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COMPASS Regional Safety Action Plan

TECHNICAL MEMORANDUM #3

April 11th, 2024 Project #: 29061.0

To: Hunter Mulhall and Austin Miller, COMPASS

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RE: Regional Safety Action Plan – Existing Conditions

This technical memorandum presents the existing conditions analysis for the COMPASS Regional Safety Action Plan (RSAP). The analysis was developed based on a two-pronged approach to developing a high-injury network (HIN). The existing conditions have been refined based on feedback from the COMPASS Project Management Team (PMT) and the Safety Working Group meeting #2.

INTRODUCTION

The USDOT adopted a Safe System Approach (SSA) to roadway safety to address and mitigate the risks that are inherent in a complex transportation system. It is a shift from the conventional safety approach because it focuses on human mistakes and vulnerability with the goal of designing a system with multiple protective redundancies. Further, an effective safe system requires buy-in and shared responsibility across all stakeholders, including all levels of government, industry, non-profit/advocacy, researchers, and the general public.[1]

Using High-injury Networks (HINs) for traffic safety planning is an example of the Safe System Approach in practice. Before the most effective interventions are implemented, it is essential to understand the most critical areas of need in a region's transportation network.

The COMPASS Regional Safety Action Plan (RSAP) includes a data-driven analysis of existing conditions and historical trends to establish a baseline understanding of safety performance on the region's multimodal roadway system. To accomplish this important task, the consultant team (High Street and Kittelson) conducted a fatal and serious injury analysis that resulted in a region-wide high-injury network (HIN). Moving towards a vision of zero deaths requires an understanding of where the most severe collisions are occurring (i.e., crashes resulting in fatalities and serious injuries). Additionally, there may be aspects of the network that correlate to more severe crashes as a result of specific roadway design features or risky driver behavior. A defensible and objective HIN highlighting the areas of the roadway system in the most need of safety improvements can help agencies continue making progress with limited resources.

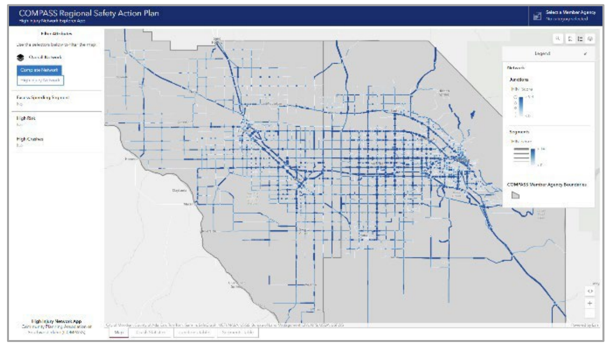
[1] What Is a Safe System Approach?: https://www.transportation.gov/NRSS/SafeSystem

EXECUTIVE SUMMARY

This document presents a comprehensive analysis of existing conditions related to traffic safety in the COMPASS region, setting the groundwork for a targeted Regional Safety Action Plan. Our analysis, grounded in rigorous examination of 2018 – 2022 crash data through location and systemic analysis, underscores the critical areas where interventions can significantly enhance road safety and reduce fatal and serious injury crashes.

The results of the analysis show a High Injury Network (HIN) that prioritizes segments and junctions with fatal and serious injury crashes through a combination of need and risk. This network can be displayed via the link below to an interactable ESRI Dashboard hosted on the COMPASS ArcGIS Online Server:

https://compassidaho.maps.arcgis.com/apps/dashboards/aa2067339363456a9fcec94b0d9875fd



Key Findings:

- **Lane Departure:** Approximately 24% of all K (fatal) and A (serious injury) crashes are lane departure crashes—such as overturns, head- on, and sideswipe collisions—highlight the importance of addressing lane departure risks. Of those lane departure fatal and serious injury crashes, the large majority (76%) of them occur on segments rather than junctions. A comparative analysis between unincorporated and incorporated areas reveals that 60% of lane departure fatal and serious crashes occur in incorporated areas, with 74% of all KA crashes occurring in incorporated areas. This illustrates the spatial distribution and context-specific nature of these crashes.
- **Junction-Related Crashes:** Approximately 37% of all K and A crashes are angle or turning movement related. This underscores the need for strategic interventions at junctions to mitigate these high-risk incidents.
- **Speed and Crash Severity:** Speed is a critical factor influencing crash severity showing that 30% of the High Injury Network has average speeds above the posted speed limit. Systemic analysis findings reveal a strong correlation between speed, functional road classification, and crash outcomes. In particular, roads with speed limits of 35 miles per hour (MPH) and higher are correlated to the most fatal and serious crashes. This relationship emphasizes the need for speed management strategies across various road types to mitigate fatal and serious crashes.
- **Exposure:** The analysis identifies certain attributes in the roadway, such as the number of lanes on segments and the number of legs at junctions, as significant contributors to crash severity. Our model determined that multi-lane segments and intersections approaches correlate with fatal and serious injury crashes. These findings support the prioritization of interventions that reduce conflict points and exposure, particularly in high-risk areas.

Causation vs. Correlation

This analysis identifies features that are correlated with higher numbers of fatal and serious injury crashes. This does not necessarily mean that the presence of the characteristic is contributing to crashes. This may be particularly true of characteristics that are likely acting as proxies for other features (e.g., the presence of a sidewalk may be a surrogate for walking activity).

Crash Type vs. Contributing Factor

Crash Type describes how a crash happens (e.g., rear-end, angle), offering an objective classification based on observable evidence. Countermeasures can be identified to target specific crash types.

In contrast, Contributing Factor (e.g., distracted driving) involves subjective judgment about why a crash occurred, such as distracted driving or weather conditions, which can be unreliable due to reporting inaccuracies or cross-cutting across multiple crash types and not informative for strategy development.

Focusing on crash types allows the plan to identify countermeasures targeted to the most common crash patterns.

- **Vulnerable Road Users:** Despite various road safety measures, vulnerable road users remain at high risk. Detailed analysis sheds light on the specific vulnerabilities and informs targeted strategies to protect these road users effectively. 12.5% of all fatal and serious crashes involved a pedestrian or bicyclist. Motorcycles, Mopeds, and Scooter crashes account for 16% of fatal and serious crashes, but only 1.8% of all crashes, showing an increase in severity when they are involved in a crash.
- **Weather and Road Safety:** Weather conditions have not been a significant factor in crash occurrences in the region. This directs attention towards human and infrastructural factors in crash causation and prevention strategies.
- **Influence of Alcohol and Seatbelt Use:** Alcohol involvement and lack of seatbelt use emerge as significant behavioral factors in crash severity, highlighting the critical need for behavioral intervention programs to address these issues. 4.8% of occupants did not wear any protection device such as a seatbelt and 13.5% of drivers were under the influence of alcohol.
- **Demographic Correlations:** A noteworthy correlation exists between some Traffic Analysis Zones (TAZ) in the COMPASS region and KA crash occurrences, particularly in areas with high Equity Index scores with respect to the Community in Motion (CIM) 2050 Equity Index. Twelve-and-a-half percent (12.5%) of TAZs in the region have an Equity Index score of 7 or above on a 0-12 scale (higher scores indicate worse conditions on various measures of equity). Further, these TAZs represent about 9.4% of the population in the region. Meanwhile, the same TAZs contain 16.1% of KA crashes. This means that there is a disproportionately high number of KA crash types happening in areas with worse equity index scores (i.e., 7 or higher). There is also a notable correlation between unemployment rate and the people living in TAZs along the HIN. The HIN TAZs have a slightly higher average unemployment rate (0.3%) compared to TAZs that do not overlap with the HIN. These observations emphasize the importance of integrating social equity considerations into safety planning.

Recommended Emphasis Areas:

Building on these findings, the table below defines emphasis areas recommended for targeted interventions:

Emphasis Area	Details
Vulnerable Road Users	Crashes involving pedestrians, bicyclists, motorcyclists, and other non-motor vehicle road users.
Junction Crashes	Crashes occurring within 150 feet of a junction or intersection.
Lane Departure Crashes	Crashes involving a vehicle leaving the lane, including overturns, head-on, and sideswipes.
Seatbelt Use	Crashes where there is no use of restraint devices.
Impaired Driving	Crashes involving drivers under the influence of alcohol, drugs, or other impairing substances.

Table 1 - Recommended Emphasis Areas

Conclusion:

The existing conditions analysis provides a data-driven foundation for the Safety Action Plan, identifying critical areas for intervention. By focusing on the recommended emphasis areas and incorporating specific findings from this analysis, the plan aims to significantly reduce the incidence and severity of crashes in the region, thereby enhancing overall road safety for all users.

METHODOLOGY

This section describes the methodology of the analysis for understanding and reproducibility.

HIGH INJURY NETWORK (HIN) DEVELOPMENT

The High Injury Network (HIN) was constructed through a methodical process that integrates both location-specific and systemic analyses as shown in Figure 1. Interstates, ramps, and local roads were removed from the analysis due to the use of crash frequency and lack of data. Using crash counts, interstates and ramps would dominate the HIN . Crashes occurring on local roads are very difficult to determine cause and correlation with the datasets acquired. Crash data was analyzed in conjunction with roadway, junction, and crash attributes to identify areas of concern through two primary types of analysis:

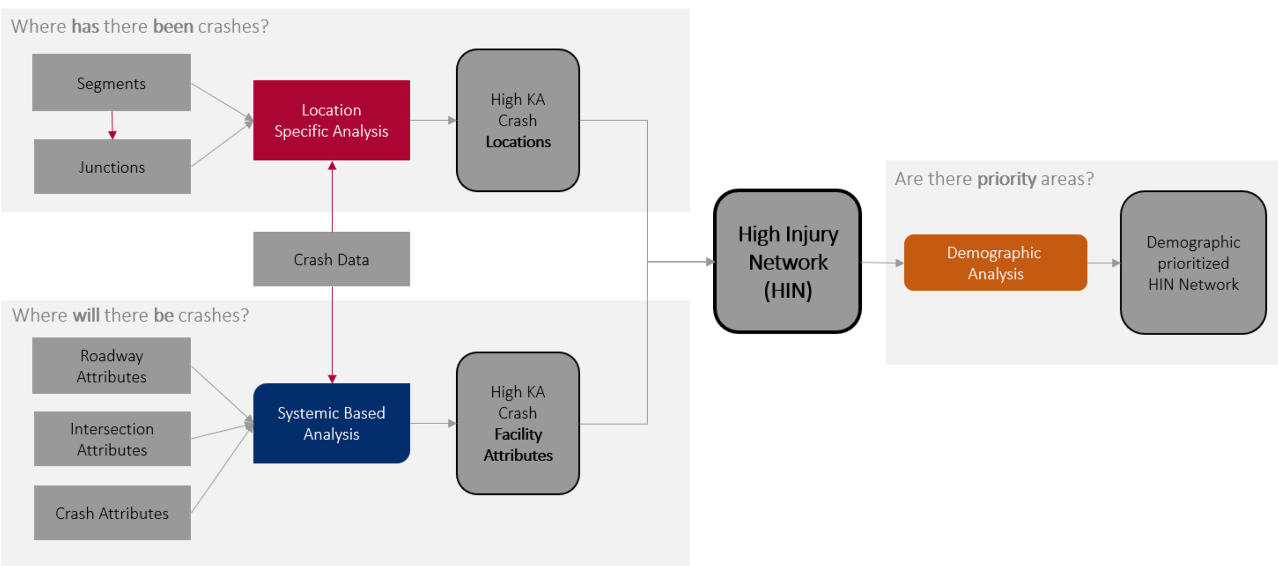


Figure 1 - Two-Prong Data Analysis Approach

1. **Location-Specific (Hot Spot) Analysis** reactively identifies roadway junctions and segments with higher concentrations of observed fatal (K) and serious injuries (A) crashes. This traditional "hot spot" analysis focuses investments at locations where a higher preponderance of severe crash events have occurred in the past five years. The resulting data layer shows high fatal and serious injury crash counts at junctions and segments and a "Location Score", which ranks features based on the number of KA crashes in the five-year period of 2018 to 2022.
2. **Systemic Based (Risk) Analysis** uses a machine learning model (random forest regression) that identifies features of the regional roadway and junction network that correlate with fatal and serious crashes regardless of whether such events have recently occurred at a site location. The goal is to flag infrastructure with roadway features (e.g., lane count), driver behaviors (e.g., speeding), or external conditions (e.g., low lighting) that may increase the likelihood of future severe incidents on the network. The resulting attribute of this work is a "Risk Score" that calls attention to particularly risky roadway and junction facilities.

The result of these two analyses was used to create a **high-injury network (HIN) score** that ranks COMPASS region's roadway segments and junctions through an identical score of features with the highest frequency of fatal and serious injury crashes and features with variables that contribute most to high risk (shown in Figure 2). More details on each of these scores can be found in their respective methodology sections. The creation of this HIN ensured that the network reflects both the granular details of specific crash sites and the broader systemic risks.

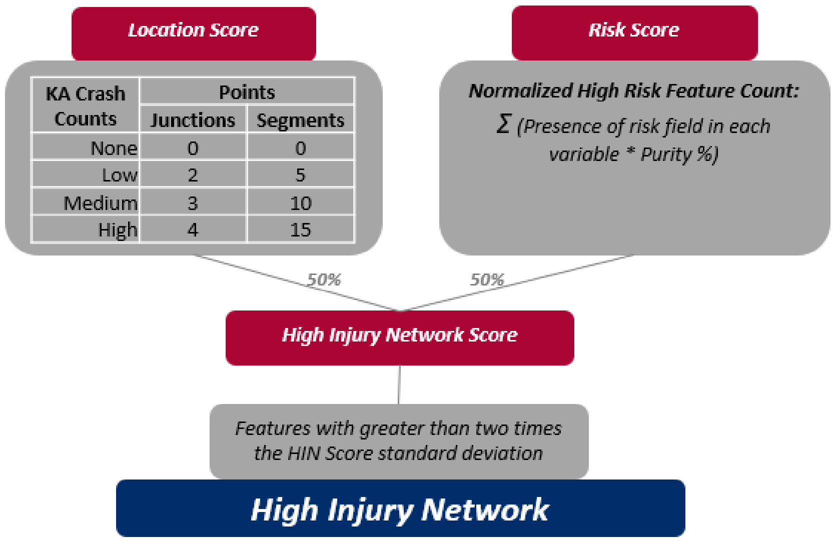


Figure 2 - High Injury Network Weighted Scoring

The HIN was further refined through a Demographic Analysis to ensure community impacts and needs were considered, leading to the creation of a **Demographic HIN Network**. The analysis examines the intersection of the HIN with spatial data about the people who live in the COMPASS region. The goal of this analysis is to discover any safety trends that may disproportionally impact certain groups of people who live close to the HIN. The analysis compares the HIN with the Community in Motion 2050 (CIM2050) Equity Index. The Equity Index utilizes data from the 2015-2019 American Community Survey 5-year summaries as well as COMPASS' transportation and population data and focuses on 23 measures with three categories: social, environmental, and transportation.[2] One limitation of the crash data is a lack of demographic information about the individuals involved in the crashes themselves. It is important to note that the information presented here does not mean that the individuals involved in the crashes used to designate the HIN correspond with the demographic characteristics of the Traffic Analysis Zone (TAZ). Rather, it applies to the people living within the closest proximity to the HIN.

In conclusion, the HIN was meticulously assembled using a dual-analysis approach, combining detailed crash site data with systemic risk factors and demographic considerations to create a prioritized network for safety enhancements. This method provides a robust, data-informed foundation for strategic planning and resource allocation to address critical safety concerns on the transportation network. The resulting HIN can be used by COMPASS to identify locations where resolving safety issues would result in the greatest safety impact.

[2] CIM 2050 Maps: https://compassidaho.maps.arcgis.com/apps/instant/portfolio/index.html?appid=6c1eebca233d49c4935825136f338fac

DATA COLLECTION

The consultant team integrated the Safe System Approach into the analysis by careful consideration of all available quality data that align with five SSA objectives of Safer People, Safer Vehicle, Safer Speeds, Safer Roads, and Post-Crash Care. Figure 3 shows the data elements the team used organized by SSA objective and Appendix A defines the data source credits and attributes used. Note that data for Safer Vehicles and Post-Crash Care are minimal compared to other regions. Example data in these categories that would enhance this analysis might include specific safety technology in the vehicles involved in serious injury and fatal crashes and emergency response time by crash for the entire region.

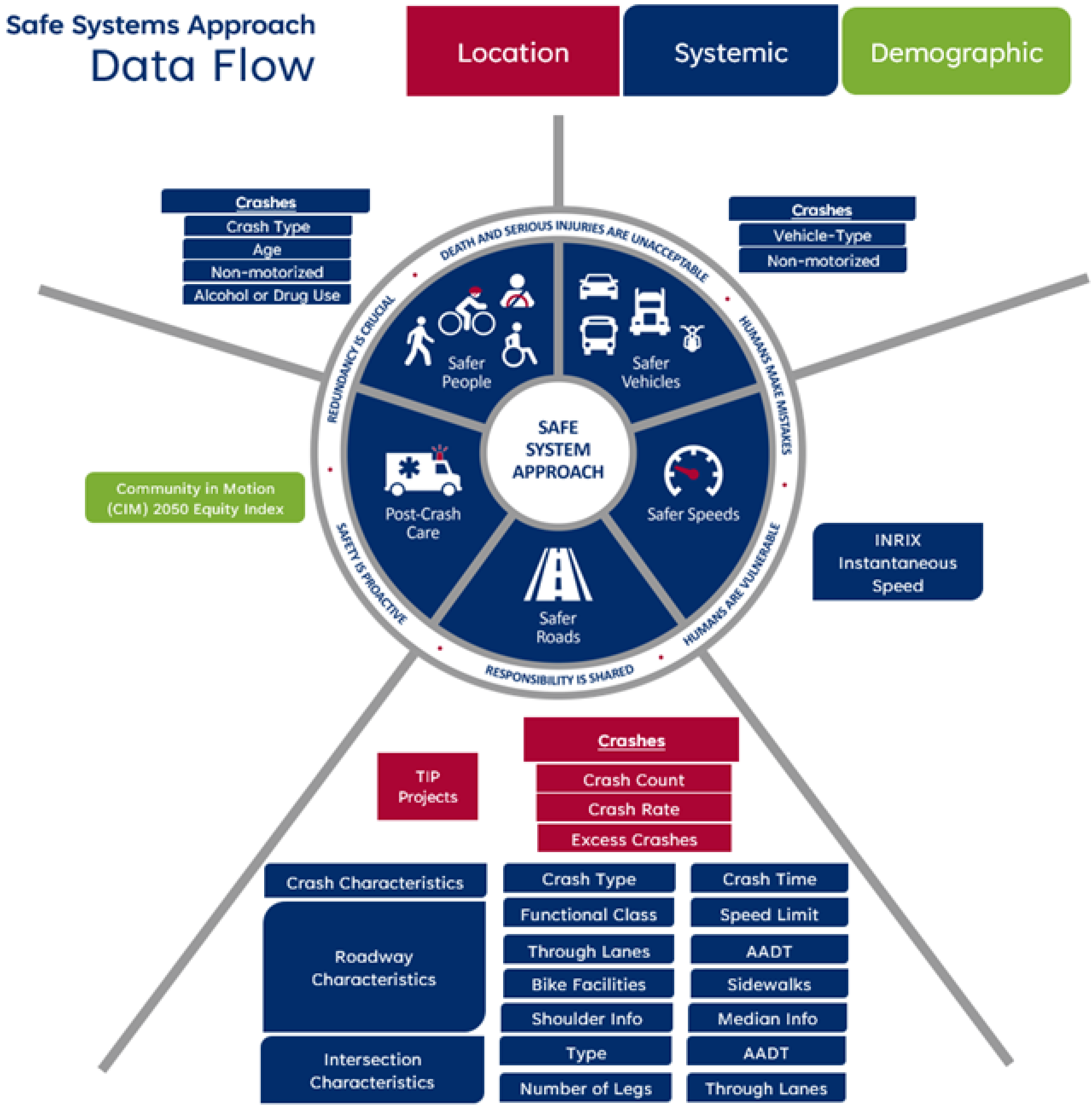


Figure 3 - Data used relative to Safe System Objectives

Additional Data to Consider Collecting

The data collection effort provided a solid foundation for understanding the existing conditions and identifying key areas for intervention within the region. The depth and breadth of the data utilized have allowed for a comprehensive and insightful analysis, rarely leaving us constrained by data limitations. To enhance this high standard of safety planning, we recommend considering the integration of additional data sources in future analyses. These sources can offer new dimensions of insight, further refining our understanding of traffic safety dynamics and enabling even more targeted and effective interventions.

Post Crash Care

- National Emergency Medical Services Information System (NEMSIS): Utilizing NEMSIS data can deepen understanding of the relationship between EMS response times, care quality, and crash outcome severity, guiding improvements in post-crash response protocols.
- Hospital Trauma Center Data: Detailed data from hospital trauma centers on patient outcomes can help evaluate the effectiveness of post-crash care and identify areas for medical intervention improvement, ultimately reducing fatalities and severe injuries.

Safer Speeds

- Connected Vehicle Data: Real-time data from connected vehicles can offer insights into prevailing speed patterns and hard breaking events across different road types and conditions, aiding in the identification of spots where speed management measures are most needed.

Safer Vehicles

- Department of Motor Vehicles (DMV) Records: Vehicle registration data can assist in determining which vehicles disproportionally are involved in severe crashes. Detailed DMV records on vehicle inspections and compliance with safety standards can identify trends in vehicle safety features' effectiveness and areas for policy intervention.
- Insurance Claim Data: Aggregated data from insurance claims can provide another layer of detail regarding the types of vehicles and safety features most commonly involved in crashes, offering a unique perspective on vehicle safety performance.

Safer Roads

- Junction/Intersection Data: More attributes of an intersection can help identify high risk attributes. Examples of that are the presence of turn lanes, left-turn phase, and other items noted in FHWA's MIRE elements[1].
- Land Use Data: Detailed zoning and land use patterns can help understand how the built environment influences traffic flow and safety. This can guide the design of safer roads that accommodate all users.
- Public Transportation Usage Data: Information on public transportation ridership and service coverage can highlight areas where enhancements in vulnerable road user safety can be most effective.

Safer People

- Mobile App Data: Analyzing anonymized data from traffic-focused mobile apps (such as Waze and Google Maps) can provide insights into public perceptions of road safety and hazardous locations.
- Health Department Records: Data on alcohol and drug consumption patterns from health departments can help identify correlations with crash occurrences, informing targeted interventions for impaired driving.

[1] https://safety.fhwa.dot.gov/tools/data_tools/mirereport/mire_elements.cfm

DATA VALIDATION

PROCESS

For each dataset, a series of data quality and assurance checks were performed as shown in Figure 4:

- **Spatial completeness** – Does the layer cover all of the COMPASS region? Are there gaps?
- **Percent of null column values** – What percentage of rows in the columns we plan to use are null?
- **Distribution of column values** – Are there outliers in the values of the columns we plan to use? Does the mean, median, max, and minimum value make logical sense? Is there evidence of default placeholder values?
- **Geocoding** – Do any points, lines, or polygons look geocoded incorrectly? If so, does this impact large amount of data or are there only a few instances?
- **Data structure** – Is the data in a wide format, meaning each attribute is in a separate column, or a long format, meaning each attribute is in a separate row? Are any transformations needed to join all of the data together and perform the analysis?

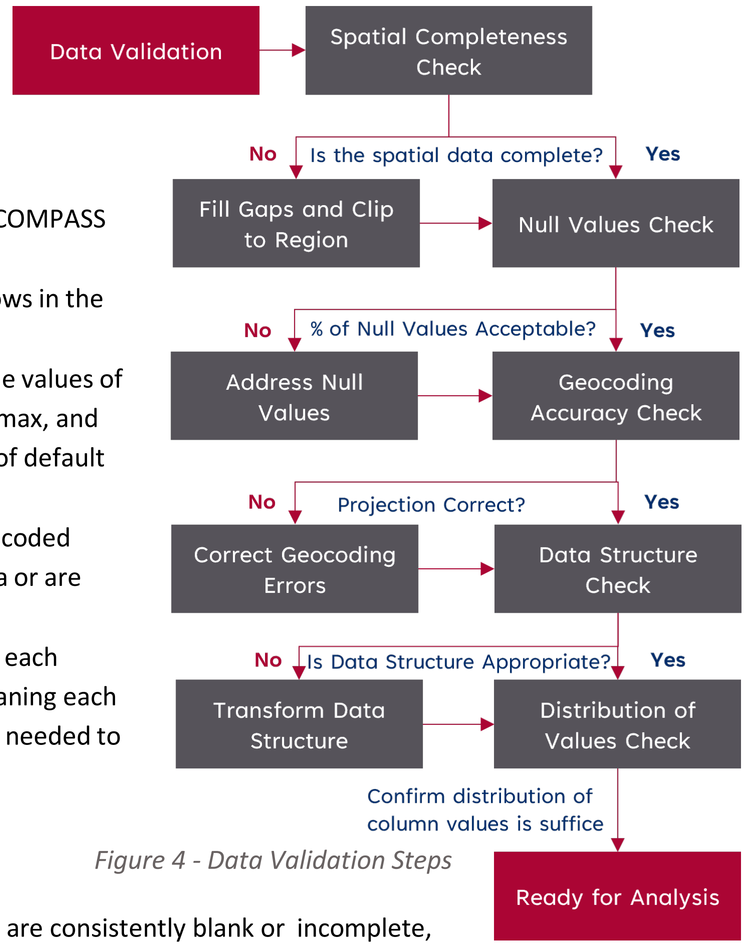


Figure 4 - Data Validation Steps

SUMMARY OF FINDINGS BY LAYER

- **Crash Data (2018 – 2022):** Identified several fields that are consistently blank or incomplete, such as Segment Code and Mile Point. Values in key columns used in the analysis such as 'Number of Fatalities' and 'Number of Serious Injuries' were checked to ensure value ranges made sense and from this check, no questionable outlier values were found. There were a few spatial data oddities, like points denoted as being within the COMPASS region via the 'County' field being geocoded outside of COMPASS boundaries. There is consistency across data each year in terms of how crashes are classified, the fields that are included, and data quality.
- **Emergency Response Data:** Investigated the fields that depict the amount of time between the emergency response call being received and the emergency response arrival to the scene. This field was blank approximately 44% of the time and varied widely in reported durations. Considered the possibility of excluding outliers based on the distribution.
- **Volume Data:** Observed that the data is in a long format meaning each different year of Annual Average Daily Traffic (AADT) for the same segment is stored in a different row rather than each year having its own column.
- **TIP Roadway Projects:** Approximately 4% of the roadway projects are identified as having a 'safety' project type in the 'Project Type' field.
- **TIP Intersection Projects:** Nearly half of the intersection projects are identified as having a 'safety' project type in the 'Project Type' field.

DATA ANALYSIS

LOCATION-SPECIFIC ANALYSIS

The location-specific analysis aimed to identify 'hotspots' of crash locations for both segments and junctions. The analysis output assigns a location score to segments and junctions within the COMPASS region based on the number of fatal and serious injury crashes. The following flowchart (Figure 5) illustrates the methodology used to perform this analysis at a high level. Specific details on each step are provided in Appendix C.

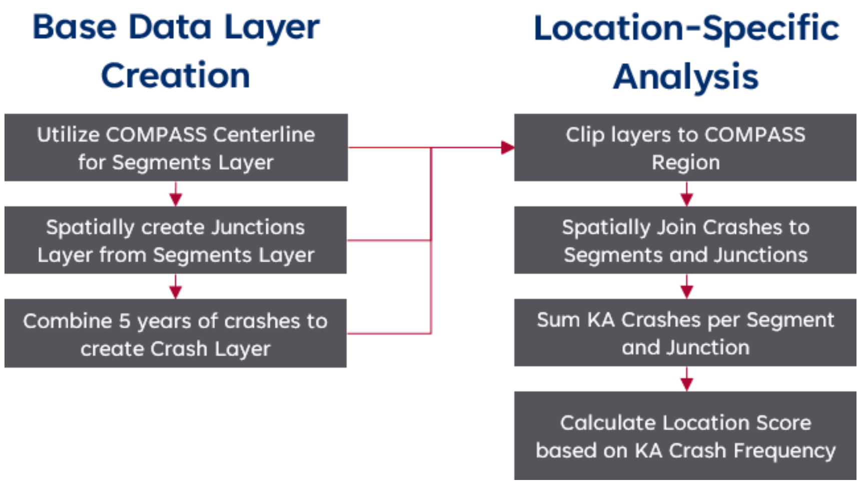


Figure 5 - Location-Specific Analysis Method Overview

The team based the analysis on the segment, junction, and crash layers. Utilizing an existing COMPASS segment layer with a functional classification filter, the analysis focused on segments of classification 'Collector' or higher. This layer served to spatially create a junction layer as a full junction layer for the COMPASS region did not exist. Junction points were created where two or more lines intersected. Attributes from any existing junction-related layers, such as the regional signals layers, non-signal intersections layer, and Ada and Canyon County Roundabouts layer, were incorporated by spatially joining these layers to the spatially created junction layer. The team used spatial joins to link 2018-2022 crashes to their nearest segment or junction. Junction-related crashes, defined as those within 150 feet of a junction per Highway Safety Manual Guidance, were exclusively joined to the junction layer. All other crashes were joined to the segment layer. This analysis calculated numerous crash-related attributes at the segment and junction level including overall crash counts and rates, serious injury crash counts and rates, fatal crash counts and rates, non-motorized crash counts, crash counts of various emphasis area types, and KA crash counts and rates. To calculate rates, COMPASS's latest AADT layer was spatially joined to the segments and junctions. This process resulted in a total of 1,904 fatal and serious injury crashes joined to segments and junctions. 148 fatal and serious injury crashes were removed from the analysis in the process due to reasons such as being on local roads or falling outside of the buffered segments or junctions. 17 of these were fatal crashes and the other 131 were serious injury crashes. Of the 148 crashes not included, 13 are potentially poorly geocoded, however most mention "private property" or "in a parking lot" as the event related to the roadway or junction so a geolocation far from any roadway segment could be correct. The rest of the 148 crashes were on local roadways.

