APPENDIX B

SAFETY ANALYSIS TECHNICAL MEMORANDUM

Memorandum

Date: December 10, 2024

To: Alex Bullen, Superior

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From: Consor Engineers

Subject: Town of Superior Vision Zero Action Plan – Safety Analysis & HIN/HRN Methodology

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Introduction

Recognizing the importance of implementing a regional approach to roadway safety, Boulder County, Lafayette, and Superior joined forces and successfully applied for Safe Streets and Roads for All (SS4A) grant funding to create a Vision Zero Action Plan for each agency. Specific to Superior, this project has analyzed historic crash activity on Superior roadways to current safety trends and incorporated community input gathered in summer 2024 to characterize roadway safety and develop a vision and plan for improving safety. The Federal Highway Administration recommends that municipalities take a holistic view of Vision Zero plans to create a safe system that anticipates human mistakes and keeps impact energy on human body at tolerable levels. The Superior Vision Zero Action Plan relies on a thorough understanding of motor vehicle, bicycle, and pedestrian crash trends to inform strategic investments in safety improvements aimed at decreasing fatal and severe injuries on roadways throughout the Town. This memorandum documents the overview of historical crash trends within Superior and development of the High-Injury Network (HIN) and High-Risk Network (HRN).

Definitions

The list below provides definitions for terms that are used throughout the memorandum.

First Harmful Event: The first harmful event is the first point of injury or damage in the sequence of events in a crash.

Approach Turn Crash: Crashes that occur when someone turns left in front of oncoming traffic without yielding the right-of-way.

Pedestrian and Bicycle Involved Crash: This crash type involves a motor vehicle and at least one person who is walking, rolling, or biking.

Broadside Crash: Also known as a T-bone crash, a broadside crash happens when the front end of one car crashes into the side of another car.

Fixed Object Crash: This crash type involves a motor vehicle and a stationary object such as utility poles, guardrails, trees, or buildings

Rear-end Crash: This crash type occurs when the front of one vehicle collides with the back of another vehicle

High Injury Network: a roadway network that identifies locations where the most injury crashes are occurring based on historical crash data.

High Risk Network: identifies contextual factors related to historical crashes to identify locations where there is a high risk for potential crashes in the future based on roadway characteristics.

Methodology: Data Collection & Study Area

Crash data within Superior was obtained from January 1, 2013 to December 31, 2022 from crash data provided by Colorado Department of Transportation (CDOT). At the time of analysis, 2023 crash data was not available. The study area included an analysis of all Town of Superior roadways and intersections which consist of approximately 63 centerline miles. This excludes crashes on Highway 128, with the exception of the segment that is in Jefferson County.

Other areas of Highway 128 in Boulder County were included in the Unincorporated Boulder County analysis and Action Plan. Highway 128 is a CDOT-owned roadway and requires coordination with CDOT Region 1. The data presented in this memorandum is the latest available data, however, it is subject to change as new information is obtained in the years to come and traffic safety trends should be monitored in future years beyond the scope of this project.

Safety Analysis Summary

This section provides a summary of reported crashes within the ten-year data for the motor vehicle, bicycle, and pedestrian crashes in study area using CDOT data. The primary goal of this analysis is to identify trends and high-risk factors that are associated with injury and fatal crashes. During the ten-year period from January 2013 to December 2022, there were a total of 744 crashes in the Superior study area. Of the 744 total crashes, there were 8 serious injury crashes and 1 fatal crash. Figure 1 displays the number of all crashes and breakdown by severity for each year.

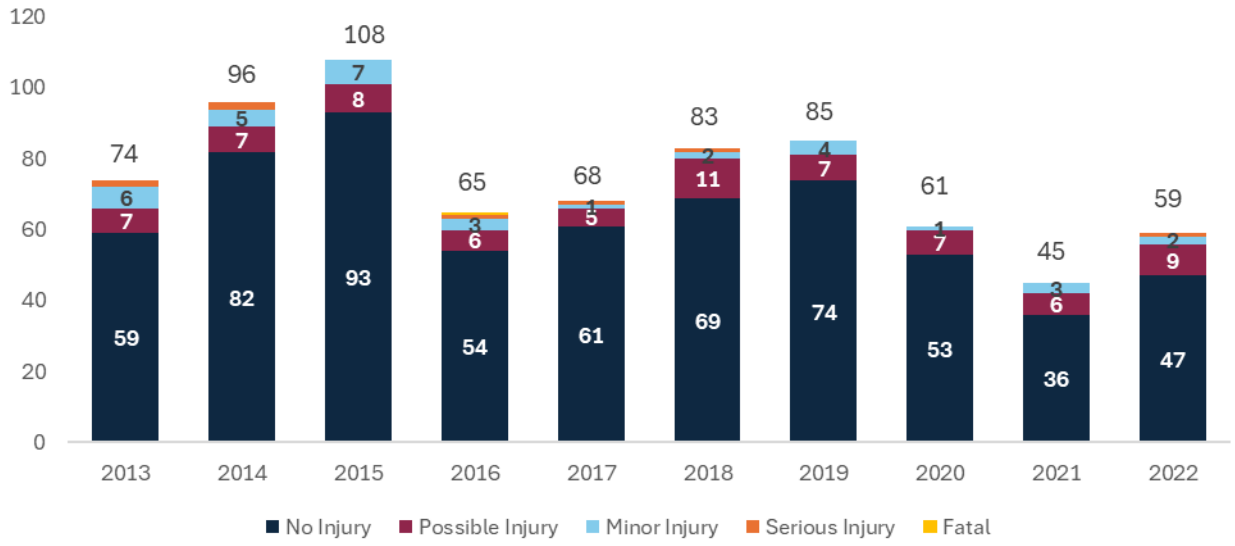

Figure 1. All Crashes by year and Severity in Town of Superior

Crash Types

Table 1 shows the distribution of crashes in Superior by crash type from highest. The most frequently reported crash type was rear-end crashes (33% of all reported crashes) followed by parked motor vehicle crashes (13% of all reported crashes) and broadside crashes (11% of all reported crashes). Together, these three crash types make up over half of all crashes. Pedestrian and bicycle crashes made up approximately 2% of all crashes.

Table 1. Town of Superior – Summary of Crash Types (All Crashes)

Crash Type	% of All Crashes
Rear End	33%
Parked Motor Vehicle	13%
Broadside	11%
Fixed Object	10%
Sideswipe (Same Direction)	10%
Approach Turn	9%
Curb/Median	3%
Overtaking Turn	2%
Overturning	2%
Bicycle	1%
Animal	1%
Pedestrian	1%
Guard Rail	1%
Head On	1%
Sideswipe (Opposite Direction)	1%
Other/Unknown	0.39%
Barricade/Traffic Barrier	0.26%
Embankment/Ditch	0.26%
Large Boulder	0.26%
Road Maintenance Equipment	0.13%
Vehicle Cargo/Debris	0.13%

Top crash types were also identified based on the injury crashes (minor injury, serious injury, and fatal). 78% of all injury crashes were from approach turn crashes, bicycle/pedestrian involved crashes, broadside crashes, fixed object crashes, and rear-end crashes. Table 2 summarizes the distribution of top injury crashes. Approach turns, broadside, and bicycle/pedestrian crashes are overrepresented in the injury crash type data. Although bicycle and pedestrian crashes only account for 2% of all crashes, they account for 25% of injury crashes. Similarly, approach turns only account for 9% of all crashes, but they account for 21% of all injury crashes. Rear-end crashes are the most common crash type for all crashes, but are less likely to result in an injury crash as they account for 33% of all crashes, but only 9% of injury crashes. Reviewing crash trends that result in injury is critical and aligns with the Vision Zero model of aiming to reduce fatalities and serious injuries on roadways.

