Memorandum

SRF No. 15417

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Met Council

From: SRF Consulting and Safe Streets Research and Consulting

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Subject: High Injury Street - Metropolitan Council Regional Safety Plan

Create a High Injury Street - Methodology

Definitions

- ***What is a high injury street?*** High injury streets are locations where a high number of fatal and serious injury crashes have occurred in close concentration along a corridor or segment in the past five years for which data are available (2018—2022). High injury streets are visualized on a map. They represent a high priority subset of the region's overall transportation network. They are used alongside other screening and safety analysis tools, like systemic safety analysis, to help the Metropolitan Council and local partners prioritize the most urgent traffic safety needs.
- ***What are sliding windows?*** Sliding windows are the underlying methodology used to identify high injury streets or high injury networks. The sliding windows methodology measures the density or concentration of severe crashes in 1-mile windows which are moved or slid in 0.1-mile increments across the network. A threshold is selected to choose which sliding windows segments are considered "high injury" and which are not; segments with concentrations above the threshold are identified as high injury streets.
- The KABCO injury scale was used and includes the following designations:

K - involves a fatal injury

A – suspected serious injury

B – suspected minor injury

C - possible injury

O- no injury or a property damage-only (PDO) Crash

High Injury Streets Purpose

- High Injury Streets (HIS) Identification (also called a High Injury Network in other places) can serve many purposes for different types of agencies. There is a difference between the ideal High Injury Streets intended to prioritize an implementing agency's next 5 years of roadway reconstruction projects and the ideal High Injury Streets intended to help a larger jurisdiction provide technical support to a collection of partner agencies.
- Different land use contexts (urban vs. suburban vs. rural) and different roadway contexts (non-highway vs. highway) may benefit from different thresholds, depending on the modes and patterns observed. Geographic stratification can also help make the network

relevant across a range of local partners and stakeholders, where local partners want to see themselves and their own agencies' needs reflected in a plan. At the same time, setting artificially low thresholds in some places and not others can dilute the significance of the High Injury Streets.

- Based on conversations with the Council and the project's Project Management Team, we are optimizing the High Injury Streets based on the following applications for it:
- The Council is not an implementing agency. Therefore, the primary purposes of the High Injury Streets are to provide technical support to local partners and prioritize regional investments to maximize safety impacts.
- When used for funding prioritization or scoring (e.g., Regional Solicitation), the High Injury Streets should be incorporated, but will likely not be the only criterion. Scoring applications based on their safety impacts will likely be based on a combination of High Injury Streets and systemic analysis results.
  - The Council might also choose to allow locally adopted High Injury Streets to "count" for any High Injury Streets -related criteria (within some boundaries, e.g., must be data-driven; may be based on raw sliding windows data provided by the Council).

Review of Data

- Decision to develop a new project network and sliding windows.
  - Opportunity to use a more recent version of Met Council's base network.
  - Opportunity to determine a way to associate short and long windows to a given window segment. The provided database of short and long windows were missing a relation class, shared geometries, or attribute denoting which short window segments would be associated with which long window segments.
  - Opportunity to split roads by street name (excluding east/west delineators so that they are all one segment) to make the dissolved corridors as uninterrupted as possible.
- Understanding there will still be some limitations/caveats with this approach.

Developing Base Segmentation and Short Windows

- Built a new roadway network of corridors based on Street Name from Met Council's RoadsCenterline file.
  - Included Primary, Secondary, and Local from the "CARTOCLASS" field.
    - Filtered out freeways (including ramps) per PMT comments.
  - Eliminated the distinction of East vs West and North vs South in the Street Name to create longer corridors than were previously developed.
  - Dissolved the road centerlines based on the simplified Street Name
  - Built route measure values for each dissolved corridor based on length in meters.
  - For each corridor, a table of records that described the From and To measures at 0.1-mile intervals for the precise length of the corridor were built.
  - Routed the built table on the new measured routes to create the 0.1-mile short segments.
- Freeways were reviewed and ultimately not included as part of the analysis and development of the high injury streets. Due to the number of crashes on freeways,

freeways would dominate the region’s high injury street and yet be the least actionable for Met council and their stakeholders. That said, a separate safety analysis of the region's freeways may be useful in the future.

