

Permian Basin Regional Planning Commission

# COMPREHENSIVE SAFETY ACTION PLAN



**DRAFT MARCH 2025**

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# High Injury Network & High Risk Network

**Introduction**

**High Injury Network**

**High Risk Network**

## INTRODUCTION

As a companion to Chapter 3's analysis, Chapter 4 will provide details on decision making tools created to aid in project selection and prioritization. The crash analysis shows there is an issue with traffic safety in the region and specific safety emphasis areas of concern, and so the following chapter dives into where these specific issues are occurring.

To aid in identifying specific problem locations, PBRPC has conducted two data-driven analyses on the region’s roads to create the high injury network (HIN) and high risk network (HRN) were developed. Each analysis utilized different methods to identify what a problem location is. **Table 13** summarizes the key differences between both networks. The biggest difference between the two networks is that the HIN relies on crash history while the HRN relies on the design attributes of a roadway. Roadways on the HRN may not be experiencing high amounts of crashes, but its design could put it at risk of developing a severe crash issue.

Both reactive and proactive approaches to safety are necessary, depending on the situation and project priorities. Ultimately, both networks are meant to aid in the decision-making process by providing information about what roadways should be prioritized when making transportation improvements. Cities and Counties in the region should use the network that best fits its needs when making selecting transportation improvement projects.

**Table 13** Differences between High Injury and High Risk Networks

| High Injury Network      |                                                              | High Risk Network                                                                             |
|--------------------------|--------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Safety Planning Approach | Reactive – only roads where crashes have previously occurred | Proactive – roads that have similar characteristics with high crash roadways                  |
| Methodology Source       | High Safety Manual - critical crash rate method              | Utilizes the Federal Highway Administration’s systemic safety planning process                |
| Data Inputs              | Crashes, road classification, traffic volumes                | Crash data, roadway design characteristics (such as lane width, number of lanes, median type) |

## HIGH INJURY NETWORK

The high injury network (HIN) is a network of road segments in the region that experience a higher-than-average rate of crashes resulting in fatal, severe, and minor injuries (KABs). This network is meant to assist the Permian Basin Regional Planning Commission (PBRPC), cities, and counties in the study area in prioritizing future transportation projects and investments. Identifying road segments with the most severe and frequent crashes is the first step in developing countermeasures and policy recommendations to improve safety for all.

# Critical Crash Rate Method

Calculating critical crash rates involves comparing roadway segments with similar functional classes and contexts, normalized by vehicle miles traveled (VMT). If the observed crash rate on a segment exceeds the expected crash rate, this means the segment has a critical crash rate and is added to the HIN. These steps are further detailed in Chapter 4 of the Highway Safety Manual.

Since the critical crash rate method requires several intermediate calculations to arrive to the final crash rate, an ArcGIS Pro model was created to complete these calculations for each segment on the region’s network. The model assigns crashes, weighted by crash severity, to an adjacent road segment and performs calculations outlined by the Federal Highway Administration (FHWA) as shown in the Appendix.

The critical crash rate was calculated for each segment in the region’s network using the following three steps:

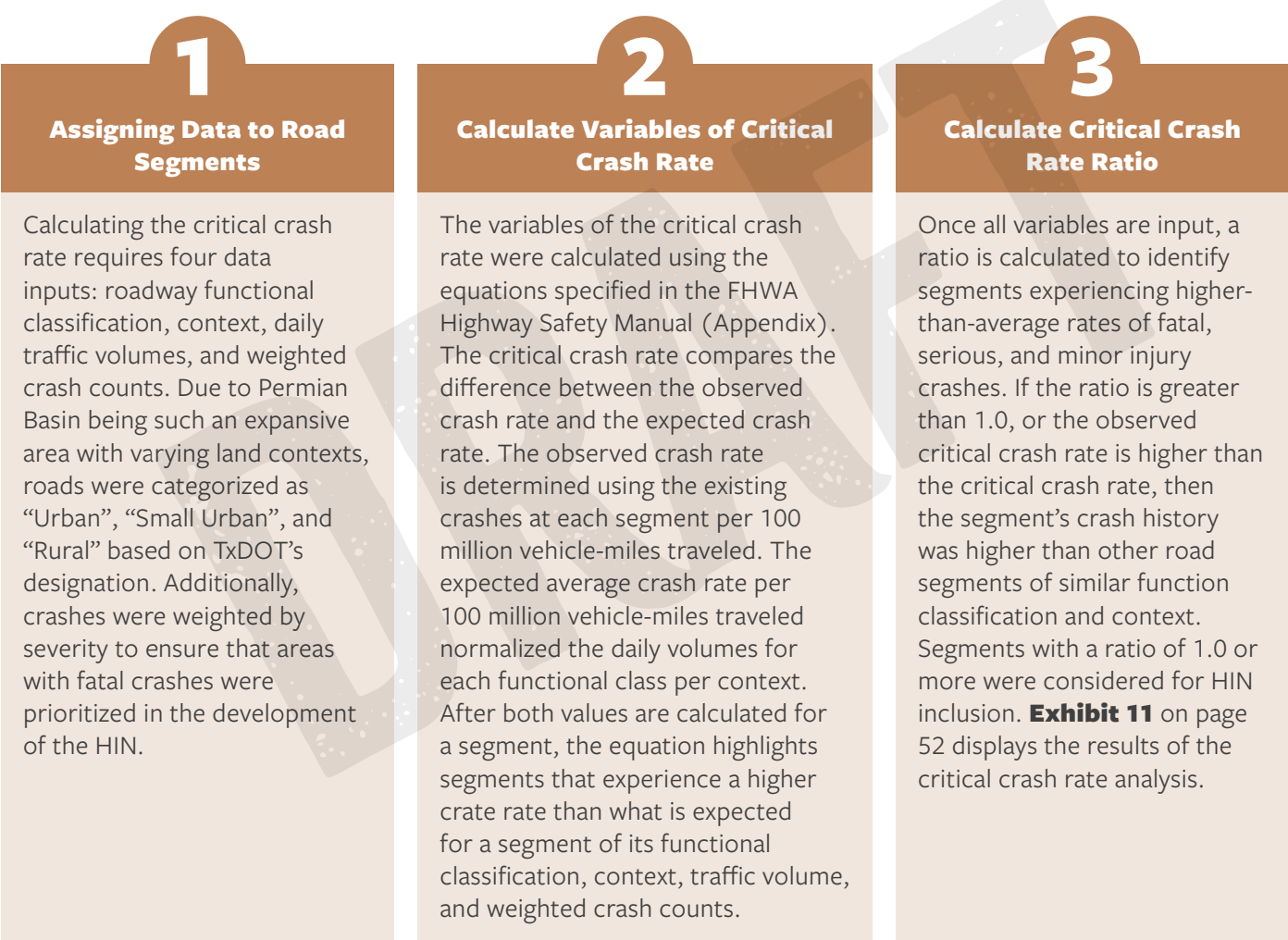
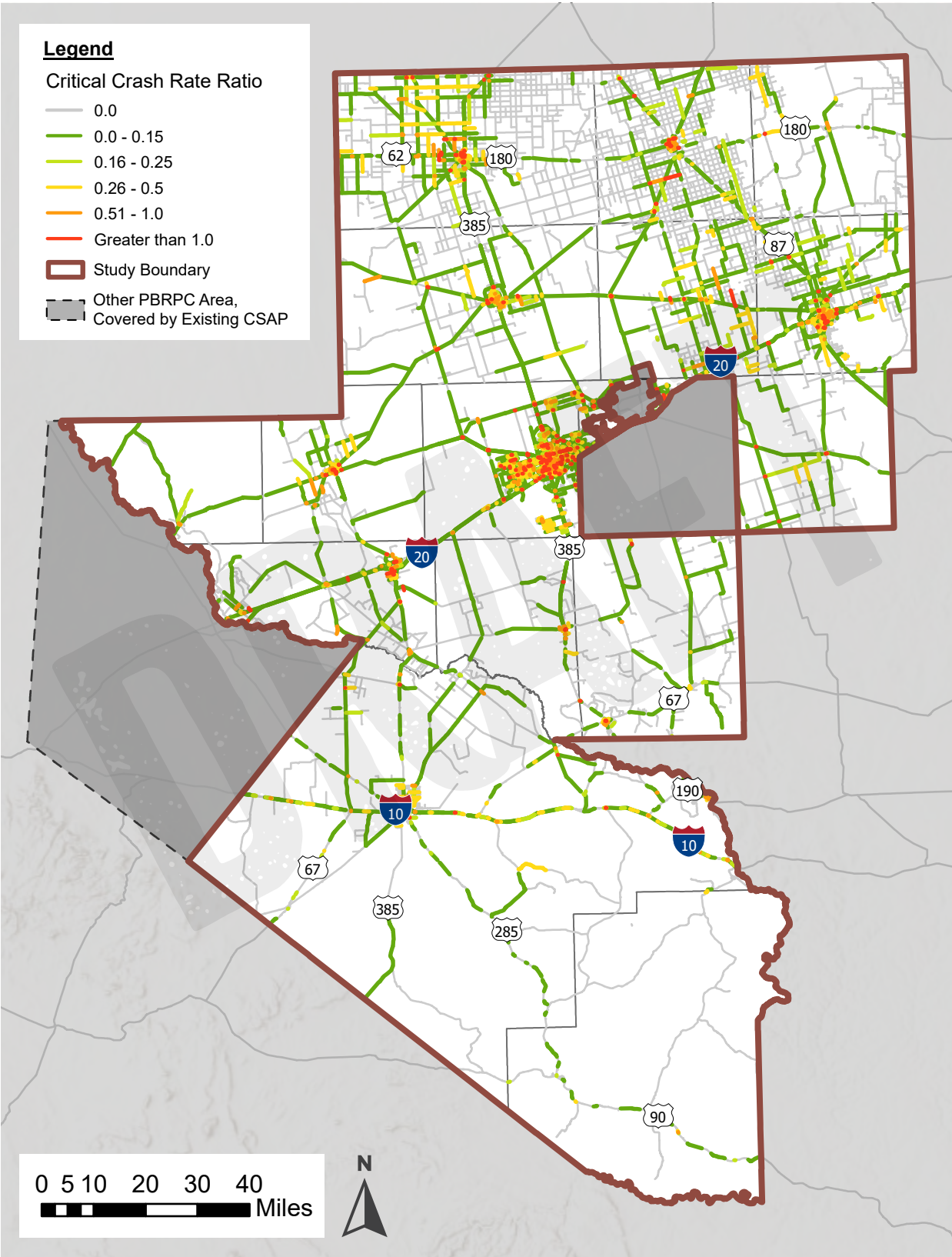