The location score normalized the total fatal and serious injury crash count into a value of 0, 5, 10, or 15 for later use in the systemic analysis. Three cutoff values were calculated using the Jenks natural breaks in the total fatal and serious injury crash count to assign a value of 5, 10, or 15. Segments or junctions with no fatal or serious injury crashes were assigned a 0. This normalization ranks each segment or junction from the most to least number of KA crashes and assists in the creation of the High Injury Network.

The result of the location-based analysis is a segment layer and junction layer, each with a variety of crash attributes summarizing crashes over the last five years. The 'High' KA crash group segments and junctions are then further utilized to develop the HIN.

SYSTEMIC SAFETY ANALYSIS

The systemic analysis (also denoted as risk analysis) focused on interpreting the relationship between variables in the roadway or junction that correlate to fatal and serious injury crashes. The analysis examined how certain roadway and junction characteristics relate to severe traffic accidents. The flow methodology shown in Figure 6 describes how conflation, simple correlation, machine learning regression, and risk scores were used.

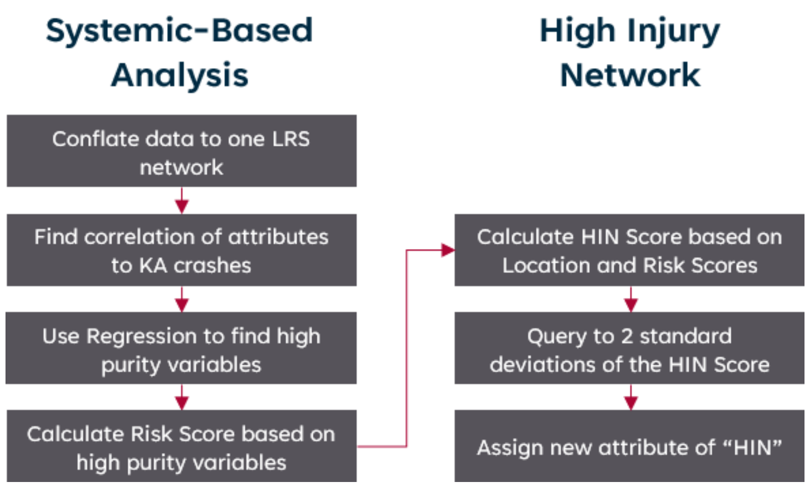


Figure 6 - Systemic Analysis Method Overview

Key to methodology was carefully preparing data on these variables for use in the correlation and machine learning regression analysis. This involved conflation, a sophisticated method of aligning datasets with differing formats, structures, or spatial references. Conflation aims to match fields across datasets and perform a spatial join, using a buffer zone to include nearby relevant features. This is essential because transportation datasets often use different Linear Referencing Systems (LRS) for locating roadway features. Without conflation, integrating these datasets would lead to inaccuracies, as they might use different reference points like state highways or local road mileposts. Conflation avoids these issues, enabling a more thorough analysis.

Our conflation process involved three key steps:

- **Identification of Matching Fields:** This initial phase involves a review of the datasets to determine common fields that can serve as anchors for integration. These fields can include geographic coordinates, road names, or unique identifiers assigned to roadway features. It was found *stname*, *milepost, and cardinal direction* attribute fields contributed the most by tabularly combining LRS data.

- **Spatial Join with Buffering:** Given the spatial nature of our datasets, a spatial join is employed when a matching field is not found. This technique not only aligns data based on location but also incorporates a buffer—a predefined area around each feature—to ensure the inclusion of spatially proximate data, as seen in Figure 7 where the roundabout linework alters between datasets. The size of the buffer is carefully selected to balance inclusivity with precision, aiming to capture all relevant data without introducing extraneous noise.
- **Resolution of Discrepancies:** Conflation is inherently complex, often surfacing discrepancies between datasets. These might include variations in the reported locations of the same feature or differing attributes for what should be identical entries. Resolving these discrepancies requires a combination of automated processes and expert review; ensuring that the final dataset represents a true, unified depiction of roadway and junction characteristics. This step involved manually removing and adding datasets that were not captured in the buffer or the tabular join.

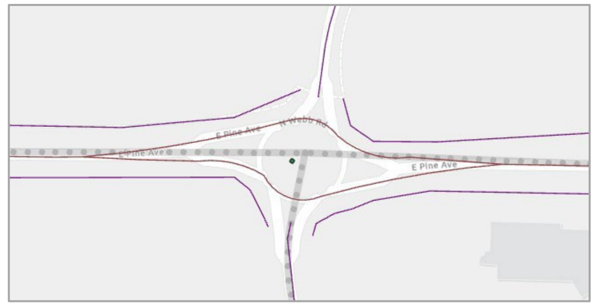


Figure 7 - Difficult roundabout conflation example

Figure 8 - Difficult junction conflation example

After the data was properly conflated to one LRS system, two tests were conducted to derive risk:

Regression Analysis: We employed regression analysis for a comprehensive understanding of how multiple factors simultaneously influence crash frequencies. This approach not only identifies associations but also quantifies the strength and direction of these relationships, enabling predictions and a deeper insight into the complex interplay of road safety variables. This involved exploring various types of regression models:

1. **Linear Regression** was tested to examine continuous data relationships, where we could predict the number of crashes based on linear combinations of road attributes.
2. **Logistic Regression** was considered for binary outcomes, especially useful in scenarios where the outcome is a crash occurrence (yes/no).
3. **Poisson Regression** was particularly apt for count data, which aligns well with crash frequency analysis, where the response variable is a count (number of crashes).
4. **Random Forest Regression** was considered to capture complex, non-linear relationships between road safety variables and crash frequencies by leveraging an ensemble of decision trees.

Correlation Analysis: We also identified correlations between various road attributes, such as the number of lanes and speed limits, and the number of KA crashes. This analysis is crucial for pinpointing single-to-single variable correlations to crash occurrences. By examining the relationships between these variables, we can better understand how certain road features may contribute to higher crash counts. Specific correlations with high variable importance from the regression analysis can be found in the analysis findings section. All other correlation plots can be found in Appendix E.

These models allowed us to integrate multiple variables (as seen in Figure 10) and assess their collective impact on KA crash frequencies. The most effective model was found to be **Random Forest Regression** and was utilized for the systemic based risk analysis. This method is a type of ensemble learning (a subset of machine learning), where multiple decision trees are combined to improve predictive accuracy and control over-fitting. Random Forest operates by constructing a multitude of decision trees during training and outputting the mean prediction of the individual trees. This technique is particularly beneficial in handling large datasets with numerous variables, as it can capture complex, non-linear relationships that traditional regression models might miss.

We developed five distinct Random Forest models to cater to different roadway systems and account for the diversity in vulnerable road user types. These models proved to be more robust and provided a better fit for our complex and varied data sets. This was particularly useful when having different coverages of datasets like shoulder and median widths, shown in Figure 10, were only available on ITD datasets. Lane widths were not considered in the analysis due to all lanes shown as 12 feet from ITD's dataset. All segments represented with 5 lanes include the center turn lane as a lane.

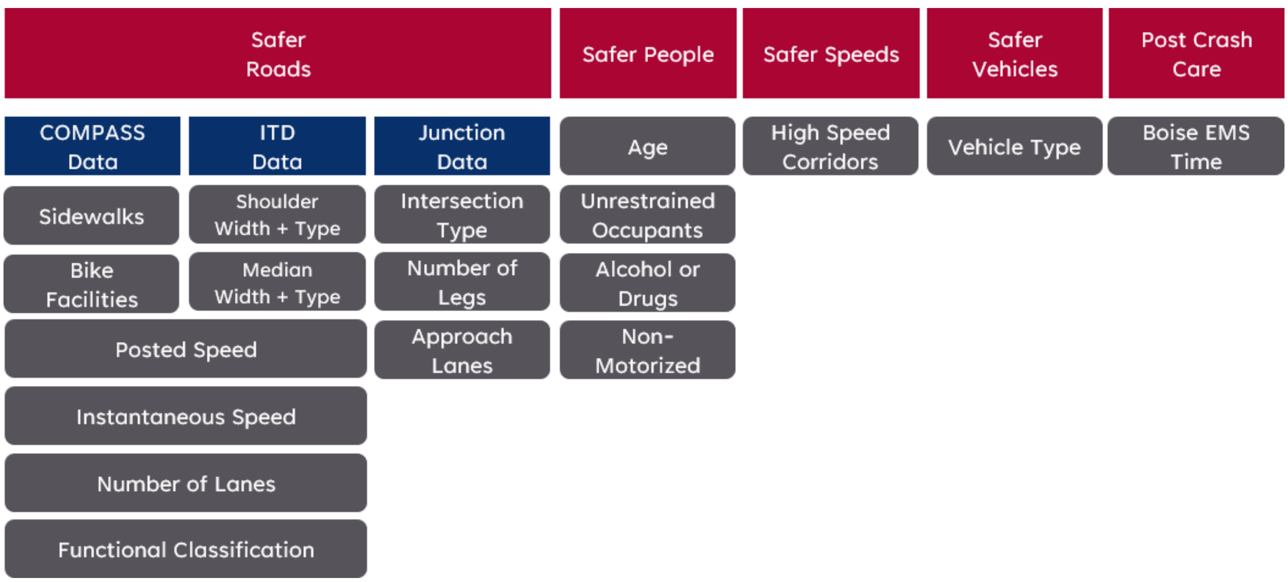


Figure 10 - Available roadway and junction variables.

DEMOGRAPHIC AND AREA CHARACTERISTICS ANALYSIS

The demographic and area characteristic analysis involved overlaying the junctions and segments on the HIN with COMPASS' Community in Motion (CIM) 2050 Equity Index. The CIM2050 Equity Index aggregates 23 social, environmental, and transportation factors such as income, educational attainment, access to open space, vehicle ownership, bicycle and pedestrian injuries, and walkability to score and map the equity/inequity of a traffic analysis zone (TAZ) relative to the region as a whole on a 0-12 scale. Higher scores indicate more inequity.[3]

For this analysis the consultant team considered the TAZs with an Equity Index of seven or higher (7-12) as "high inequity." This definition of a "high equity score" is derived from COMPASS' project scoring and ranking methodology documentation.[4]

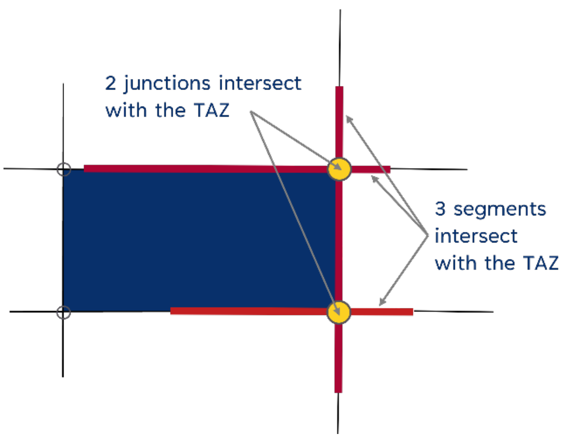


Figure 11 - High Equity Index Score TAZ and HIN Intersection

Most of this analysis focuses on the TAZs with a high Equity Index that intersects with or are immediately adjacent to HIN junctions and segments. To find the TAZs that overlap with the HIN, the team first applied a 200-foot buffer to each segment and junction on the HIN and performed a basic intersection analysis to extract the relevant TAZs. The team counted the TAZ if the buffered point (junction) or line (segment) intersected with a "high inequity" TAZ. Similarly, a junction or segment was counted if it overlapped with a "high inequity" TAZ. Figure 11 illustrates an example of a "counted" TAZ and the segments and junctions that intersect with it.

The team also analyzed the relationship between TAZs that overlap with the HIN and the following five variables considered in the Equity Index: graduation rate, unemployment rate, percentage of residents without a vehicle, percentage of residents without health insurance, and median rent as a percentage of income. The goal of this analysis was to uncover any specific characters that are significantly different about the people residing in TAZs that overlap with the HIN when compared to people residing in TAZs that do not overlap with the HIN.

[3] CIM 2050 Equity Index:
https://compassidaho.maps.arcgis.com/apps/mapviewer/index.html?webmap=a76f5dd73f6442129cf92761c8318707

[4] https://compassidaho.org/wp-content/uploads/I.Scoring_and_Ranking.pdf

ANALYSIS FINDINGS

This section describes the results of our analysis and conclusions that can be derived from it.

REGIONAL TRENDS

The COMPASS region has been making strides towards the performance measure target of 137 fatal and serious injury crashes (5-year average) as seen in Figure 12, but still has progress to be made. 1,904 total fatal and serious crashes that were identified in this analysis and joined to segments or junctions, the majority of crashes analyzed occurred on segments as seen in Figure 13.

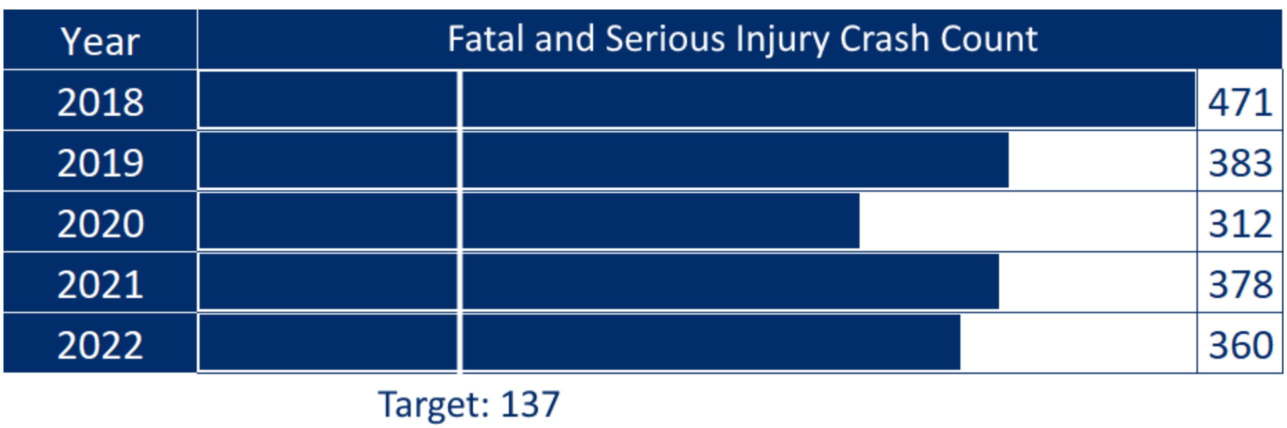


Figure 12 - Fatal and Serious Injury Crash County by Year

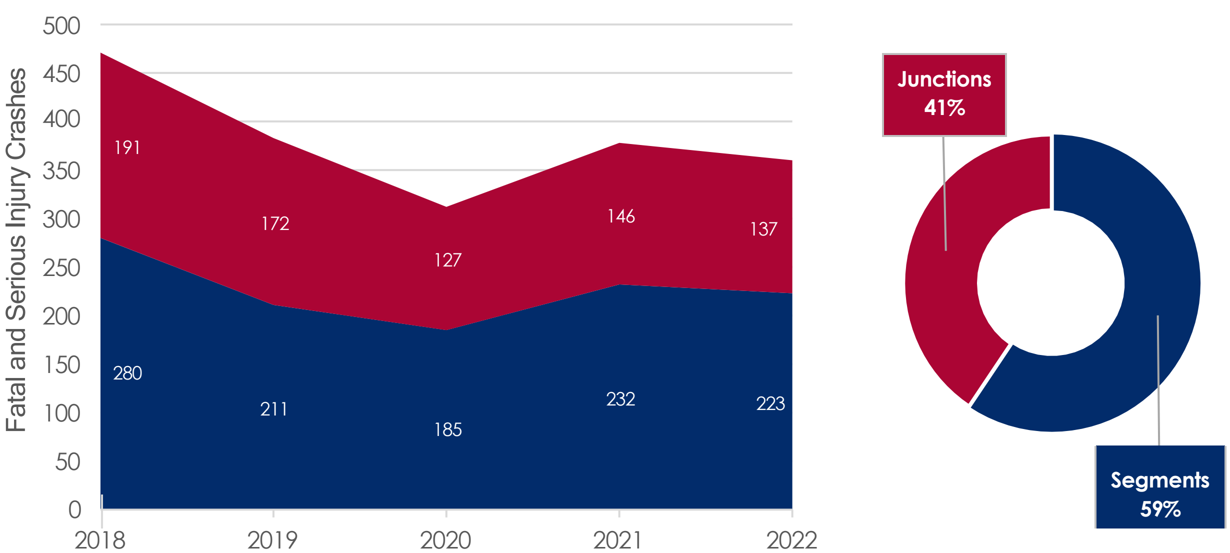


Figure 13 - Fatal and Serious Injury Crashes by feature type

Table 2 below showcases the count and percentage of fatal and serious injury crashes by top crash types. Notable observations include:

1) **36%** of KA crashes are angle or turning crash types where someone may not be following the traffic control, yielding right-of-way properly, and/or speeding without time to correct. The majority of these crashes occur at junctions.
2) **24%** of KA crashes are lane departure type crashes with the majority occurring on segments.
3) **13%** of KA crashes are related to pedestrians and bicyclists.
4) While rear-ends account for **17**% of KA crashes they account for **33%** of all crashes and shows that while some crashes may be severe, this type of crash is just the most frequent.

Crash Type	Segments KA Count	Junctions KA Count	Total KA Count	Percent
Angle (Angle, Angle-Turning, and Head On Turning)	257	444	701	36.8%
Lane Departure (Overturn, Head-On, Side Swipe Same, Side Swipe Opposite, and Fixed Object)	340	107	447	23.5%
Rear End	225	105	330	17.3%
Pedestrian	90	58	148	7.8%
Bicycle	53	37	90	4.7%
All Other Crash Types	166	22	188	9.9%
TOTAL	**1131**	**773**	**1904**	**100%**

Table 2 - Crash Types per feature type

Functional Class	Count	Percentage
Principal Arterial	360	37%
Minor Arterial	253	26%
State Highway	159	16%
Collector	131	14%
U.S. Highway	63	7%

Table 3 - KA Crashes by Functional Class

Lanes	Count	Length (Miles)	Crash Rate
1	0	35	0
2	464	1511	0.31
3	94	115	0.82
4	51	70.87	0.72
5+	357	155.19	2.30

Table 4 – KA Crashes and crash rates per number of lanes

Table 3 above showcases fatal and serious crash types and functional classes excluding interstates, ramps, and local roads. Table 4 has the distribution of crashes by number of lanes excluding interstates, ramps, and local roads. It shows that while 2 lane roadways account for 48% of KA crashes, they account for the majority of the roads in the region with a KA crash rate of 0.31 per mile. Multi-lane (5+ lane) roadways produce the 2nd most KA crashes and have a high KA crashes per mile (2.30), showcasing the high frequency and highest risk. 5 lane roads denote 4 through lanes and one Two-Way Left Turn Lane (TWTL).

Table 5 below breaks down the count of crashes by type occurring in and out of city limits (denoted as incorporated and unincorporated). The table also breaks down the percentage of KA crash types compared to the total number of KA crashes to find which crash types disproportionately occur relative to their jurisdiction. 60% of KA crashes occur in incorporated areas with rear-ends and pedestrian/bicyclist crashes disproportionately occurring. 40% of KA crashes occur in unincorporated areas with angle and lane departure crashes disproportionately occurring. However, from a count perspective the majority of crashes occur in incorporated areas as shown in Figure 14 below.

Crash Type	KA Crash Count		Percentage of KA Crash Count	
	Unincorporated	Incorporated	Unincorporated	Incorporated
Angle	267	434	**48%**	32%
Lane Departure	157	290	**28%**	21%
Rear-End	65	265	12%	**20%**
Ped/Bike	32	206	6%	**15%**
Other	31	157	6%	12%
Total	**552**	**1352**		

Table 5 - Unincorporated vs Incorporated KA Crash Count per Crash Type

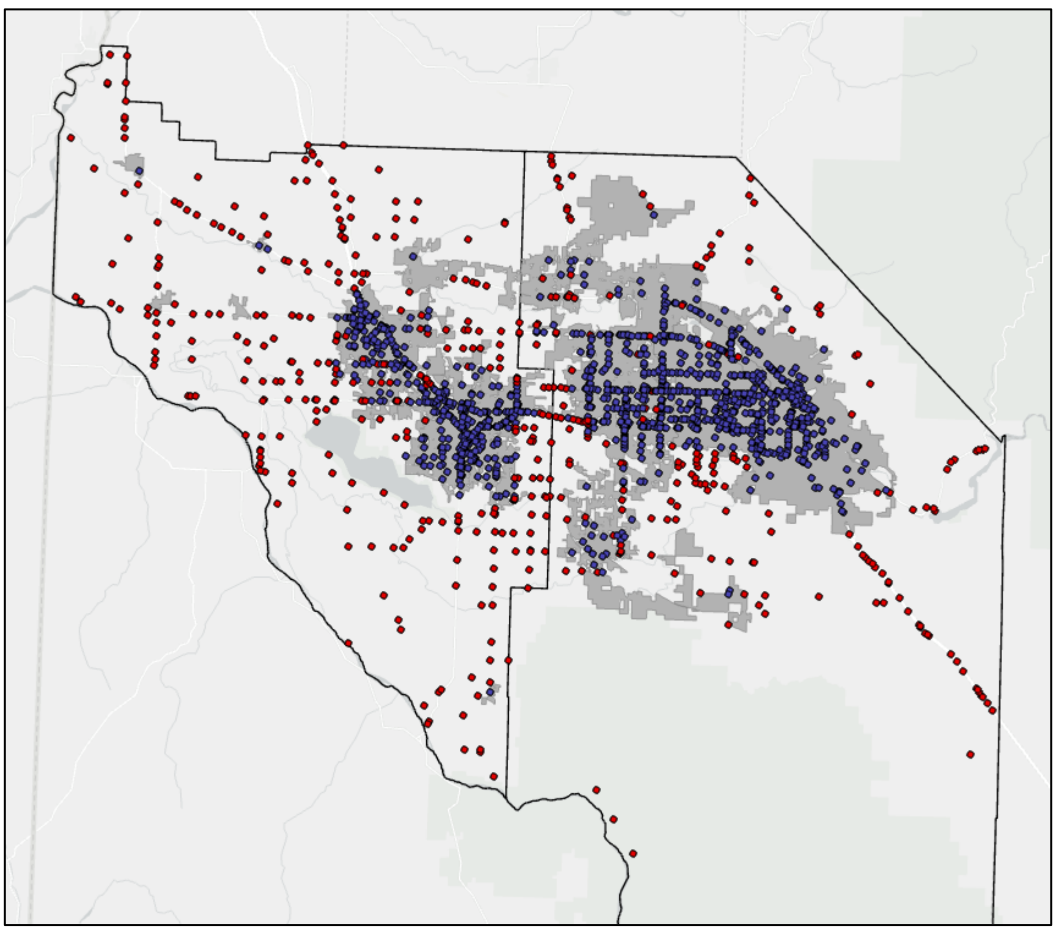


Figure 14 - Incorporated crashes in Blue and Unincorporated crashes in Red

The two figures (Figure 15 and 16) below denote a high number of KA crashes occurring in clear conditions with dry road surfaces, which is consistent with the area's semi-arid climate.

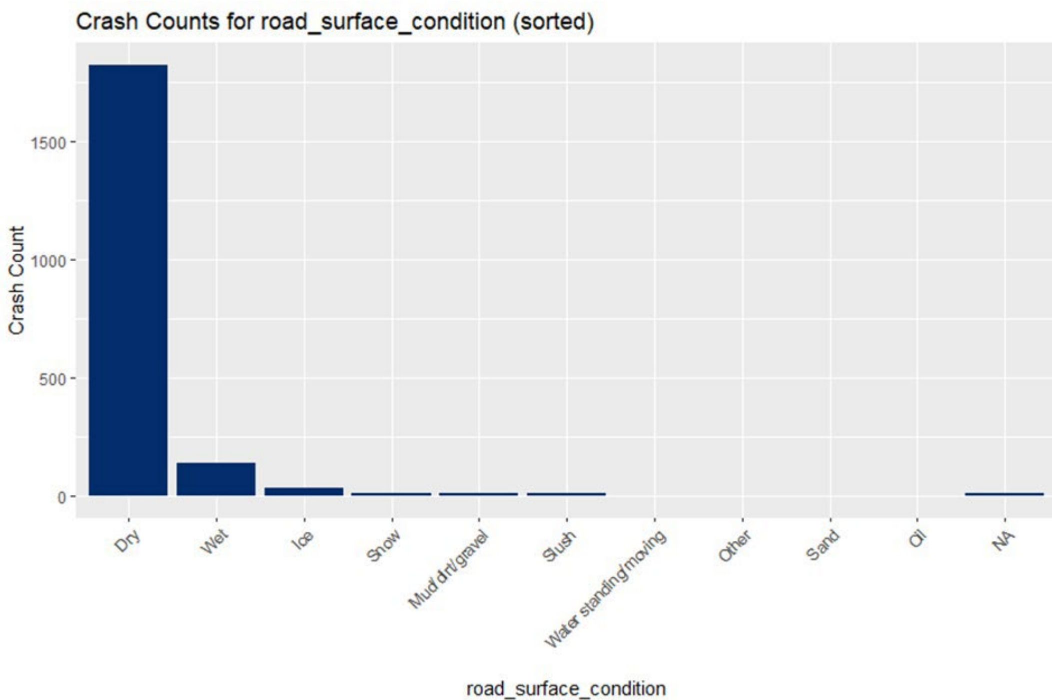


Figure 15 - Fatal and Serious Crash Count by Road Surface Condition

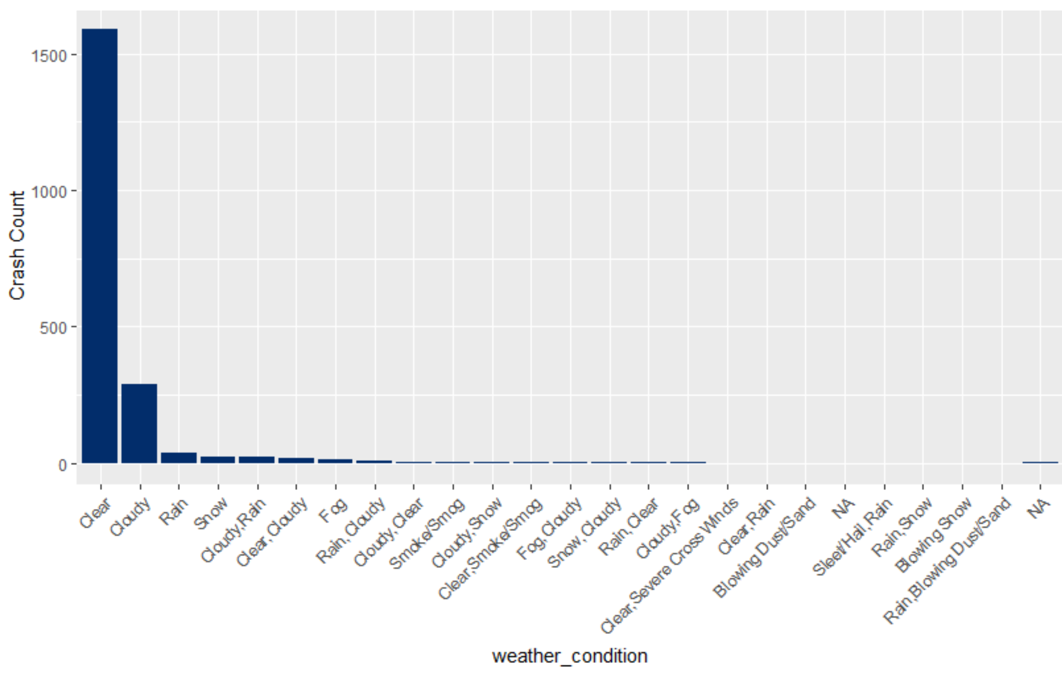


Figure 16 - Fatal and Serious Crash Count by Weather Condition

Figure 17 below denotes a high number of KA crashes occurring during the daytime.