Table 2. Town of Superior – Summary of Top Crash Types (Injury Crashes)

Crash Type	% of Injury Crashes
Approach Turn	21%
Bicycle	19%
Broadside	13%
Fixed Object	11%
Rear End	9%
Pedestrian	6%

Where Crashes Are Occurring

A heatmap of all crashes in Superior from 2013 to 2022 is shown in Figure 2. Most crashes are concentrated in the northern part of the town near the US 36 interchange. Figure 3 displays the locations where injury crashes are occurring by minor injury, serious injury, and fatal crashes. Figure 4 describes the summary of location where all crashes are occurring. The majority of the crashes are occurring at intersections with 55% occurring at intersections (signalized, two-way stop controlled, or all-way stop controlled), 27% occurring at non-intersections, and 9% occurring at roundabouts.

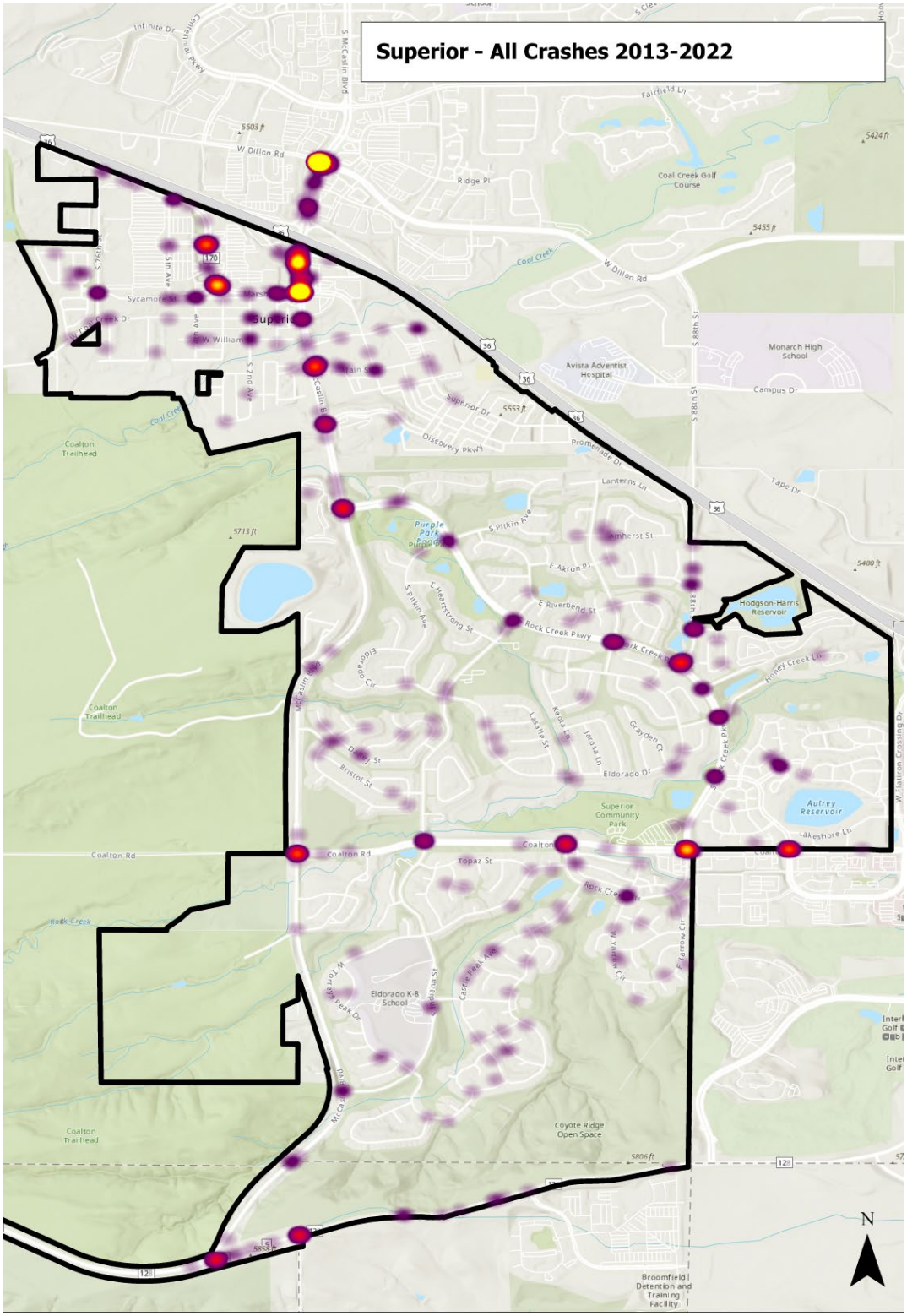

Figure 2. Town of Superior – All Crashes

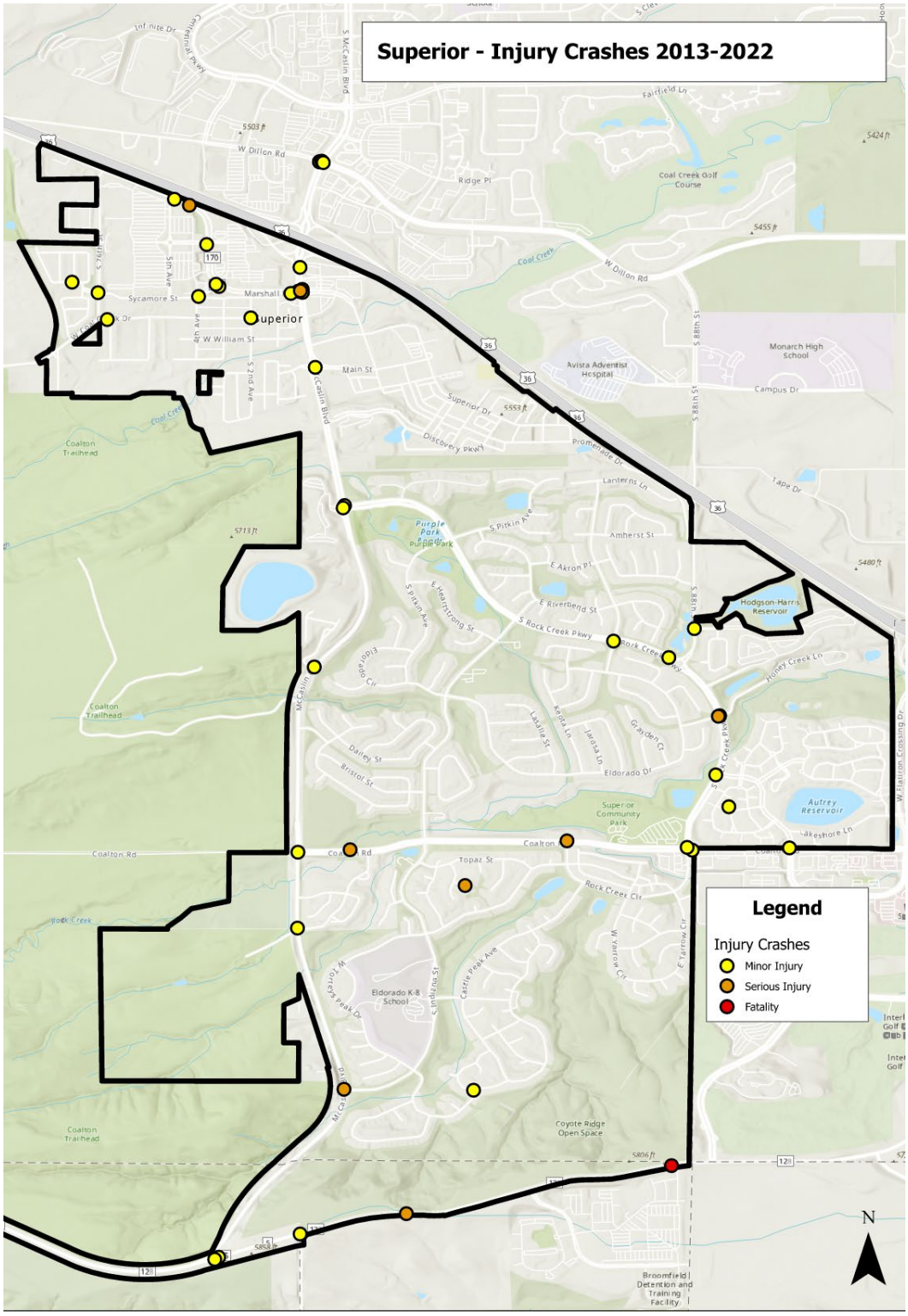

Figure 3.Town of Superior – Injury Crashes

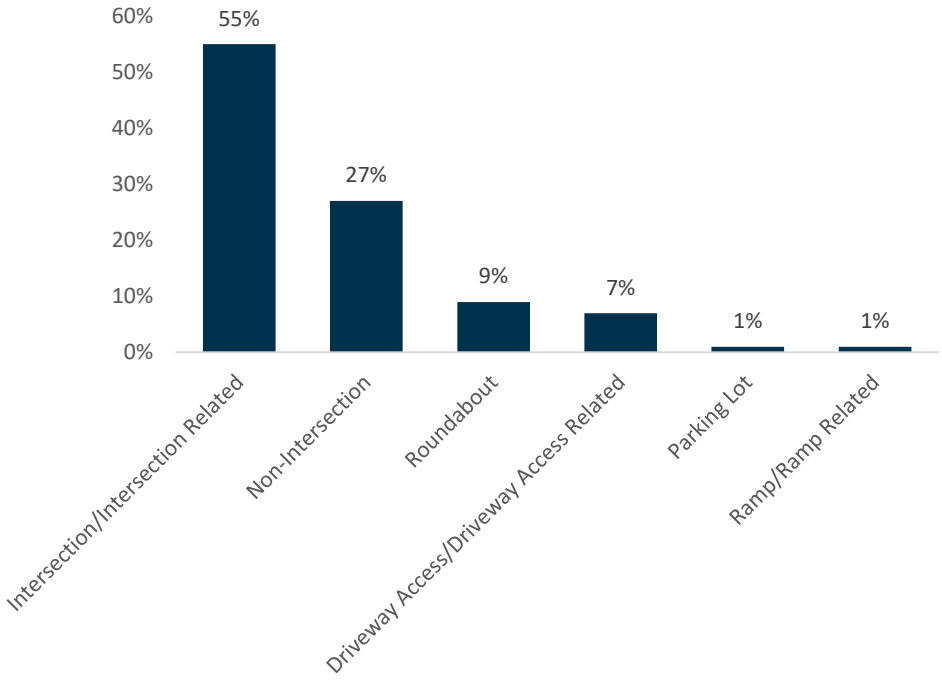

Figure 4. Town of Superior – Location Description (All Crashes)

When Crashes Are Occurring