**Exhibit 11** Critical Crash Rate Ratio Map



## High Injury Network Results

Creating the finalized HIN requires both a qualitative and quantitative approach. While the critical crash rate method (as described in the Appendix A) does produce results that identify segments with higher-than-average crash rates, to create a network as shown in **Exhibit 12** on page 54 post processing must be done. To refine and clean the initial model results, segments with only one crash were removed from the results to prioritize segments with more of a history of incidents. Additionally, gaps between the remaining segments were connected to create a consistent and continuous HIN. Ultimately, the goal of the HIN selection process is to maximize the total fatal, severe, and minor injury crashes on the least mileage of roads on the network.

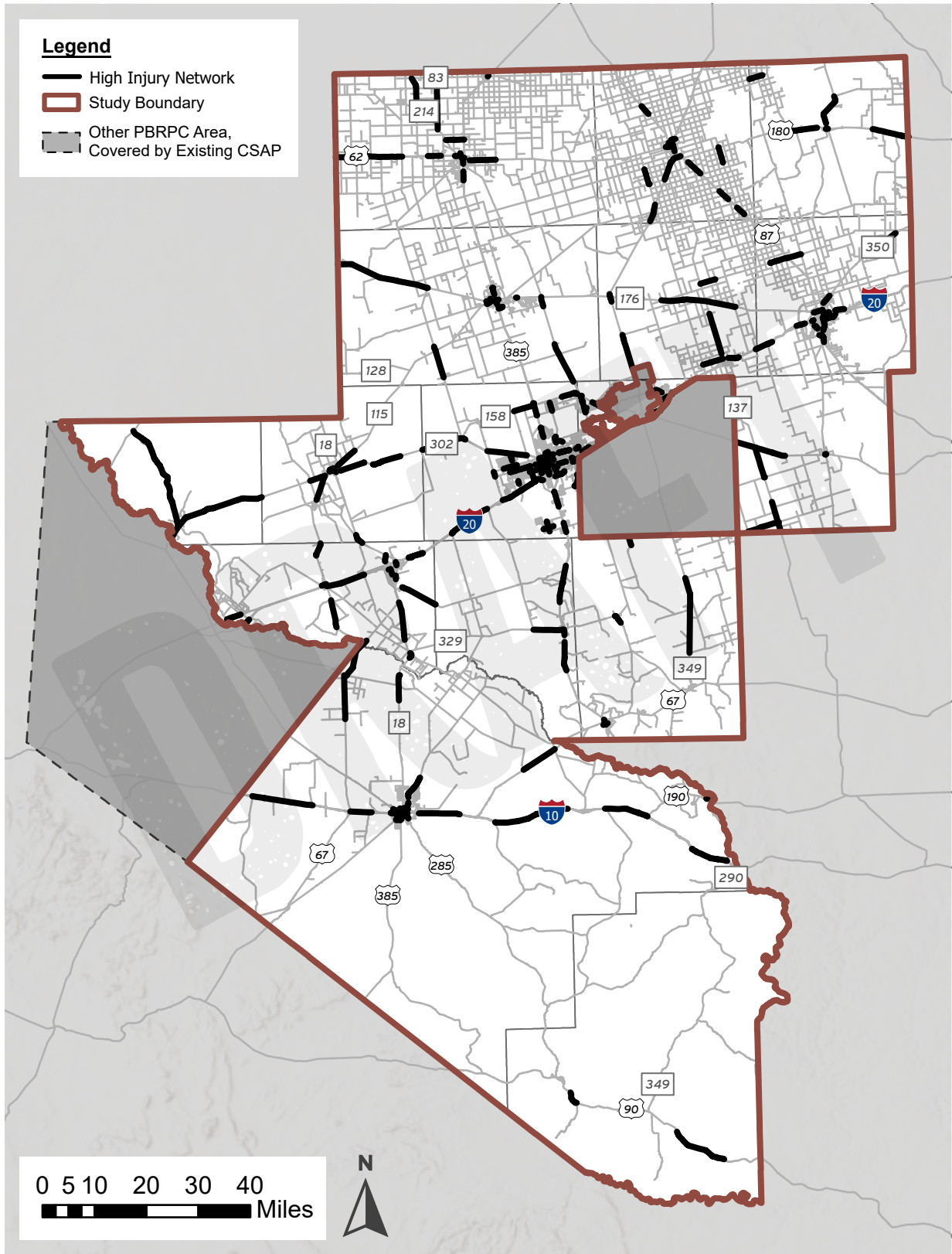
The final HIN for the region was comprised of only 5% of the total road network while capturing 64.5% of all fatal crashes and 42.4% of fatal, suspected serious, and suspected minor injury crashes. **Exhibit 12** on page 54 shows the finalized HIN for the study area with the addition of the HINs for Midland County and the City of Midland which were not completed through their own independent CSAPs (adopted in 2024). Since the cleaning process was done per County, **Table 14** shows the HIN statistics for each County.