Developing Long Sliding Windows

- To develop the long sliding windows, compared 0.5-mile and 1.0-mile long window. The shorter length was too fragmented (especially for non-motor vehicle mobile crashes) so the 1-mile windows were used.
- For roads that are less than a half mile in length, the windows were stacked using a tenth mile.
    - Set the minimum length of the last consecutive window along the less than half mile segment set to 0.4 miles so that we avoid short sliding window segments at the end that would result in “squares”.

Join the Crashes by Mode

- Four separate High Injury Streets Selections by mode were developed:
    - Pedestrian
    - Bicycle
    - Motor vehicle mobile
    - Motorcycle
- Using 2018-2022 crash data provided by the Minnesota Department of Public Safety and Minnesota Department of Transportation.
- The table we initially used included one record per unit involved in the crash (the crash dataset provided includes up to two units per crash). In other words, if a crash involved two motor vehicle mobiles, there were two records in the dataset – one representing the worst injury sustained by an occupant of each vehicle. The following processing steps were used to transform a unit-based dataset into four mode-specific crash-based datasets.
- Initially, reviewed the crash emphasis area flags included as part of the dataset and compared them to the Unit Type/Vehicle Type attributes in the data to determine how to separate the four modes.
    - Excluded units within crashes based on severity and vehicle type for each unit in crash record (KAB for bike, ped, and motorcycle and KA for motor vehicle included)
    - If both units are the same mode (ex. motor vehicle vs motor vehicle), one record was created in the corresponding mode’s crash dataset (using the more severe injury). This scenario applied to many of the motor vehicle crashes where 10,676 out of 14,566 motor vehicle KAB crashes were motor vehicle vs motor vehicle crashes. Very few of the ped, bike, and motorcycle crashes involved another unit of the same type.
    - If the units were different modes (ex. motor vehicle vs ped), one record was created in each of the corresponding modes’ crash datasets (i.e. one was added to the motor vehicle crashes and one was added to the ped crash dataset for the development of the High Injury Streets). This allows us to account for situations where both a vulnerable road user and a motorist are injured in the same crash.

KAB Unit Total:

Mode	Selection Criteria Unit Type + Vehicle Type	Selection Criteria Emphasis Area Flags	Notes
Exclude (null)	55,089	-	
Exclude (parked)	22,872	-	
Motor Vehicle	515,326	-	
Motorcycle	3,895	3,650	Added moped
other	3,624	-	Golf cart, snowmobile, farm equipment, etc. PLUS wheelchair, horse, buggy, skates, skateboard, segway, etc.
bicycle	3,154	3,106	
pedestrian	4,240	4,797	Up to 323 of the crashes with the pedestrian emphasis area flag could be a person(s) in wheelchairs, on skates, etc., but some are also just not peds.

- There were 557 crashes with the pedestrian emphasis area flag and a vehicle type of "Other Personal Conveyance (Wheelchair, Horse, Buggy, Skates, Skateboard, Segway, etc.)." A quick scan of the narratives for these crashes revealed that some of the crashes involved someone in a person using an assistive device (e.g., wheelchair) or a person using another type of micromobility device or active mode (e.g., skateboards, scooters, etc.).
- The emphasis area flag for motorcycles did not include moped crashes. For the development of the motorcycle high injury street, moped crashes (293 total) were added to the motorcycle mode.
- Multimodal crashes (e.g., one bicyclist and one driver) were counted separately for their respective modes. In other words, that one crash appears in both the bicyclist dataset and the motorist dataset. Mode-specific injury severity helps account for differences in outcomes when drivers crash into vulnerable road users.

- What was excluded in the analysis?
    - Units where the vehicle type was listed as "Parked/Stalled Motor Vehicle."
    - Units where the vehicle type is null.

