at-intersection locations.
- Many crashes occurred where pedestrian or bicycle facilities were unavailable, especially in rural areas. When facilities existed, non-motorists didn't always use them. Midblock crashes involving crossings at unmarked locations were common even when adjacent crosswalks were available.
- Drivers often failed to notice pedestrians or bicyclists due to visibility issues, lack of anticipation, non-motorists being in improper positions, or the failure to look for and yield to them.