# Appendix 4 - Crash Data Review and HIN Memo

To: Colleen Hoesly, Greater Madison MPO

From: Kim Voros, Erin Daly Davenport and Alia Awwad, Alta Planning + Design

Date: June 2023

Re: Task 2.1 Crash Data Review

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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 the human body at tolerable levels.[1] The Greater Madison MPO Regional Transportation Safety Action Plan (Safety 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 region.

This technical memorandum documents the High-Injury Network (HIN) for the Greater Madison MPO region. A HIN consists of the roadway corridors on which many people have been killed or severely injured due to motor vehicle crashes. Adoption of a HIN is recommended as part of a Vision Zero strategy. This moves beyond typical crash history and allows for a better description of the types of roadways and intersections in the Madison MPO where users are the most at risk. This allows the MPO to proactively work to minimize the occurrence and severity of crashes into the future.

In addition to the development of a HIN, the Safety Action Plan will also rely on collision profiles, which considers crash types, land use context and road user behavior to identify the most prevalent and severe injury crashes in the area to inform implementation recommendations.[2] Collision profiles will be developed as part of Task 2.2. The potential use of StreetLight data as an input to future analysis is discussed at the end of this memorandum, though it was not determined feasible to use the data as part of this project.

## Madison MPO HIN Overview

The HIN was developed by the Traffic Operations and Safety Laboratory (TOPS Lab) at the University of Madison Wisconsin. The HIN is comprised of two separate analyses: the first considers segments while the second considers intersections. Both analyses use collisions occurring from the four-year period from 2017 through 2020. While a 5-year time period is frequently used in collision analyses, the Wisconsin crash reporting format changed at the beginning of 2017, therefore increasing the complexity of collision reporting with data organized in multiple formats.

The analysis primarily considers arterial and collector roadways though some additional roadways and intersections were also evaluated (see Map 1).

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[1] Federal Highway Administration. Lessons Learned from Development of Vision Zero Action Plans. Accessed at https://safety.fhwa.dot.gov/zerodeaths/docs/FHWA-SA-20-073_Lessons_Learned_from_Development_of_Vision_Zero_Action_Plans.pdf

[2] Wisconsin collision data uses a KABCO collision assessment scale For more information on various collision ranking methods see: https://safety.fhwa.dot.gov/hsip/spm/conversion_tbl/pdfs/kabco_ctable_by_state.pdf

### Statistical Basis of HIN

In Wisconsin, collision severity is assessed using the KABCO scale utilizing the following definitions:[3]

- K – Fatal Injury
- A – Suspected Serious Injury
- B – Suspected Minor Injury
- C – Possible Injury
- O – No Apparent Injury

The HIN considers K, A, B and C collisions, that is those with a possibility of injury or greater.

The HIN was identified through the development of Safety Performance Functions (SPFs), which are then used to implement the Empirical Bayes method to calculate segment or intersection level scores. These ratings are then translated into a Level of Safety Service (LOSS) for intersections and segments.[4]

The LOSS method was used to sort segments and intersections into four categories. Scores of LOSS 1 and 2 have a low to moderate potential for crash reduction. Scores of LOSS 3 and 4, which are used to define the HIN, have a moderate to high potential for crash reduction. For additional detail on how the HIN was developed see Appendix A and Appendix B.

The Madison MPO's highly statistical basis to develop an HIN is rigorous and atypical. Many HINs are typically comprised of intersections and segments with a high number of observed severe collisions. However, the HIN methods attempt to identify long-term trends in collision patterns that account for regression to the mean.

## HIN Findings

The HIN is comprised of 1,688 segments and 1,146 intersections. See Map 2 through Map 4 for additional information on their location around the region.

### HIN Segments

Roadway segments in the HIN are predominately local roadways (35% by mileage) and county highways (31%). US Highways and highway ramps account for another 13% of segments, each. Accordingly, 64% of HIN segments have one lane of travel in each direction, while 27% have two lanes in each direction and 9% have three lanes.

[3] Federal Highway Administration. (n.d.). KABCO Conversion Table by State. Retrieved from https://safety.fhwa.dot.gov/hsip/spm/conversion_tbl/pdfs/kabco_ctable_by_state.pdf

[4] The Federal Highway Administration defines SPFs as crash prediction models, mathematical equations that relate the number of crashes of different types at a given location to specific site characteristics such as traffic volumes, lane width and traffic controls.

The speed limit of HIN segments ranges from 15 to 55 mph, with 55 mph as the most common segment speed limit (24%) and followed by 25 mph (21%). The full distribution of speed limits is shown in Figure 1.

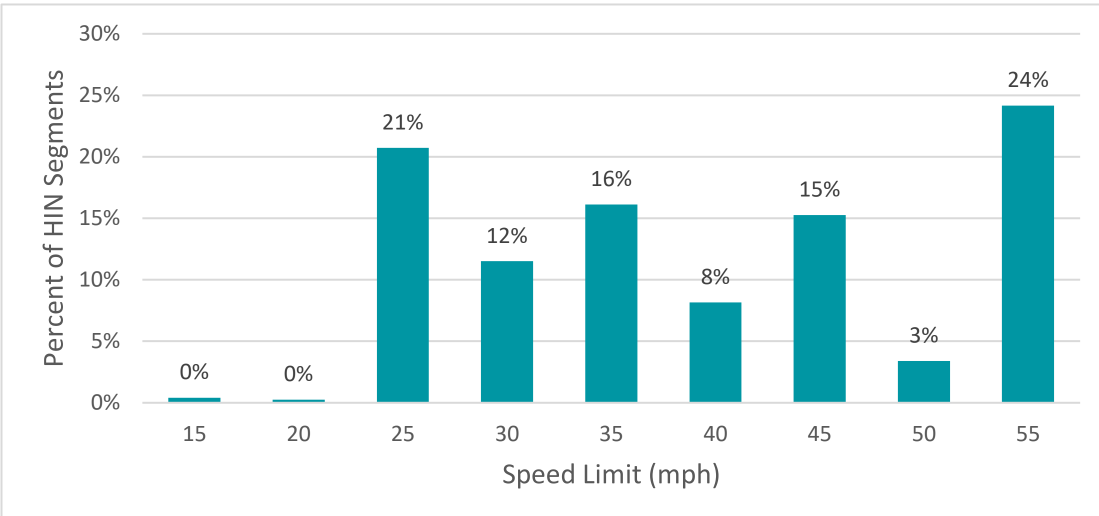



*Figure 1. HIN Segment Speed Limit*

The volume of roadway segments in the HIN ranges from less than 2,000 to over 25,000 AADT (or vehicles per day). Figure 2 shows that the distribution is heaviest on the lower volume end of the range, clustered from 1-12,000 AADT.