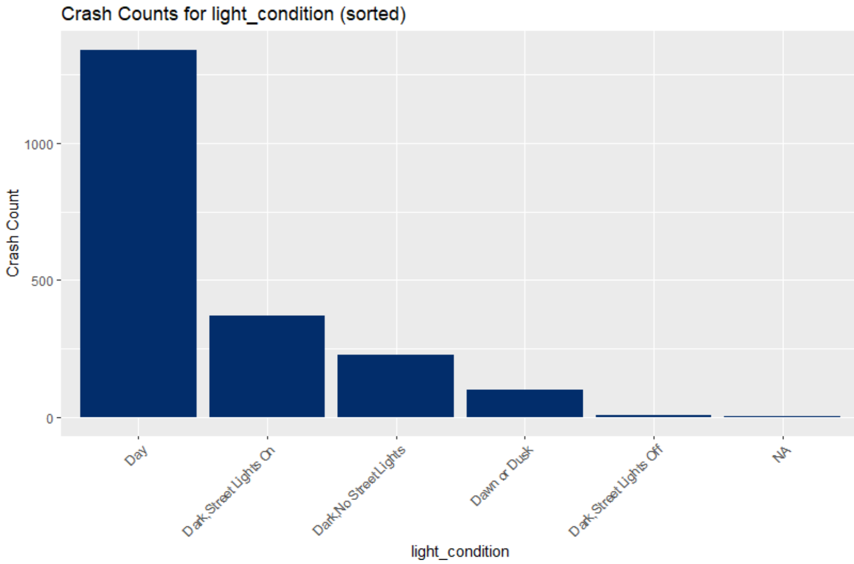


Figure 17 - Fatal and Serious Crash Count by Light Condition

Roadway Volume and Crash Count:
Figures 18 and 19 below show that higher motor vehicle traffic volumes are generally correlated with more total (i.e., all severities) crash counts. This remains true when zero crash locations and seeming outliers are removed.

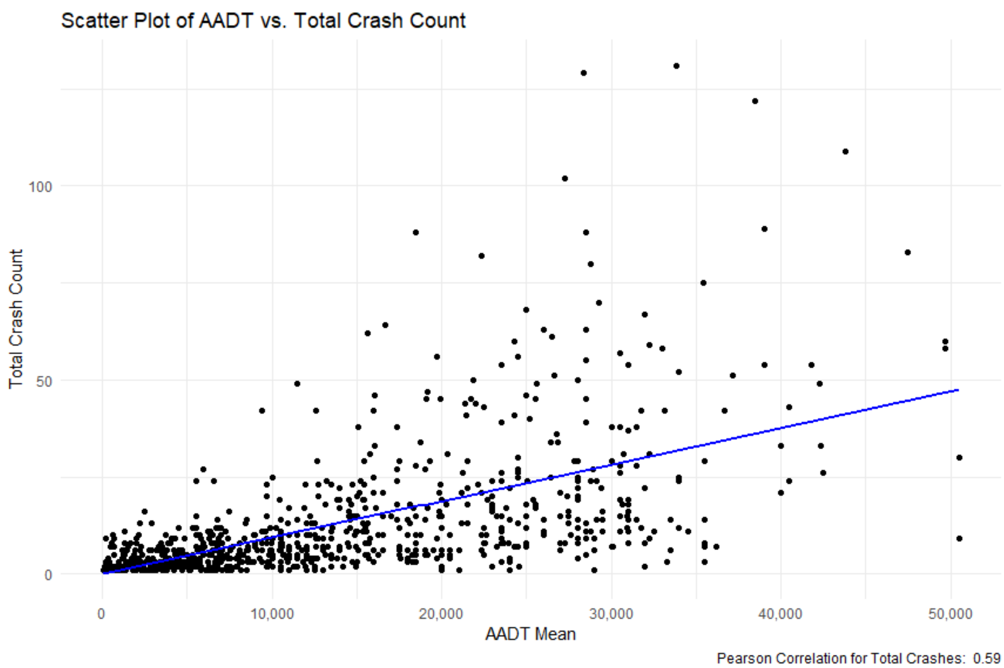


Figure 18 - Scatter Plot of AADT vs Total Crash Count

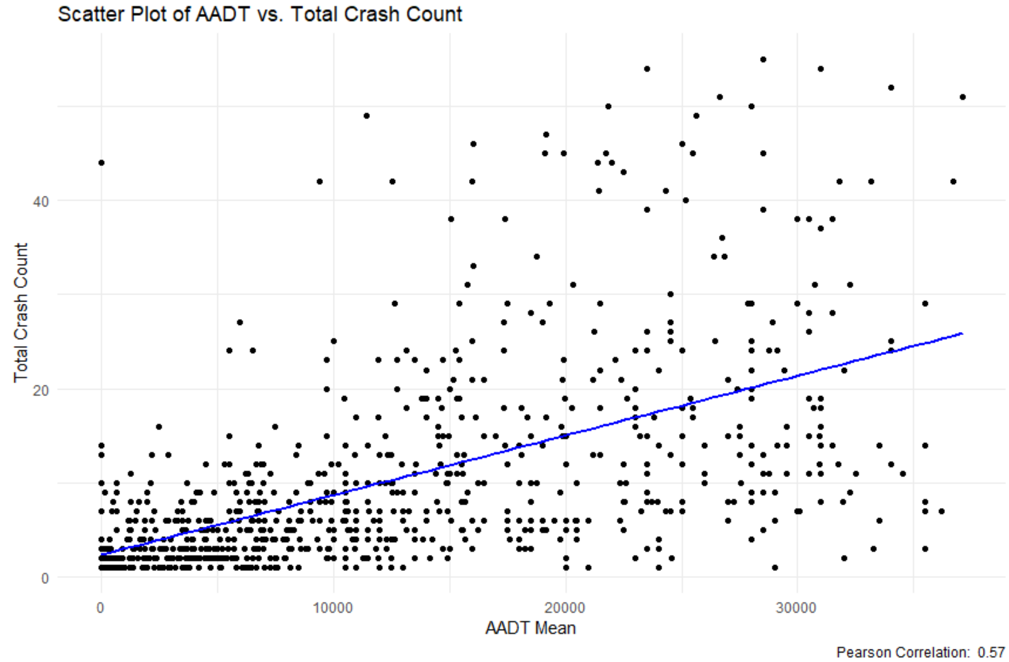


Figure 19 - Scatter Plot of AADT vs Total Crash Count with outliers removed

Figure 20 shows that there is not a strong relationship between crash severity and motor vehicle volumes, with a Pearson correlation of only 0.25. While correlation occurs between crash count and volume, higher volume roads do not correlate to a higher chance of severe crashes. The location analysis conducted in this analysis may generate high volume roads with more severe crashes, but the systemic analysis pulls the High Injury Network away from high volume roads with a normalized look at each correlating variable in the roadway or junction.

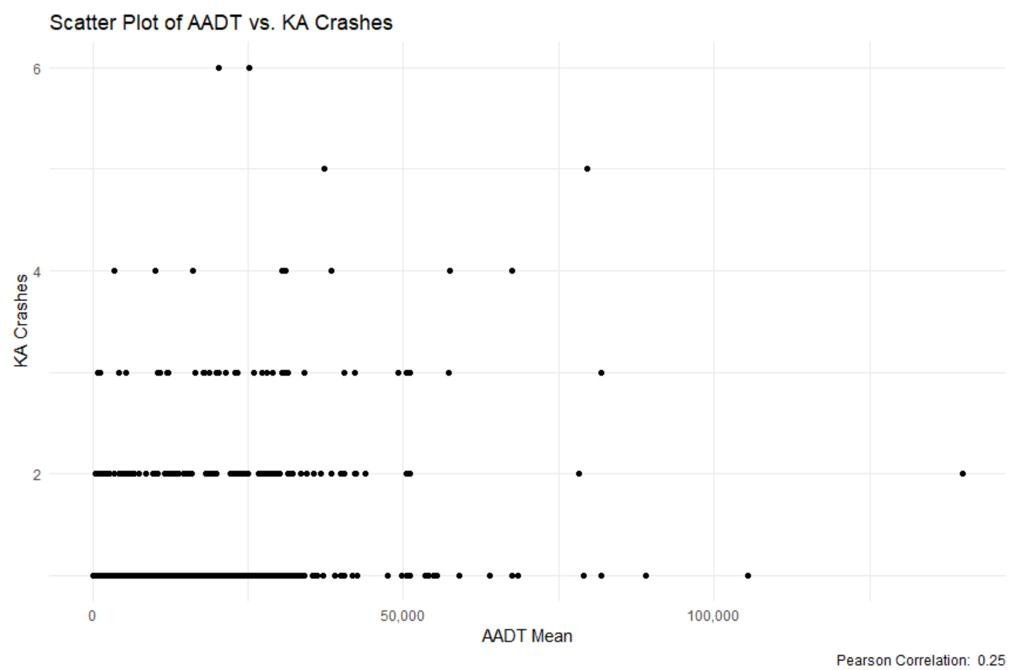
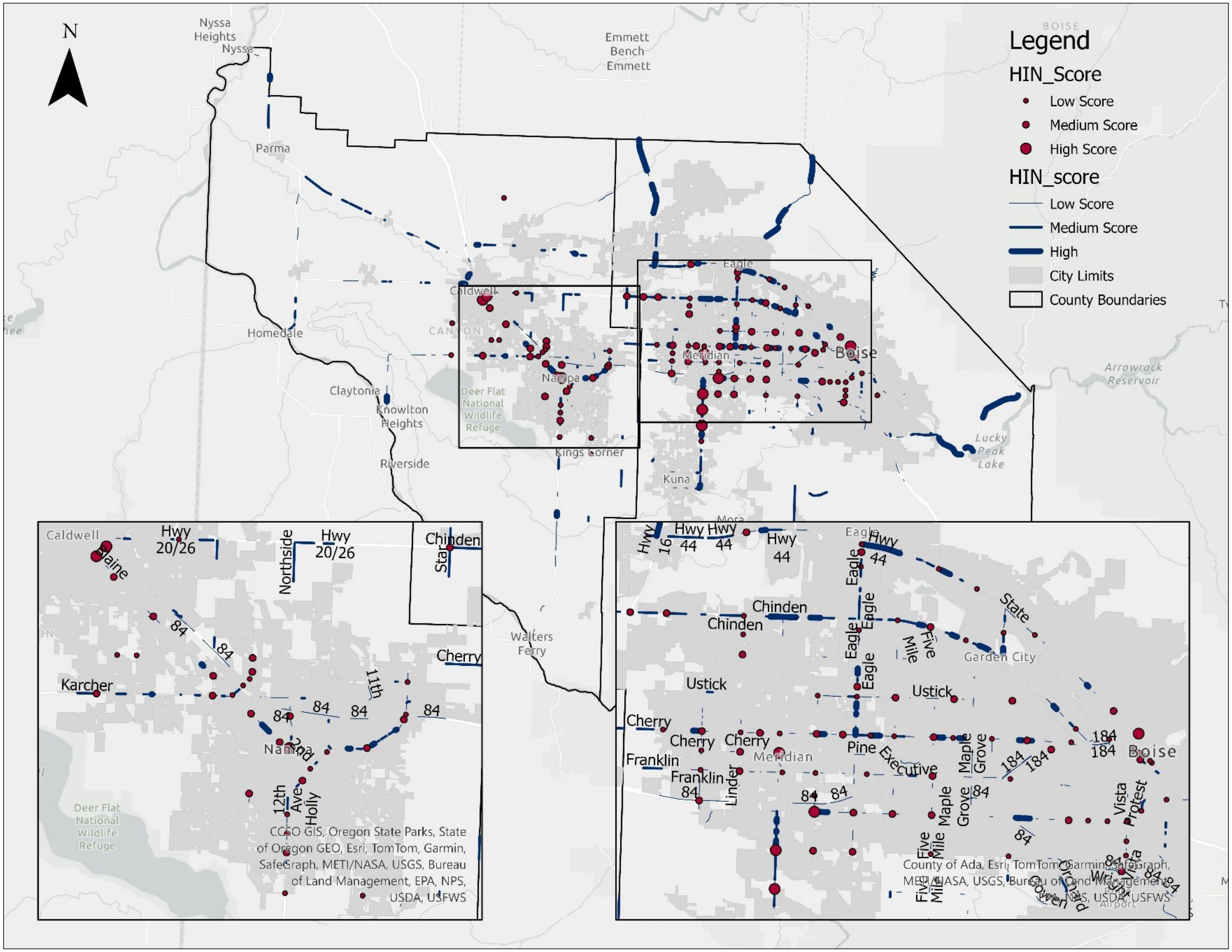


Figure 20 - Scatter Plot of AADT vs KA Crashes with 0 crashes removed

HIGH INJURY NETWORK



Highest Crashes & Highest Risk

The culmination of the analysis results in a High Injury Network (HIN) that prioritizes segments and junctions with fatal and serious injury crashes through a combination of need and risk. Iterations were made to the scoring of the HIN to prioritize segments and junctions that could be the most impactful. Our scoring method ensured that the HIN consisted of both high-crash locations and high-risk locations. Interstates were removed from the HIN determination due to their unique nature.

Highest attributes of the High Injury Network based on length:

57% of the HIN is on **State Highways**

23% is on **55 MPH** posted speed.
16% is on **35 MPH** posted speed.

49% is on segments with **2 lanes.**
31% is on segments with **5+ lanes.**

OVERLAPPING TIP PROJECTS

Using published TIP project data for the COMPASS region[5], the team compared the location of safety projects, pathway projects, and widening projects to the HIN. Projects were filtered to only include those in the current program – FY2024 – FY2030. The project type field was used to determine safety projects and pathway projects. The project description field was used to determine widening projects by searching for the keyword "widen". In the current TIP program, there are 5 safety projects, 19 paved pathway projects, and 28 widening projects. 17 HIN junctions and 48 HIN segments overlap with at least one of these projects. Figure 21 compares project locations to the HIN network and shows that these project locations and the HIN have a comparable geographic spread. Of the 52 safety, pathway, and widening TIP projects, the **22 projects** that are addressing a portion of the High Injury Network are shown below in the following map and Table 5. More details on those overlapping projects can be found in Appendix D.

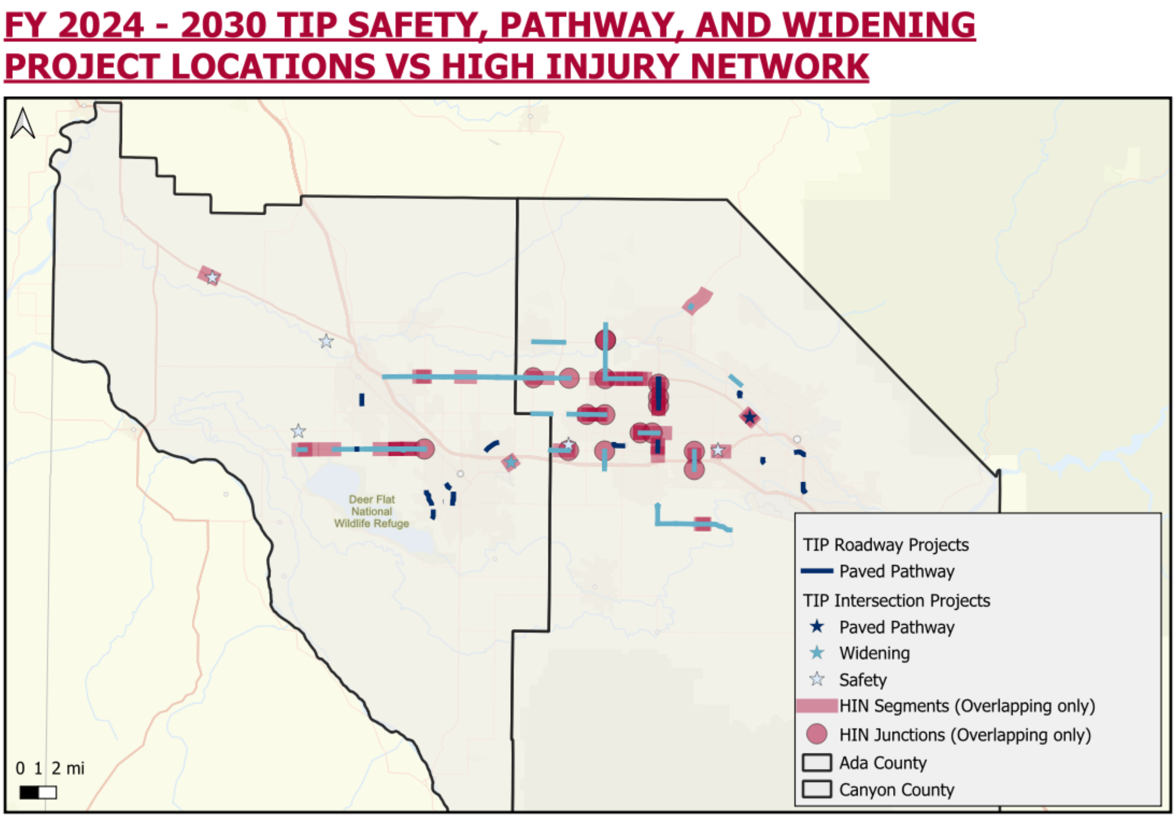


Figure 21 – TIP Safety Projects vs HIN Overlaps Only

[5] TIP Roadways https://share-open-data-compassidaho.hub.arcgis.com/datasets/compassidaho::tip-roadways/explore?location=43.540752%2C-116.390750%2C10.77 and TIP Intersections https://share-open-data-compassidaho.hub.arcgis.com/datasets/compassidaho::tip-intersections/explore?location=43.541975%2C-116.390750%2C10.77

TIP Project Type	TIP Project Name
Safety	Railroad Crossing, Lemp Lane, Canyon County
Safety	Railroad Crossing, Benjamin Lane, Boise
Paved Pathway	Pathway, SH-55 (Eagle Road), Franklin Road to Pine Ave, Meridian
Paved Pathway	Pathway, SH-55 (Eagle Road), Jasmine to McMillan, West Side, Boise
Paved Pathway	Pathway, SH-55 (Eagle Road), McMillan to US 20/26 (Chinden) West Side, Boise
Paved Pathway	Pedestrian Improvements, US 20/26 (Chinden) at 43rd St, Garden City
Widening	US 20/26, Middleton Rd to Star Rd, Eastbound & Westbound, Ada and Canyon Counties
Widening	US 20/26, I-84 to Middleton Road, Canyon County
Widening	SH-55 (Karcher Road), Farmway Rd to Middleton Rd, Canyon County
Widening	US 20/26 (Chinden), Phyllis Canal Bridge to SH-16, Ada County
Widening	Ustick Rd, McDermott Rd to Black Cat Rd
Widening	Linder Rd, SH-44 (State St) to Floating Feather Rd, Eagle
Widening	Linder Rd, US 20/26 (Chinden) to SH-44 (State), Ada County
Widening	US 20/26 (Chinden), Linder Rd to Locust Grove, Meridian, and Eagle
Widening	Ustick Road, Ten Mile Road to Linder Road, Meridian
Widening	Franklin Road, McDermott Road to Black Cat Road, Ada County
Widening	Linder Road Overpass, Overland Road to Franklin Road, Meridian
Widening	Fairview Avenue, Locust Grove Road to SH-55 (Eagle Road), Meridian
Widening	Lake Hazel Road, Five Mile Road to Maple Grove Road, Ada County
Widening	Five Mile Road Overpass and Widening, Boise
Widening	SH-55, Beacon Light Road to Brookside Lane, Ada County
Widening	I-84B (Garrity Boulevard) and Stamm Lane Intersection Improvements, Nampa

Table 5 - TIP Projects Overlapping the HIN

NETWORK LEVEL SYSTEMIC ANALYSIS

RANDOM FOREST MODELS AND SIGNIFICANT FIELDS

The network level systemic analysis conducted involves examining data across an entire roadway system, seeking patterns and trends that affect fatal and serious injury crashes in the region. In contrast, site analysis typically focuses on specific locations, like individual junctions or road segments, to identify localized issues and solutions that can improve safety and performance in those targeted areas. The team fit four random forest regression models to determine network-wide variable importance related to serious and fatal crash risk. Four models were needed due to the variation in the available data between COMPASS and ITD. Random forest regression models are highly beneficial in systemic safety, specifically in their ability to handle large datasets with numerous variables, making them ideal for uncovering complex, non-linear relationships between road characteristics and safety outcomes. Additionally, their inherent feature of random sampling and decision tree aggregation reduces the risk of overfitting, ensuring more robust and generalizable predictions for safety interventions across various road network scenarios. All Random Forest Model outputs can be found in Appendix D for more information.

As seen in Figure 22; ITD maintains geometric attributes to only some of the roadways within the region and while COMPASS maintains a separate roadway inventory, they both have unique attributes as seen earlier in Figure 10, but ITD only has coverage for 14% of the roadways by mileage in the region. We've accounted for this by fitting five different random forest models for each subset of data for segments, with one including the comparison of both. Due to many of the roadways maintained by ITD having a crash proxy of volume, we separated these models to determine risk, rather than volume. Additionally, non-motorized crashes are a subset of crashes that may lead to different geometric needs, and we've fit different models to account for them. In the following pages, we've outlined the variable importance and frequency of crashes per variable attribute field that came from the results of these five models described in the table below.

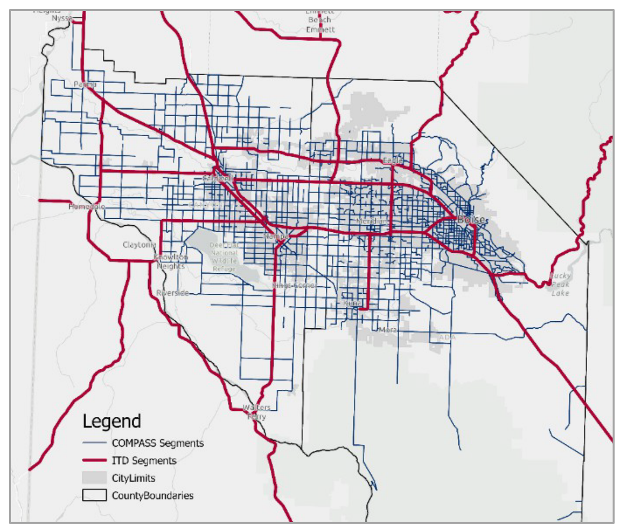


Figure 22 - ITD Data vs COMPASS Data

Random Forest Model Name	Description
Segments - ITD Data	Subset of data that only includes data from ITD
Segments - COMPASS Data	Subset of data that only includes data from COMPASS
Segments - Overlapping ITD/COMPASS	Subset of data that only includes overlapping data
Non-Motorized Crashes	Subset of data with dependent variable of non-motorized crashes
Junctions	Subset of junction data

Table 6 - Description of the five random forest machine learning models fitted to the data.

SAFER ROADS

The subsequent results shown in the Random Forest Models are informative to determine the fields and attributes in segments and junctions that predict a fatal and serious injury crash. As seen in Table 7, the higher the variable importance percentage tells us the variable that correlates the most to fatal and serious injury crashes. This variable importance derived gives us the ability to find the features with the most risk. Each significant field was determined by observing the largest amount of fatal and serious injury crashes for each variable's field. Figures for these can be found in Appendix D, showcasing a jitter plot distribution of crashes per variable field attribute for each of the 5 models used.

Segments Variables	Variable Importance Percentage	Most Significant Fields
Speeding Segment	29.3%	TRUE
Average Speed	27.6%	>= 30 Miles Per Hour
Functional Classification	12.4%	State or U.S. Highway
Number of Lanes	5.7%	5 Lanes
Posted Speed	5.4%	35 or 55 Miles Per Hour
Presence of a Sidewalk	4.4%	TRUE
Right Shoulder Width	4.3%	0, 8, 10 Feet
Road Terrian Type	3.8%	Flat
Shoulder Type	2.6%	Surfaced with Bituminous Material
Left Unpaved Shoulder Width	1.2%	0 Feet
Bike Facility Type	0.9%	No Bike Facility
Right Unpaved Shoulder Width	0.9%	0 Feet
Median Width	0.7%	0 Feet
Median Type	0.6%	None
Left Shoulder Width	0.1%	0 Feet

Table 7 - Segment Random Forest Variable Importance

Our analysis includes the comparison of average INRIX instantaneous speed to posted speed to find excess speeding segments. As seen in Table 2, speed is the primary driver of KA crashes **on segments**, followed by functional class, and number of lanes. With a smaller importance comes median and shoulder width geometric information. For segments, the results show that segments with the most risk correlate closely with speeding on state highways with a posted speed of 35 mph or 55 mph. **A focus on road features for multi-lane State Highways to manage speeds would be advisable.** State highways were found to have **disproportionately more** speeding segments and high-risk roadway features than non-state roadways as seen in Table 8.

Attribute	Count		Percentage of Segment Count	
	State	Non-State	State	Non-State
Speeding Corridor	77	27	**4%**	0.2%
Lanes > 4	566	1154	**29%**	9%
Average Speed > 30	1604	5471	**83%**	44%
Posted Speed > 30	826	3094	**43%**	25%
On the High Injury Network	305	226	**16%**	2%
Segment Count	1936	12514		

Table 8 - State vs Non-State Count of Risk Attributes

Junctions Variables	Variable Importance Percentage	Most Significant Fields
Lanes on Major Leg	35.3%	5 Lanes
Lanes on Minor Leg	28.9%	2 Lanes
Total Legs	28.6%	4 Legs
Intersection Type	7.1%	Signalized

Table 9 - Junction Random Forest Variable Importance

For junctions, there are a smaller number of attributes compared to segments to accurately identify the characteristics of the junction such as intersection angle, lighting, offset distance, left turn lane type, left/right turn prohibitions, and other attributes defined in FHWA's MIRE Elements[2]. Table 9 shows that **4-leg signalized junctions with 5 lanes** on the major approach and 2 lanes on the minor correlate the most to KA crashes. A look at the top crash types in Table 1 of Regional Trends section shows that certain crashes could occur at a junction; Angle Types and Rear-Ends contribute to 60% of all KA crashes. **A focus on junction features to mitigate all angle and rear-end type crashes at the intersection is recommended.**

SAFER PEOPLE

ITD's Strategic Highway Safety Plan[6] (SHSP) defines vulnerable road users as motorcyclists, pedestrians, bicyclists, youthful drivers, and mature drivers. The team also found correlations between fatal and serious injury crashes with certain ages, protection devices, and awareness states of the driver. We noted that **20%** of fatal and serious injury crashes occurred with drivers between the ages of 16-22 years old (as shown in Figure 23), **4.8%** of occupants did not wear any protection device such as a seatbelt, **13.5%** of drivers were under the influence of alcohol, and **5.7%** were under the influence of drugs.

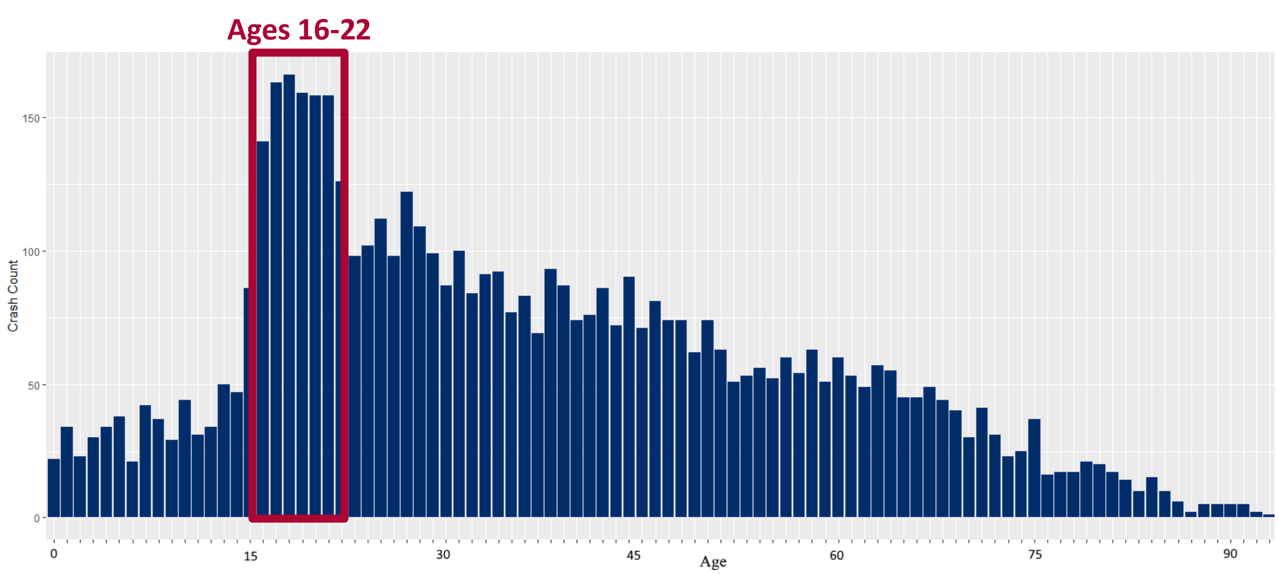


Figure 23 - KA Crashes by Age

[2] https://safety.fhwa.dot.gov/tools/data_tools/mirereport/mire_elements.cfm
[6] https://apps.itd.idaho.gov/Apps/OHS/Plan/SHSP_2021-2025.pdf

In our initial analysis, we found that pedestrians account for only **0.9%** of all crashes, but **7.8%** of all fatal and serious crashes. Deducing that it is less likely for a pedestrian to survive or leave a crash without a serious injury. Similarly, bicyclists account for only **1.2%** of all crashes, but **4.7%** of fatal and serious injury crashes. Due to the disproportionate impact, the project team also fitted a random forest model for all non-motorized crashes to find variables that correlate to pedestrians and bicyclists. All crashes were used instead of fatal and serious due to a small sample size. The team found that while speed and functional class remained one of the highest variables, the presence of a bike facility correlates to less KA crashes. **Multi-lane U.S. Highways** with **sidewalks**, **no bike lanes,** and **average high speeds** correlated the most to non-motorized crashes as shown in Figure 24. More information, including the breakdown of each roadway attribute that correlated to non-motorized crashes, can be found in Appendix D, Random Forest Model 4.