- Motor vehicle Injury B (minor injury) crashes. [1]
  Scoring
- Use the weights for all crashes (same as the Regional Pedestrian Safety Action Plan) but exclude motor vehicle B crashes due to the sheer number of them and the Safe System Approach's emphasis on life-altering crashes. The weights by severity are as follows:
  - Fatal and serious injury crashes (KA) – 3
  - Minor injury crashes (B) – 1
  - All others – 0
- Calculated a length-weighted average of associated long window score and a highest or maximum associated long window score. Compared these results to determine which to use. The maximum score provided cleaner break points when setting a threshold. It also showed greater differentiation between the highest risk areas and other areas. We proceeded with the maximum score for threshold selection.

Metrics for Setting a High Injury Streets Threshold

High Injury Streets may be identified using a uniform threshold across the whole region (option 1) or a geographically balanced approach that targets thresholds to land use context (option 2). We tested both approaches.
We used the following rough targets to recommend thresholds.

- **Coverage of severe (KA) crashes** - can about 40-50% or more of fatal and serious injury crashes be contained by the High Injury Streets without sacrificing other targets? *At a regional scale, this target is difficult to achieve.*
- **Mileage or extent of High Injury Streets** - can the High Injury Streets be kept to less than about 1-3% of the network? How does this vary by geography type?
- **Natural breaks** - would increasing or decreasing the threshold result in a significant change in severe crash density on the network? Are there natural breaks in the data where severe crash density changes a lot?
- **Minimum threshold** - Thresholds that are too low dilute the meaning of High Injury Streets. We typically advise a minimum threshold of 7 or greater. A score of 7+ implies a *spatial pattern* of at least 3 crashes. In some contexts (e.g., rural Minnesota in MnDOT's VRUSA High Injury Streets), we recommend thresholds as low as 5. High Injury Streets status should not be driven by a single severe crash.

These four targets are sometimes at odds with one another. For example, covering 50% or more of fatal and serious injury crashes might require an unwieldy number of miles in the High Injury Streets or a threshold that is too low to be meaningful – especially at the regional scale and in places where crashes are less concentrated. In these cases, we erred toward a higher threshold and a more targeted draft High Injury Streets. Refinement with Metropolitan Council

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[1] Injury B crashes were included for pedestrians, bicyclists, and motorcyclists because crashes for these modes are fewer in number, and the additional crashes are needed to help avoid "regression to the mean". Further, there is some randomness based on victim age and fragility in whether a vulnerable road user's injury severity is serious injury or minor injury; any time drivers strike people outside the vehicle, there is significant risk of harm. Injury B crashes are weighted less than fatal and serious injury crashes to ensure the high injury streets still prioritize the most severe, life-altering crashes.

staff and stakeholders can help make sure the decision heuristics used to select a threshold are aligned with the region's goals and priorities.

Selecting a High Injury Threshold

Based on a summary of sliding window scores stratified by Thrive Community type, it is recommended to evaluate a geographically stratified approach with distinct thresholds for Urban Center separate from the rest of the region for each mode. Separate thresholds may not be necessary for all modes. The results of our testing both option 1 (single threshold for the whole region) and option 2 (geographically tailored threshold) showed that for motorists, motorcyclists, and bicyclists, the same thresholds across the whole region made sense (option 1). For pedestrians, a geographically tailored approach allowed greater capture of fatal and serious injury crashes outside the urban center.

Some modes and some geography groups may have sparse crashes and a few miles of High Injury Streets. Pair High Injury Streets with proactive or systemic methods to help identify safety needs in areas with few or no identified High Injury Streets.

The following table summarizes the recommended thresholds for each mode. For each geography and mode, the table shows how many miles of the network and how many crashes and severe crashes would be on the High Injury Streets at the given threshold. The current recommendation(s) for thresholds in each modal section:

Mode	Geography	Threshold	Miles	Fatal + Serious Injury Crashes	Fatal+Serious Injury Crash Density per Mile
Pedestrians	Urban Center	12	77.3 (2.8%)	185 (50.01%)	2.39
Pedestrians	Rest of Region	7	52.0 (0.3%)	51 (21.9%)	.98
Pedestrians	*Modal Composite*		*129/3 (0.7%)*	*236 (39.2%)*	*1.82*
Bicyclists	Entire Region	5	163.7 (0.8%)	104 (44.3%)	.64
Motorcyclists	Entire Region	9	35.8% (0.2%)	70 (12.1%)	1.96
Motor Vehicle	Entire Region	12	129.6 (0.6%)	301 (17.4%)	2.32
Composite/All Modes	Entire Region		370.7 (1.8%)	968 (30.8%)	2.61

The following figures illustrate the regional High Injury Streets maps by mode.