Figure 5 shows the frequency of crashes in Superior by month. The months with the greatest percentage of crashes are October through February. From March to September, there was a decrease in the frequency of crashes. Increased crashes in the winter months may coincide with snow and ice on the roadways and increased hours of dark light road conditions. Figure 6 displays the road conditions for all crashes. Most crashes were occurring in dry roadway conditions whereas 12% of crashes were occurring when it was snowy, slushy, or icy and 8% of crashes were occurring when the road was wet.

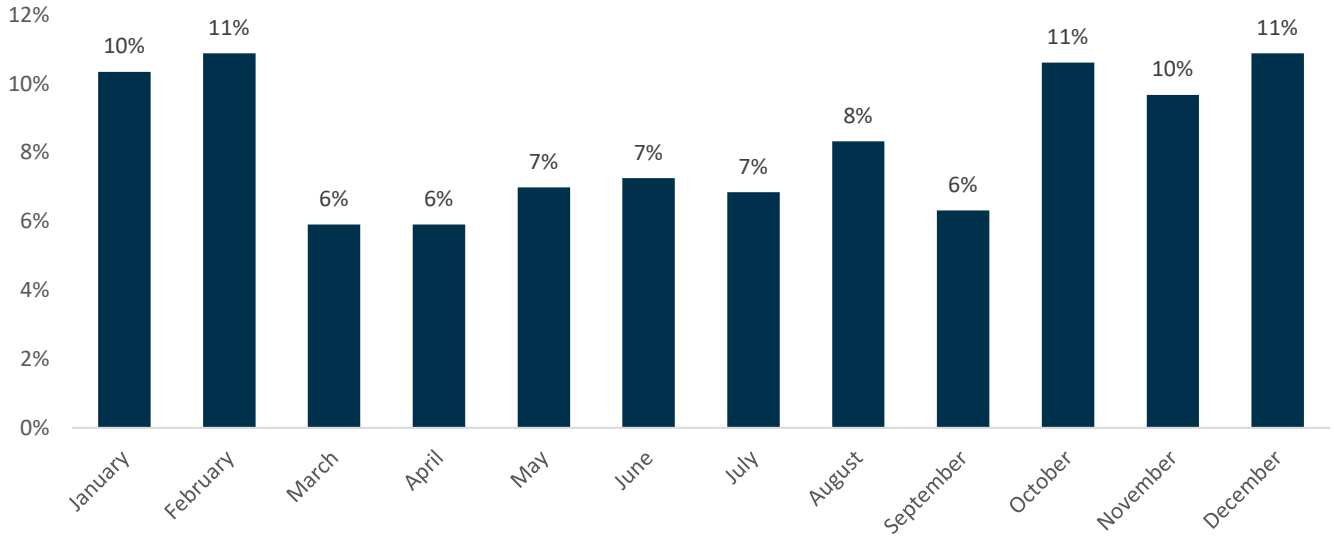

Figure 5. All Crashes by Month in Town of Superior

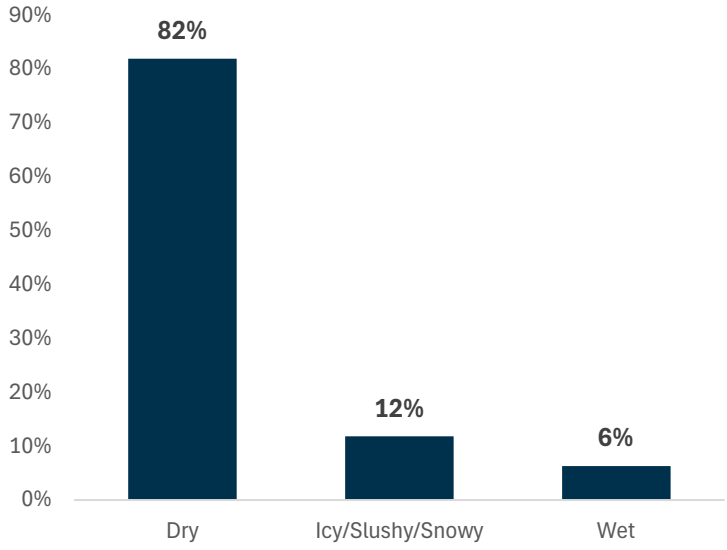

Figure 6. Town of Superior – Road Condition

Figure 7 displays the summary of all crashes by time of day. Most crashes in Superior occur from 12PM-3PM (29% of all crashes) with the second highest time period being 3PM-6PM with 26% of all crashes. **Figure 8** displays how the crashes are distributed by lighting conditions over the course of a day. Most crashes occur in the daylight (70% of all crashes). However, 23% of crashes are occurring when the lighting conditions are dark lighted or dark unlighted and 8% of crashes are occurring during dusk/dawn.