**Table 14** HIN Statistics by County

| County    | Percent of Roadways | Fatal Crashes on HIN | Fatal and Severe Injury Crashes on HIN |
|-----------|---------------------|----------------------|----------------------------------------|
| Andrews   | 4.6%                | 20 (55.6%)           | 142 (45.7%)                            |
| Borden    | 5.3%                | 5 (83.3%)            | 15 (44.1%)                             |
| Crane     | 6.7%                | 6 (60.0%)            | 30 (39.0%)                             |
| Dawson    | 2.0%                | 12 (60.0%)           | 99 (52.7%)                             |
| Ector     | 5.7%                | 141 (66.2%)          | 1330 (41.2%)                           |
| Gaines    | 2.6%                | 25 (67.6%)           | 134 (39.0%)                            |
| Glasscock | 7.1%                | 12 (91.7%)           | 43 (50.6%)                             |
| Howard    | 2.5%                | 27 (50.0%)           | 214 (32.9%)                            |
| Loving    | 48.3%               | 11 (91.7%)           | 56 (73.7%)                             |
| Martin    | 4.8%                | 35 (70.0%)           | 156 (41.5%)                            |
| Midland*  | 7.1%                | 38 (59.4%)           | 323 (47.2%)                            |
| Pecos     | 6.2%                | 23 (62.2%)           | 208 (52.8%)                            |
| Terrell   | 5.6%                | 4 (50.0%)            | 11 (35.5%)                             |
| Upton     | 4.1%                | 9 (56.3%)            | 37 (34.9%)                             |
| Ward      | 7.1%                | 26 (65.0%)           | 152 (53.0%)                            |
| Winkler   | 7.8%                | 22 (84.6%)           | 84 (44.2%)                             |

\* Only crashes within the Study Area were included in the analysis.

**Exhibit 12** High Injury Network Map



## HIGH RISK NETWORK

In addition to the high injury network, a high risk network (HRN) was developed for the region to serve as another tool in the decision-making process. The HRN consists of roadways that share design attributes associated with a specific crash type. Since this network is dependent on similarities to high crash roadways, the HRN can aid in proactive prioritization and decision-making regarding future transportation projects and investments.

### Process

The creation of the HRN was a quantitative process outlined by the Federal Highway Administration's (FHWA) Systemic Safety Planning Process Methodology. The following five steps were taken to achieve the finalized HRN:

- + Identifying Focus Crash Types
- + Identifying Focus Facilities
- + Identifying and Evaluating Potential Risk Factors
- + Scoring the Network
- + Selecting the High Risk Network Segments

### Identifying Focus Crash Types

Based on the guidance from FHWA, focus crash types should be selected from the safety emphasis areas outlined in the state or regional strategic highway safety plan (SHSP) therefore the potential crash types were:

- + Distracted Driving
- + Impaired Driving
- + Intersection Safety
- + Occupant Protection
- + Roadway & Lane Departures
- + Speed-related
- + Vulnerable Road Users
- + Post Crash Care (no crash data)

Since the study area encompassed 16 counties, each with different safety needs, the top safety emphasis area for each county was identified by determining the percentage of fatal, severe, and minor injury (KAB) crashes associated with each emphasis area (**Exhibit 8** as seen in Chapter 3). The final focus crash types were roadway and lane departures, speed-related, and intersection crashes. **Table 15** displays the top emphasis areas for each county in the study area.

