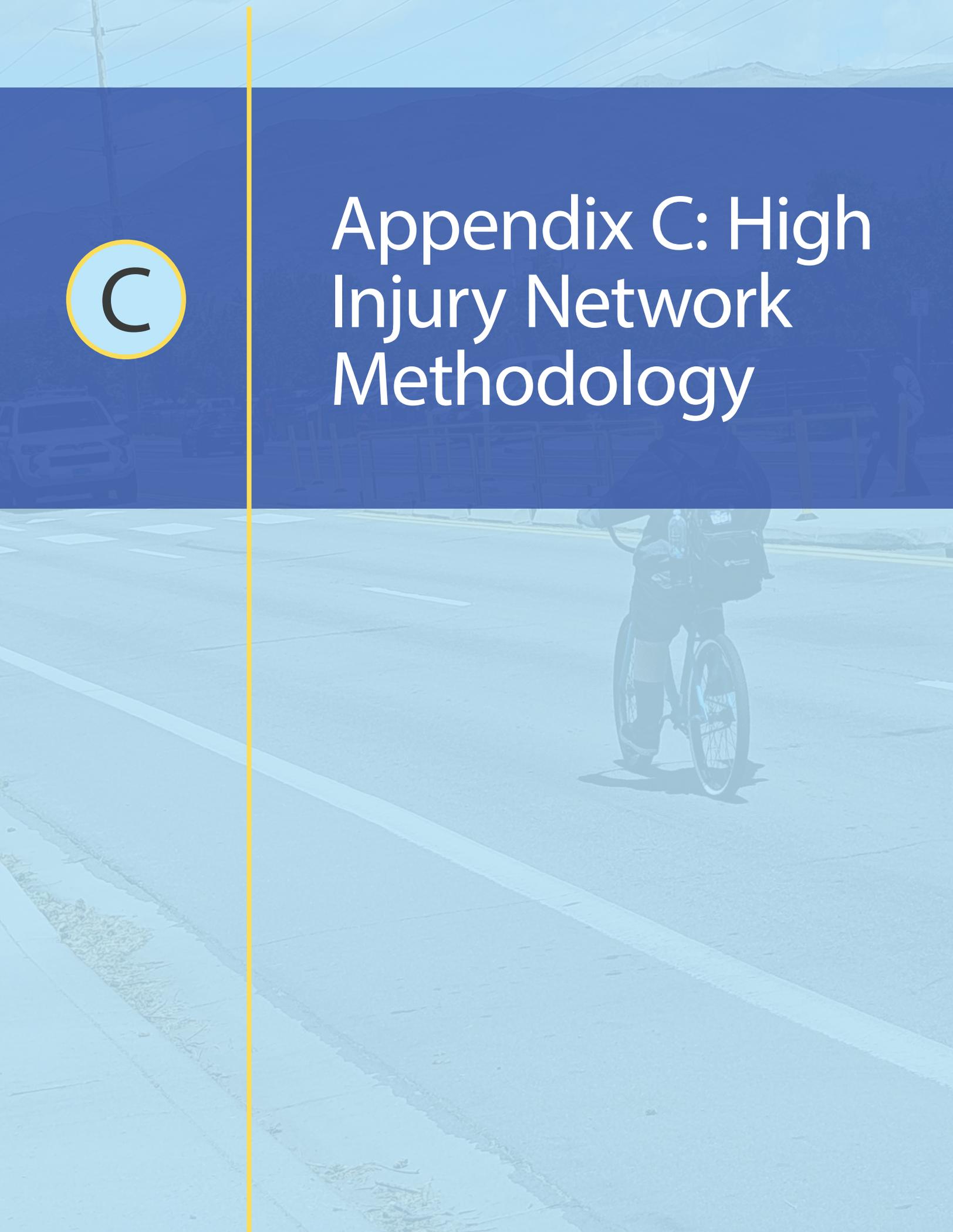




# Appendix C: High Injury Network Methodology





To: Scott Bohemier, Project Manager, Carson City  
From: Cole Peiffer, Project Manager, Alta Planning + Design  
Date: May 1, 2025  
Re: Carson City SRTS Action Plan - High Injury Network Methodology

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## High Injury Network Development

### Introduction

A High Injury Network (HIN) is a data-driven tool used to identify the small percentage of roadways where a disproportionate number of fatal and serious injury crashes occur. These networks are critical in understanding where countermeasures can have the greatest impact on reducing crashes that lead to life-altering injuries or deaths. By focusing resources on these high-risk roadways, counties and municipalities can address systemic safety challenges and make meaningful progress toward goals like Vision Zero, which aims to eliminate traffic-related fatalities and serious injuries.