Figure 1 Regional High Injury Network – All Modes

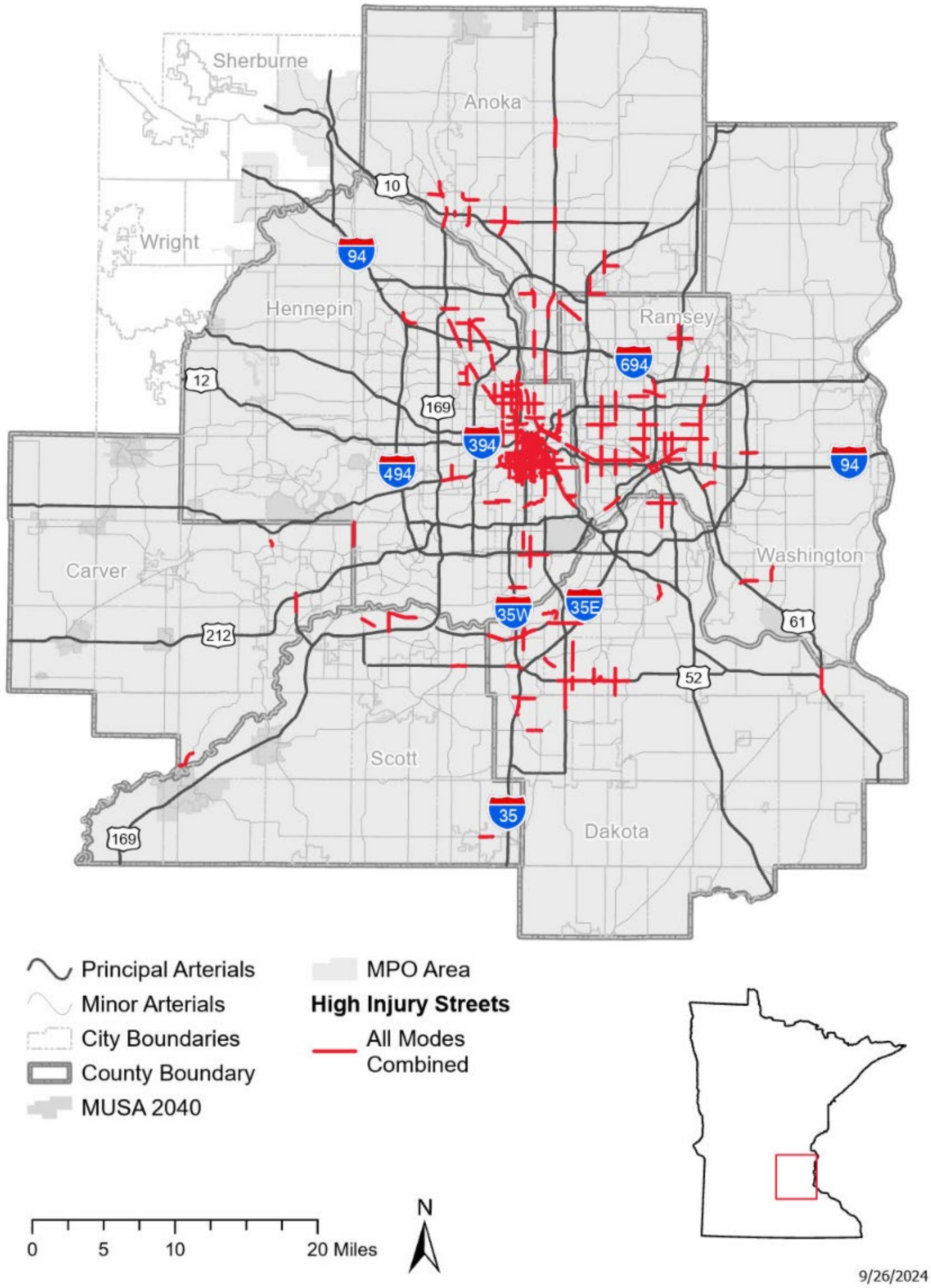