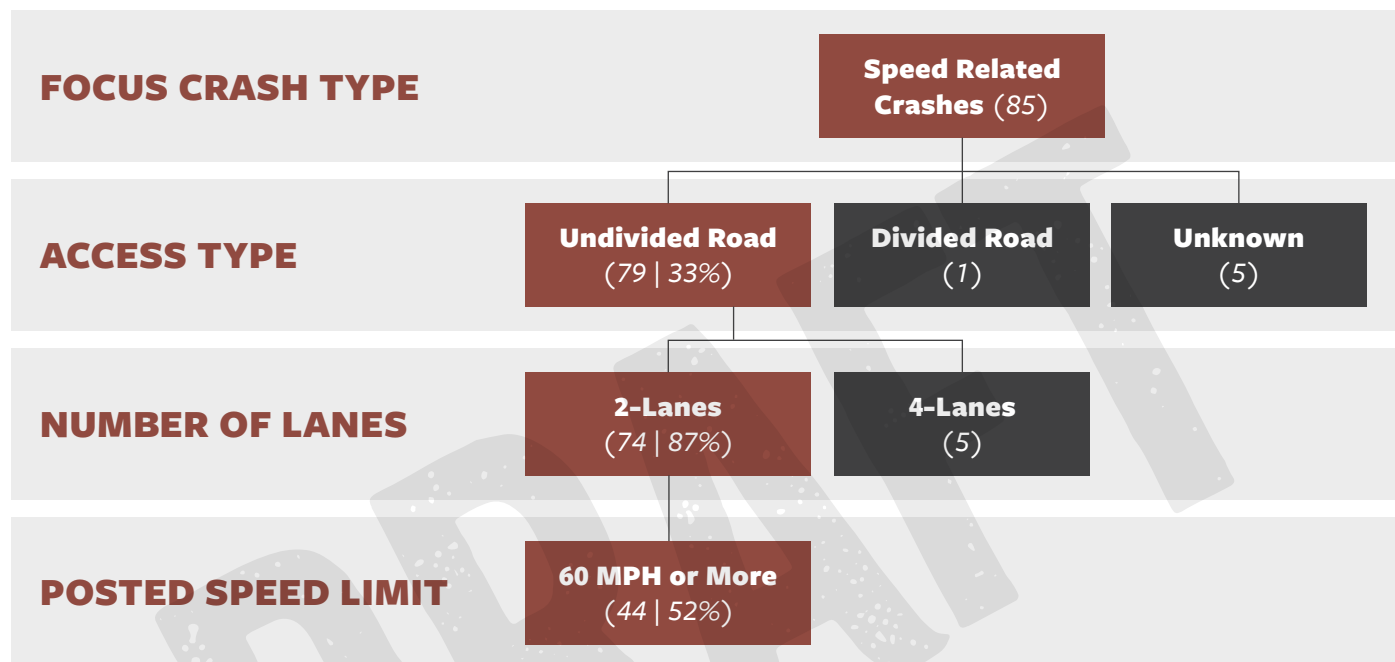
**Table 15** Top Emphasis Area for Each County

| County    | Top Emphasis Area        |
|-----------|--------------------------|
| Andrews   | Intersection Related     |
| Borden    | Roadway & Lane Departure |
| Crane     | Roadway & Lane Departure |
| Dawson    | Intersection Related     |
| Ector     | Intersection Related     |
| Gaines    | Intersection Related     |
| Glasscock | Speed-Related            |
| Howard    | Intersection Related     |
| Loving    | Speed-Related            |
| Martin    | Speed-Related            |
| Midland*  | Intersection Related     |
| Pecos     | Roadway & Lane Departure |
| Terrell   | Roadway & Lane Departure |
| Upton     | Speed-Related            |
| Ward      | Roadway & Lane Departure |
| Winkler   | Speed-Related            |

## Identifying Focus Facilities

After identifying the focus crash types, focus facilities had to be identified; focus facilities being roadways in which more than 50% of focus crashes in the County occurred on. To identify focus facilities, crash tree diagrams were utilized with the total number of KAB focus crash types were at the highest level and each subsequent level separated the crashes by facility type. The crash trees included separation based on land area context, access, number of lanes, posted speed limit, and traffic control type for crash trees regarding intersection crashes (**Figure 17**).

**Figure 17** Example Crash Tree Result from Winkler County



Crash trees such as the one shown above were created for each county to determine their focus facilities based on their emphasis areas. **Table 16** lists the focus facilities by County as a result of the analysis.