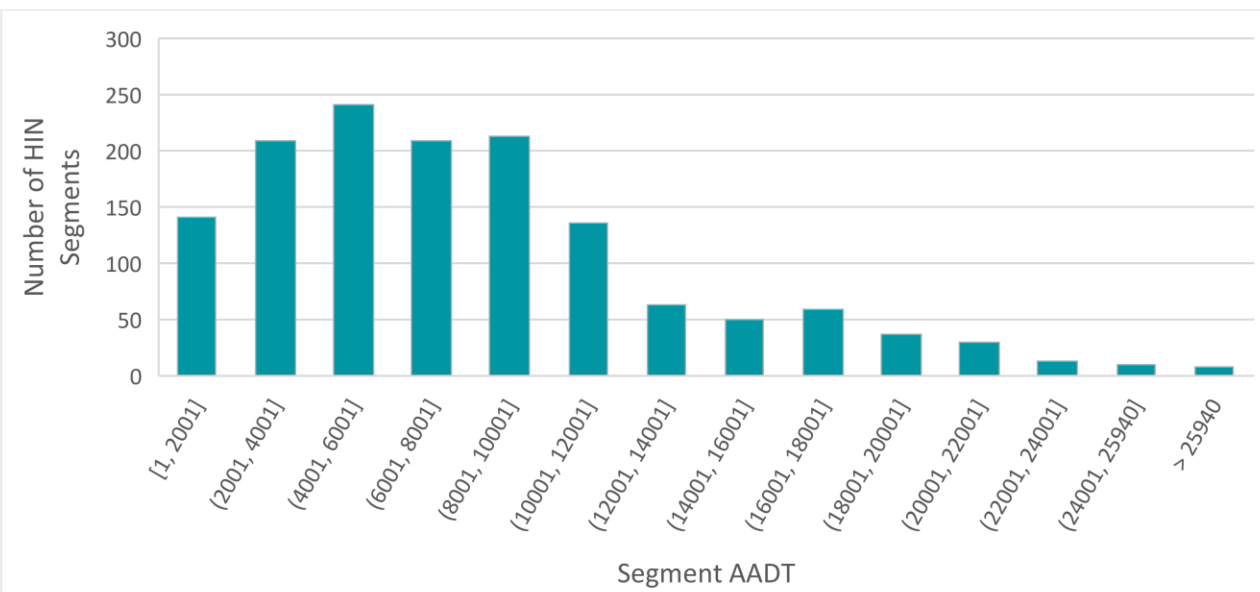



*Figure 2. HIN Segment Traffic Volumes (AADT)*

The HIN is spread throughout the Greater Madison MPO region, with a concentration in the City of Madison (40% of segments by mileage). The Cities of Fitchburg and Middleton, and the Towns of Burke, Sun Prairie, and Pleasant Springs all have 10 or more miles of HIN in their jurisdictions. Mileage for these communities is shown in Table 1, with their distribution shown in Map 3. All additional MPO Jurisdictions encompass three percent or less of the HIN, each.

*Table 1. HIN Segment Distribution Across MPO Jurisdictions*

| Municipality | Percent of MPO HIN Miles | Miles |
|---|---|---|
| City of Madison | 40% | 116.43 |
| City of Fitchburg | 9% | 24.95 |
| City of Middleton | 5% | 13.24 |
| Town of Burke | 4% | 13.07 |
| Town of Sun Prairie | 4% | 11.44 |
| Town of Pleasant Springs | 4% | 10.75 |

## HIN Intersections

There are 1,114 total intersections in the HIN analysis, shown in Map 2. Of these, the vast majority are stop-controlled from one direction (71%), with 18% signal-controlled. An additional four percent are all-way stop-controlled or have no control, respectively.

The maximum speed limit at HIN intersections ranges from 20 to 55 mph. The most frequent speed limit of HIN intersections is 25 mph (36%), which is consistent with the high number of intersections in the City of Madison.

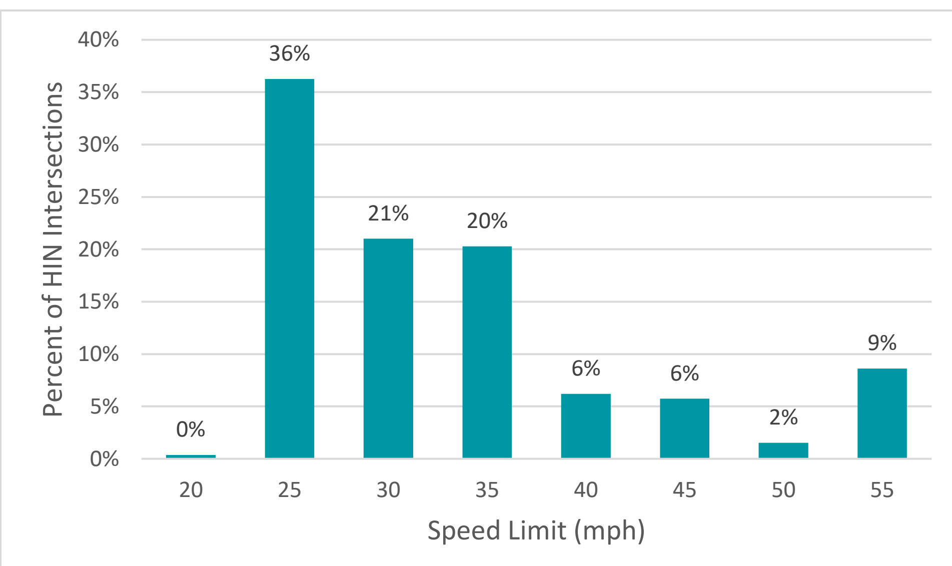



*Figure 3. HIN Intersection Speed Limit*

The traffic volume of intersections in the HIN (representing the highest volume leg of the intersection) ranges from less than 2,000 to over 38,000 AADT. Figure 4 shows that the distribution is heaviest on the lower volume end of the range, especially from 2,000-10,000 AADT.