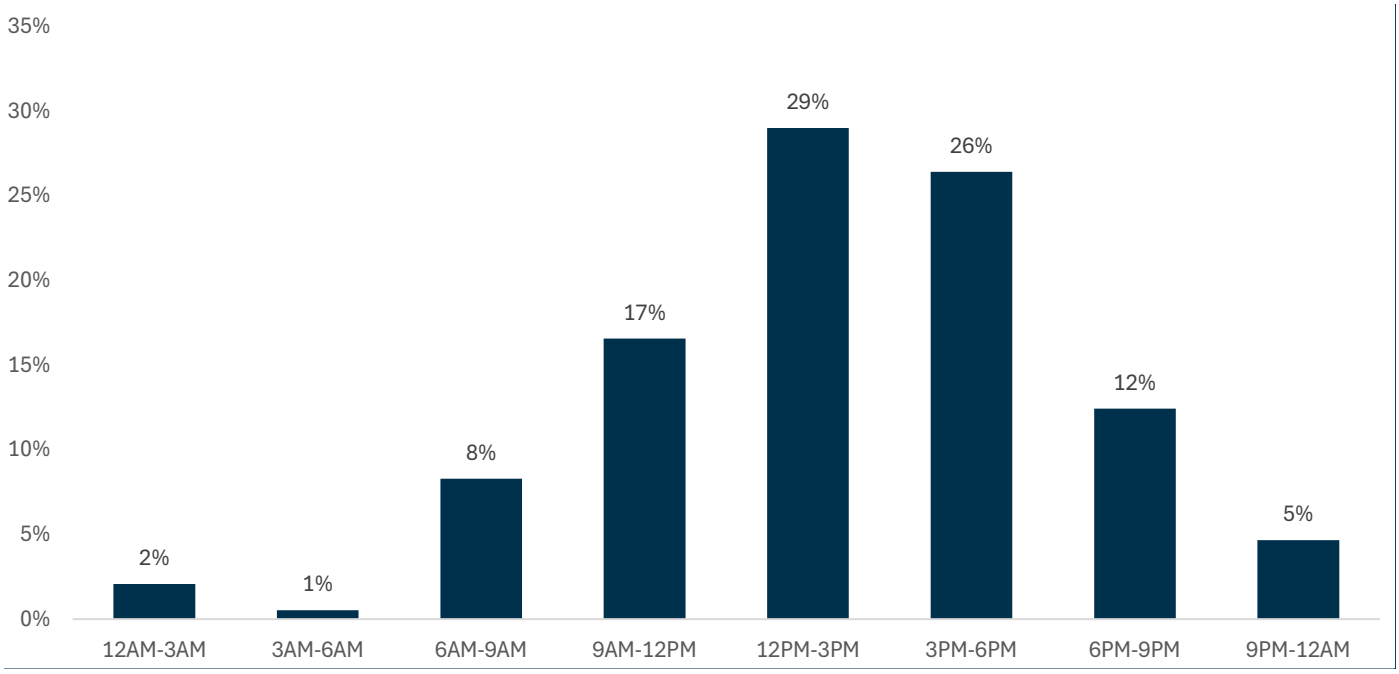

Figure 7. All Crashes by Time of Day in Town of Superior

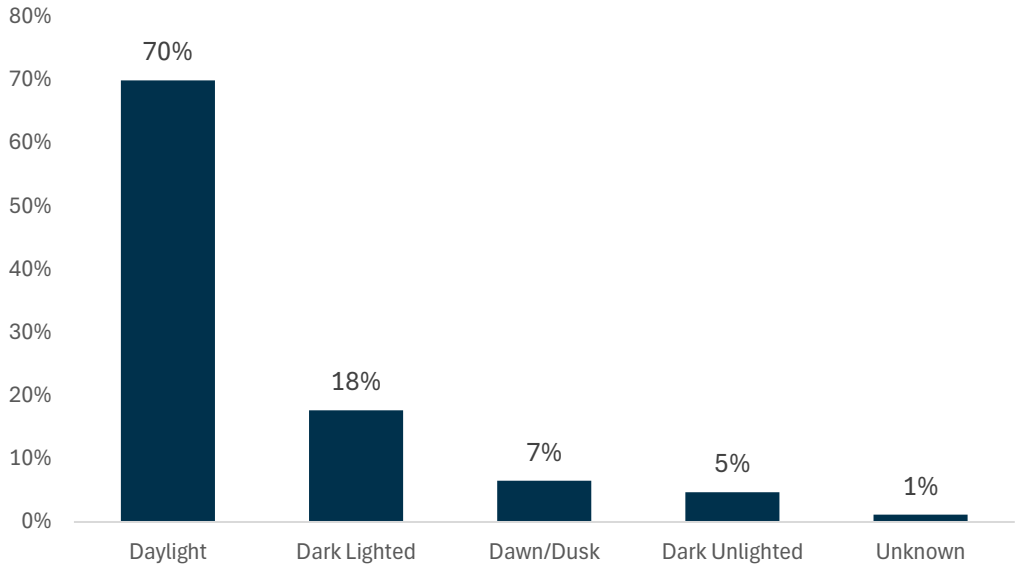

Figure 8. Town of Superior – Lighting Condition

Crash Characteristics and Contributing Factors

Figure 9 displays the vehicle type for the vehicle at fault. The majority of the vehicles at fault include a passenger car or an SUV. Figure 10 displays the movement of the vehicle at fault. The top two movements are going straight (36%) and making a left-turn (16%).

The top driver actions for the vehicles at fault include:

- Carless Driving – 43%
- Followed Too Closely – 7%
- Driver Under Influence of Alcohol – 3%
- Unsafe Backing – 3%
- Left-turn/Oncoming Traffic – 2%

The top human contributing factor for the vehicles at fault include:

- No Apparent Contributing Factor – 36%
- Unknown – 24%
- Driver Inexperience – 14%
- Driver Preoccupied – 14%
- Driver Unfamiliar with Area – 7%