**Table 16** Focus Facilities for Each County

| County    | Focus Facility                                                                                                                                                                                        |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Andrews   | + Rural, 2-lane roadways with stop sign controlled intersections and speed limits between 60-75 MPH<br>+ Small urban, 2-lane roadways with signal controlled intersections and speed limits of 75 MPH |
| Borden    | + Rural, 2-lane undivided roadways with speed limits of 75 MPH                                                                                                                                        |
| Crane     | + Rural, 2-lane roadways with speed limits of 75 MPH                                                                                                                                                  |
| Dawson    | + 4-lane roadways with stop sign controlled intersections<br>+ 4-lane roadways with signal controlled intersections<br>+ 4-lane roadways with marked lanes at intersections                           |
| Ector     | + Urban, 2-lane roadways with stop sign controlled intersections<br>+ Urban, 4-lane roadways with signal controlled intersections                                                                     |
| Gaines    | + 2-lane roadways with stop sign controlled intersections<br>+ 4-lane roadways with signal controlled intersections<br>+ 2-lane roadways with marked lanes at intersections                           |
| Glasscock | + Rural, undivided roadways with speed limits of 75 MPH                                                                                                                                               |

| County   | Focus Facility                                                                                                                                                                                          |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Howard   | + Small urban roadways with stop sign controlled intersections and speed limits between 30 – 40 MPH<br>+ Small urban roadways with signal controlled intersections and speed limits between 40 – 45 MPH |
| Loving   | + Rural, undivided, 2-lane roadways with speed limits of 55 MPH                                                                                                                                         |
| Martin   | + Rural, undivided roadways with speed limits of 75 MPH                                                                                                                                                 |
| Midland* | + Urban, 4-lane roadways with intersections controlled by signals, stop signs, or that have marked lanes                                                                                                |
| Pecos    | + Rural, 2-lane undivided roadways with speed limits of 75 MPH<br>+ Rural, 4-lane divided roadways with speed limits of 80 MPH                                                                          |
| Terrell  | + Rural, 3-lane undivided roadways with speed limits of 75 MPH                                                                                                                                          |
| Upton    | + Rural, 2-lane undivided roadways with speed limits of 75 MPH                                                                                                                                          |
| Ward     | + Rural roadways with speed limits between 75 – 80 MPH                                                                                                                                                  |
| Winkler  | + 2-lane, undivided roadways with speed limits between 60 – 75 MPH                                                                                                                                      |

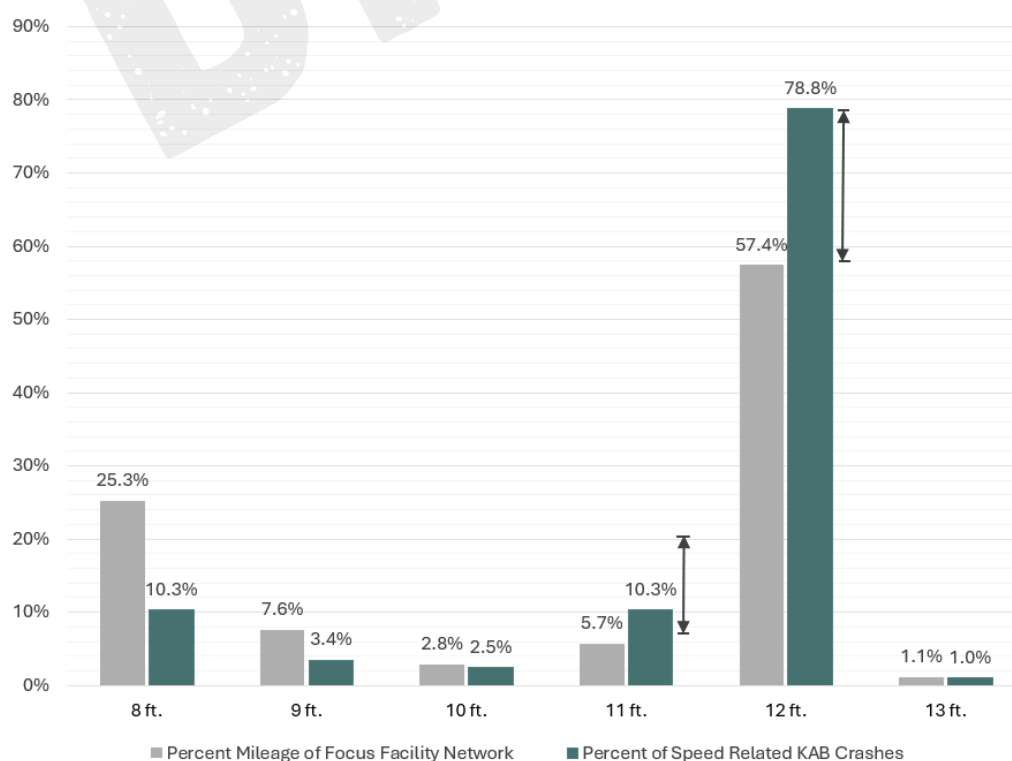
### Identifying and Evaluating Potential Risk Factors