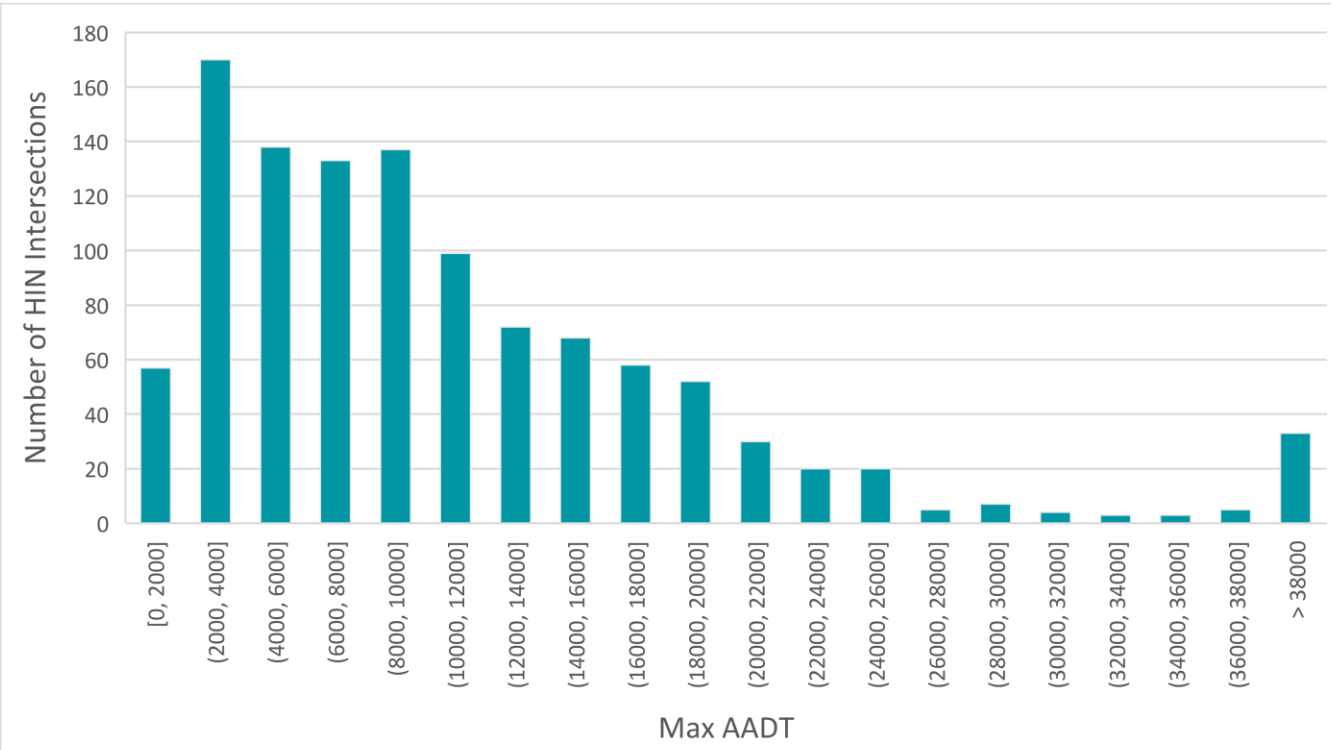



*Figure 4. Intersection Traffic Volumes (AADT)*

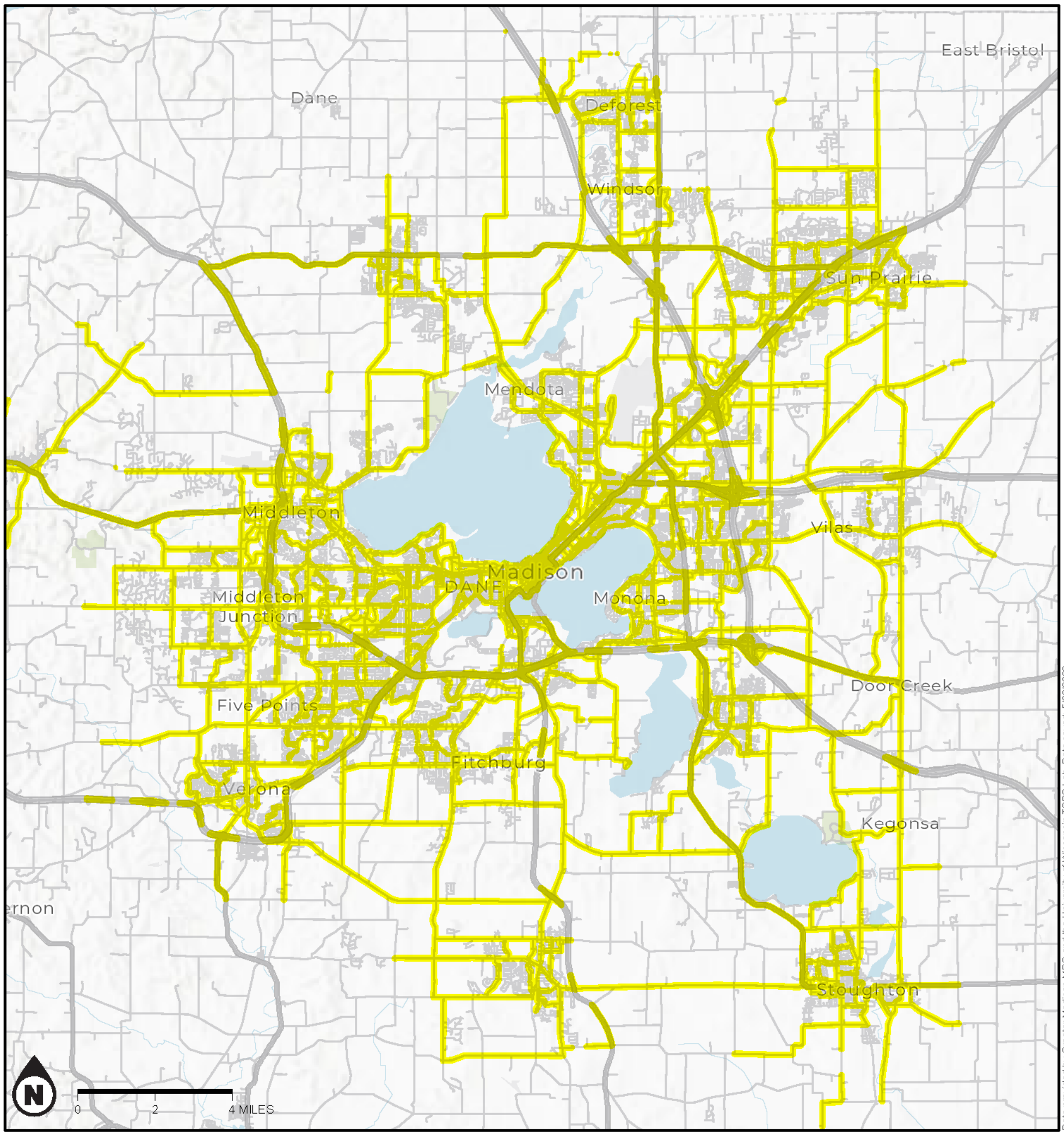
Like segments, the HIN intersections are spread throughout the region, but have a heavy concentration in the City of Madison (57%). Intersection distribution for the remaining jurisdictions with two percent or more of the HIN intersections is shown in

Table 2. All additional MPO Jurisdictions encompass one percent or less of the HIN intersections, each.

*Table 2. HIN Intersection Distribution Across Jurisdictions*

| Municipality | Percent of MPO HIN Intersections | Number of Intersections |
|---|---|---|
| City of Madison | 57% | 654 |
| City of Fitchburg | 6% | 70 |
| City of Sun Prairie | 6% | 68 |
| City of Middleton | 5% | 63 |
| City of Stoughton | 3% | 33 |
| City of Verona | 2% | 22 |
| Village of Waunakee | 2% | 21 |
| Village of DeForest | 2% | 19 |