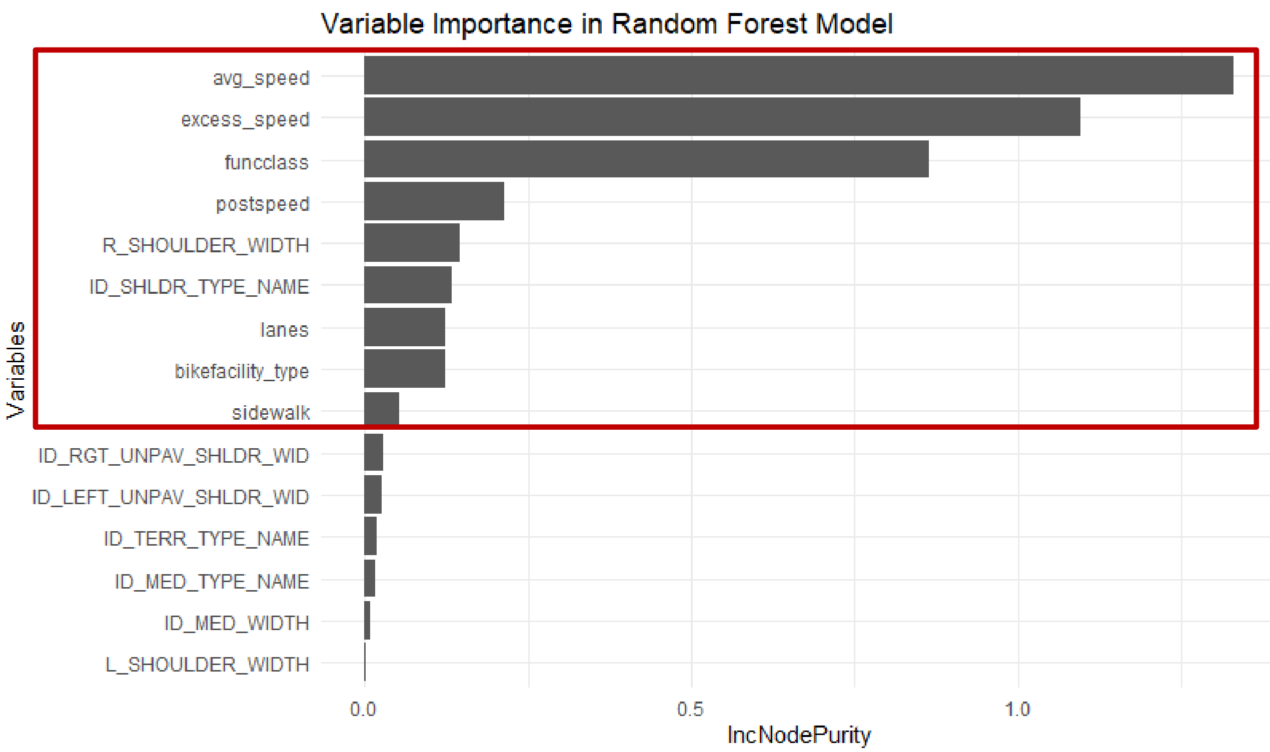


Figure 24 - Variable Importance of Roadway Features effect on KA Crashes

SAFER SPEEDS

The project team used instantaneous speed data from INRIX and the posted speed limit on each road. Excess speeding segments were defined where the average speed was greater than the posted speed of the same segment. Excess speed was one of the variables used in the random forest regression models to determine risk. Figure 25 below showcases the excess speeding segments, and Table 7 shows **29%** of KA crashes occurred on **Principal Arterials** relative to total miles of speeding segments. The team utilized a length-weighted percentage that compared the frequency of crashes to the mileage of roadway to prioritize roads finding roads with high risk rather than high quantity/mileage. As seen in Figure 26, there is a rise in KA crashes on segments with a posted speed of **35 mph** or **55 mph**.

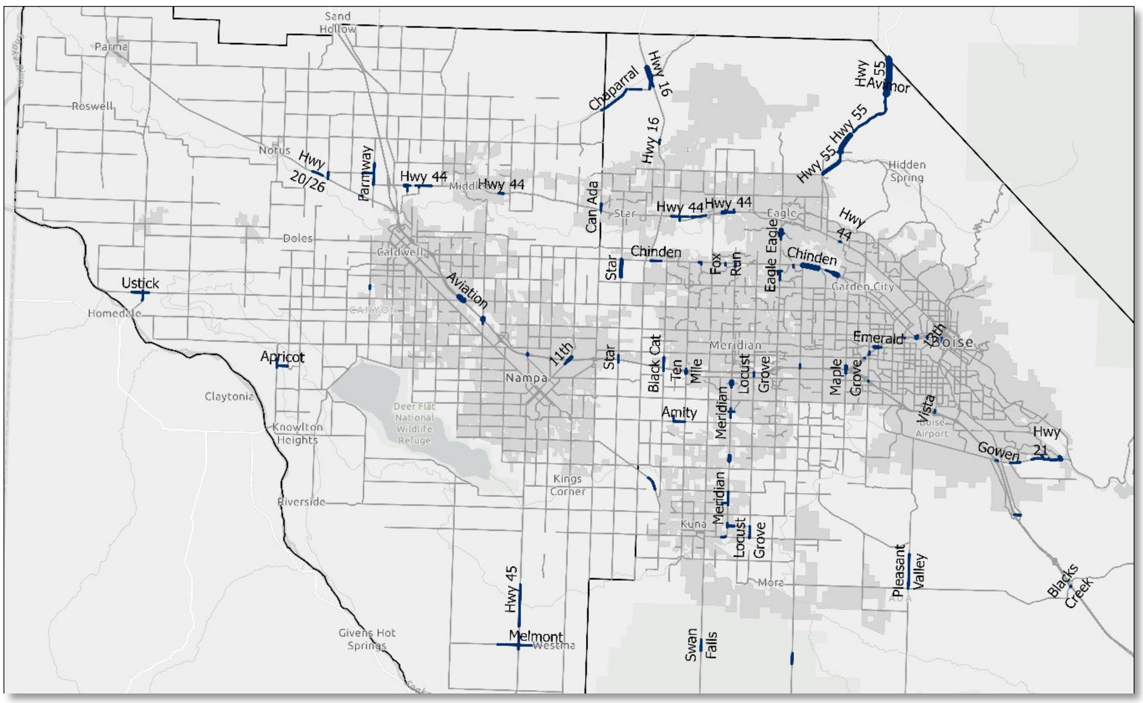


Figure 25 - Segments with average speeds above the posted speed limit

Functional Class	Sum of miles	Count of Excess Speeding Segments	Count of Segments over Mileage Percentage
Principal Arterial	3.41	41	29%
Minor Arterial	6.69	43	16%
U.S. Highway	2.55	13	12%
Ramp	11.26	55	12%
Collector	10.10	48	12%
State Highway	13.08	54	10%
Interstate	25.33	95	9%

Table 7 - Top Functional Classes with exceeding speeding segments

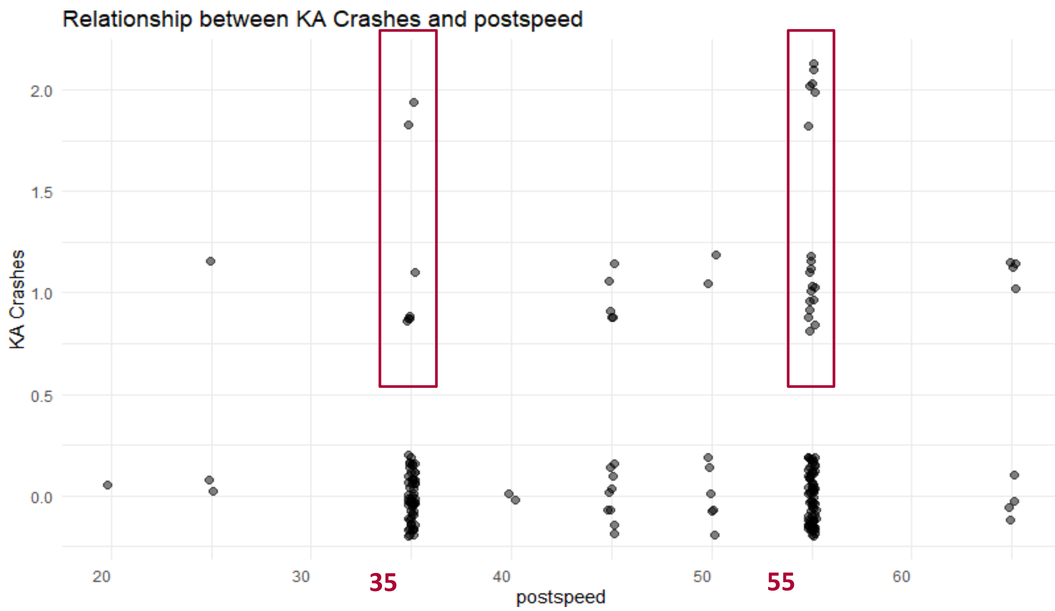


Figure 26 – Fatal and Serious Injury Crashes per posted speed.

SAFER VEHICLES

According to the 5-Year Census American Community Survey (ACS)[7], Idaho has one of the highest rates of car ownership nationwide with 96.2% of households reporting access to at least one vehicle in 2021. The project team found correlations between fatal and serious injury crashes with specific vehicle types. A rising discussion in transportation safety is the effect of heavier vehicles relative to KA crashes. However, while **42%** of fatal and serious injury crashes occurred with heavy vehicles (SUVs, Crossovers, Pickups, Vans), they still account for **54%** of all crashes as shown in Table 8. Commercial trucks account for **1.9%** of KA crashes but also **1.9%** of all crashes. Motorcycles, Mopeds, and Scooter crashes account for only **1.8%** of all crashes, but **16%** of all fatal and serious injury crashes. Similarly described in the Safer People section, Pedestrians and Pedal cyclists overrepresent KA crashes compared to all crashes of their respective types.

Vehicle Type	Percent of Fatal & Serious Injury Crashes	Percent of All Crashes
Heavy Vehicle	41.5%	53.8%
Car	26.6%	39.9%
Motorcycle/Moped/Scooter	16.0%	1.8%
Pedestrian	7.8%	0.9%
Pedal cycle	4.7%	1.2%
Commercial Vehicle	1.9%	1.9%
Other	1.5%	0.6%

Table 8 - Comparison of KA crashes to all crashes by Vehicle Type

POST CRASH CARE

The analysis of using EMS data to determine post-crash care will be evaluated for inclusion in the action plan.

[7] https://www.census.gov/newsroom/press-kits/2022/acs-5-year.html

DEMOGRAPHIC ANALYSIS RESULTS

When considering the complete HIN (i.e., both segments and junctions), about 28% of TAZs in the COMPASS region are geographically adjacent to the HIN (i.e., both segments and junctions). The majority of these TAZs (92%) have an Equity Index of 7 or below, accounting for about 91% of the population. These scores correspond with better (more desirable) levels of the equity measures used to calculate the Equity Index compared to TAZs with higher Equity Index scores (7 or above). Specifically, people living in the TAZs closest to the HIN generally have higher incomes and high school graduation rates, are more likely to have health insurance, and have better access to a personal vehicle when compared to people living in TAZs along the HIN with higher Equity Index scores. TAZs with lower Equity Index scores tend to score lower on auto crash density (i.e., the density of automobile crashes within the last five years) and have fewer bicycle and pedestrian injury-causing crashes. In terms of land use, the region adjacent to most of the HIN is generally more walkable and has better access to open spaces such as parks or reserves. It should be noted that TAZ boundaries are determined based upon Census geographies (e.g., block, block group, tract) and should be relatively homogenous. However, boundaries may change depending on shifts in population and land use.

The map in Figure 27 shows the HIN relative to the CIM2050 Equity Index for the entire COMPASS region. The darker the blue, the higher the Equity Index and, therefore, the higher the inequity.

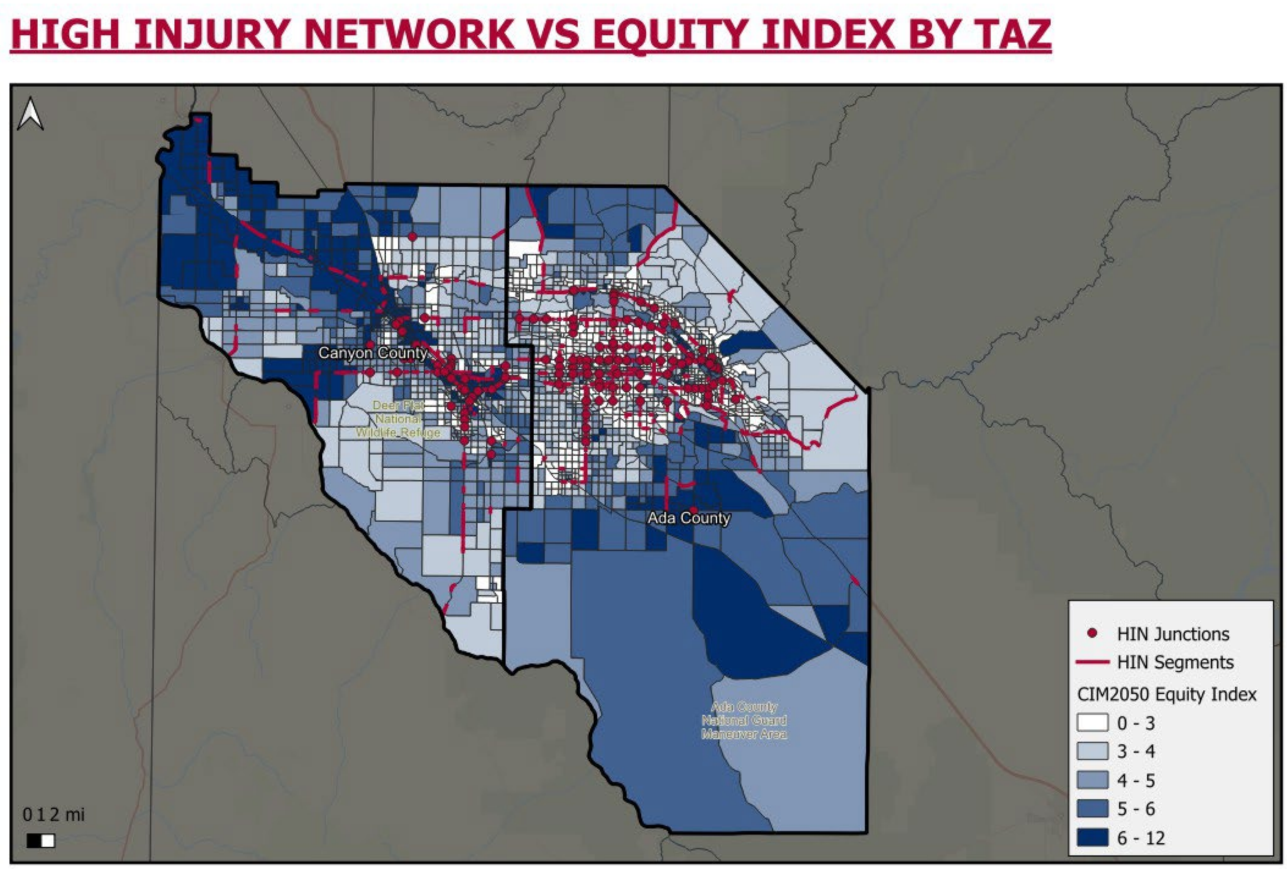


Figure 27 – CIM2050 Equity Index with HIN Overlay

Upon zooming in (Figure 28) it becomes clear that most of the HIN junctions lie within Ada County and the cities of Boise and Meridian; the majority of the TAZs within these cities have an Equity Index score of five or lower. There's also a cluster of HIN junctions in the Nampa area and this area has higher Equity Index scores compared to Boise and Meridian.

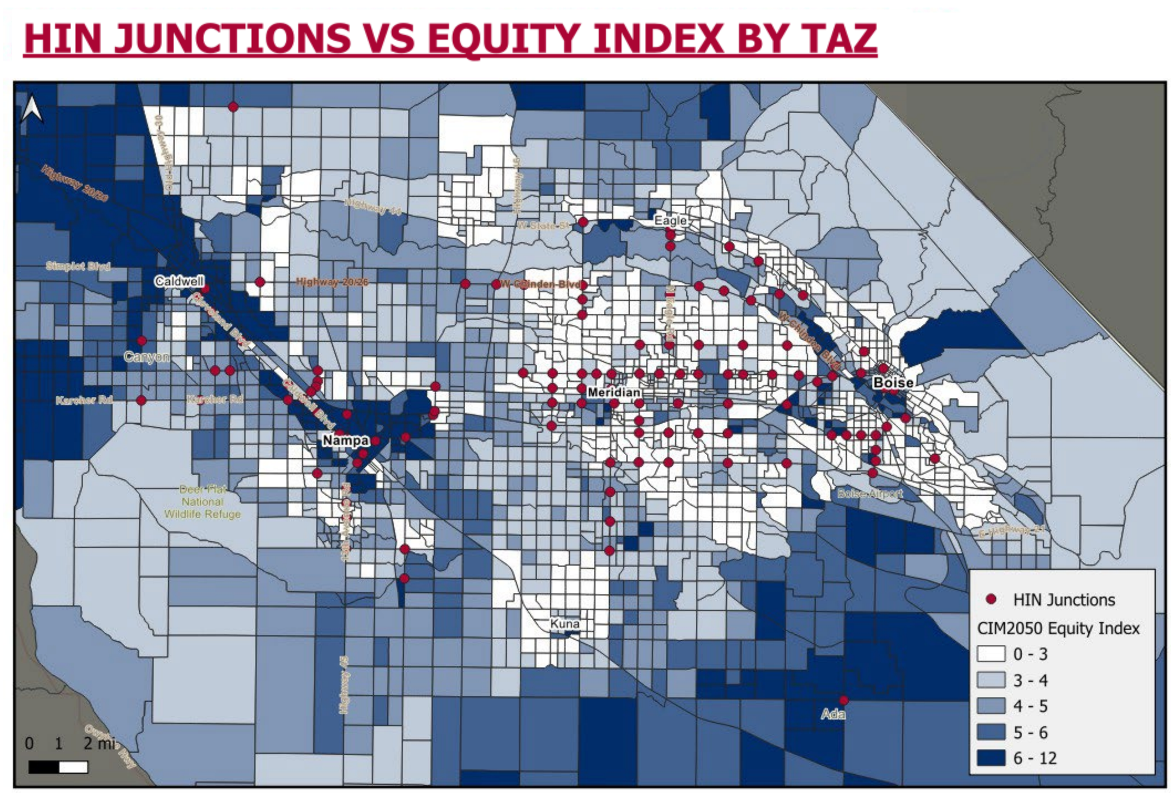


Figure 28 – CIM2050 Equity Index with HIN Junctions

Roadway segments on the HIN are more geographically dispersed as shown in Figure 29. While most of the HIN roadway network is still clustered in the more densely populated, urban areas of the two counties, there are some sections on the outer edges of each county in more rural parts of the region. TAZs that intersect with HIN segments in the southeast and foothill regions of Ada County have large percentages of farmland (11%-63%). The Equity Index scores for these TAZs range from 4 to 7. The more rural western region and northwest corner of Canyon County also contain portions of HIN roadway segments. TAZs along this portion of the HIN have Equity Index scores ranging from 4 to 9. The map below illustrates the urban and rural HIN roadway segment distribution.

HIN SEGMENTS VS EQUITY INDEX BY TAZ

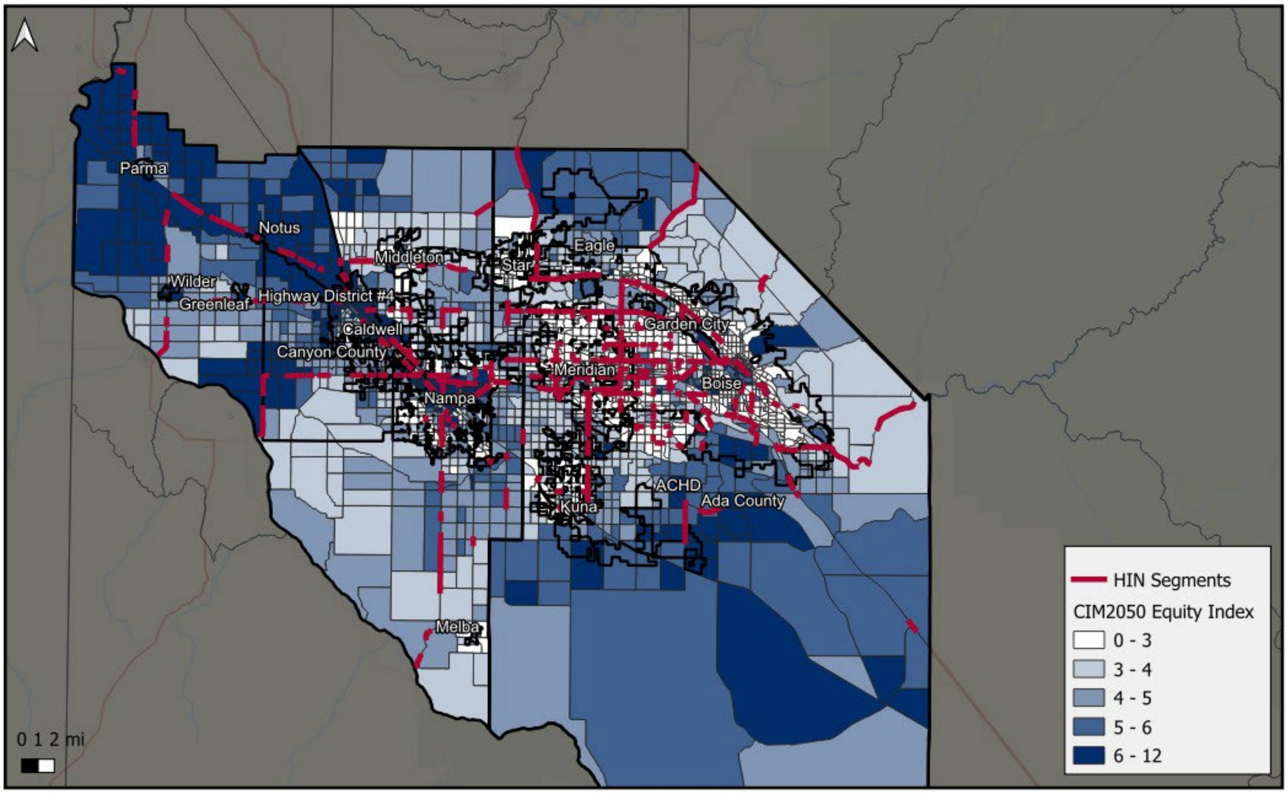


Figure 29 - CIM2050 Equity Index with HIN Segments

There are portions of the HIN that overlap with areas with high Equity Index scores. Specifically, within the cities of Nampa and Caldwell, there is a concentration of segments and junctions on the HIN that intersect with TAZs with an Equity Index of 7 or higher. These TAZs tend to be lower income households, have lower high school graduation rates, and residents may be less likely to have health insurance. People living in these TAZs may have less access to open spaces and fewer walkable destinations. The following map (Figure 30) shows the largest concentration of TAZs with high Equity Index scores along the HIN.

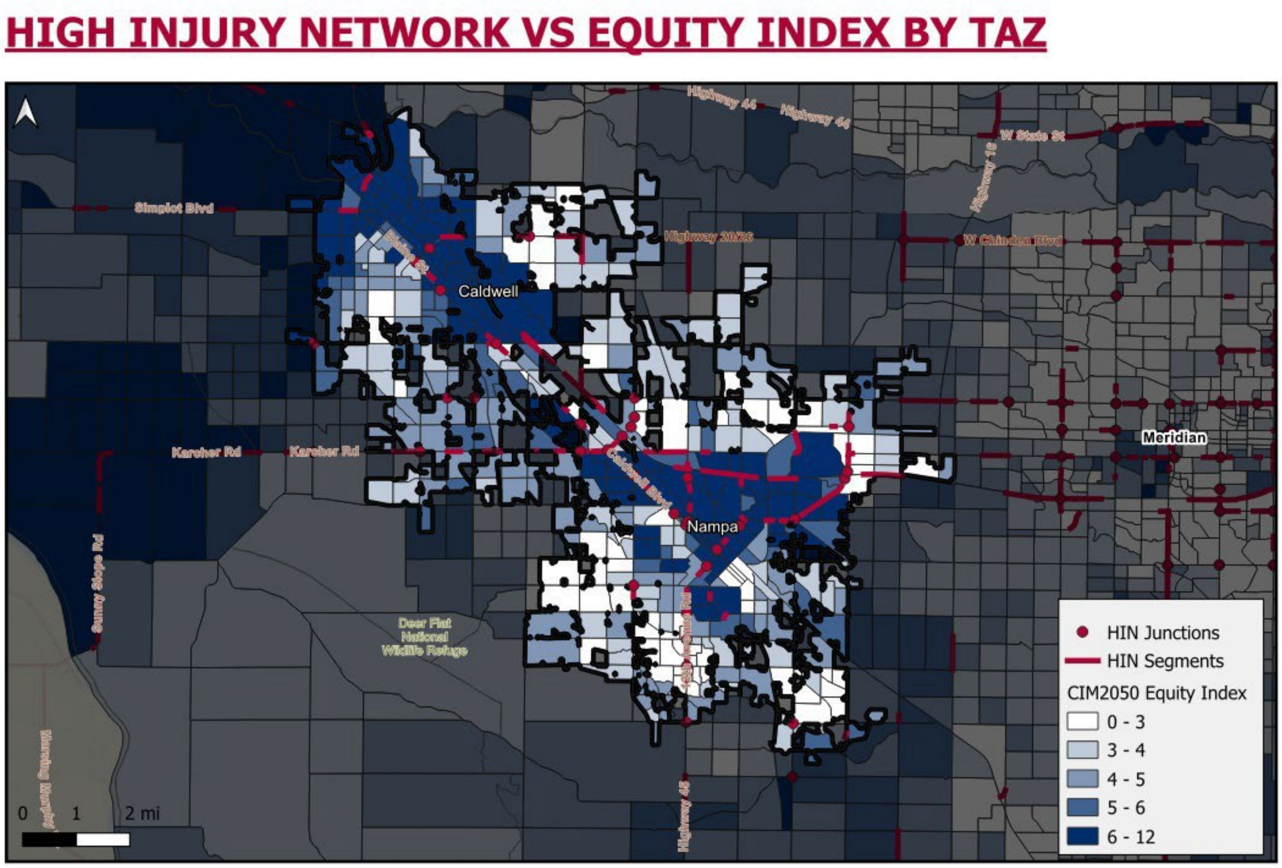


Figure 30 - CIM2050 High Equity Index Score TAZs Along the HIN

When the focus shifts to KA crash counts, the picture looks slightly different. Around 12.5% of the TAZs in the COMPASS region have an Equity Index of 7 or above, which corresponds with about 9.4% of the total population in the region. Meanwhile, these TAZs contain 16.1% of all KA crashes as is summarized in Table 9 below.

Equity Index	Number of TAZs	Population	Percent of Region by Population	Total Number of KA Crashes	Percent of Total KA Crashes
0	9	4,411	0.6%	7	0.4%
1	105	43,335	6.0%	88	4.6%
2	279	150,443	20.7%	205	10.8%
3	372	149,906	20.6%	260	13.7%
4	614	156,676	21.6%	399	21.0%
5	507	101,170	13.9%	376	19.8%
6	288	51,630	7.1%	258	13.6%
7	167	34,866	4.8%	136	7.2%
8	82	17,255	2.4%	86	4.5%
9	42	11,192	1.5%	28	2.0%
10	14	1,592	0.2%	34	1.8%
11	5	2,178	0.3%	1	0.1%
12	1	1,418	0.2%	10	0.5%
TOTAL	**2,485**	**726,072**	**100%**	**1,898***	**100%**

Table 9 - Crashes by Equity Index, Population, and Number of TAZs

** = This value is slightly lower than the total number of KA crashes in the region (1,904) due to a few crashes falling just outside of a TAZ boundary.*

In the final step of the analysis, the team conducted pair-wise t-tests to analyze the relationship between five specific variables within Equity Index and the presence of a TAZ on the HIN. Table summarizes the analysis results. Of the variables tested, only unemployment rate was significant at a 95% confidence level. TAZs adjacent to the HIN have a slightly higher unemployment rate (0.3%) compared to the TAZs outside of the HIN.