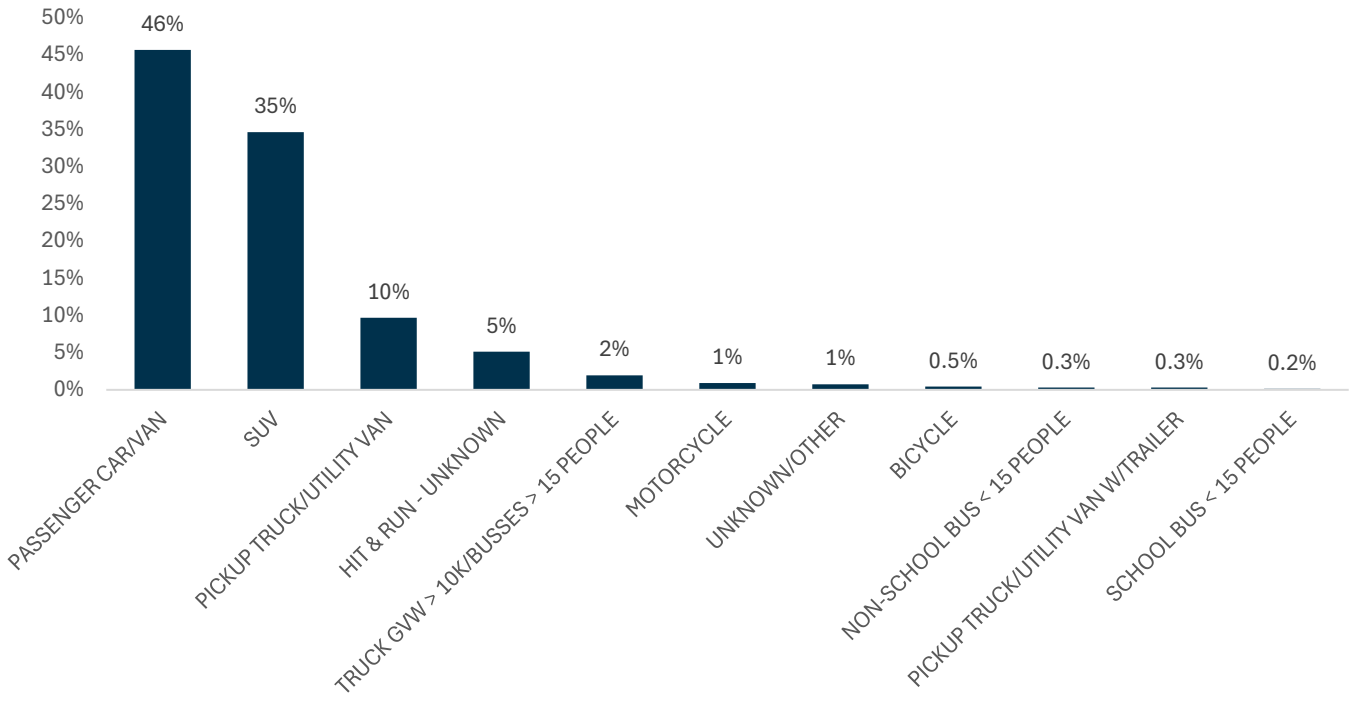

Figure 9. Town of Superior – Vehicle Type of Vehicle at Fault

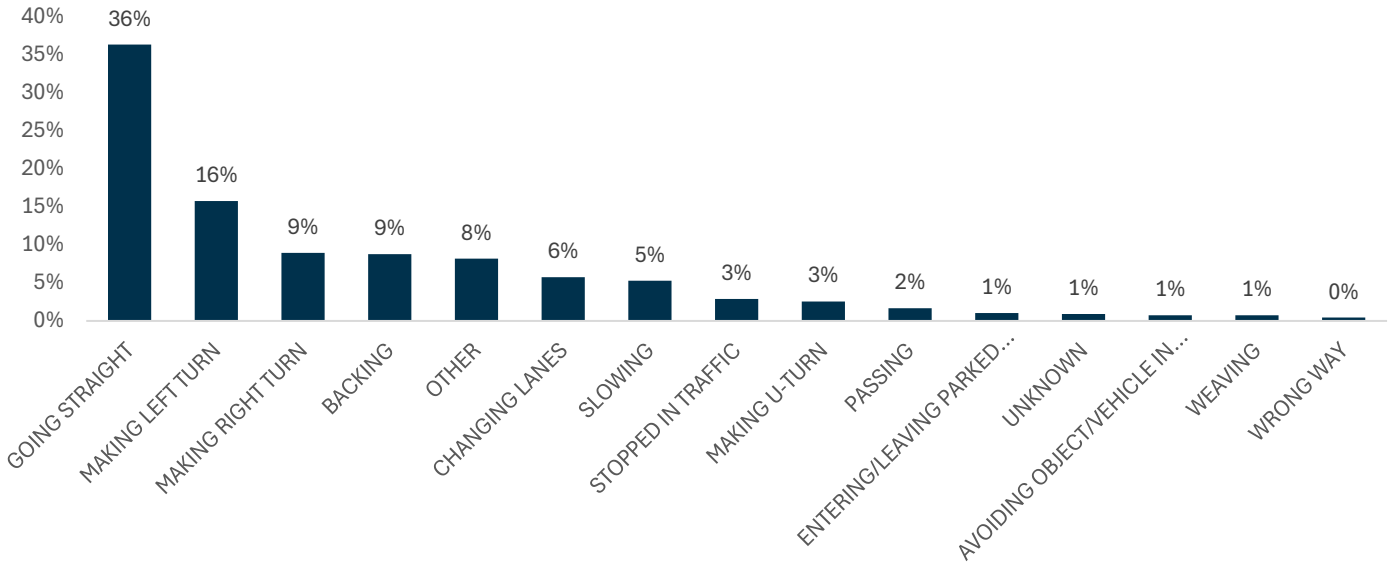

Figure 10. Town of Superior – Movement of Vehicle at Fault

High Injury Network (HIN) Development

The ten-years of CDOT crash data in Town of Superior was utilized to develop a High Injury Network (HIN), which is a network of roadway segments and intersections that historically show a higher concentration of crashes resulting in injury. The HIN provides a framework for identifying high priority locations to focus improvements designed to address traffic fatalities and injuries. Development of a HIN assists Superior staff focus resources on where safety improvements are most critical. Further data analysis of roadway characteristics along the HIN allows for identification of appropriate safety countermeasures.

Due to the relatively small dataset of fatalities and serious injuries in Superior (8 serious injury and 1 fatality in the ten-year data set), minor injury crashes were also included in the analysis to improve the ability to reach meaningful conclusions. To maintain a focus on areas with high rates of fatalities and serious injuries, crashes were weighted according to their severity with minor injuries having a weight of 1, serious injuries having a weight of 2, and fatalities having a weight of 4.

To avoid roadway segments where most injury crashes were occurring at intersections appearing on the high injury network, it was decided to analyze intersection crashes separately from segments. This separation of injury crashes allowed the project team to more clearly pinpoint locations where injury crashes are occurring and improve the accuracy of the HIN. Following this separation, the project team determined that there were not any significant concentrations of injury crashes occurring along segments. As such, the high injury network analysis was focused only on intersections with high concentrations of injury crashes.

Intersection points were created at the intersections of each roadway segment. Intersection points that included only local roadway segments were buffered by 50ft, while intersection points with non-local roadway segments were buffered by 75ft. These two buffer layers were combined into one full dataset comprising the buffers for all intersections.

The total number of crashes as well as the sum of the crash weights occurring within each intersection was summarized. Intersections with 2 or more weighted crashes were selected to be included on the HIN. In summary, 413 total intersections were analyzed and the HIN consists of 8 intersections, resulting in the HIN consisting of only 1.9% of the total intersection network in Superior. **Figure 11** displays the High Injury Network in Superior.