*Map 1. Evaluated Intersections and Roadways*



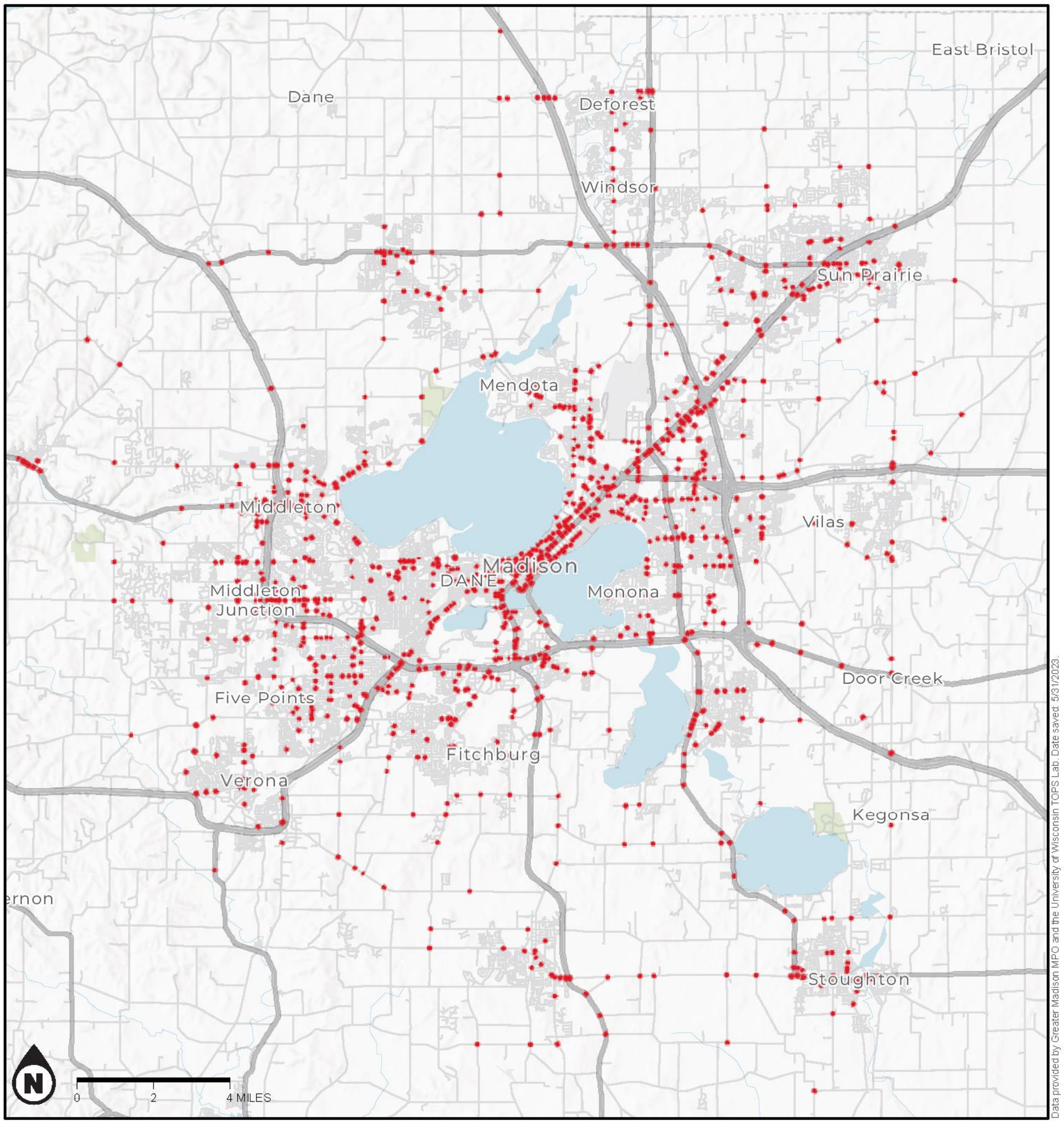

MADISON MPO HIN (2017 - 2020)
INTERSECTIONS AND SEGMENTS ANALYZED FOR POTENTIAL INCLUSION IN HIN

MADISON MPO
SAFETY ACTION PLAN

SAFETY ASSESSMENT

Intersection or Segment Analyzed for Potential Inclusion in HIN

*Map 2. HIN Intersections*