Equity Index Variable	HIN TAZ Mean	Non-HIN TAZ Mean	P-Value
Graduation Rate	90.2%	90.5%	0.1804
Unemployment Rate	**4.6%**	**4.3%**	**0.0364**
% No Car	4.2%	3.8%	0.1577
% No Health Insurance	10.9%	10.5%	0.0838
Median Rent as % of Income	29.2%	28.8%	0.2624

Table 10 - Correlation of Select Equity Index Variables vs. HIN

Figure 31 and Figure 32 compare the distribution of unemployment rates for TAZs that are not adjacent to the HIN versus those that are as a percentage of all TAZs in the region. Appendix F has comparison figures for all five variables.

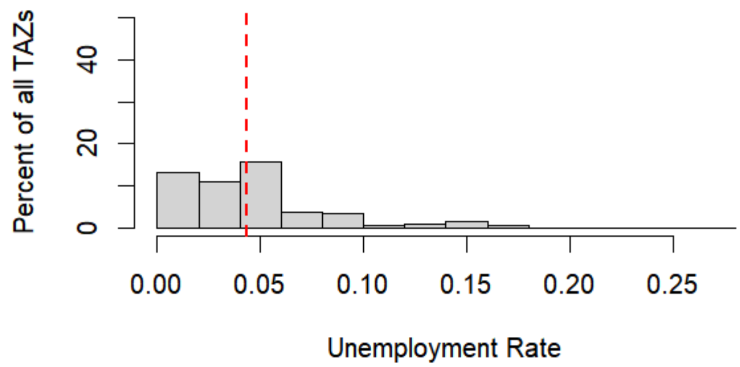


Figure 31 - Non-HIN TAZ Unemployment Rate Comparison

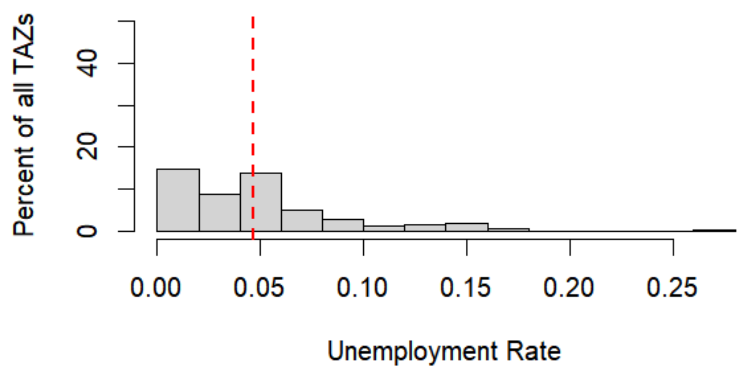


Figure 32 - HIN TAZ Unemployment Rate Comparison

SUMMARY STATISTICS

General Statistics

- The average Equity Index score in the region is 4.4.
- The average Equity Index score is 3.8 in Ada County and 5.4 in Canyon County.
- The average Equity Index score for the region adjacent to the HIN is 4.4.
- TAZs that overlap with the HIN have a slightly higher unemployment rate (0.3%) compared to TAZs not adjacent to the HIN.

HIN Segments

- 26% of the TAZs in the COMPASS region intersect with a segment on the HIN
    - Of these TAZs, 14% have an Equity Index score of 7 or above
- 40 miles of the HIN intersect with a TAZ that has an Equity Index score of 7 or above
    - This is the equivalent of 23% of the total miles on the HIN

HIN Junctions

- 4.7% of the TAZs in the COMPASS region intersect with a junction on the HIN
    - Of these TAZs, 11% have an Equity Index score of 7 or above
- 14 junctions on the HIN intersect with a TAZ that has an Equity Index score of 7 or above
    - This is the equivalent of 11% of all junctions on the HIN

LOCATION ANALYSIS – COMPASS MEMBER AGENCY FINDINGS

The following pages contain location-based analysis findings for each COMPASS member agency. Callout values show the total number of fatal crashes and serious injury crashes within the agency boundary. Note that these values are based on the locations of the segments and junctions the crashes were joined to, not the location of the crash itself. In most cases, the segment or junction and the crash lie within the same agency boundary. For segments that span more than one agency boundary, any crash along that segment is included for all the relevant agencies. A map shows the count of fatal and serious injury crashes at each analyzed segment and junction. The first table shows the count and percent of fatal and serious injury crashes by crash events (emphasis areas shown in the table 11 below) as well as a ranking of that member agency for that emphasis area. Rankings are based on the percent of total KA crashes with a ranking of 1 meaning the agency has the highest percentage of KA emphasis area crashes. Instances where the agency is ranked 1, 2, or 3 are in **bold**.

The second and third tables present the top five segments and junctions in the member agency based on HIN score. To give context on why the segment or junction scored high the location score and number of serious and fatal injury crashes are presented, as well as the risk score and the risk attributes contributing the most to risk score.

Table 11 - Crash Emphasis Areas

Crash Emphasis Area	Definition
Non-Motorized Involved	Vehicle Type field includes any non-motorized vehicle (pedestrian, pedal cycle, etc.)
Motorcycle-Involved	Vehicle Type field includes Motorcycle
Alcohol-Involved	Alcohol or Drug Involved field includes Alcohol or 'Both'
Drug-Involved	Alcohol or Drug Involved field includes Drugs or 'Both'
No Protection Device	Protection Device field is None
The rest of the Crash Emphasis Areas are based on the value of the Most Harmful Event field. These represent the top events amongst KA crashes in the COMPASS region	
Angle-Related Event	Most Harmful Event includes Angle
Rear-End-Related Event	Most Harmful Event includes Rear-End
Overturn-Related Event	Most Harmful Event includes Overturn
Angle Turning-Related Event	Most Harmful Event includes Angle Turning
Head-On Turning-Related Event	Most Harmful Event includes Head on Turning
Pedestrian-Related Event	Most Harmful Event includes Pedestrian
Head-On Related Event	Most Harmful Event includes Head-On
Bicycle-Related Event	Most Harmful Event includes Bicycle
Side Swipe Same-Related Event	Most Harmful Event includes Side Swipe Same

ADA COUNTY & ADA COUNTY HIGHWAY DISTRICT (ACHD)

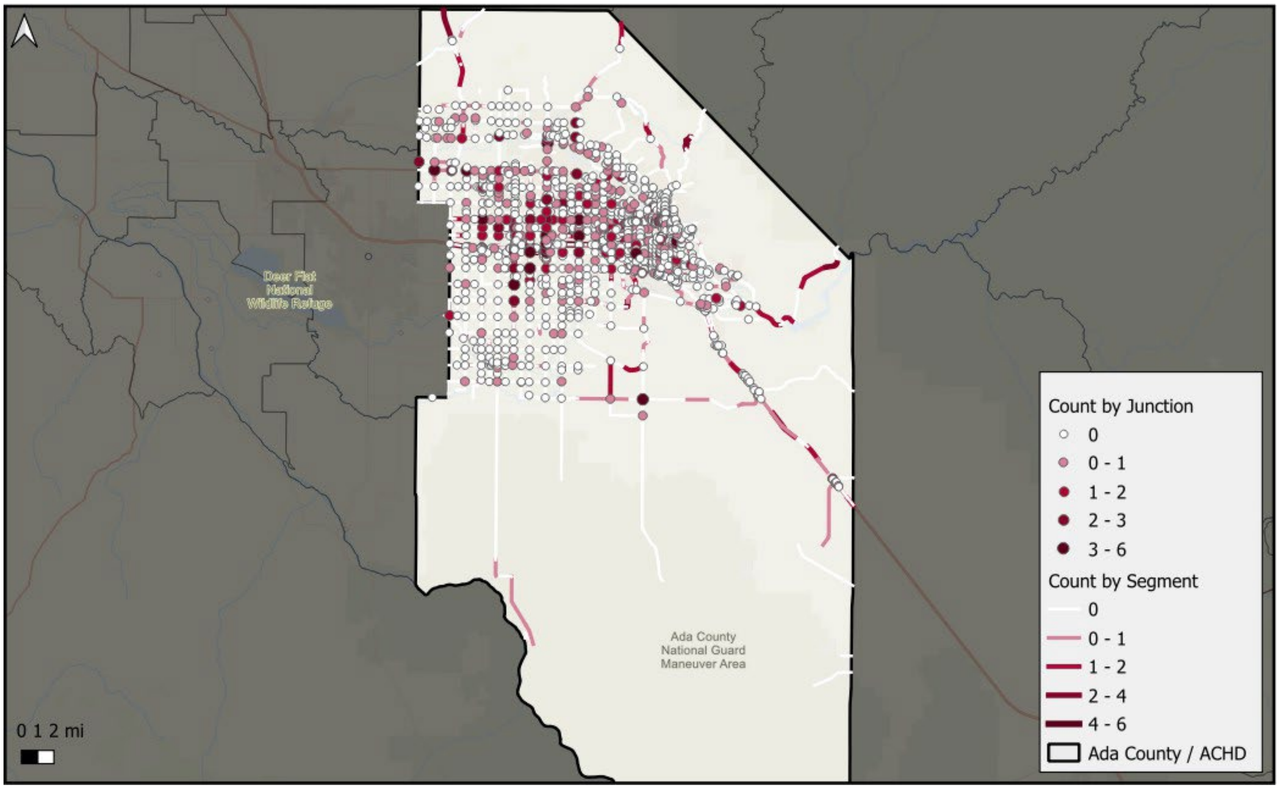
100

Fatal Crash Count

1,013

Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT



Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	184	16.5%	6
Motorcycle-Involved	166	14.9%	6
Alcohol-Involved	145	13.0%	8
Drug-Involved	69	6.2%	6
No Protection Device	44	3.9%	5
Angle-Related Event	114	10.2%	8
Rear-End-Related Event	237	21.3%	4
Overturn-Related Event	139	12.5%	6
Angle Turning-Related Event	103	9.25%	8
Head-On Turning-Related Event	125	11.2%	4
Pedestrian-Related Event	101	9.1%	6
Head-On Related Event	51	4.6%	10
Bicycle-Related Event	74	6.6%	5
Side Swipe Same-Related Event	49	4.4%	6

Top Segments and Junctions

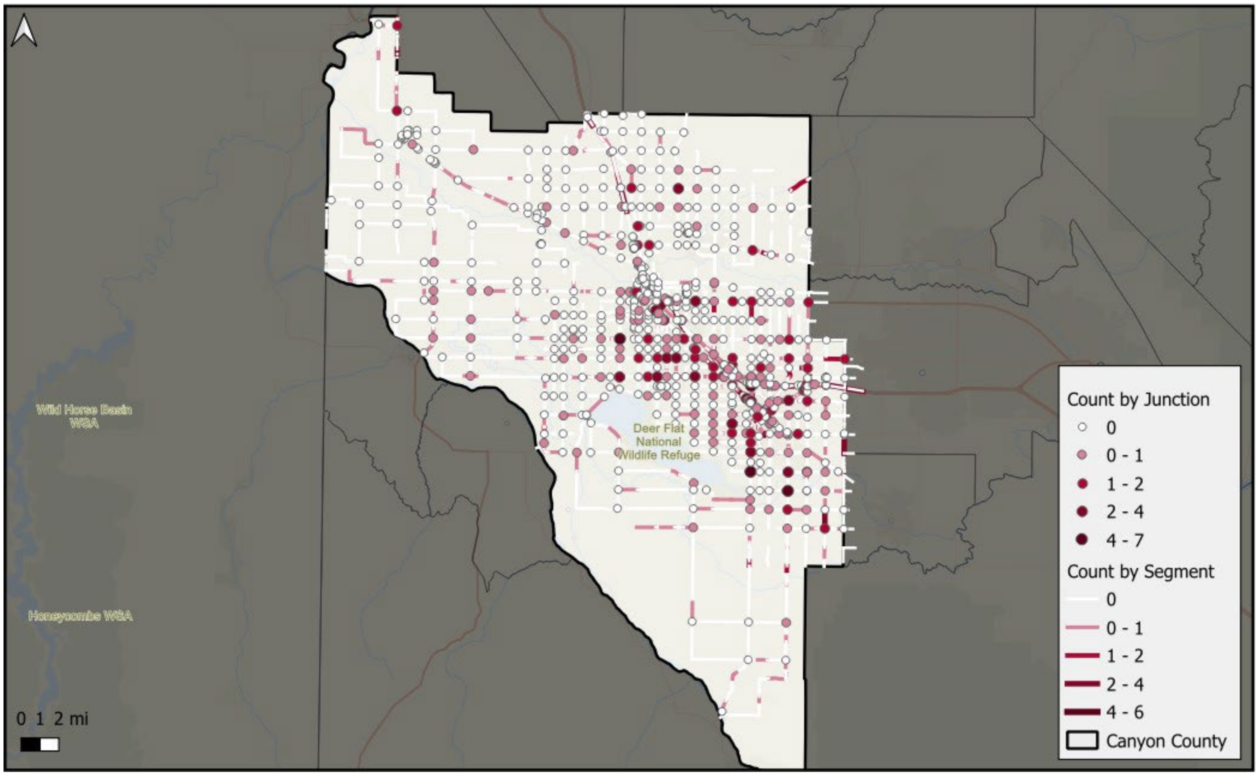
Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
N Highway 55 exiting Boise County	11.78	10	2	13.56	Speeding, high average speed, functional classification
E Highway 21 South of mores Creek	11.0775	15	4	7.155	High average speed, functional classification
N Hwy 16 exiting Ada County	11.025	15	4	7.05	High average speed, functional classification
E Overland Rd between S Locust Grove Rd and S Millenium Way	10.3275	15	6	5.655	High average speed, multi-lane roadway
S Meridian Rd between E Rosalyn Dr and E Edmonds Dr	10.295	10	2	10.59	High average speed, functional classification, multi-lane roadway

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
W Amity Rd & S Meridian Rd	3.998	4	5	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
E Overland Rd & S Locus Grove Rd	3.998	4	4	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W Lake Hazel Rd & S Meridian Rd	3.998	4	3	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W Victory Rd & S Meridian Rd	3.998	4	3	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W State St & N 15th St	3.998	4	3	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W Pine Ave & N Meridian Road	3.998	4	3	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized

CANYON COUNTY

100	695
Fatal Crash Count	Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT



Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	64	8.1%	10
Motorcycle-Involved	106	13.3%	7
Alcohol-Involved	113	14.2%	5
Drug-Involved	40	5.0%	7
No Protection Device	**48**	**6.0%**	**3**
Angle-Related Event	**182**	**22.9%**	**2**
Rear-End-Related Event	94	11.8%	7
Overturn-Related Event	113	14.2%	5
Angle Turning-Related Event	107	13.5%	5
Head-On Turning-Related Event	70	8.9%	7
Pedestrian-Related Event	48	6.0%	9
Head-On Related Event	61	7.7%	5
Bicycle-Related Event	15	1.9%	10
Side Swipe Same-Related Event	37	4.7%	5

Top Segments and Junctions

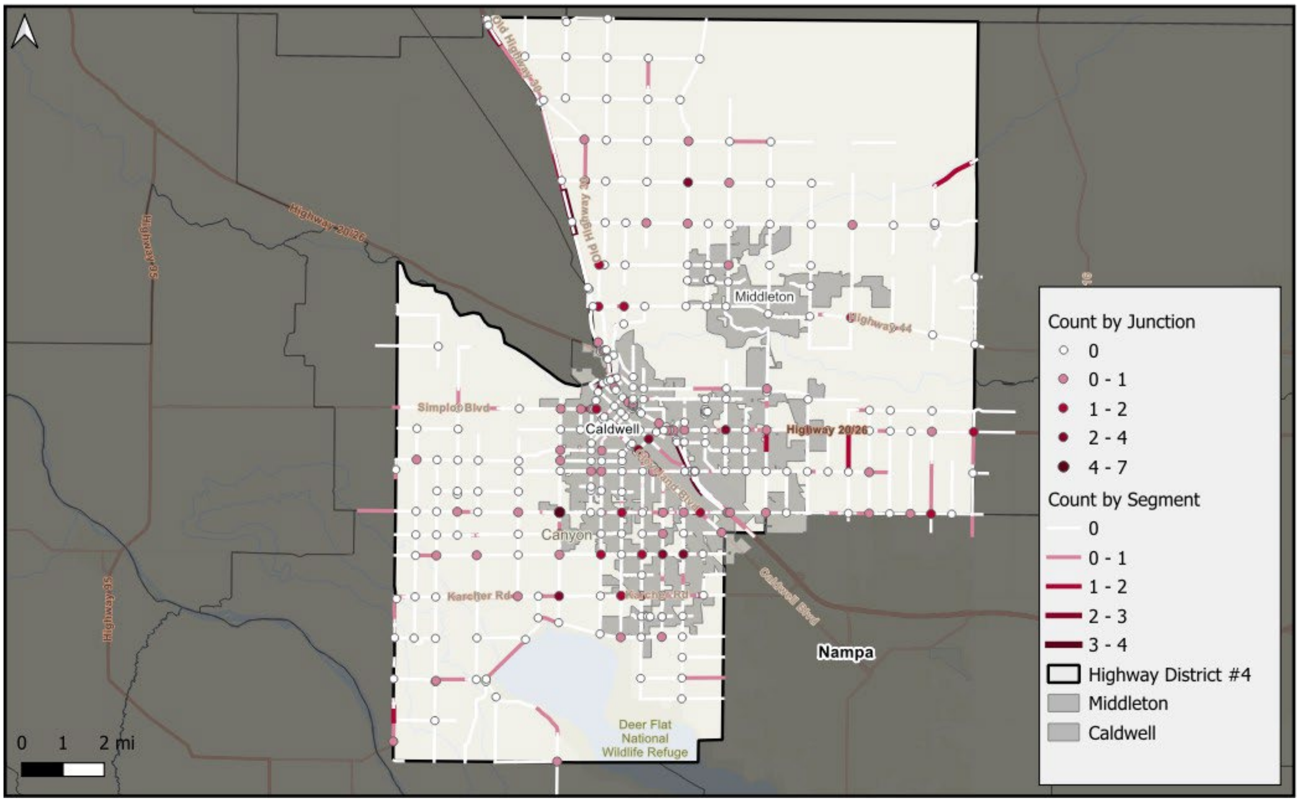
Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
Garrity Blvd between N Sugar Ave and Carnation Dr	12.195	15	4	9.39	High average speed, functional classification, multi-lane roadway
Garrity Blvd between N Sister Catherine Way and N Jacob Allcott Way	9.695	10	3	9.39	High average speed, functional classification, multi-lane roadway
Garrity Blvd between Barger St and 42nd St North	9.695	10	2	9.39	High average speed, functional classification, multi-lane roadway
W Simplot Blvd between Kit Ave and Centennial Way	9.695	10	2	9.39	High average speed, functional classification, multi-lane roadway
Centennial Way between W Chicago St and W Freeport St	9.17	10	3	8.34	High average speed, functional classification, multi-lane roadway

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
Blaine St & S 21st Ave	3.998	4	4	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
E Chicago St & N 21st Ave	3.998	4	3	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
2nd St South & Northside Blvd	3.998	4	3	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
Cherry Lane & Midland Blvd	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
N Marketplace Blvd & Midland Blvd	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
Caldwell Blvd & N Middleton Rd	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized

HIGHWAY DISTRICT #4

48	232
Fatal Crash Count	Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT



Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	20	7.1%	11
Motorcycle-Involved	35	12.5%	9
Alcohol-Involved	**57**	**20.4%**	**3**
Drug-Involved	14	5.0%	8
No Protection Device	**18**	**6.4%**	**2**
Angle-Related Event	**72**	**26.1%**	**1**
Rear-End-Related Event	25	8.9%	10
Overturn-Related Event	**55**	**19.6%**	**2**
Angle Turning-Related Event	**40**	**14.3%**	**2**
Head-On Turning-Related Event	20	7.1%	8
Pedestrian-Related Event	16	5.7%	10
Head-On Related Event	**24**	**8.6%**	**3**
Bicycle-Related Event	4	1.4%	11
Side Swipe Same-Related Event	8	2.9%	9

Top Segments and Junctions

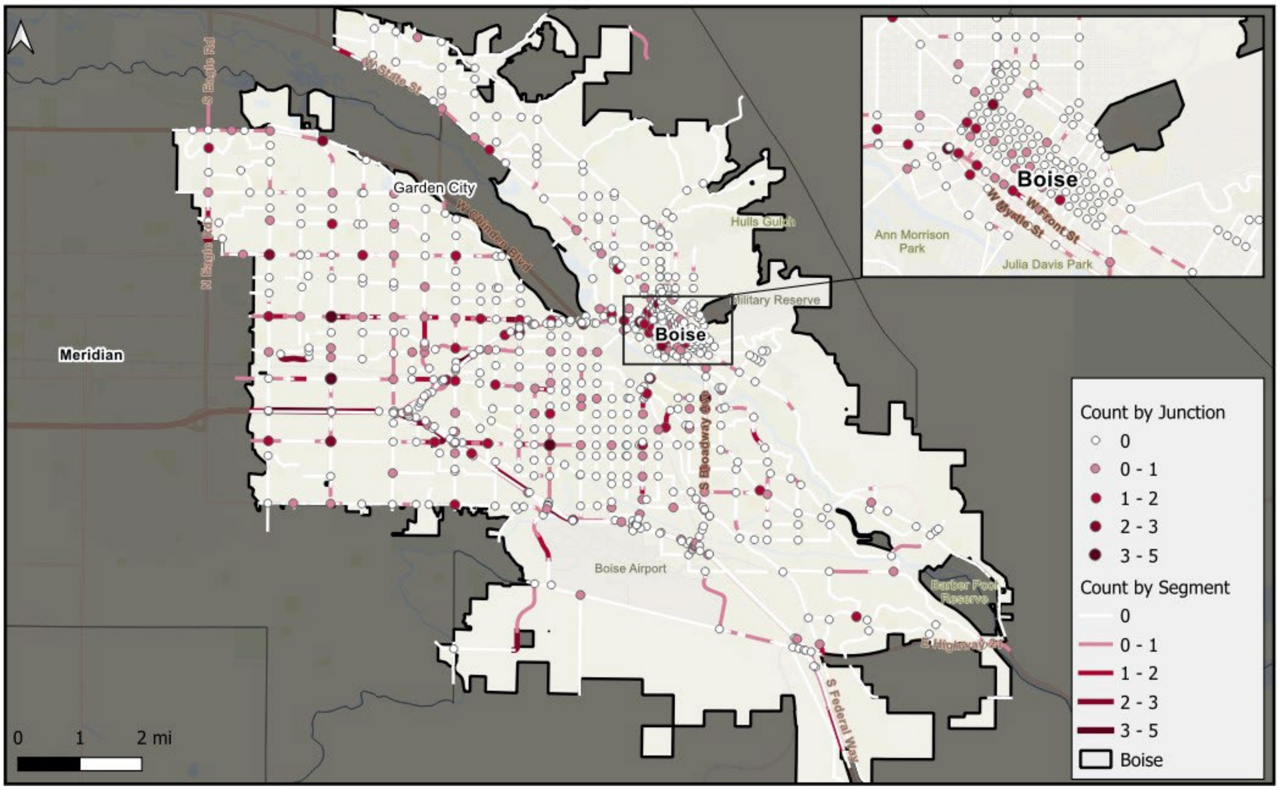
Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
Hwy 19 between N Kit Ave and Centennial Way	9.695	10	2	9.39	High average speed, functional classification, multi-lane roadway
Centennial Way between W Chicago St and W Freeport St	9.17	10	3	8.34	High average speed, functional classification
Karcher Rd between Canyon View Way and Celeste Ave	9.14	10	2	8.28	High average speed, functional classification
Hwy 44 between Eel Lane and Stoffle Lane	9.1325	10	2	8.265	High average speed, functional classification
Hwy 44 between Stone Lane and River Road	8.83	5	1	12.66	Speeding, high average speed, functional classification

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
Blaine St & S 21st Ave	3.998	4	4	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
E Chicago St & N 21st Ave	3.998	4	3	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
E Ustick Rd & Cleveland Blvd	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
E Linden St & Cleveland Blvd	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
Karcher Rd & S Indiana Ave	3.292	4	3	2.584	2 lane minor, 4 legged, signalized

CITY OF BOISE

34	473
Fatal Crash Count	Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT



Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	**124**	**24.5%**	**3**
Motorcycle-Involved	78	15.4%	5
Alcohol-Involved	68	13.4%	7
Drug-Involved	33	6.5%	5
No Protection Device	16	3.2%	6
Angle-Related Event	52	10.3%	7
Rear-End-Related Event	101	19.9%	5
Overturn-Related Event	34	6.7%	11
Angle Turning-Related Event	47	9.3%	7
Head-On Turning-Related Event	48	9.5%	6
Pedestrian-Related Event	**66**	**13.0%**	**3**
Head-On Related Event	19	3.7%	12
Bicycle-Related Event	**52**	**10.3%**	**3**
Side Swipe Same-Related Event	**34**	**6.7%**	**2**

Top Segments and Junctions

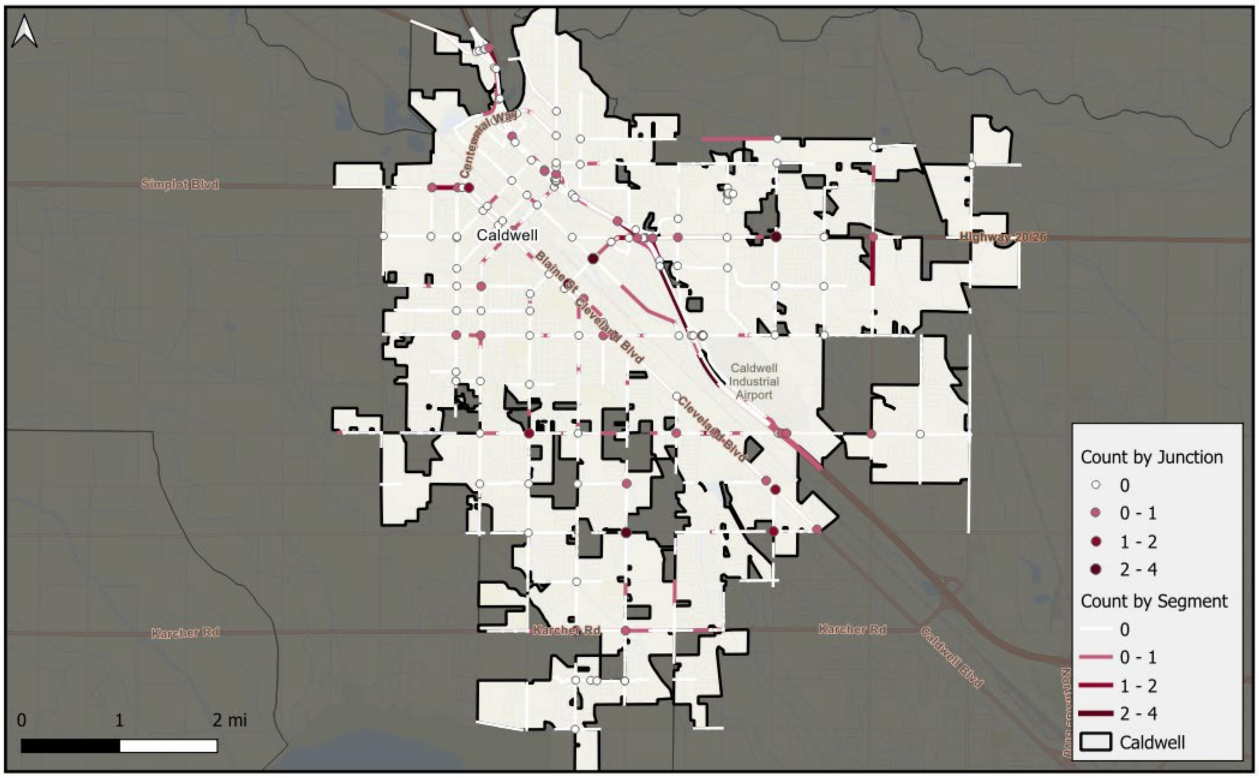
Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
W Chinden Blvd between W Chinden Ridge Drive and N Five Mile Road	9.325	5	1	13.65	Speeding, high average speed, functional classification, multi-lane roadway
N Eagle Road between W Meadowdale St and W Wainwright Drive	9.0725	10	2	8.145	High average speed, multi-lane roadway
W Fairview St between N Five Mile Rd and N Kimball St	8.3	10	3	6.6	High average speed, multi-lane roadway
W Overland Rd between W Cedarwood Dr and S Brooklawn Dr	8.3	10	2	6.6	High average speed, multi-lane roadway
W Overland Rd between S Brooklawn Dr and S Raymond St	8.3	10	2	6.6	High average speed, multi-lane roadway
W Fairview St between N Fry St and N Raymond St	8.3	10	2	6.6	High average speed, multi-lane roadway