The development of an HIN moves beyond simply analyzing crash histories; it provides critical insights into the patterns, characteristics, and systemic factors that contribute to crash risks. This method emphasizes prioritizing safety improvements on corridors where the potential for reducing serious crashes is highest, ensuring that investments in safety improvements are both effective and equitable. While the SRTS Action Plan is focused primarily within one mile from a priority school, the HIN will cover all of Carson City.

This memorandum outlines Alta’s methodology for analyzing crash data and developing the HIN for Carson City. It details the inputs, data preparation, and analytical processes required to identify high-injury corridors, offering a roadmap for addressing the most pressing safety issues in the city’s transportation network.

### Inputs

Alta will use the following data sets to develop a High Injury Network for Carson City:

**1) Crash layer:** Five-year crash data (2019 – 2023), from NDOT - provided by CAMPO.

- Inclusive of motor vehicle, bicyclist, pedestrian, and motorcycle crashes.
- Removed crashes outside of city limits.
- Removed crashes on limited-access interstates from this analysis using ArcGIS Pro.
- Filtered crashes to remove Property Damage Only (PDO) severity crashes involving a vehicle or motorcycle.  
Property Damage Crashes
- Checked crash points for unique crash identification numbers to confirm no duplicate records were included.
- Tagged crashes that were within 1-mile of one of the 11 priority schools.

**2) Street Centerlines:** GIS Streets, obtained from the Carson City open data portal

- Removed limited-access interstates and ramps. (I-580)
- Removed streets outside of city boundaries
- Consolidated divided roads so each roadway is represented by a single line.

- Used “unsplit lines tool” to merge road segments based on road name and functional classification. This eliminates any arbitrary splits in the centerline shapefile.
- Divided centerlines into segments of approximately 0.25 miles (1,320 ft.) each so that crashes can be summarized for segments of equal length.
- Created unique IDs for roadway segments.

## Methodology

Alta used the following methodology to develop a High Injury Network for Carson City:

### 1. Prepare the Crash Data:

- a. Weight each crash based on the most serious injury sustained by any individual involved in the crash. This effectively prioritizes areas where more serious crashes are occurring to identify areas where the most serious injuries can be reduced. These proportions are based on the ratio of the average cost to society from fatal and serious crashes compared to minor injury crashes. While some analyses may weight serious crashes higher in proportion to minor crashes, that can lead to every segment with a fatal crash being represented on the HIN. Using this ratio avoids overweighting fatal crashes that occur as isolated events so that the HIN can represent roadways with patterns of serious crashes.<sup>1</sup>
  - Fatal injury (K) or serious injury (A): 4
  - Minor (B), Possible (C), or Unknown injury: 1
  - Bike or Pedestrian involved PDO crash (O): 1
- b. Snap all analysis crashes within 250 feet of the street centerline network to a prepared network segment. This distance generally accounts for collisions on divided highways that occur far from the now-consolidated centerline (such as wide highways) but is not long enough to capture collisions that occurred in parking lots adjacent to roadways. Crashes that were within 50 feet of a major road were snapped to the prepared network segments. This accounts for crashes at intersections between local roads and major roads. Crashes are joined to the higher speed and higher volume roadways rather than smaller side streets.

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<sup>1</sup> There are many calculations of average cost of serious and fatal crashes. The ratio shown here is based on FHWA’s *Crash Costs for Safety Analysis* (Harmon et al, 2018), table 17. The weights shown here are proportional to the average of the square root of costs to society of serious crashes (fatal and serious injury) compared to the baseline of minor-injury crashes. Source: <https://safety.fhwa.dot.gov/hsip/docs/fhwasa17071.pdf>.