This portion of the HRN analysis identifies if focus facility crashes were overrepresented on focus facilities with specific design attributes. Design features were chosen to be included in this analysis based on their association with the chosen focus crashes. The design features used in the analysis were:

- + Median Type
- + Median Width
- + Shoulder Type
- + Roadway Alignment
- + Volume (AADT)
- + Lane Width
- + Truck % AADT
- + Shoulder Width

To determine if a potential risk factor was overrepresented, the percent mileage of focus facilities with that attribute was compared to the percent of focus crashes occurring in those locations. **Figure 18** shows an example of this comparison for lane width in Winkler County. By graphing these values, the overrepresentation of focus crash types on specific roadway types was easily identifiable.

**Figure 18** Potential Risk Factor of Lane Width for Speed-related KAB Crashes



As shown in **Figure 18** on page 57, both 11 ft. and 12-foot lanes are risk factors for severe speed related crashes in Winkler County, but the level of overrepresentation is different. While lane widths of 11 feet are overrepresented by 4.6 percent, lane widths of 12 feet are overrepresented by 21.4 percent. Based on the level of overrepresentation, risk factors were weighted differently; overrepresentation by 2 or more percentage points received 0.5 points while overrepresentation through 15 or more percentage points received 1 point.

### Scoring the Network

All roadway segments were scored using one of the three scoring tables shown below (**Tables 17-19**) depending on their top emphasis area. For example, roadways in Winkler County were scored using the criteria listed in **Table 17** since Winkler County's safety emphasis area was speeding.

**Table 17** Speeding Risk Factors and Point Allocation

| Roadway Characteristics                  | High Correlation Risk Factors (1 pt) | Medium Correlation Risk Factor (0.5) |
|------------------------------------------|--------------------------------------|--------------------------------------|
| Shoulder Type                            | Asphalt, paved                       | -                                    |
| Shoulder Width                           | 6-12 ft                              | -                                    |
| Volume                                   | 5,000 - 12,500                       | 2,500 - 5,000                        |
| Lane Width                               | 12 ft                                | 11 ft                                |
| Truck % AADT                             | 20 - 25%, 30 - 45%                   | -                                    |
| <b>Total Possible Risk Factor Points</b> |                                      | <b>5.0 points</b>                    |

**Table 18** Intersection Risk Factors and Point Allocation

| Roadway Characteristics                  | High Correlation Risk Factors (1 pt) | Medium Correlation Risk Factor (0.5)      |
|------------------------------------------|--------------------------------------|-------------------------------------------|
| Median Type                              | -                                    | Unprotected, Curbed                       |
| Median width                             | -                                    | 12 - 18 ft, 24 - 48 ft, 250 ft or Greater |
| Shoulder Type                            | -                                    | Asphalt, paved                            |
| Shoulder Width                           | 18 - 24 ft                           | 12 - 18 ft                                |
| Volume                                   | 12,500 - 25,000                      | 2,500 - 5,000,                            |
| Truck % AADT                             | 5 - 15%                              | 20 - 25%, 30 - 55%                        |
| Lane Width                               | 12 ft                                | 11 ft, 13 ft, 15 ft                       |
| <b>Total Possible Risk Factor Points</b> |                                      | <b>5.5 points</b>                         |

**Table 19** Roadway & Lane Departure Risk Factors and Point Allocation

| Roadway Characteristics                  | High Correlation Risk Factors (1 pt) | Medium Correlation Risk Factor (0.5) |
|------------------------------------------|--------------------------------------|--------------------------------------|
| Median Type                              | Unprotected                          | -                                    |
| Median Width                             | 54 - 102 ft                          | 30 - 42 ft.                          |
| Shoulder Type                            | -                                    | Asphalt, paved                       |
| Shoulder Width                           | 6 - 18 ft                            | -                                    |
| Volume                                   | 5,000 - 12,500                       | 12,500 - 25,000                      |
| Roadway Alignment Type                   | -                                    | Curve, Level                         |
| Truck % AADT                             | 25 - 60%                             | -                                    |
| Lane Width                               | -                                    | 11 ft                                |
| <b>Total Possible Risk Factor Points</b> |                                      | <b>6.5 points</b>                    |

### Selecting the High Risk Network Segments

After the appropriate scoring table was selected for grading, risk points were allocated to a roadway segment based on its design attributes. A segment's final risk score was calculated using the equation below:

$$\text{Risk Score (\%)} = \left( \frac{\text{Total Number of Assigned Risk Factor Points}}{\text{Maximum Possible Number of Risk Factor Points}} \right) * 100$$

Segments were added to the HRN if their risk score met one of the two conditions listed below:

- + Risk score was greater than or equal to 50%.
- + Risk score was greater than or equal to the county average risk score.