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
W State St & N 15th St	3.998	4	3	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W Overland Rd & S Cloverdale Rd	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W Ustick Rd & N Cole Rd	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W State St & N 27th St	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W Ustick Rd & N Mitchell St	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized

CITY OF CALDWELL

22	124
Fatal Crash Count	Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT



Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	17	11.6%	7
Motorcycle-Involved	**26**	**17.8%**	**3**
Alcohol-Involved	**33**	**22.6%**	**1**
Drug-Involved	4	2.7%	12
No Protection Device	**11**	**7.5%**	**1**
Angle-Related Event	**28**	**19.2%**	**3**
Rear-End-Related Event	14	9.6%	9
Overturn-Related Event	21	14.4%	4
Angle Turning-Related Event	**23**	**15.7%**	**1**
Head-On Turning-Related Event	16	11.0%	5
Pedestrian-Related Event	14	9.6%	4
Head-On Related Event	11	7.5%	6
Bicycle-Related Event	3	2.1%	9
Side Swipe Same-Related Event	6	4.1%	7

Top Segments and Junctions

Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
W Simplot Blvd between N Kit Ave and Paynter Ave	9.695	10	2	9.39	High average speed, functional classification, multi-lane roadway
Centennial Way between W Chicago St and W Freeport St	9.17	10	3	8.34	High average speed, functional classification
Karcher Rd between Canyon View Way and Celeste Ave	9.14	10	2	8.28	High average speed, functional classification
Middleton Rd between I 84 and Laster Lane	7.4675	10	2	4.935	High average speed
Middleton Rd between Skyway St and Hwy 20	7.4675	10	2	4.935	High average speed

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
Blaine St & S 21st Ave	3.998	4	4	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
E Chicago St & N 21st Ave	3.998	4	3	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
E Ustick Rd & Cleveland Blvd	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
E Linden St & Cleveland Blvd	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
Karcher Rd & S Indiana Ave	3.292	4	3	2.584	2 lane minor, 4 legged, signalized

CITY OF EAGLE

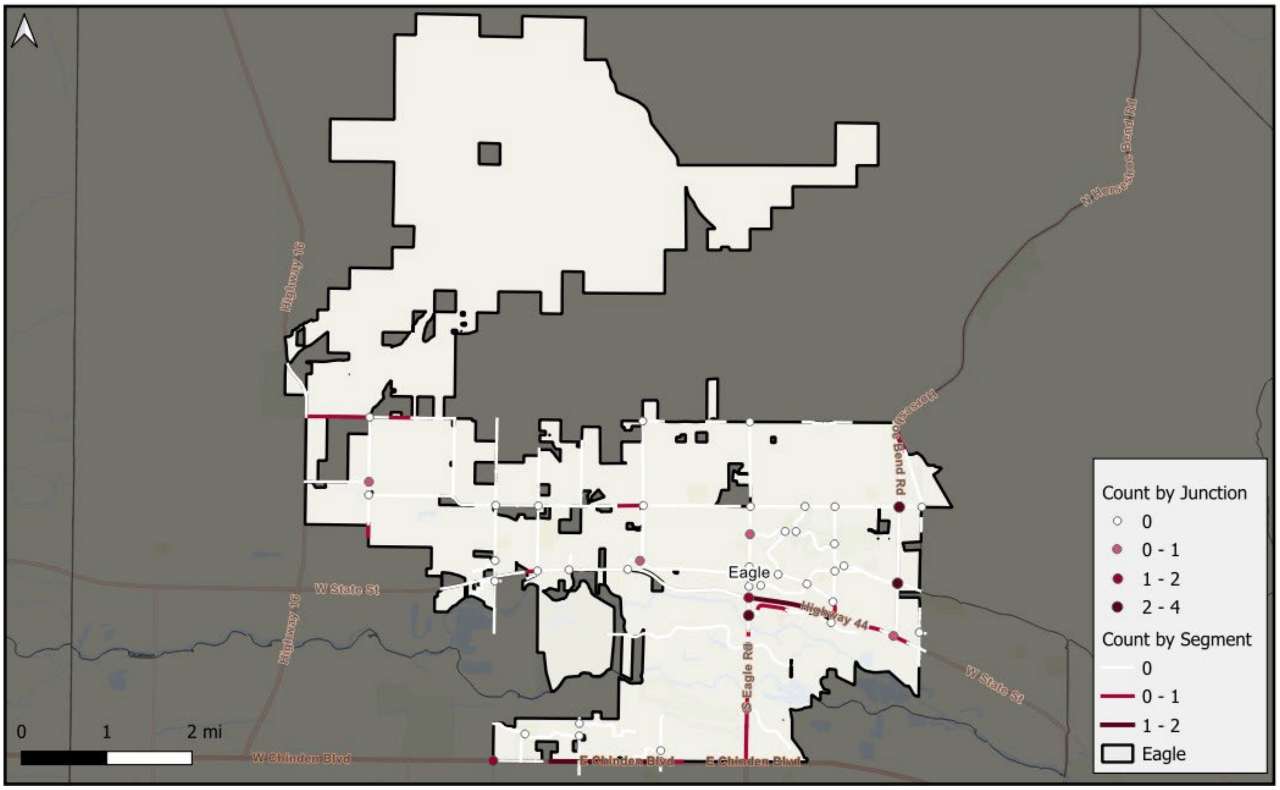
5

Fatal Crash Count

41

Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT



Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	2	4.3%	12
Motorcycle-Involved	2	4.3%	11
Alcohol-Involved	7	15.2%	4
Drug-Involved	3	6.5%	4
No Protection Device	0	0%	-
Angle-Related Event	7	15.2%	6
Rear-End-Related Event	**10**	**21.7%**	**3**
Overturn-Related Event	4	8.7%	7
Angle Turning-Related Event	4	8.7%	10
Head-On Turning-Related Event	**10**	**21.7%**	**1**
Pedestrian-Related Event	0	0%	-
Head-On Related Event	0	0%	-
Bicycle-Related Event	2	4.3%	6
Side Swipe Same-Related Event	1	2.1%	11

Top Segments and Junctions

Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
E Hwy 44 between S Eagle Rd and S Edgewood Lane	10.295	10	2	10.59	High average speed, functional classification, multi-lane roadway
Hwy 44 between Linder Rd and N Park Lane	9.9925	5	1	14.985	Speeding, high average speed, functional classification, multi-lane roadway
Chinden Blvd between N Fox Run Way and N Locust Grove Rd	9.8675	10	2	9.735	High average speed, functional classification
Hwy 44 between Hwy 55 and N Horseshoe Bend Rd	7.795	5	1	10.59	High average speed, functional classification, multi-lane roadway
Hwy 44 between N park Lane and S Eagle Island Parkway	7.4925	0	0	14.985	Speeding, high average speed, functional classification, multi-lane roadway

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
E Riverside Dr & S Eagle Rd	3.426	4	4	2.852	Multi-lane major, 2 lane minor, signalized
E Island Wood Dr & S Eagle Rd	2.998	2	1	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
Hwy 44 & S Eagle Rd	2.92	3	2	2.84	Multi-lane major, 4 legged, signalized
W Chinden Blvd & N Linder Rd	2.92	3	2	2.84	Multi-lane major, 4 legged, signalized
State St & N Eagle Rd	2.792	3	2	2.584	2 lane minor, 4 legged, signalized

CITY OF GARDEN CITY

6	30
Fatal Crash Count	Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT

Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	**11**	**30.5%**	**2**
Motorcycle-Involved	6	16.7%	4
Alcohol-Involved	**8**	**22.2%**	**2**
Drug-Involved	**3**	**8.3%**	**2**
No Protection Device	1	2.8%	8
Angle-Related Event	2	5.6%	10
Rear-End-Related Event	4	11.1%	8
Overturn-Related Event	3	8.3%	8
Angle Turning-Related Event	4	11.1%	6
Head-On Turning-Related Event	2	5.6%	9
Pedestrian-Related Event	**5**	**13.9%**	**2**
Head-On Related Event	3	8.3%	4
Bicycle-Related Event	**6**	**16.7%**	**1**
Side Swipe Same-Related Event	1	2.8%	10

Top Segments and Junctions

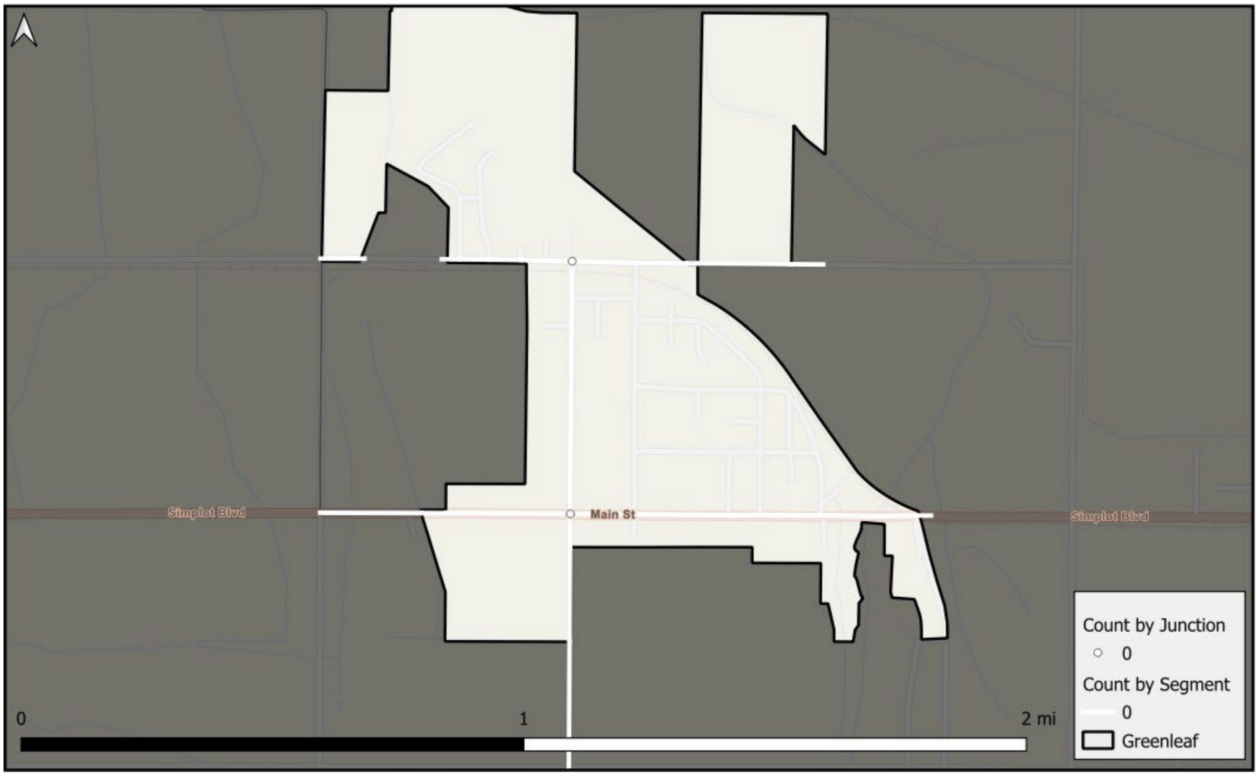
Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
W Chinden Blvd between 43rd St and 42nd St	10.1	10	2	10.2	High average speed, functional classification, multi-lane roadway
N Glenwood St between W Midway Drive and W Lorimer Lane	9.62	10	2	9.24	High average speed, functional classification, multi-lane roadway
W Chinden Blvd between N Millstone Dr and N Coffey St	9.5675	10	2	9.135	High average speed, functional classification, multi-lane roadway
W Chinden Blvd between 38th St and 37th St	8.03	10	2	6.06	Functional classification, multi-lane roadway
N Glenwood St between W State St and W Riverside Dr	7.6	5	1	10.2	High average speed, functional classification, multi-lane roadway

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
W Chinden Blvd & N Orchard St	2.998	2	1	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W Chinden Blvd & N Maple Grove Rd	2.998	2	1	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W Marigold St & N Glenwood St	2.926	3	2	2.852	Multi-lane major, 2 lane minor, signalized
W Chinden Blvd & N Kent Lane	2.426	2	1	2.852	Multi-lane major, 2 lane minor, signalized
W Riverside Dr & N Glenwood St	2.426	2	1	2.852	Multi-lane major, 2 lane minor, signalized

CITY OF GREENLEAF

0	0
Fatal Crash Count	Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT



Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	0	-	-
Motorcycle-Involved	0	-	-
Alcohol-Involved	0	-	-
Drug-Involved	0	-	-
No Protection Device	0	-	-
Angle-Related Event	0	-	-
Rear-End-Related Event	0	-	-
Overturn-Related Event	0	-	-
Angle Turning-Related Event	0	-	-
Head-On Turning-Related Event	0	-	-
Pedestrian-Related Event	0	-	-
Head-On Related Event	0	-	-
Bicycle-Related Event	0	-	-
Side Swipe Same-Related Event	0	-	-

Top Segments and Junctions

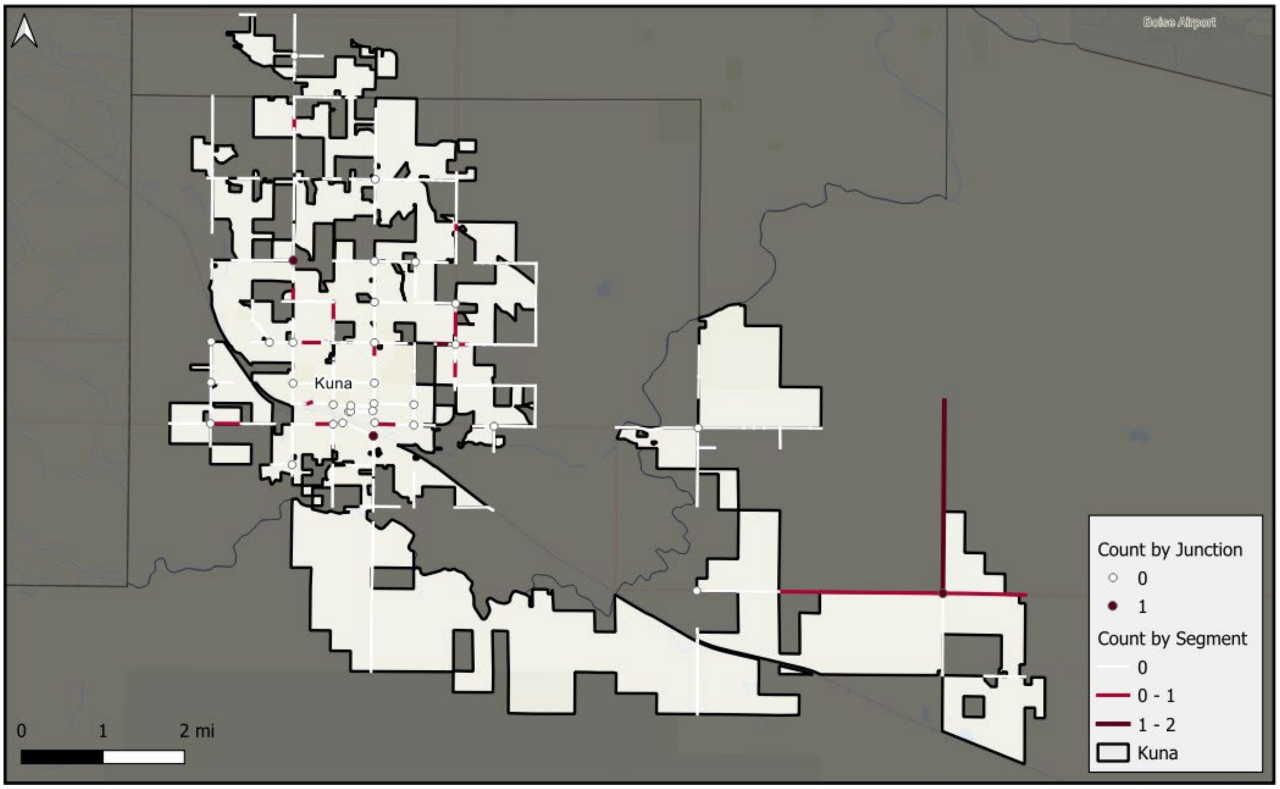
Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
Main St between Academy Rd and Antrim Dr	4.2675	0	0	8.535	High average speed, functional classification
Main St between Tucker Rd and Top Rd	3.9375	0	0	7.875	High average speed, functional classification
Friends Rd between Greenleaf Friends Academy and Lower Pleasant Ridge Rd	2.1375	0	0	4.275	High average speed

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
Main St & Friends Rd	1.15	0	0	2.3	2 lane minor, 4 legged
Peckham Rd & Friends Rd	0.0578	0	0	1.156	2 lane minor

CITY OF KUNA

3	19
Fatal Crash Count	Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT



Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	5	22.7%	4
Motorcycle-Involved	**6**	**27.2%**	**2**
Alcohol-Involved	3	13.6%	6
Drug-Involved	1	4.5%	11
No Protection Device	0	0%	-
Angle-Related Event	4	18.2%	4
Rear-End-Related Event	0	0%	-
Overturn-Related Event	**4**	**18.2%**	**3**
Angle Turning-Related Event	2	9.1%	9
Head-On Turning-Related Event	1	4.5%	10
Pedestrian-Related Event	2	9.1%	5
Head-On Related Event	**2**	**9.1%**	**2**
Bicycle-Related Event	**3**	**13.6%**	**2**
Side Swipe Same-Related Event	0	0%	-

Top Segments and Junctions

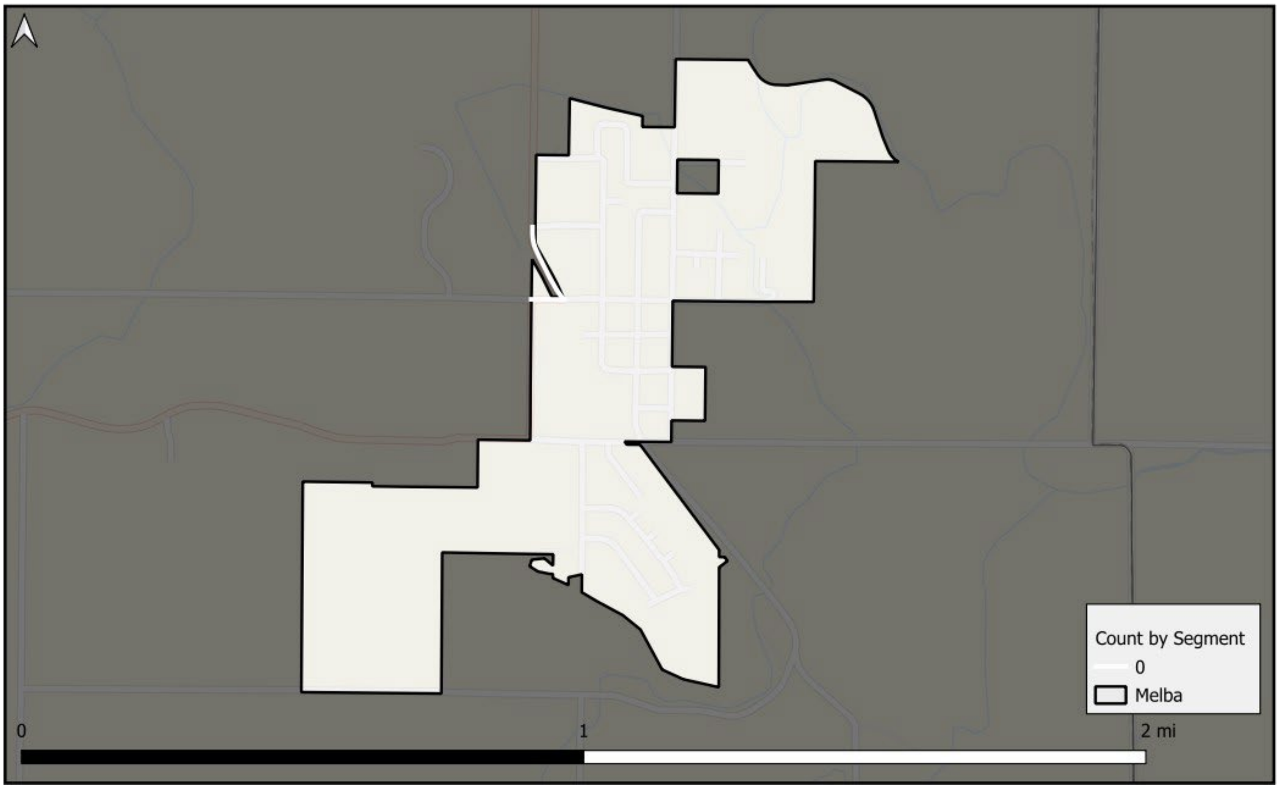
Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
N Meridian Rd between E Profile Lane and E Meadow View Rd	7.795	5	1	10.59	High average speed, functional classification, multi-lane roadway
E Deer Flat Rd between N Sailer Way and N Abstein Lane	7.4675	10	2	4.935	High average speed
Meridian Rd between E Mason Creek Lane and E Deer Flat Rd	7.465	5	1	9.93	High average speed, functional classification, multi-lane roadway
S Cole Rd between W Tenmile Creek Rd and W Kuna Mora Rd	7.1375	10	2	4.275	High average speed
E Avalon St between S Swan Falls Rd and S Orchard Ave	5.965	5	1	6.93	High average speed

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
W Kuna Mora Rd & S Cole Rd	2.15	2	1	2.3	2 lane minor, 4 legged
W Hubbard Rd & S Ten Mile Rd	2.15	2	1	2.3	2 lane minor, 4 legged
E Deer Flat Rd & N Meridian Rd	1.998	0	0	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W Shortline St & S Swan Falls Rd	1.578	2	1	1.156	2 lane minor
W Columbia Rd & S Linder Rd	1.292	0	0	2.584	2 lane minor, 4 legged, signalized

CITY OF MELBA

0	0
Fatal Crash Count	Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT



No junctions within the City of Melba were included in the analysis.

Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	0	-	-
Motorcycle-Involved	0	-	-
Alcohol-Involved	0	-	-
Drug-Involved	0	-	-
No Protection Device	0	-	-
Angle-Related Event	0	-	-
Rear-End-Related Event	0	-	-
Overturn-Related Event	0	-	-
Angle Turning-Related Event	0	-	-
Head-On Turning-Related Event	0	-	-
Pedestrian-Related Event	0	-	-
Head-On Related Event	0	-	-
Bicycle-Related Event	0	-	-
Side Swipe Same-Related Event	0	-	-

Top Segments and Junctions

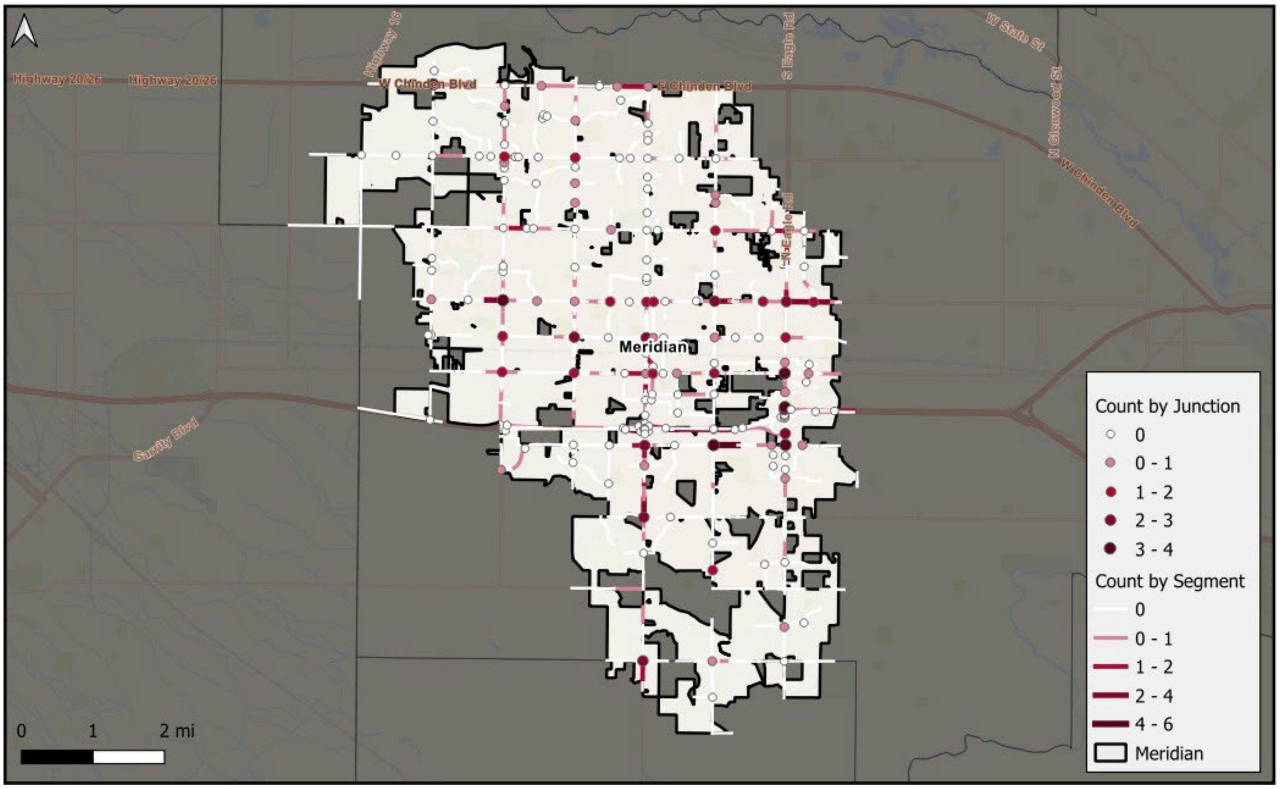
Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
Murphy Rd between Potato Rd and Southside Blvd	4.6375	5	1	4.275	High average speed
Baseline Rd between S Powerline Rd and Potato Rd	4.6375	5	1	4.275	High average speed
Southside Blvd between Murphy Rd and Stokes Ave	2.1375	0	0	4.275	High average speed
Potato Rd between Baseline Rd and Murphy Rd	2.1375	0	0	4.275	High average speed

No junctions within the City of Melba were included in the analysis.