Figure 2 Regional High Injury Network – Motor Vehicle

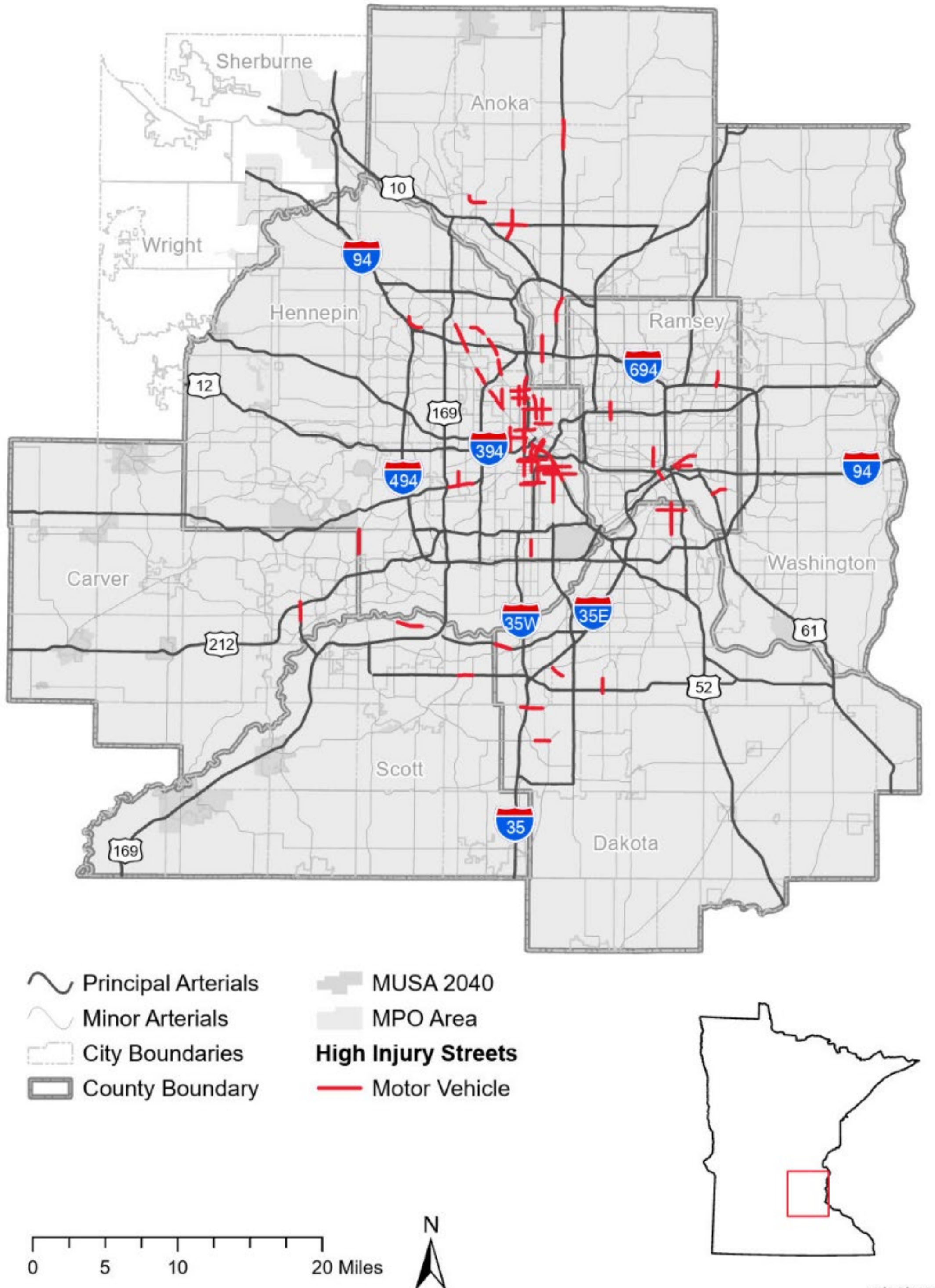

Figure 3 Regional High