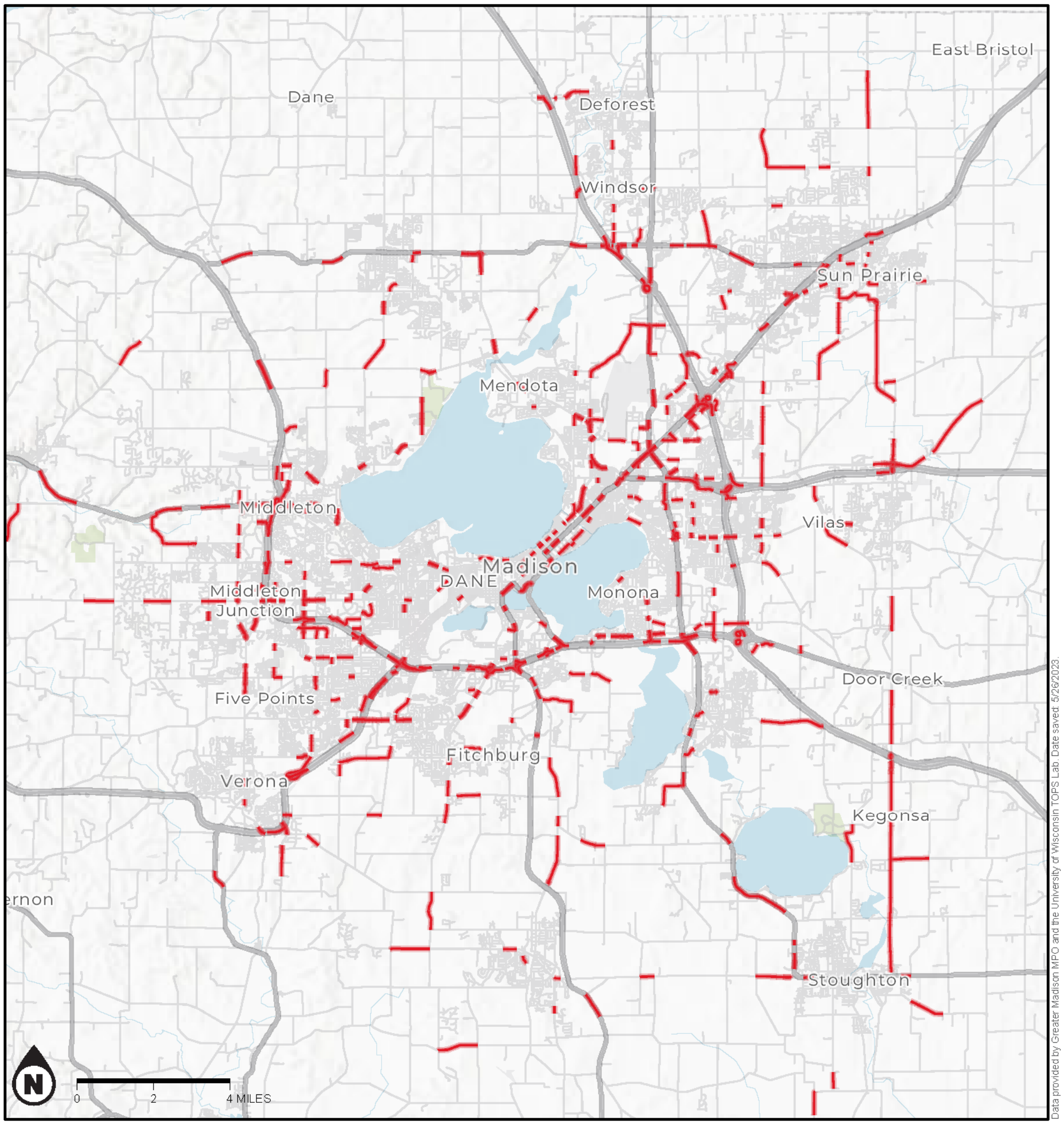



MADISON MPO HIN (2017 - 2020) INTERSECTIONS

MADISON MPO
SAFETY ACTION PLAN

HIGH INJURY NETWORK
HIN Intersection

*Map 3. HIN Segments*

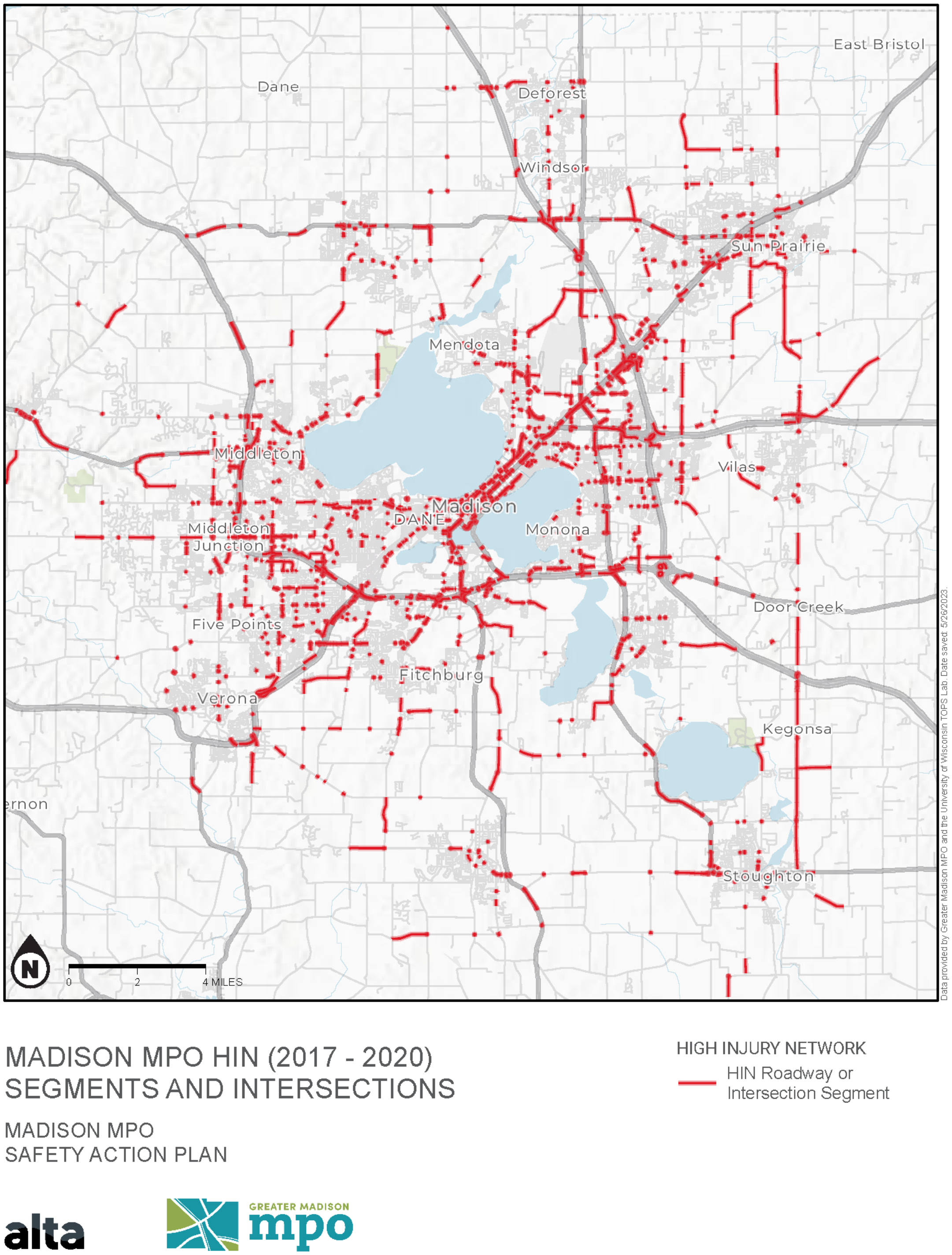



MADISON MPO HIN (2017 - 2020)
SEGMENTS

MADISON MPO
SAFETY ACTION PLAN

HIGH INJURY NETWORK
HIN Roadway Segment

*Map 4. HIN Intersections and Segments*