## 2. Prepare the Street Network:

- c. Create a Rolling Window / Sliding Window feature class where the lines are extended over each road segment approximately 1,320 feet, or 0.25 miles, with a 25% overlap in each direction (330 feet), for a total rolling segment length of approximately 1,980 feet. Alta will use custom splitting tools that have an overlap percentage (Wasserman, 2023). Lines will overlap with adjacent lines by the 25% set percentage. This process allows rolling window statistics to be calculated on each road segment. The benefits of rolling window analyses are that they reduce the impact that dead-end streets, the [boundary effect](#) (where boundaries from the centerline file are imposed on unbounded crash data), or anomalous crashes have on the final HIN. Fundamentally, it better captures the linear corridor crash patterns where they exist (Fitzpatrick, 2018)<sup>2</sup>. The rolling window concept is illustrated in **Figure 1**.

## 3. Applied Rolling Window Analysis:

- d. Spatially joined the crash layer to the rolling window road network.
- e. Calculated the summed rolling crash weight for each rolling road segment. This sums the weight of crashes on each rolling segment to reflect total crash severity on each segment.
- f. Rejoined the rolling crash weight from the rolling window layer to the original centerline network to calculate the rolling crash weight per mile for each segment. This step normalizes the crash weight based on road length. For segments shorter than 0.25 miles, a minimum length of 0.25 miles was applied to prevent overrepresenting crashes on small road segments, as dividing by very small numbers can produce disproportionately large values.

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<sup>2</sup> These patterns would take into account collisions sometimes not directly on a particular segment in order to smooth out analysis results. Examples of this type of analysis are provided by FHWA in their [Guide Book on High Pedestrian Crash Locations](#).

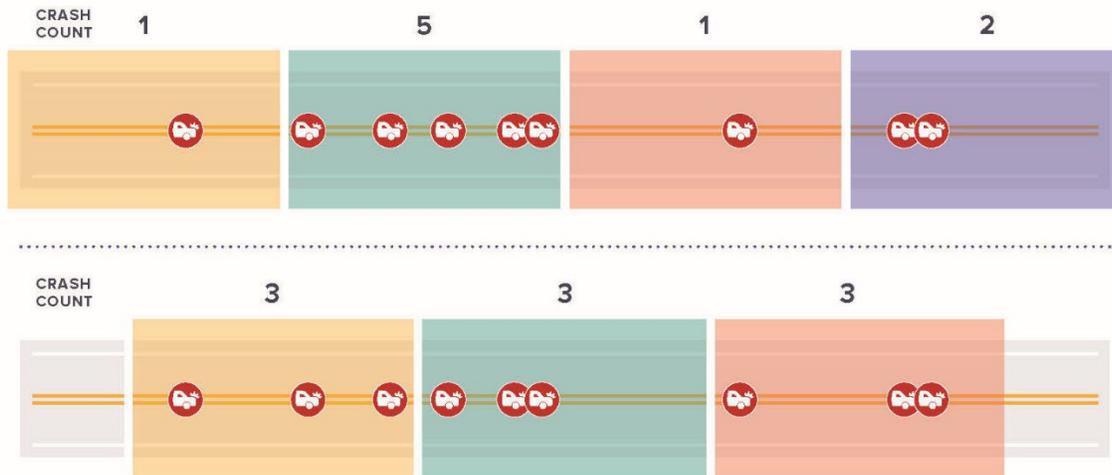
Alta Civic Analytics Explainer

# Rolling Window Approach



**Segmented roadways can be misleading.**

The same roadway, segmented in two different ways, paints a different picture of where crashes are happening. Where segments get divided is somewhat arbitrary.



**The rolling window approach more accurately represents crash count figures.**

The rolling window approach helps mitigate bias caused by arbitrary segmentation.

Rolled crash counts are shown here for simplicity. In the analysis, a sum of crash weights is used, and then divided by the segment length to show the weighted crash rate per mile.

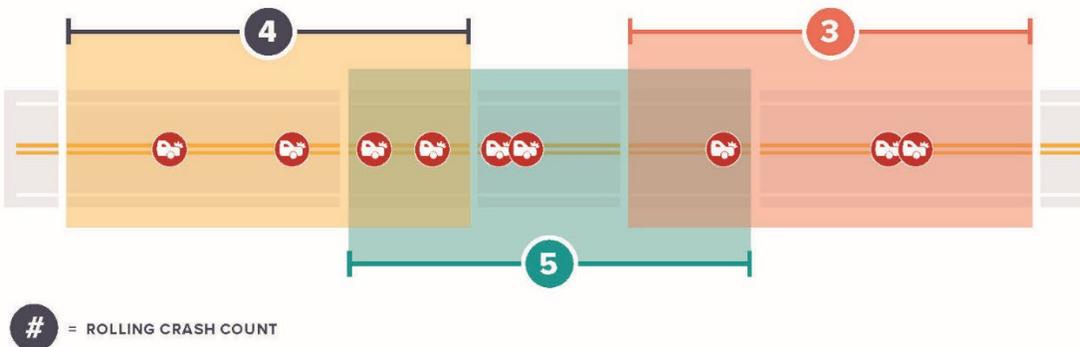


Figure 1: Rolling window approach.