Injury Network – Pedestrian

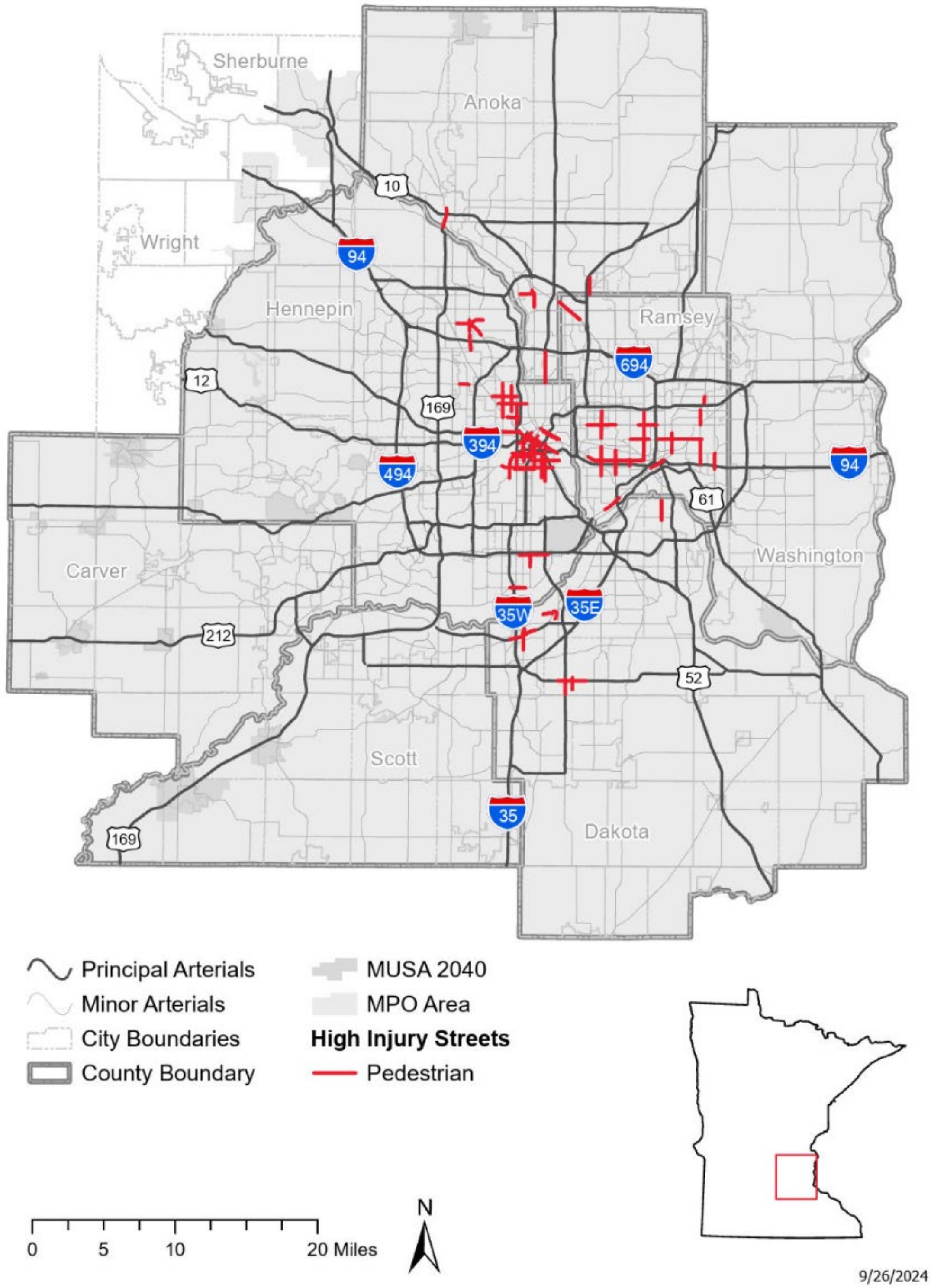

Figure 4 Regional High Injury Network – Bicyclist