## HIN Use Considerations

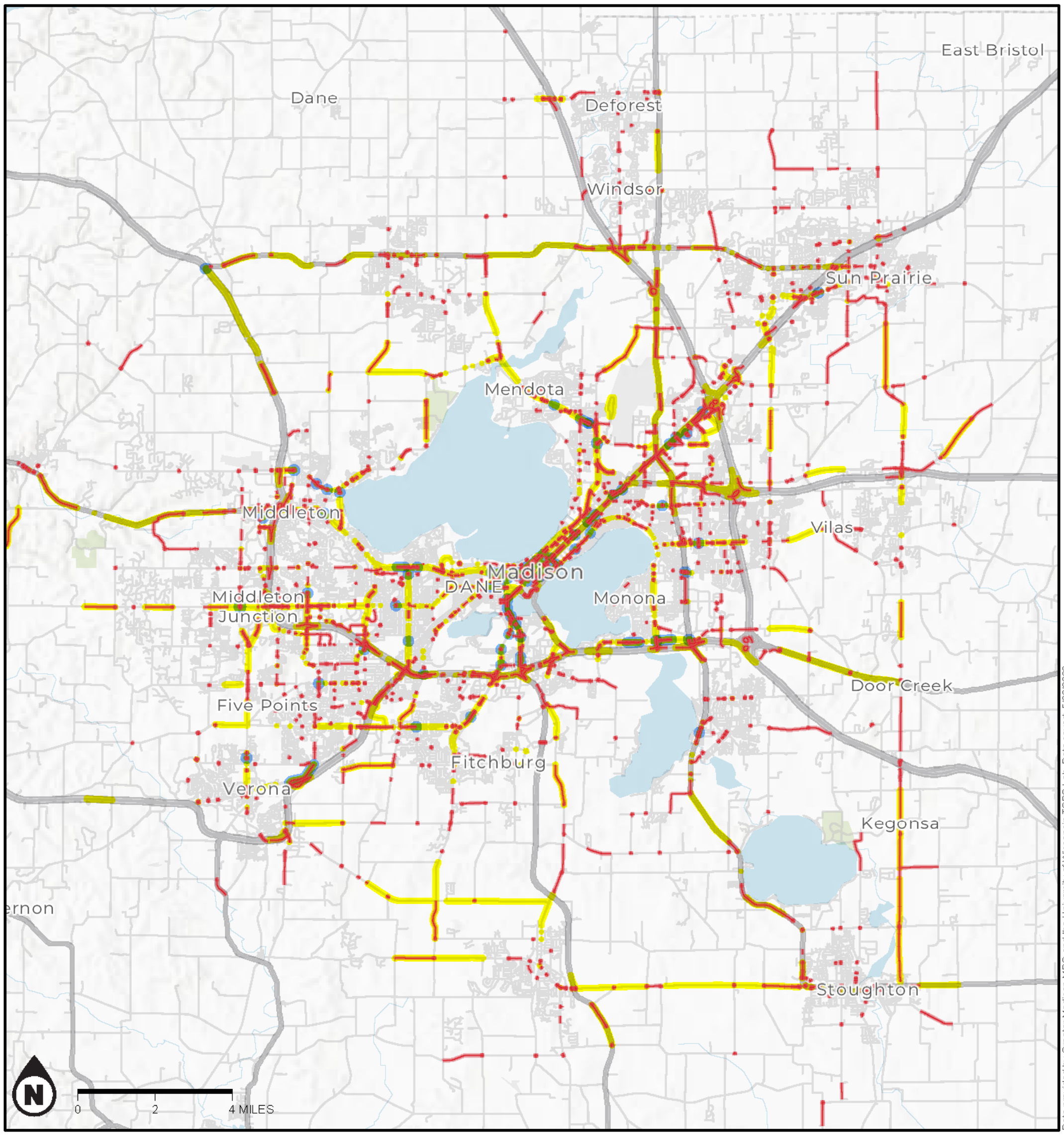
As mentioned earlier, the Madison MPO HIN is unique among other HINs developed by different city, MPO, and state agencies due to the methods and data structure used. The following list outlines these differences and includes relevant considerations for usage.