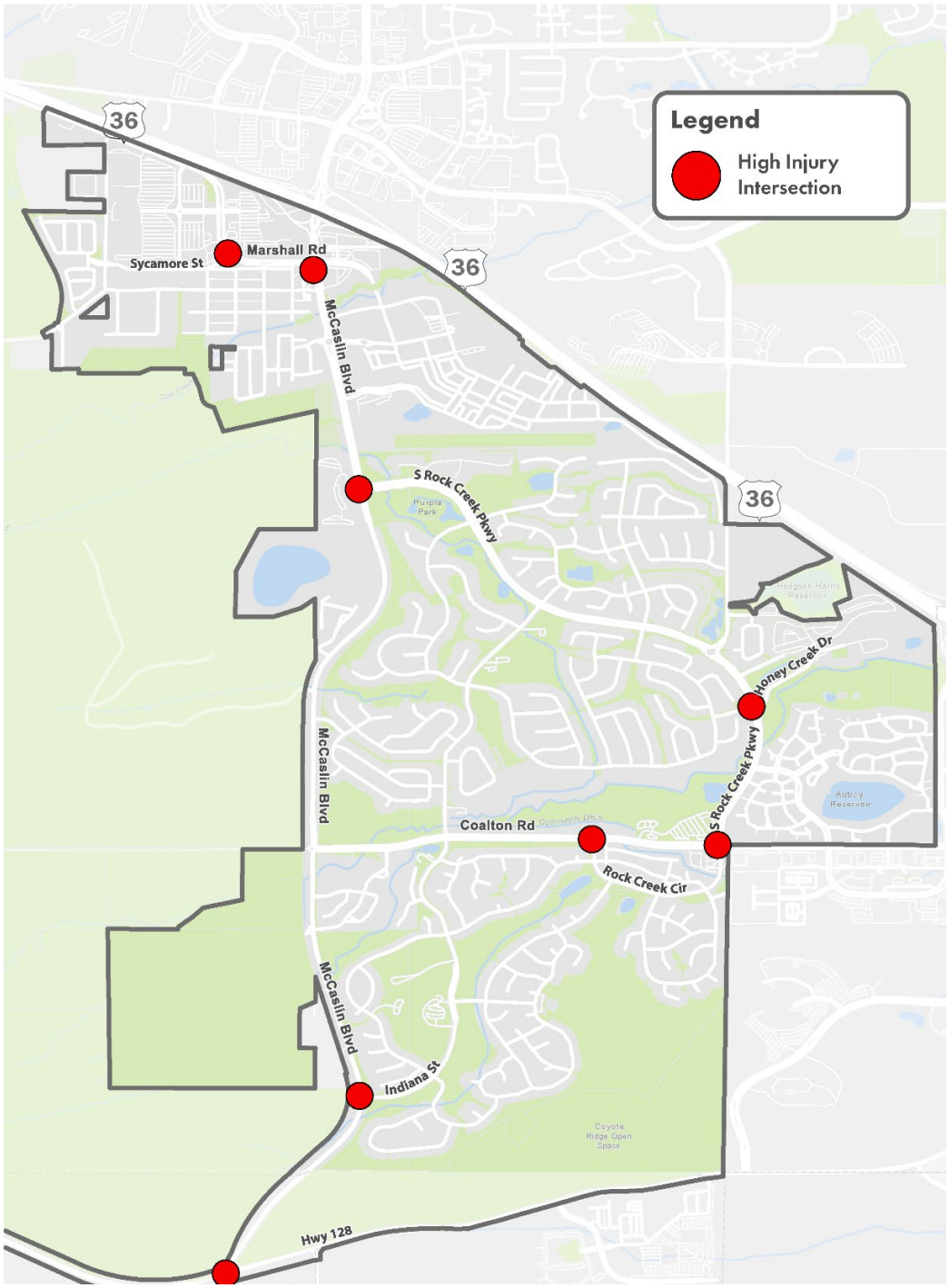

Figure 11. High Injury Intersections in Superior

High Risk Network (HRN) Development

Crash data and roadway characteristics were used to develop a High Risk Network (HRN), which is a network identifying areas where conditions may increase the risk of serious injury or fatality crashes occurring. The HRN can be used to proactively address locations that have risk of future serious injury or fatality crashes, rather than implementing safety measures reactively following such incidents.

Determination of risk factors along Superior roadways was somewhat constrained by data availability. Data regarding roadway functional classification, speed limit, crossing type, sidewalk presence, signal timing, streetlights, transit facilities, trailheads, and schools was available at the onset of this effort. Aerial imagery was used to verify and update this existing data, as well as to create new layers displaying the number of travel lanes and locations of medians in Superior.

The relatively small number of injury crashes in Superior limited the accuracy of identification of risk factors based on historic crash data. Instead, the project team focused on known risk factors based on engineering judgement to determine appropriate risk factors to apply to the Superior network. The risk factors used for this analysis were:

Risk Factor	Thresholds
Functional Classification	Collector/Arterial
Speed Limit	30 MPH or Greater
Number of Lanes	4 or more Travel Lanes
Presence of Bicycle Lane	No
Sidewalk	No
Zoning/Land Uses	Commercial/Downtown
Zoning/Land Uses	Access to School (1/4 mile)
Crosswalk	Unmarked or Partially Marked

To apply these risk factors to the Superior network, street centerline data was broken into segments, with each segment being assigned a score depending on the number of risk factors present. Visual analysis of the existing available centerline data showed roadway segments broken into varying lengths, primarily split at intersections. In order to connect roadways across intersections and provide more control over segment length, centerlines were dissolved using the roadway name. Centerlines with collector or arterial functional classification were then split at intersections with other arterials and collectors. Segments were manually divided further to account for transitions in speed limit or number of travel lanes. All segments were assigned a unique segment ID. Individual layers were created displaying the locations of each risk factor, and then spatially joined to segments meeting those factors. Segments were assigned a value of “1” for each risk factor they met, and then those values were summed to determine the overall risk score for each segment. Figure 12 displays the number of risk factors for each segment of roadways in Superior. Segments with 4 or more risk factors were selected to be included on the High Risk Network. Figure 13 displays the proposed high-risk network including the roadways that had 4 or more risk factors.