4. Accumulate Crashes:

- a. Beginning with segments with the highest crash weight per mile, use Alta’s custom-build *HIN Generation Tool* to progressively add segments to the HIN. This tool calculates the length in miles for each segment as it is added and keeps track of the cumulative miles in the HIN and the number of crashes occurring on those segments. It stops when the designated threshold of KSI collisions have been accumulated. The tool also generates a table that shows the number of crashes, and the number of roadway miles accounted for with each HIN segment.
- b. Decide the threshold for the percentage of crashes included in the HIN by examining a graph of accumulated collisions and accumulated centerline miles and identifying the natural inflection point in the data. This represents the point at which adding more roadways to the HIN has diminishing returns in terms of identifying more crashes. An example graph is shown in **Figure 2**.

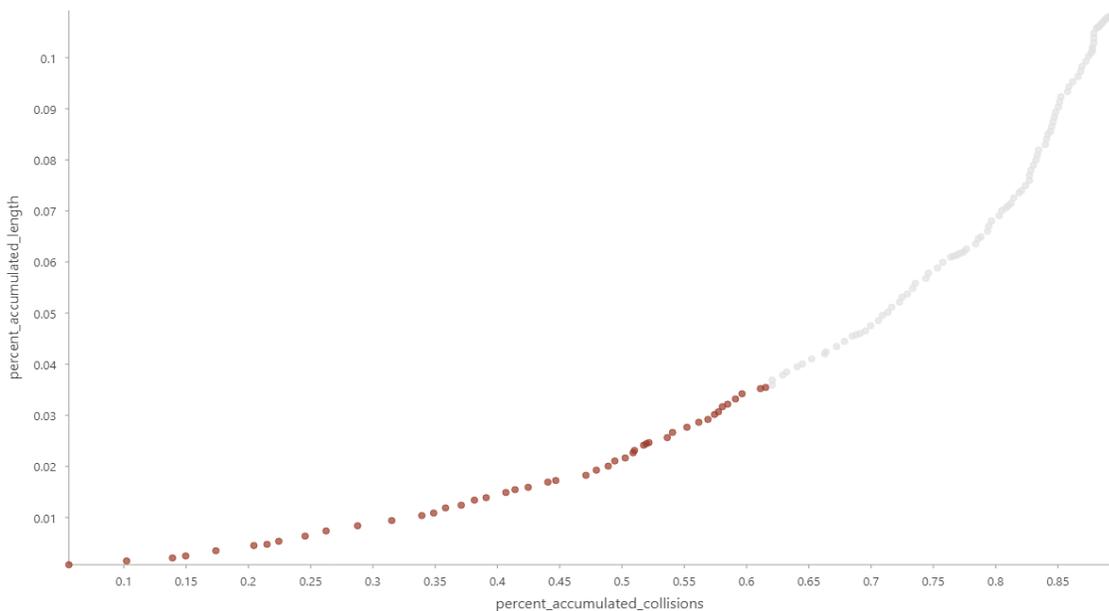


Figure 2: Example of a graph of accumulated collisions and accumulated centerline length. Collisions selected for the HIN are represented in brown.

5. Final Refinement:

- a. Examine the map of qualifying HIN segments and perform manual cleaning output from the tool. This step eliminates segments that the tool may have selected where no crashes have occurred. It also fills small gaps in otherwise contiguous networks on major roadways.
- b. Calculate the percent of roadway miles and the percent of KSI crashes accounted for in the final HIN.



## References

Fitzpatrick, K. A. (2018). *Guidebook on Identification of High Pedestrian Crash Locations. FHWA-HRT-17-106. Supplemental Material*. McLean, VA: Federal Highway Administration Office of Safety Research and Development.

Harmon, T. G. (2018). *Crash Costs for Highway Safety Analysis. Report No. FHWA-SA-17-071*. Washington, D.C.: Federal Highway Administration.

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