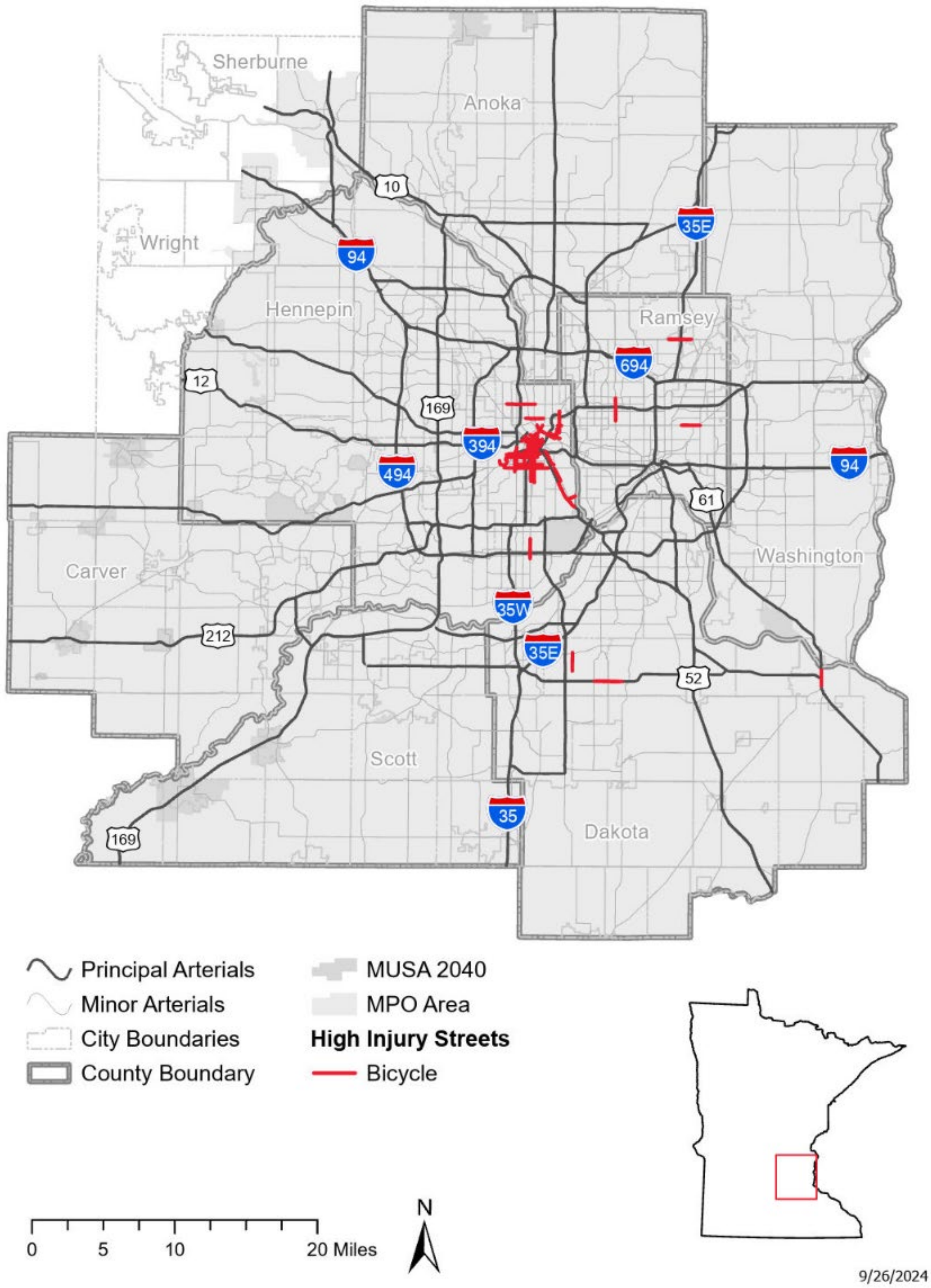

Figure 5 Regional High Injury Network – Motorcycle