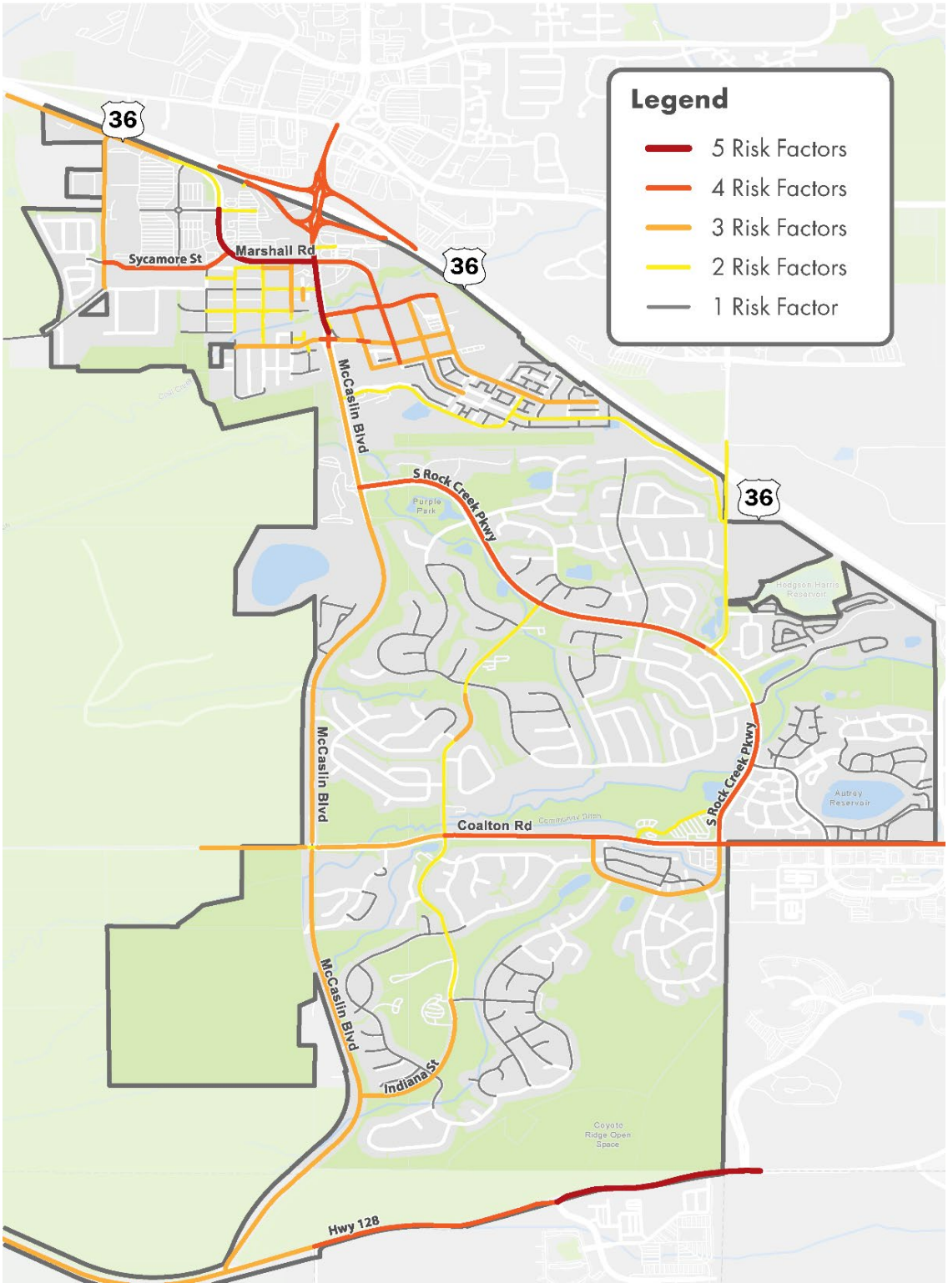

Figure 12. Superior Risk Network by of Number of Factors

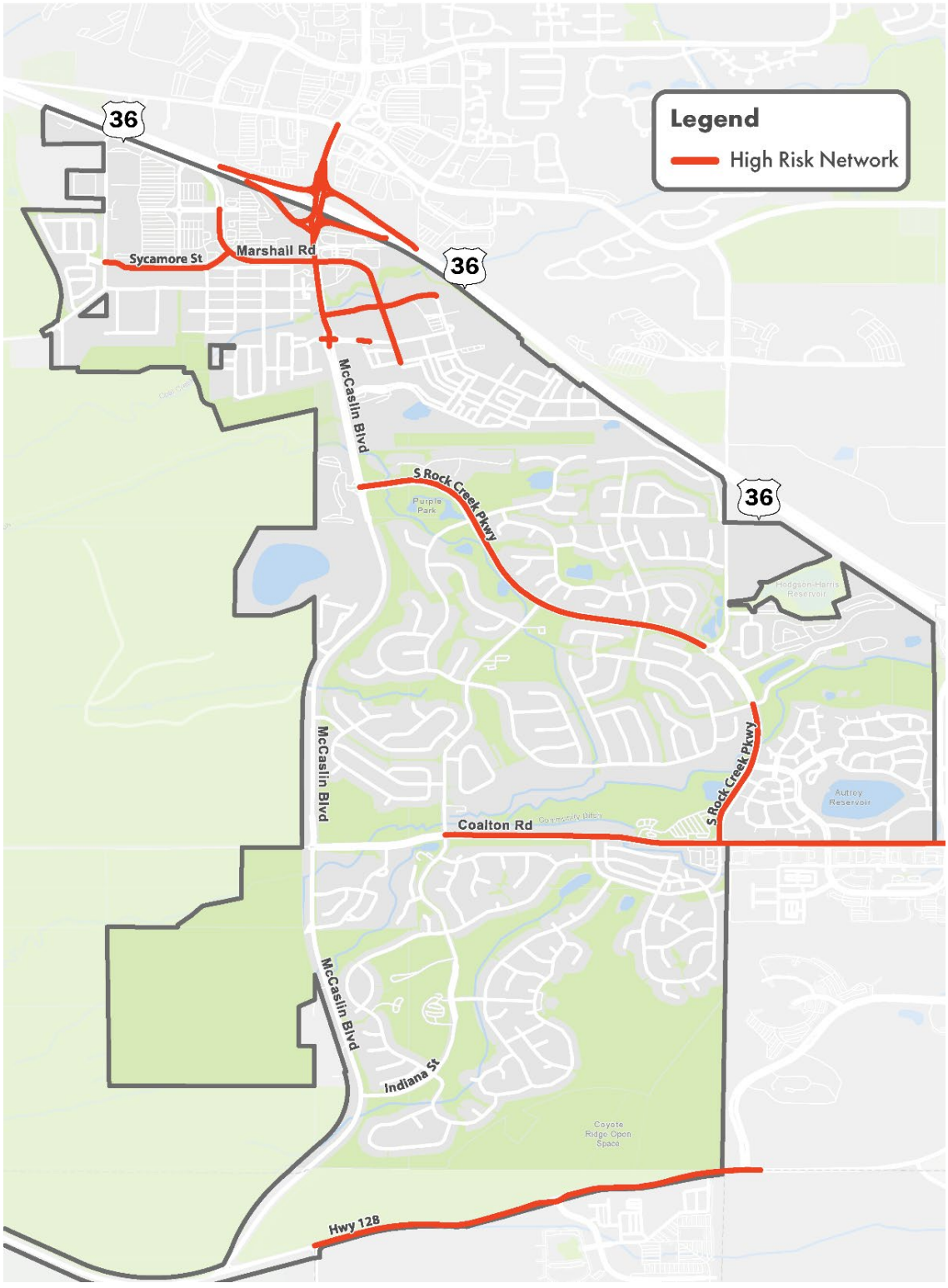

Figure 13. Town of Superior High Risk Network

High Injury Network, High Risk Network, and Public Outreach Overlay

The HIN, HRN, and Phase 1 public outreach comments were overlayed with each other to understand if there were gaps with the HIN and HRN and where the public left comments. **Figure 14** displays the HIN, HRN, and outreach overlayed onto one map to help identify gaps. Locations that received comments, but weren't on the HIN or HRN:

- McCaslin Boulevard between Main Street and Rock Creek Parkway
- McCaslin Boulevard near Coalton Road
- Downtown Superior