- **Comprised of two unique datasets.** The HIN is comprised of two data sets, one that represents segments and one that represents intersections. While both are composed of segment-based geometry and represent the same 4-year time period, each has a unique set of data attributes and was created at a different time. While each dataset is very robust, this data structure may complicate analysis that considers both intersections and segments simultaneously. For example, there are often wide geographic differences between clusters of identified HIN intersections and segments.
- **Consideration of Expected, Not just Observed Collisions.** The HIN is based on a LOSS score which describes the expected crash risk which is derived through SPF factors which considers both observed and predicated collisions. Typically, HINs are calculated solely on observed collisions and naturally reactive. Consideration of expected collisions within a HIN deviates from the current industry standard, which constructs an HIN based solely on observed collisions. This makes the HIN a dataset that is both proactive and reactive and care should be taken when using the data. For example, if a grant application will provide funding for locations with a known safety risk (observed collisions), the HIN should be used in conjunction with collision data to confirm that the appropriate types of collisions were present at the segment or intersection in question. This is because it is common for grant applications to ask for an actual collision history as part of the grant application. Since the HIN is constructed using both observed and predicted collisions either the collision data itself or the underlying HIN network data should be consulted to confirm that observed collisions occurred at the location in question.
- **Not all locations with fatalities are represented in the HIN.** For the reasons mentioned previously, not all in locations with fatality collisions were represented. This may be due to data aggregation of attributes in the underlying network segmentation or because the of a lower LOSS score calculate for a given segment or intersection. Intersections and segments with an observed fatality, located within 500 feet of the designated HIN with a LOSS score of II and therefore not included in the HIN are shown on Map 4. Madison MPO may choose to review these locations and consider whether these types of locations should be considered in future iterations of the HIN.
- **Observed Locations with bicycle and pedestrian injury collisions.** Map 5 shows the locations of observed bicycle and pedestrian fatality or injury collisions in blue. The HIN is shown in red as well as segments and intersections with a bike or pedestrian EPDO ranking in the top 20% of bicycle and pedestrian are shown in yellow.[5] There is substantial overlap between all three types of locations, though the overlap is inconsistent across the MPO. While areas of blue show locations with observed collisions that might be included in an HIN developed solely based on observed collision locations shown in yellow are highlighted through predictive analysis and would not be identified as potential HIN locations if observed locations only were used as inputs. These findings will be assessed further in development of collision profiles (Task 2.2.)

**Use of proxy data to identify bicycle and pedestrian exposure.** Proxy datasets (e.g., bicycle activity estimates from StreetLight and presence of commercial areas) were used to help develop assessment of bicycle and pedestrian risk. These data sets represent best industry practice, but care should still be taken when to validate modeled data findings when assessing individual corridors in more detail.

[5] Additional information on EPDO crash valuation is found here. https://safety.fhwa.dot.gov/hsip/resources/fhwasa09029/sec2.cfm#:~:text=Equivalent%20Property%20Damage%20Only%20(EPDO,property%20damage%20only%20crash%20cost.

*Map 5. KA Bike Ped Collisions in Proximity to HIN*




MADISON MPO HIN (2017 - 2020)
BIKE PED FATALITY AND INJURY COLLISIONS AT ANALYZED LOCATIONS IN RELATION TO HIN

MADISON MPO
SAFETY ACTION PLAN

SAFETY ASSESSMENT

- HIN Roadway or Intersection Segment
- Intersection or Segment with Bike/Ped EPDO Ranking in Top 20%
- Intersection or Segment with Bike/Ped KA Collision