CITY OF MERIDIAN

18	259
Fatal Crash Count	Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT



Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	26	9.4%	9
Motorcycle-Involved	32	11.6%	10
Alcohol-Involved	27	9.7%	10
Drug-Involved	13	4.7%	9
No Protection Device	8	2.9%	7
Angle-Related Event	27	9.7%	9
Rear-End-Related Event	**87**	**31.4%**	**2**
Overturn-Related Event	21	7.6%	10
Angle Turning-Related Event	38	13.7%	4
Head-On Turning-Related Event	**45**	**16.2%**	**2**
Pedestrian-Related Event	18	6.5%	8
Head-On Related Event	13	4.7%	8
Bicycle-Related Event	7	2.5%	8
Side Swipe Same-Related Event	8	2.9%	8

Top Segments and Junctions

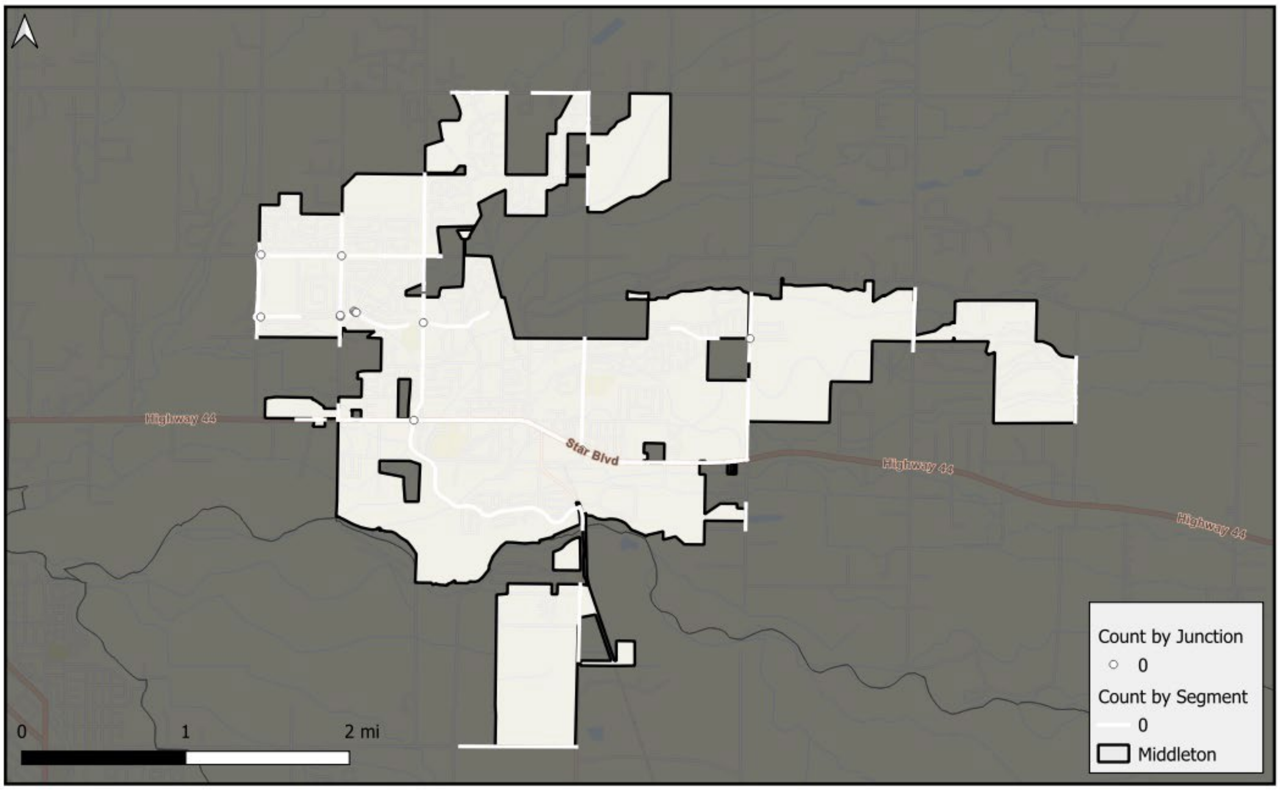
Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
E Overland Rd between S Locust Grove Rd and S Millennium Way	10.3275	15	6	5.655	High average speed, multi-lane roadway
S Meridian Rd between E Rosalyn Dr and Victory Rd	10.295	10	3	10.59	High average speed, functional classification, multi-lane roadway
S Meridian Rd between Lake Hazel Rd and W Paint Horse Lane	9.965	10	2	9.93	High average speed, functional classification, multi-lane roadway
Chinden Blvd between N Fox Run Way and N Elk Ranch Lane	9.8675	10	2	9.735	High average speed, functional classification
S Meridian Dr between W Davenport Dr and W Calderwood St	9.5875	10	1	14.175	Speeding, high average speed, functional classification, multi-lane roadway

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
W Pine Ave & N Meridian Rd	3.998	4	3	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W Lake Hazel Rd & S Meridian Rd	3.998	4	3	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W Victory Rd & S Meridian Rd	3.998	4	3	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
E Overland Rd & S Locust Grove Rd	3.998	4	4	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W Cherry Lane & Northwest 8th St	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W Franklin Rd & Linder Rd	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W McMillan Rd & Linder Rd	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized

CITY OF MIDDLETON

0	**0**
Fatal Crash Count	Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT



Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	0	-	-
Motorcycle-Involved	0	-	-
Alcohol-Involved	0	-	-
Drug-Involved	0	-	-
No Protection Device	0	-	-
Angle-Related Event	0	-	-
Rear-End-Related Event	0	-	-
Overturn-Related Event	0	-	-
Angle Turning-Related Event	0	-	-
Head-On Turning-Related Event	0	-	-
Pedestrian-Related Event	0	-	-
Head-On Related Event	0	-	-
Bicycle-Related Event	0	-	-
Side Swipe Same-Related Event	0	-	-

Top Segments and Junctions

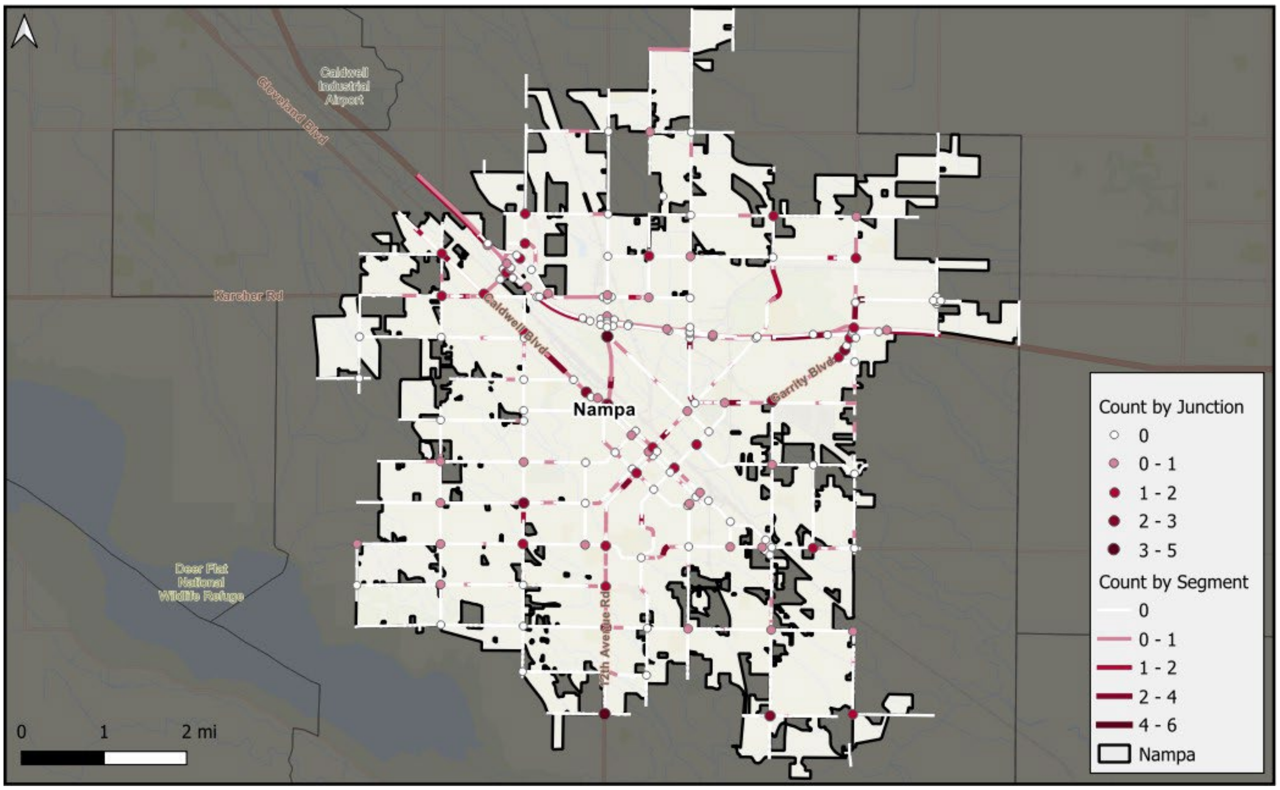
Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
W Main St between Eaton Rd and Cemetery Rd	6.66	0	0	13.32	Speeding, high average speed, functional classification
Hwy 44 between Greenlinks Ave and Duff Lane	6.66	0	0	13.32	Speeding, high average speed, functional classification
W Main St between Hartley Lane and Eaton Rd	4.4625	0	0	8.925	High average speed, functional classification
Hwy 44 between N Middleton Rd and Greenlinks Ave	4.4625	0	0	8.925	High average speed, functional classification

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
Roundabout at W Highlands Parkway & 9th St	1.15	0	0	2.3	2 lane minor, 4 legged
Willis Rd & Hartley Lane	1.15	0	0	2.3	2 lane minor, 4 legged
9th St & Hartley Lane	0.578	0	0	1.156	2 lane minor
9th St & Cemetery Rd	0.578	0	0	1.156	2 lane minor

CITY OF NAMPA

21	303
Fatal Crash Count	Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT



Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	37	11.4%	8
Motorcycle-Involved	42	12.9%	8
Alcohol-Involved	33	10.2%	9
Drug-Involved	15	4.6%	10
No Protection Device	14	4.3%	4
Angle-Related Event	58	17.9%	5
Rear-End-Related Event	57	17.6%	6
Overturn-Related Event	25	7.7%	9
Angle Turning-Related Event	**46**	**14.2%**	**3**
Head-On Turning-Related Event	**42**	**12.9%**	**3**
Pedestrian-Related Event	26	8.0%	7
Head-On Related Event	15	4.6%	9
Bicycle-Related Event	10	3.1%	7
Side Swipe Same-Related Event	21	6.5%	4

Top Segments and Junctions

Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
Garrity Blvd between N Sugar Ave and Carnation Dr	12.195	15	4	9.39	High average speed, functional classification, multi-lane roadway
Garrity Blvd between Barger St and N Jacob Allcott Way	9.695	10	3	9.39	High average speed, functional classification, multi-lane roadway
Caldwell Blvd between Homedale Rd and Orchard Ave	8.765	10	3	7.53	High average speed, multi-lane roadway
Franklin Blvd between Industrial Rd and Garrity Blvd	7.895	10	3	5.79	High average speed, multi-lane roadway
W Karcher Rd between N Middleton Rd and N Cassia St	7.625	10	3	5.25	Functional classification, multi-lane roadway

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
2nd Street South & Northside Blvd	3.998	4	3	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
Cherry Lane & Midland Blvd	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
N Marketplace Blvd & Midland Blvd	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
Caldwell Blvd & N Middleton Rd	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
W Karcher Rd & N Middleton Rd	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized
Caldwell Blvd & Yale St	3.498	3	2	3.996	Multi-lane major, 2 lane minor, 4 legged, signalized

CITY OF NOTUS

0	2
Fatal Crash Count	Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT

Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	0	0%	-
Motorcycle-Involved	0	0%	-
Alcohol-Involved	0	0%	-
Drug-Involved	0	0%	-
No Protection Device	0	0%	-
Angle-Related Event	0	0%	-
Rear-End-Related Event	0	0%	-
Overturn-Related Event	0	0%	-
Angle Turning-Related Event	0	0%	-
Head-On Turning-Related Event	0	0%	-
Pedestrian-Related Event	0	0%	-
Head-On Related Event	**1**	**50%**	**1**
Bicycle-Related Event	0	0%	-
Side Swipe Same-Related Event	**1**	**50%**	**1**

Top Segments and Junctions

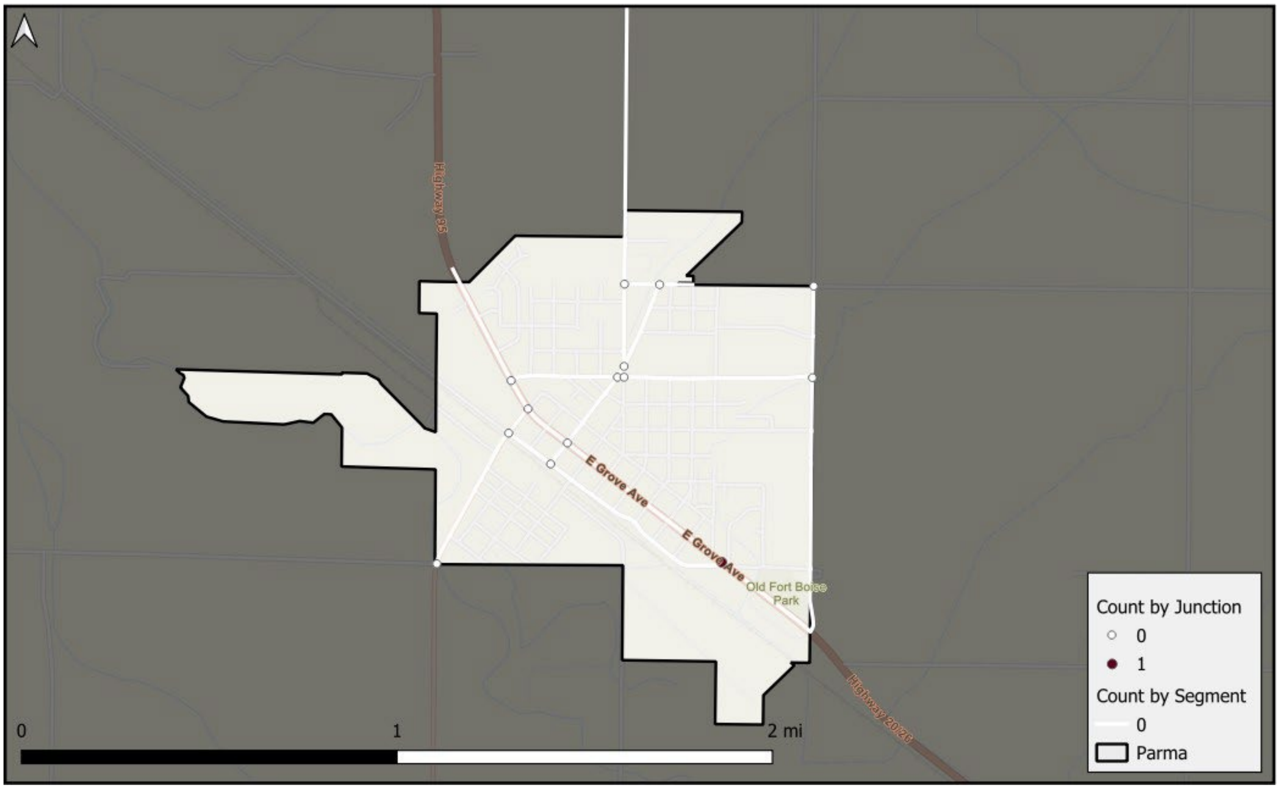
Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
Hwy 20/26 between 3rd St and 2nd St	6.6325	5	1	8.265	High average speed, functional classification
Elgin Ave between Iverson Rd and Conway Rd	4.1325	0	0	8.265	High average speed, functional classification
Hwy 20/26 between Conway Rd and Hop Rd	3.81	0	0	7.62	High average speed, functional classification
Conway Rd between Elgin St and Kremmwood Dr	2.4675	0	0	4.935	High average speed
Notus Rd between Boise River and Elgin St	2.1375	0	0	4.275	High average speed

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
Elgin St & Conway Rd	1.578	2	1	1.156	2 lane minor
Elgin St & Notus Rd (North end)	0.578	0	0	1.156	2 lane minor
Elgin St & Notus Rd (South end)	0.578	0	0	1.156	2 lane minor
1st St & Notus Rd	0.578	0	0	1.156	2 lane minor
Jasper Ave & 3rd St West	0.578	0	0	1.156	2 lane minor

CITY OF PARMA

1	0
Fatal Crash Count	Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT



Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	**1**	**100%**	**1**
Motorcycle-Involved	0	0%	-
Alcohol-Involved	0	0%	-
Drug-Involved	**1**	**100%**	**1**
No Protection Device	0	0%	-
Angle-Related Event	0	0%	-
Rear-End-Related Event	0	0%	-
Overturn-Related Event	0	0%	-
Angle Turning-Related Event	0	0%	-
Head-On Turning-Related Event	0	0%	-
Pedestrian-Related Event	**1**	**100%**	**1**
Head-On Related Event	0	0%	-
Bicycle-Related Event	0	0%	-
Side Swipe Same-Related Event	0	0%	-

Top Segments and Junctions

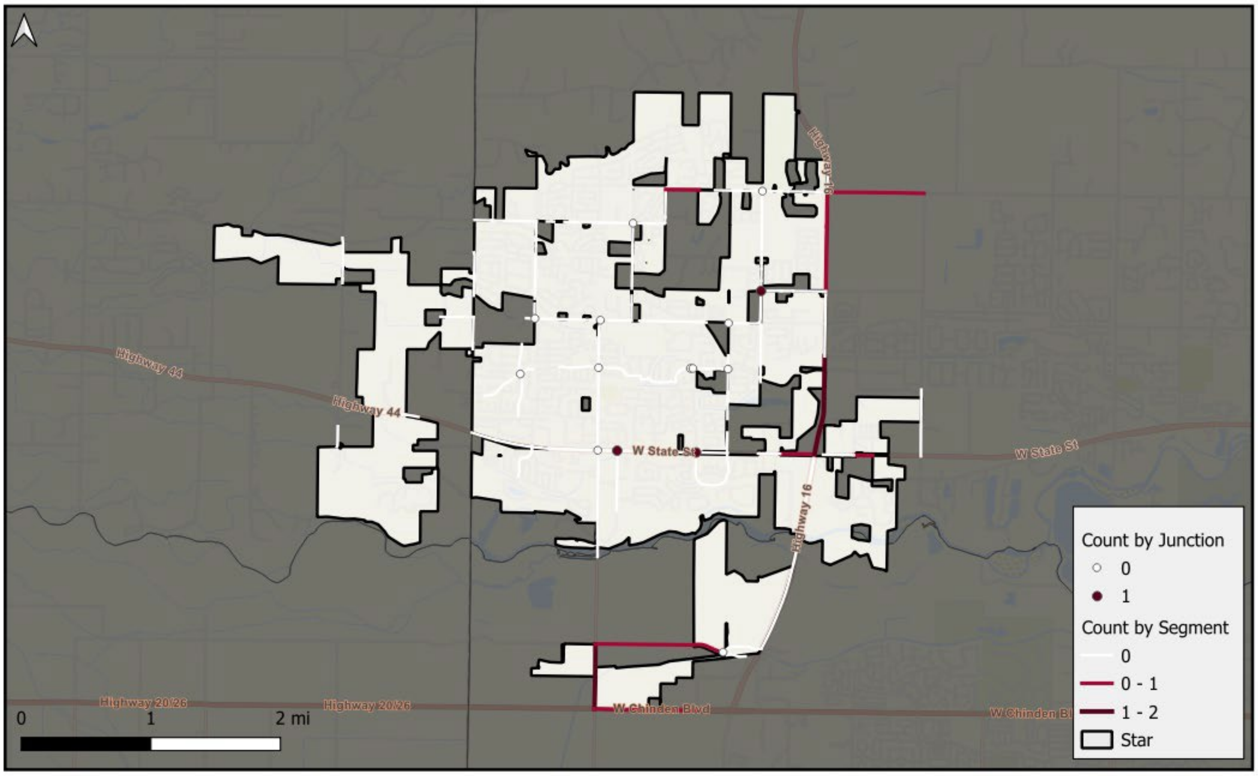
Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
E Grove Ave / Hwy 95 between N 1st St and N 8th St	4.2675	0	0	8.535	High average speed, functional classification
W Grove Ave / Hwy 95 between Parma Cemetery and E McConnell Ave	4.1775	0	0	8.355	High average speed, functional classification

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
E Main St & E Grove Ave	1.578	2	1	1.156	2 lane minor
E Grove Ave & N 2nd St	1.15	0	0	2.3	2 lane minor, 4 legged
E McConnell Ave & N 2nd St	1.15	0	0	2.3	2 lane minor, 4 legged
E McConnell Ave & N Valley Rd	1.15	0	0	2.3	2 lane minor, 4 legged
Walker Rd & Parma Rd	0.578	0	0	1.156	2 lane minor

CITY OF STAR

1	14
Fatal Crash Count	Total Serious Injuries

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT



Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	0	0%	-
Motorcycle-Involved	**6**	**40%**	**1**
Alcohol-Involved	1	6.7%	11
Drug-Involved	**1**	**6.7%**	**3**
No Protection Device	0	0%	-
Angle-Related Event	0	0%	-
Rear-End-Related Event	**6**	**40%**	**1**
Overturn-Related Event	**3**	**20%**	**1**
Angle Turning-Related Event	0	0%	-
Head-On Turning-Related Event	0	0%	-
Pedestrian-Related Event	0	0%	-
Head-On Related Event	1	6.7%	7
Bicycle-Related Event	0	0%	-
Side Swipe Same-Related Event	**1**	**6.7%**	**3**

Top Segments and Junctions

Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
N Hwy 16 between Hwy 44 and W Floating Feather Rd	8.81	10	2	7.62	High average speed, functional classification
Hwy 44 between N Hamlin Ave and N Short Rd	7.3675	5	1	9.735	High average speed, functional classification
N Star Rd between W Chinden Blvd and W Joplin Rd	7.1375	10	2	4.275	High average speed
W Chinden Blvd between N Star Rd and N Mystic Creek Ave	7.0375	5	1	9.075	High average speed, functional classification
N Hwy 16 between W Broken Arrow St and W Beacon Light Rd	6.31	5	1	7.62	High average speed, functional classification

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
W State St & N Secena Springs Way	1.578	2	1	1.156	2 lane minor
W State St & N Main St	1.578	2	1	1.156	2 lane minor
W Broken Arrow Lane & N Pollard Lane	1.578	2	1	1.156	2 lane minor
W State St & N Star Rd	1.292	0	0	2.584	2 lane minor, 4 legged, signalized
W Hidden Brook Dr & N Deerhaven Way	1.15	0	0	2.3	2 lane minor, 4 legged

CITY OF WILDER

0

Fatal Crash Count

0

Serious Injury Crash Count

2018 - 2022 FATAL AND SERIOUS INJURY CRASH COUNT

Crash Event Table

Crash Emphasis Area	KA Crash Count	Percent of Total KA Crashes	Member Agency Ranking
Non-Motorized-Involved	0	-	-
Motorcycle-Involved	0	-	-
Alcohol-Involved	0	-	-
Drug-Involved	0	-	-
No Protection Device	0	-	-
Angle-Related Event	0	-	-
Rear-End-Related Event	0	-	-
Overturn-Related Event	0	-	-
Angle Turning-Related Event	0	-	-
Head-On Turning-Related Event	0	-	-
Pedestrian-Related Event	0	-	-
Head-On Related Event	0	-	-
Bicycle-Related Event	0	-	-
Side Swipe Same-Related Event	0	-	-

Segment	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
5th St / Hwy 95 between Patriot Way and Dove Lane	4.2675	0	0	8.535	High average speed, functional classification
Simplot Blvd between 5th St / Hwy 95 and Travis Rd	3.7875	0	0	7.575	High average speed, functional classification
5th St / Hwy 95 between Penny Lane and Patriot Way	3.525	0	0	7.05	High average speed, functional classification
Golden Gate Ave between 6th St and 4th St	2.4675	0	0	4.935	High average speed
Golden Gate Ave between Batt Corner Rd and 6th St	0.3975	0	0	0.795	Presence of a sidewalk

Junction	HIN Score	Location Score	KA Crash Count	Risk Score	Highest Risk Factor(s)
Golden Gate Ave & 5th St	1.15	0	0	2.3	2 lane minor, 4 legged

SUMMARY

Location Summary:
Fatal and serious injury crashes tend to cluster in more densely populated cities of the COMPASS region such as Boise, Meridian, and Nampa. Segments and junctions with the highest number of KA crashes are predominantly located on Principal Arterials, State, and U.S. Highways, especially those with higher AADT. Since crash counts were used to determine the high crash locations, this aligns with expectations as higher traffic volume typically correlates with higher crash frequency.

Risk / Systemic Summary:
High-Risk factors can be broken into two groups, roadway features and behavioral characteristics. Regardless of group, most crashes occur on multi-lane roads with a posted speed of 35 or 55 miles per hour. High- risk roadway features align with multi-lane State or U.S. Highways and typically host lane departure type crashes. High- risk junction features correlate with multi-lane 4-leg signalized junctions. Youthful drivers, Pedestrians, Cyclists, and Motorcycle fatal or serious crashes are disproportionately impacted compared to all crashes of the same types. Alcohol use, Drug Use, and no seatbelt usage was a high factor in the severity of the crash.

High Injury Network (HIN):
The HIN took a weighted percentage of both location and risk. Its key characteristics include a combo of excess speed and overall volume of users.

Recommended Emphasis Areas:
Using the results from the above, the project team recommends the following emphasis areas:

Emphasis Area	Details
Vulnerable Road Users	Crashes involving pedestrians, bicyclists, motorcyclists, and other non-vehicle road users.
Junction Crashes	Crashes occurring within 150 feet of a junction or intersection.
Lane Departure Crashes	Crashes involving a vehicle leaving the lane, including overturns, head-on, and sideswipes.
Seatbelt Use	Crashes where there is no use of restraint devices.
Impaired Driving	Crashes involving drivers under the influence of alcohol, drugs, or other impairing substances.

Table 12 - Recommended Emphasis Areas

FINAL LAYERS AND APPLICATION

ESRI DASHBOARD

The High Injury Network App assists each member agency by integrating the High Injury Network on the AGOL platform and allows the data to be filterable and jurisdiction specific. The application used was ESRI Dashboards as it allows filtering multiple layers. Use the left column to filter by attribute and the top right to filter by agency boundary. The hosted data and app are hosted on the ESRI COMPASS AGOL.

Click on the map or the below link to access:

https://compassidaho.maps.arcgis.com/apps/dashboards/aa2067339363456a9fcec94b0d9875fd

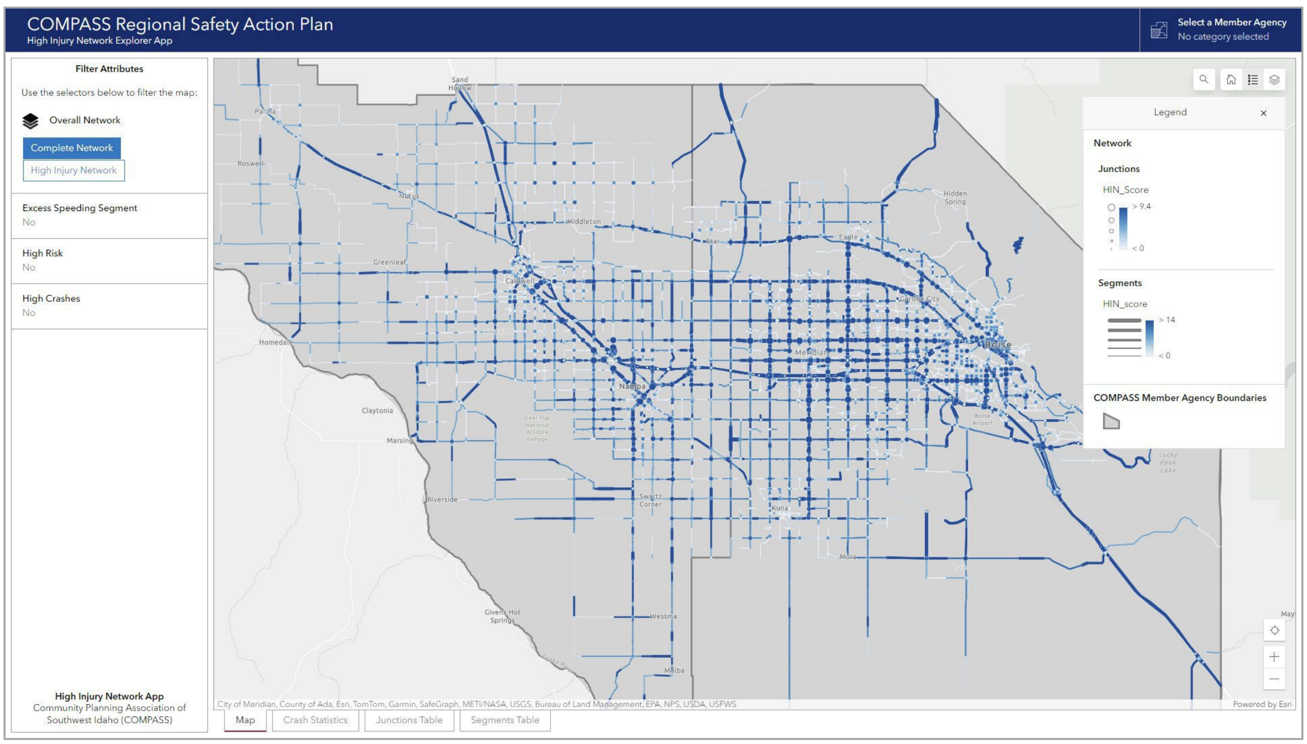


Figure 33 - Screenshot of the HIN App hosted using ESRI Dashboards

DATA SHARING

As an integral part of this memorandum, we include ArcGIS Online (AGOL) links to the key datasets used in our analysis. These datasets not only provide a comprehensive view of the data that informed our study but also provide an opportunity to build on conflated attributes and are presented for reference and further exploration.

1. **Junctions**: Link to Junctions AGOL Data
   This dataset contains the created junction layer which calculated 5-year crash frequency, crash rate, excess crashes, location score, risk score, HIN score, and demographic score.

2. **Segments**: Link to Segments AGOL Data
   This dataset contains conflated segment attributes that match the COMPASS LRS and calculated crash frequency, crash rate, excess crashes, location score, risk score, HIN score, and demographic score.

3. **Crashes**: Link to Crashes AGOL Data
   A dataset comprising incident and conflated person 2018-2022 point file records of traffic crashes, is essential for analyzing trends and identifying safety concerns.

These datasets are made available to complement the findings and discussions presented in this memorandum. They offer a detailed perspective of the data framework and support the conclusions drawn in our analysis.