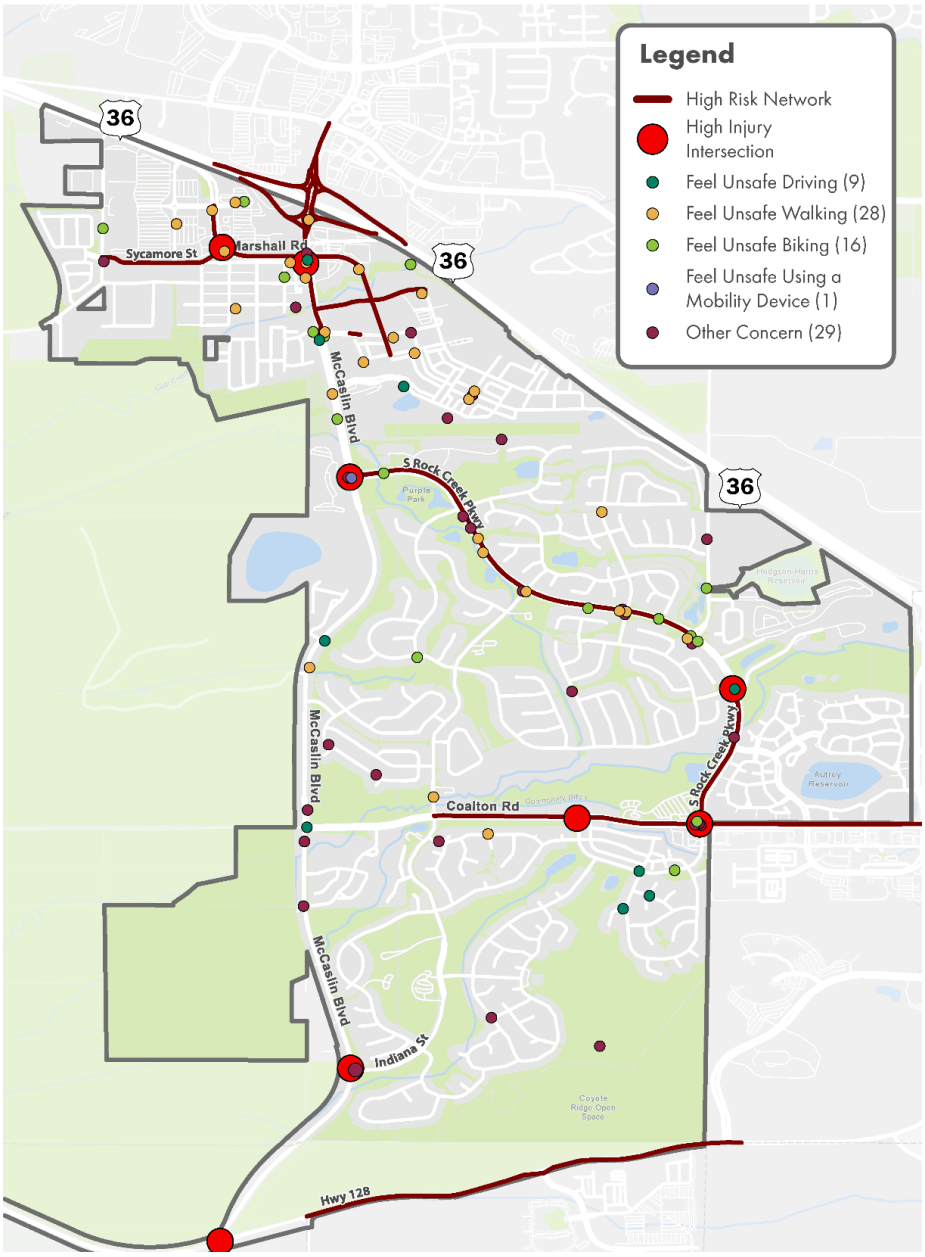

Figure 14. Town of Superior HIN, HRN, and Public Outreach Overlay

National and Statewide Road Safety Context

National and statewide statistics were analyzed to better understand Superior's crash statistics compared to regional and national trends. The Colorado Crash Data Dashboard developed by CDOT summarizes statewide crash data from 2010 to 2024 and was used as the source for statewide data[1]. National crash data was obtained from the National Highway Traffic Safety Administration's annual crash reports which contain data from 1988 to 2021[2]. The total amount of crashes for each analysis year was compared between Superior, Colorado statewide, and national data. Figure 15 displays the growth rate between the last five successive years calculated for Superior, Statewide, and National.

The growth rates for the national and statewide data follow similar trends. Superior generally follows the same trends except for 2021 and 2022. This is potentially because statewide and nationally, traffic crashes likely increased correlating with increasing traffic volumes in 2021 after the after Covid-19, where Superior's traffic crashes remained lower in 2021 and grew in 2022. Additionally, since Superior's data set is much smaller sample size than the national or statewide data sets, percentages are subject to significant variability.

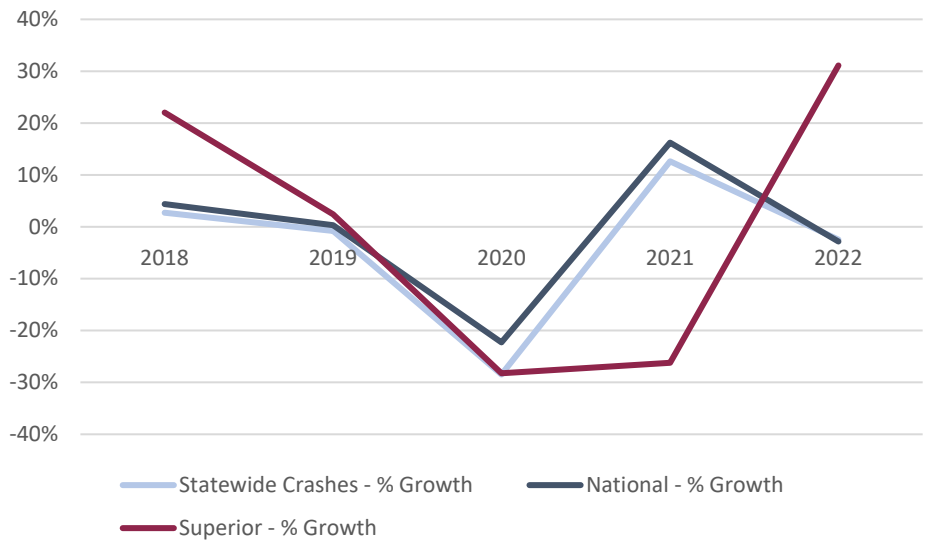

Figure 15. Crash Growth Rate for Superior, Statewide, and National , 2016-2022

Figure 16 displays the severity of crashes for all three sets of data. The Superior and state data classifies injury severity into five categories: no injury, possible injury, minor injury, serious injury, fatal. Whereas the national data separates into three categories, no injury, injury, and fatal.

[1] Colorado Department of Transportation - Colorado Crash Data Dashboard

[2] National Highway Traffic Safety Administration - Traffic Safety Facts Annual Report Tables

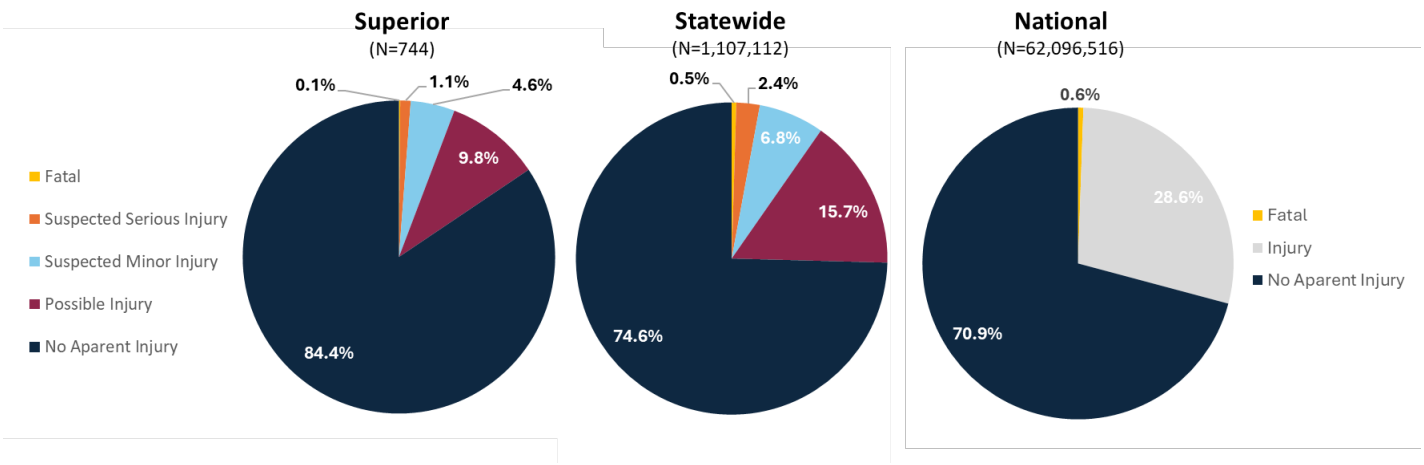

Figure 16. Crash Severity Comparison of Superior, Statewide, and National Crashes, 2013-2022

Conclusion

Ten years of crash data was obtained from CDOT from January 1, 2013 to December 31, 2022 for completion of the safety analysis and developments of the HIN and HRNs. The following key findings are based on a review of crash data from 2013 to 2022:

- Over the January 2013 to December 2022 ten-year analysis period, 1 person died and 8 were seriously injured in traffic crashes in Superior.
- A total of 744 crashes were reported in the ten year study period, which is an average of 74 crashes per year.
- Most crashes result in no injury (84.4%), 4.6% result in minor injury, 1.1% result in serious injury, and 0.1% result in fatality.
- Majority of crashes (55%) are occurring at intersections.
- Rear-end crashes were the most common crash type, followed by parked motor vehicles crashes. These two crash types account for almost half of the total crashes (46%).
- Approach turns, pedestrian/bicycle, broadside, fixed object, and rear-end crashes make up 78% of injury crashes.
- A high-injury network (HIN) identifying locations where the highest number of injury crashes have been occurring based on historical crash data has been developed to assist Superior in **prioritizing locations with highest need for safety improvements.**
- A high-risk network (HRN) identifying locations where the highest potential for crashes based on roadway characteristics has been developed to assist Superior in **proactively and systemically addressing locations with safety improvements before serious crashes occur.**
- Superior experiences a smaller percentage of fatal and serious injury crashes compared to statewide and national averages.