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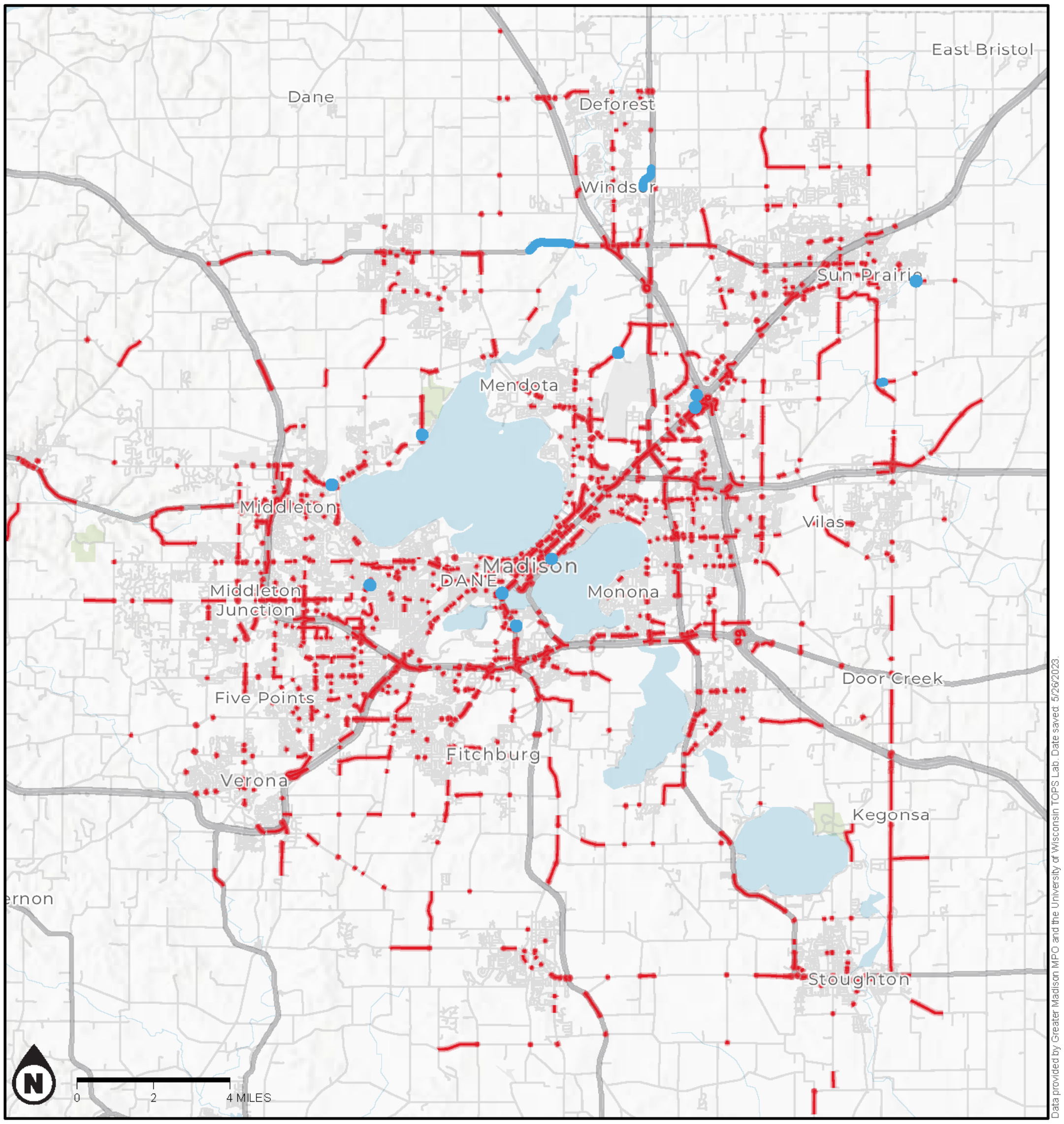
GREATER MADISON mpo

*Map 6. FI Collisions in Proximity to HIN*




MADISON MPO HIN (2017 - 2020)
FSI LOCATIONS IN PROXIMITY TO HIN

MADISON MPO
SAFETY ACTION PLAN

HIGH INJURY NETWORK
- FSI Location in Proximity to HIN
- HIN Roadway or Intersection Segment

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## StreetLight Data Use in Future Collision Analysis

StreetLight is a big data provider that measures and calculates trip information to better understand travel patterns. StreetLight data provides insights into traffic volumes, trip origins and destinations, and speed of travel along roadway segments. Trip information is derived from either connected vehicle data (CVD) or location-based services (LBS) data, which vary slightly in quality in different contexts.

The Madison MPO has access to the StreetLight platform for potential additional analyses, pending time and budget. One potential use of this data is to understand locations with excessive speeding and how they relate to equity and other focus areas throughout the region, such as the HIN. Speeding data can be overlaid with socioeconomic data such as race and income, or specifically the regional Environmental Justice Tier 1 and Tier 2 areas. This analysis can help planners understand where communities that face other socioeconomic burdens are also experiencing burdens associated with traffic safety.

An analysis like this is possible with the available data, however it is not feasible with the timeline and budget associated with this Safety Action Plan. Specific challenges include:

- The relatively short time period that CVD is available for. This dataset is the most accurate offering that StreetLight currently provides, due to the frequency of location pings and more precise trip stops and starts than LBS. However, CVD is currently only available for one year (2022). Due to slight differences in accuracy, the two datasets should not be combined to analyze longer-term trends.
- The number of segments that can be analyzed through the StreetLight web interface is far lower than the miles of arterial and collector roadways in the MPO (approximately 2,000, with 200 in the HIN). While there is command line level access available to help improve the processing speed of the analysis, the Madison MPO does not have the technical capacity to utilize that function.
- The StreetLight data follows Open Street Map block level segmentation, providing information in one-block segments through their easily accessible Zone Library. Best practice for analyzing average travel speeds recommends using .25 to .5 mile long segments. This requires additional data processing to set up the analysis.

Based on these considerations, additional future analysis is recommended as a part of Safe Streets for All grant implementation, including:

- Utilizing corridor level analysis where robust data is available. Additional years of CVD speed information will provide more detailed insights into travel patterns on priority corridors.
- Supporting detailed analysis of traffic patterns overlaid with socioeconomic factors (including environmental justice areas and the HIN).
- While speeding data will be utilized in this Safety Action Plan for collision profile analysis, the underlying data will be drawn from a field flagged in crash data from the TOPS Lab. Based on their methodology to derive this information from crash reports (which rely on police officer judgment), the influence of speed may be underreported throughout the region. Future analysis with Streetlight data could provide a more thorough understanding of where speed influences traffic safety in the region.