### High Risk Network Results

**Exhibit 13** on page 60 shows the final high risk network for the region. Additionally, **Exhibit 14** on page 61 demonstrates how the HRN acts as extension of the HIN. This is because roadways on the HRN share similar attributes to roadways with severe crash histories which are attributes held by roadways on the HIN. The final HRN is only 17.1% of the total roadway network but encompasses 64.2% of the HIN.

**Exhibit 13** High Risk Network Map

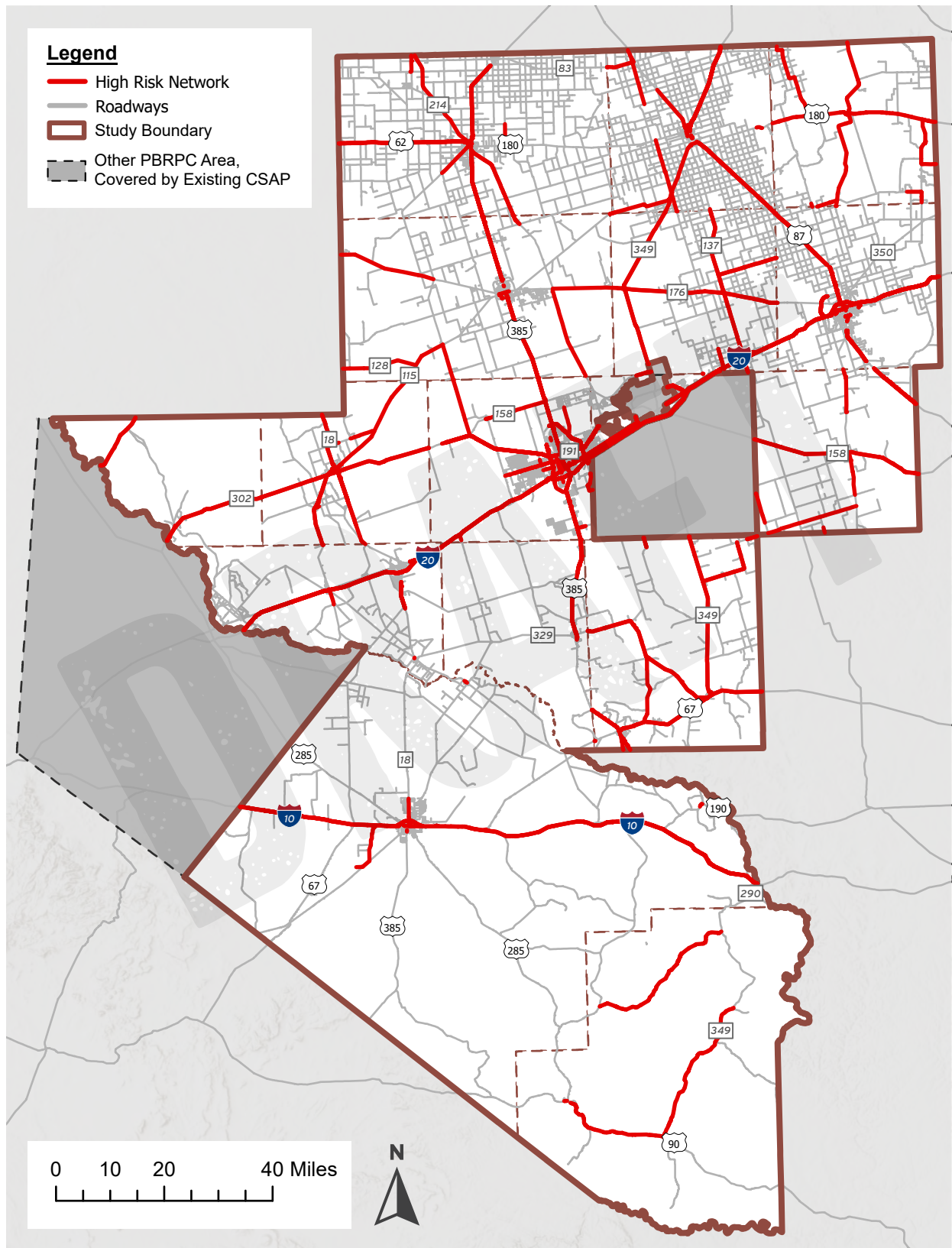


**Exhibit 14** High Injury Network vs. High Risk Network