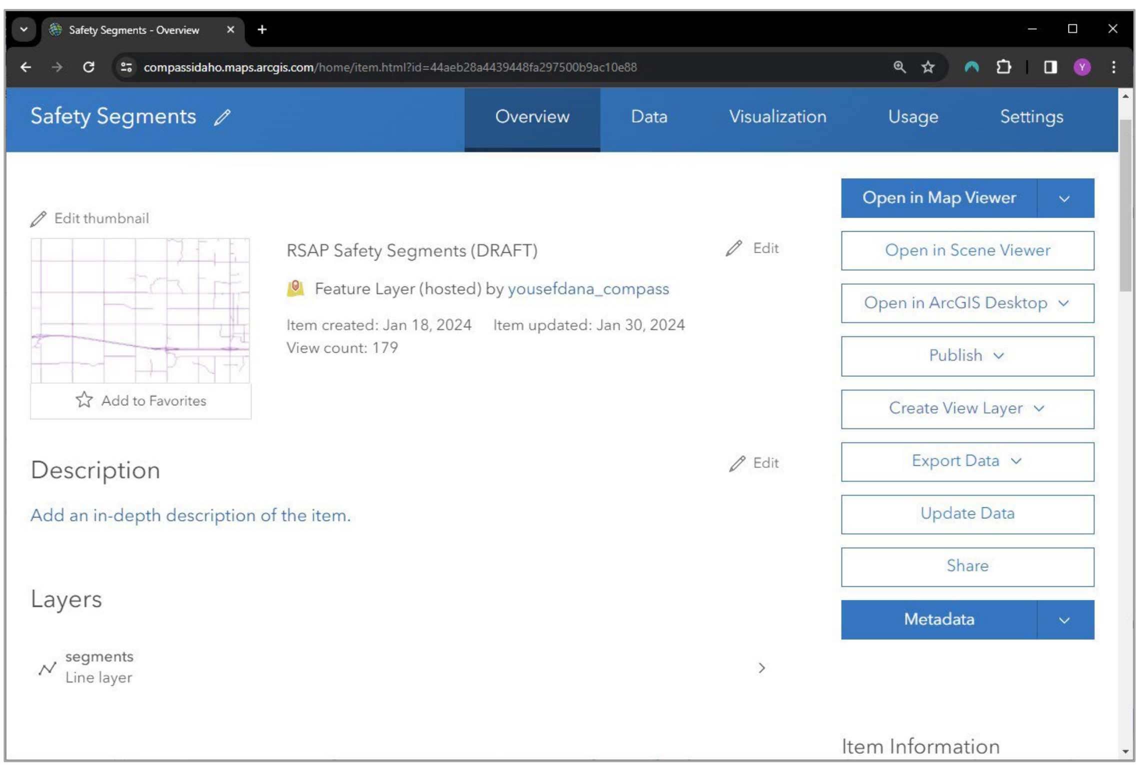


Figure 34 - Screenshot of the Segments layer hosted within COMPASS AGOL

APPENDIX

APPENDIX A: DATA SOURCES

The below table lists all of the data sources used in the analysis. The consultant team compiled and reviewed data sources related to crashes, roadways, junctions, measures of equity, and other common jurisdictional boundaries such as counties and cities. Most of the data sources are maintained in an Esri ArcGIS Online Portal and can be easily accessed through the Portal Item URL. This ensured that all sources were publicly available for use.

Name	Source Owner	Field(s) Used	Analyses Used In
ITD Crash Data 2018 – 2022	ITD	serial_number, Severity, Number_Of_Fatalities, Number_Of_Injuries, vehicle_type, contrib_circ, accident_time, road_surface_condition, other_road_conditions, weather_condition, light_condition, number_of_lanes, traffic_control_device, traffic_cntrl_function, speed_limit, work_zone_related, functional_class, road_type, road_surface, event_rel_to_rdwy, event_1_rel_to_jct, distracted_by, most_harmful_event, sex, age, protection_device, alcohol_drug_involve, vehicle_year, vehicle_make, vehicle_body_style	Location, Systemic
COMPASS Regional Centerline	COMPASS	All fields brought into final layer	Location, Systemic
County Boundaries	COMPASS	Only spatial property used	Location, Systemic
ITD Roadways	ITD	Terrain Type, Shoulder Type, Shoulder Width, Median Type, Median Width	Systemic
Instantaneous Speed	INRIX	Hourly Instantaneous Speed	Systemic
Intx_type_2022model	COMPASS	INT_TYPE	Location, Systemic
KAI_Roundabouts_Ada_Canyon_Counties	Kittelson	Type, Status, Control_Type, Other_Control_Type, Previous_Control_type, Approaches, Driveways, Functional_Class, Lane_Type, Year_Completed, ICD	Location, Systemic
Regional Signals – ITS	COMPASS	Its_device	Location, Systemic
Nonsignal Intersections – ITS	COMPASS	type	Location, Systemic

AADT2022	ITD	AADT	Location, Systemic
City boundaries	COMPASS	Only spatial property used	Location, Systemic
CIM2050 Equity Index	COMPASS	county, gencity, equityscore (considers several demographic, environmental, and transportation measures)	Demographics and Area Characteristics
Emergency Response Time	City of Boise	Average Response Time by Area	Demographics and Area Characteristics

APPENDIX B: DATA DICTIONARY

This section defines the attributes used in the posted data layers.

Segments

Attribute Name	Attribute Type	Description
OBJECTID	integer	A unique identifier for each record in the dataset.
RID_N	character	Linear Referencing System Route ID
stpredir	character	Street prefix directional (e.g., N, S, E, W).
stprefix	character	Street type prefix (e.g., Old, New).
stname	character	Street name.
stsuffix	character	Street type suffix (e.g., St, Rd, Ave).
stpostdir	character	Street postfix directional (e.g., N, S, E, W).
stpostmod	character	Additional modifiers for the street address post-directional (if applicable).
strtconcat	character	Concatenated street name including all prefixes, suffixes, and directionals.
postspeed	integer	Posted speed limit.
emergspeed	integer	Emergency vehicle speed limit.
oneway	character	Indicator if the road is one-way (and the direction if applicable).
funcclass	character	Functional classification of the road.
private	character	Indicator if the road is private.
county	character	County in which the road is located.
direction	character	General direction of the road (e.g., Northbound, Southbound).
state	integer	Identifier for state routes.
lanes	integer	Number of lanes.
city	character	City in which the road is located.
miles	numeric	Length of the road segment in miles.
AADT_mean	numeric	Annual Average Daily Traffic (not verified)
avg_speed	numeric	Average speed on segment from INRIX data
max_speed	numeric	Maximum speed on segment from INRIX data
POSTSPD	integer	Posted Speed Limit
bikefacility_type	character	Bike facility on road type
sidewalk_type	character	Presence of a sidewalk
excess_speed	numeric	Average miles per hour above posted speed limit
excess_speeding_corridor	character	Indicator of the segment having an average speed above the posted speed limit
ID_ASC_PAV_TYP_ID	integer	Pavement Type from ITD
ID_LANE_WID	integer	Lane Width from ITD
ID_MED_TYPE_NAME	character	Median Type from ITD
ID_MED_WIDTH	integer	Median Width from ITD
ID_SHLDR_TYPE_NAME	character	Shoulder Type from ITD
ID_LEFT_UNPAV_SHLDR_WID	integer	Left Unpaved Shoulder Width from ITD

L_SHOULDER_WIDTH	integer	Left Shoulder Width from ITD
ID_RGT_UNPAV_SHLDR_WID	integer	Right Unpaved Shoulder Width from ITD
R_SHOULDER_WIDTH	integer	Right Shoulder Width from ITD
ID_TERR_TYPE_NAME	character	Terrain Type from ITD
total_crash_count	integer	All crashes crash count.
total_crash_rate	numeric	All crashes crash rate. (not verified)
high_risk_low_crashes	integer	Feature has a high risk score but low historical fatal and serious crash count.
low_risk_high_crashes	integer	Feature has a low risk score but high historical fatal and serious crash count.
serious_injury_crash_count	integer	Total number of serious injury crash count.
si_non_motorized	integer	Total number of serious injury crashes involving non-motorized transportation modes (e.g., bicycles, walking).
si_motorcycle_involved	integer	Total number of serious injury crashes that involved at least one motorcycle.
si_alcohol_involved	integer	Total number of serious injury crashes where alcohol involvement by the driver was reported.
si_drug_involved	integer	Total number of serious injury crashes where drug involvement by the driver was reported.
si_alcohol_drug_involved	integer	Total number of serious injury crashes where either alcohol or drugs, or both, were involved.
si_no_protection_device	integer	Total number of serious injury crashes where no protective devices were used (e.g., seatbelts, helmets).
si_angle_event	integer	Total number of angle collision serious injury crashes.
si_rear_end_event	integer	Total number of rear-end collision serious injury crashes.
si_overturn_event	integer	Total number of serious injury crashes where a vehicle overturned.
si_angle_turning_event	integer	Total number of serious injury crashes involving angle collisions with turning vehicles.
si_head_on_turning_event	integer	Total number of serious injury crashes involving head-on collisions with turning vehicles.
si_pedestrian_event	integer	Total number of serious injury crashes involving a pedestrian.
si_head_on_event	integer	Total number of head-on collision serious injury crashes.
si_pedalcycle_event	integer	Total number of serious injury crashes involving a pedal cycle (bicycle).
si_side_swipe_same_event	integer	Total number of side-swipe serious injury crashes involving vehicles traveling in the same direction.
fatal_crash_count	integer	Total number of fatal crashes.
fatal_non_motorized	integer	Total number of fatal crashes involving non-motorized transportation modes (e.g., bicycles, walking).
fatal_motorcycle_involved	integer	Total number of fatal crashes that involved at least one motorcycle.

fatal_alcohol_involved	integer	Total number of fatal crashes where alcohol involvement by the driver was reported.
fatal_drug_involved	integer	Total number of fatal crashes where drug involvement by the driver was reported.
fatal_alcohol_drug_involved	integer	Total number of fatal crashes where either alcohol or drugs, or both, were involved.
fatal_no_protection_device	integer	Total number of fatal crashes where no protective devices were used (e.g., seatbelts, helmets).
fatal_angle_event	integer	Total number of angle collision fatal crashes.
fatal_rear_end_event	integer	Total number of rear-end collision fatal crashes.
fatal_overturn_event	integer	Total number of fatal crashes where a vehicle overturned.
fatal_angle_turning_event	integer	Total number of fatal crashes involving angle collisions with turning vehicles.
fatal_head_on_turning_event	integer	Total number of fatal crashes involving head-on collisions with turning vehicles.
fatal_pedestrian_event	integer	Total number of fatal crashes involving a pedestrian.
fatal_head_on_event	integer	Total number of head-on collision fatal crashes.
fatal_pedalcycle_event	integer	Total number of fatal crashes involving a pedal cycle (bicycle).
fatal_side_swipe_same_event	integer	Total number of side-swipe fatal crashes involving vehicles traveling in the same direction.
non_motorized_sum	integer	Total number of fatal and serious injury crashes involving non-motorized transportation modes (e.g., bicycles, walking).
motorcycle_involved_sum	integer	Total number of fatal and serious injury crashes that involved at least one motorcycle.
alcohol_involved_sum	integer	Total number of fatal and serious injury crashes where alcohol involvement by the driver was reported.
drug_involved_sum	integer	Total number of fatal and serious injury crashes where drug involvement by the driver was reported.
alcohol_drug_involved_sum	integer	Total number of fatal and serious injury crashes where either alcohol or drugs, or both, were involved.
no_protection_device_sum	integer	Total number of fatal and serious injury crashes where no protective devices were used (e.g., seatbelts, helmets).
angle_event_sum	integer	Total number of angle collision fatal and serious injury crashes.
rear_end_event_sum	integer	Total number of rear-end collision fatal and serious injury crashes.
overturn_event_sum	integer	Total number of fatal and serious injury crashes where a vehicle overturned.
angle_turning_event_sum	integer	Total number of fatal and serious injury crashes involving angle collisions with turning vehicles.
head_on_turning_event_sum	integer	Total number of fatal and serious injury crashes involving head-on collisions with turning vehicles.

pedestrian_event_sum	integer	Total number of fatal and serious injury crashes involving a pedestrian.
head_on_event_sum	integer	Total number of head-on collision fatal and serious injury crashes.
pedalcycle_event_sum	integer	Total number of fatal and serious injury crashes involving a pedal cycle (bicycle).
side_swipe_same_event_sum	integer	Total number of side-swipe fatal and serious injury crashes involving vehicles traveling in the same direction.
serious_injury_crash_rate	numeric	Fatal Crash Rate (no quality control conducted / not verified)
fatal_crash_rate	numeric	Serious Injury Crash Rate (no quality control conducted / not verified)
fatal_group	character	High, Medium, and Low classification of number of fatal crashes
injury_group	character	High, Medium, and Low classification of number of serious injury crashes
ka_crashes	integer	Total number of fatal and serious injury crashes
ka_crash_rate	numeric	Fatal and Serious Injury Crash Rate (no quality control conducted / not verified)
ka_group	character	High, Medium, and Low classification of number of fatal and serious injury crashes
expected_crashes	numeric	Average expected crashes based on functional classification
excess	numeric	Excess count of crashes based on expected crashes
excess_pct	numeric	Percent of excess crashes compared to expected crashes
location_score	integer	Location score depending on total amount of fatal and serious injury crashes
risk_attr_score1	numeric	Systemic score for the presence of Speeding Segment
risk_attr_score2	numeric	Systemic score for the presence of Average Speed is >= 30 Miles Per Hour
risk_attr_score3	numeric	Systemic score for the presence of Functional Classification is State or U.S. Highway
risk_attr_score4	numeric	Systemic score for the presence of Number of Lanes is 5 Lanes or greater
risk_attr_score5	numeric	Systemic score for the presence of Posted Speed is 35 or 55 Miles Per Hour
risk_attr_score6	numeric	Systemic score for the presence of Presence of a Sidewalk
risk_attr_score7	numeric	Systemic score for the presence of Right Shoulder Width is 0, 8, 10 Feet
risk_attr_score8	numeric	Systemic score for the presence of Road Terrian Type is Flat
risk_attr_score9	numeric	Systemic score for the presence of Shoulder Type is Surfaced with Bituminous Material
risk_attr_score10	numeric	Systemic score for the presence of Left Unpaved Shoulder Width is 0 Feet

risk_attr_score11	numeric	Systemic score for the lack of bike facility presence
risk_attr_score12	numeric	Systemic score for the presence of Right Unpaved Shoulder Width is 0 Feet
risk_attr_score13	numeric	Systemic score for the presence of Median Width is 0 Feet
risk_attr_score14	numeric	Systemic score for the presence of Median Type is None
risk_attr_score15	numeric	Systemic score for the presence of Left Shoulder Width is 0 Feet
risk_score	numeric	Systemic / Risk Analysis Score
equityscore_max	integer	Max value of intersecting equity index score
HIN_score	numeric	High Injury Network score
HIN	integer	High Injury Network indicator
HIN_Demographic	integer	High Injury Network indicator focused on segments that intersect TAZ's with an Equity Index of 7 or greater
HIN_non_state	character	High Injury Network indicator focused on non-state segments
HIN_non_motorized	character	High Injury Network indicator focused on non-motorized crashes

Junctions

Attribute Name	Attribute Type	Description
OBJECTID	integer	A unique identifier for each record in the dataset.
funcclass	character	Functional classification of the highest intersecting road.
state	integer	Identifier if state routes intersect the junction.
int_type	character	Intersection Type
total_crash_count	integer	All crashes crash count.
AADT_mean	numeric	Mean Annual Average Daily Traffic (not verified)
AADT_minor	integer	Minor Leg Annual Average Daily Traffic (not verified)
AADT_major	integer	Major Leg Annual Average Daily Traffic (not verified)
lanes_minor	integer	Minor Leg Number of Lanes
lanes_major	integer	Major Leg Number of Lanes
legs	integer	Number of Legs
tpopcensus	integer	Population from Census
tazid_current	integer	TAZ ID
high_risk_low_crashes	integer	Feature has a high risk score but low historical fatal and serious crash count.
low_risk_high_crashes	integer	Feature has a low risk score but high historical fatal and serious crash count.
serious_injury_crash_count	integer	Total number of serious injury crash count.
si_non_motorized	integer	Total number of serious injury crashes involving non-motorized transportation modes (e.g., bicycles, walking).
si_motorcycle_involved	integer	Total number of serious injury crashes that involved at least one motorcycle.
si_alcohol_involved	integer	Total number of serious injury crashes where alcohol involvement by the driver was reported.
si_drug_involved	integer	Total number of serious injury crashes where drug involvement by the driver was reported.
si_alcohol_drug_involved	integer	Total number of serious injury crashes where either alcohol or drugs, or both, were involved.
si_no_protection_device	integer	Total number of serious injury crashes where no protective devices were used (e.g., seatbelts, helmets).
si_angle_event	integer	Total number of angle collision serious injury crashes.
si_rear_end_event	integer	Total number of rear-end collision serious injury crashes.
si_overturn_event	integer	Total number of serious injury crashes where a vehicle overturned.
si_angle_turning_event	integer	Total number of serious injury crashes involving angle collisions with turning vehicles.
si_head_on_turning_event	integer	Total number of serious injury crashes involving head-on collisions with turning vehicles.
si_pedestrian_event	integer	Total number of serious injury crashes involving a pedestrian.
si_head_on_event	integer	Total number of head-on collision serious injury crashes.

si_pedalcycle_event	integer	Total number of serious injury crashes involving a pedal cycle (bicycle).
si_side_swipe_same_event	integer	Total number of side-swipe serious injury crashes involving vehicles traveling in the same direction.
fatal_crash_count	integer	Total number of fatal crashes.
fatal_non_motorized	integer	Total number of fatal crashes involving non-motorized transportation modes (e.g., bicycles, walking).
fatal_motorcycle_involved	integer	Total number of fatal crashes that involved at least one motorcycle.
fatal_alcohol_involved	integer	Total number of fatal crashes where alcohol involvement by the driver was reported.
fatal_drug_involved	integer	Total number of fatal crashes where drug involvement by the driver was reported.
fatal_alcohol_drug_involved	integer	Total number of fatal crashes where either alcohol or drugs, or both, were involved.
fatal_no_protection_device	integer	Total number of fatal crashes where no protective devices were used (e.g., seatbelts, helmets).
fatal_angle_event	integer	Total number of angle collision fatal crashes.
fatal_rear_end_event	integer	Total number of rear-end collision fatal crashes.
fatal_overturn_event	integer	Total number of fatal crashes where a vehicle overturned.
fatal_angle_turning_event	integer	Total number of fatal crashes involving angle collisions with turning vehicles.
fatal_head_on_turning_event	integer	Total number of fatal crashes involving head-on collisions with turning vehicles.
fatal_pedestrian_event	integer	Total number of fatal crashes involving a pedestrian.
fatal_head_on_event	integer	Total number of head-on collision fatal crashes.
fatal_pedalcycle_event	integer	Total number of fatal crashes involving a pedal cycle (bicycle).
fatal_side_swipe_same_event	integer	Total number of side-swipe fatal crashes involving vehicles traveling in the same direction.
non_motorized_sum	integer	Total number of fatal and serious injury crashes involving non-motorized transportation modes (e.g., bicycles, walking).
motorcycle_involved_sum	integer	Total number of fatal and serious injury crashes that involved at least one motorcycle.
alcohol_involved_sum	integer	Total number of fatal and serious injury crashes where alcohol involvement by the driver was reported.
drug_involved_sum	integer	Total number of fatal and serious injury crashes where drug involvement by the driver was reported.
alcohol_drug_involved_sum	integer	Total number of fatal and serious injury crashes where either alcohol or drugs, or both, were involved.
no_protection_device_sum	integer	Total number of fatal and serious injury crashes where no protective devices were used (e.g., seatbelts, helmets).
angle_event_sum	integer	Total number of angle collision fatal and serious injury crashes.

rear_end_event_sum	integer	Total number of rear-end collision fatal and serious injury crashes.
overturn_event_sum	integer	Total number of fatal and serious injury crashes where a vehicle overturned.
angle_turning_event_sum	integer	Total number of fatal and serious injury crashes involving angle collisions with turning vehicles.
head_on_turning_event_sum	integer	Total number of fatal and serious injury crashes involving head-on collisions with turning vehicles.
pedestrian_event_sum	integer	Total number of fatal and serious injury crashes involving a pedestrian.
head_on_event_sum	integer	Total number of head-on collision fatal and serious injury crashes.
pedalcycle_event_sum	integer	Total number of fatal and serious injury crashes involving a pedal cycle (bicycle).
side_swipe_same_event_sum	integer	Total number of side-swipe fatal and serious injury crashes involving vehicles traveling in the same direction.
total_crash_rate	numeric	All crashes crash rate. (not verified)
serious_injury_crash_rate	numeric	Fatal Crash Rate (no quality control conducted / not verified)
fatal_crash_rate	numeric	Serious Injury Crash Rate (no quality control conducted / not verified)
fatal_group	character	High, Medium, and Low classification of number of fatal crashes
injury_group	character	High, Medium, and Low classification of number of serious injury crashes
ka_crashes	integer	Total number of fatal and serious injury crashes
ka_crash_rate	numeric	Fatal and Serious Injury Crash Rate (no quality control conducted / not verified)
ka_group	character	High, Medium, and Low classification of number of fatal and serious injury crashes
location_score	integer	Location score depending on total amount of fatal and serious injury crashes
risk_attr_score1	numeric	Systemic score for the presence of 5 or greater lanes on the major leg
risk_attr_score2	numeric	Systemic score for the presence of 2 lanes on the minor leg
risk_attr_score3	numeric	Systemic score for the presence of 4 legs
risk_attr_score4	numeric	Systemic score for the presence of signalization
risk_score	numeric	Systemic / Risk Analysis Score
equityscore_max	integer	Max value of intersecting equity index score
HIN_Score	numeric	High Injury Network score
HIN	integer	High Injury Network indicator
HIN_Demographic	integer	High Injury Network indicator focused on segments that intersect TAZ's with an Equity Index of 7 or greater
HIN_non_state	character	High Injury Network indicator focused on non-state segments
HIN_non_motorized	character	High Injury Network indicator focused on non-motorized crashes

APPENDIX C: DETAILED METHODOLOGY

LOCATION-SPECIFIC ANALYSIS

- The location-specific analysis involved creating three separate layers:
  - The combined and clean crash data layer covering the last five years,
  - The junction layer with junction-related fields and junction-related crashes joined to each junction, and
  - The segment layer with roadway-related fields and non-junction-related crashes joined to each segment.
- The following sections walk through the steps used to create each of these layers.
- Crashes
  - Row bind the ITD crash data from 2018, 2019, 2020, 2021, and 2022. Each year is a separate dataset.
  - For attributes that have multiple columns (i.e. contributing circumstance is broken out into contrib_circ_1, contrib_circ_2, and contrib_circ_3), combine together into a single column with each instance separated by a comma.
    - Columns where this was performed were contributing circumstances, weather conditions, and speed limits.
  - Ensure there is only one row per crash using the serial_number field.
  - Replace all “None’s”, “NA’s”, and “N/A” with a blank entry throughout the dataset.
  - Using the COMPASS area county boundaries, clip the crashes to only include those within the COMPASS boundary.
  - Create binary fields using the following crash field, denoting whether or not a crash was related to the relevant variable:
    - Non-motorized: vehicle_type includes ‘Pedestrian’ or ‘Pedal cycle’
    - Motorcycle-involved: vehicle_type includes ‘Motorcycle’
    - Alcohol-involved: alcohol_drug_involved includes ‘Alcohol’ or ‘Both’
    - Drug-involved: alcohol_drug_involved includes ‘Drugs’ or ‘Both’
    - Alcohol or drug-involved: alcohol_drug_involved ‘Alcohol’, ‘Drugs’, or ‘Both’
    - No protection device: protection_device includes ‘None’
    - Angle-related event: most_harmful_event includes ‘Angle’
    - Rear end-related event: most_harmful_event includes ‘Rear-End’
    - Overturn-related event: most_harmful_event includes ‘Overturn
    - Angle-related event: most_harmful_event includes ‘Angle’
    - Angle turning-related event: most_harmful_event includes ‘Angle Turning’
    - Head-on turning-related event: most_harmful_event includes ‘Head-On Turning
    - Pedestrian-related event: most_harmful_event includes ‘Pedestrian’
    - Head-on-related event: most_harmful_event includes ‘Head-On
    - Pedal cycle-related event: most_harmful_event includes ‘Pedal cycle
    - Side swipe same-related event: most_harmful_event includes ‘Side swipe same
- Junctions

- Creating the Junctions Layer
    - As the Intx_type_2022model layer seemed to have missing junctions, a full junctions layer was created spatially and then attributes from the various junction layers, including Intx_type_2022model, were joined to this created layer. The following steps were used to create the junction layer.
        - Start with a version of the roadway network (COMPASS Regional Centerline) filtered by functional class. Only include the following functional classifications: Collector, Interstate, Minor Arterial, Principal Arterial, Ramp, State Highway, U.S. and Highway.
        - Perform a complete dissolve of the roadway network (COMPASS Regional Centerline). This combines all individual line segments into one segment.
        - Run the 'Multipart to singleparts' tool on the dissolved roadway network. This splits back out the dissolved roadway network into individual segments but this time each segment is a full roadway rather than one roadway being broken out into many small segments. This step was needed so that junctions were not identified at each individual segment's beginning and end point along a roadway.
    - Run the 'Line intersections' tool which creates points at each instance of an intersection.
    - Clip the points layer created in the previous step to the COMPASS county boundaries layer.
    - Remove any duplicate geometries.
    - With the created junction layer, join attributes from the Intx_type_2022model layer by performing a 'Join to nearest' spatial join with a 500 ft cutoff. This means each point in the Intx_type_2022model layer gets joined to its closest created junction point, and if no Intx_type_2022model point exists within 500 ft of a created junction point then this junction does not have data in the Intx_type_2022model layer. The attributes brought over from Intx_type_2022model are listed in Table 1 of the memo.
    - Perform the same step above between the created junction layer and the roundabouts layer (KAI_Roundabouts_Ada_Canyon_Counties). The attributes brought over are listed in Table 1.
- Spatial Joining
    - Buffer the created junction layer by 150 feet following direction from Highway Safety Manual.
    - Perform a one-to-many spatial join between the buffered junctions and the crash data layer, summing up the crash data for each junction. Sum up the total number of crashes, the total number of serious injury crashes, the total number of fatal crashes, and the number of fatal and/or serious injury crashes involving a non-motorized vehicle, a motorcycle, alcohol, drugs, alcohol or drugs, no protection devices, angle event, rear end event, overturn event, angle turning event, head on turning event, pedestrian event, head-on event, pedal cycle event, and sideswipe same event.
    - Create a field that sums up the total number of serious injury crashes and fatal crashes to create a KA crash sum.
    - Clean up the roundabouts.
        - Each roundabout has multiple points per roundabout, one at each entry and exit point. To summarize crash data per roundabout vs per entry/exit point, perform the following steps.
            - Create a filtered version of the junction layer that just includes the roundabout points.

- Dissolve the points using the roundabout identifier fields. This will create one collection of points per roundabout.
- Find the centroid of each collection of dissolved roundabout points.
- Snap the centroid to the roadway network.
- Ensure crash attributes have been summarized at the roundabout level.
- Remove all previous roundabout rows from the junction layer, and then merge (row bind) the clean roundabout points.
  - Perform a spatial join between the junctions buffered by 150 feet to the ITS signals and non-signals layers to pull in attributes where they exist. The attributes brought over are listed in Table 1.
  - Buffer the AADT layer by 150 feet and join to junctions taking the average AADT. Calculate total, fatal, and serious injury crash rates by dividing the number of crashes by the AADT and multiplying by 1,000.
- Using the KA crash sum field, find four Jenks breaks in all of the non-zero values to create KA crash sum groups of 'Low', 'Medium', and 'High'. All junctions with zero KA crashes will have a value of 'None'.

- Roadway Segments
  - The junctions layer needed to be created first in order to identify all junction-related crashes. To join the roadway segments (COMPASS Regional Centerline layer) to the non-junction-related crashes the following steps were performed.
    - Clip the roadway network to the COMPASS boundary.
    - Using the junction layer buffered by 150 feet, find the spatial difference in the full crash layer and the buffered junctions. The resulting crash points will be those outside of the 150-foot buffer i.e. the non-junction-related crashes.
    - Buffer the non-junction related crashes by 150 ft just to ensure a large enough buffer to join the crash points to the segments.
    - Perform a one-to-many spatial join between the roadway network and the buffered crash points. Again summarizing the crash data fields at the segment level.
    - Create a field that sums up the total number of serious injuries and fatal crashes to create a KA crash sum.
    - Buffer the AADT layer by 150 feet and join to points taking the average AADT. Calculate total, fatal, and serious injury crash rates by dividing the number of crashes by the AADT and multiplying by 1,000.
  - Using the KA crash sum field, find four Jenks breaks in all of the non-zero, non-Interstate or Ramp values to create KA crash sum groups of 'Low', 'Medium', and 'High'. All segments with zero crashes will have a value of 'None'. All segments of functional classification 'Interstate' or 'Ramp' are assigned a value of 'Low' to ensure the 'High' group is not only made up of Interstate segments.
  - An excess number and percentage of KA crashes were also calculated for each segment.
    - An expected number of crashes was determined for each functional classification by first dividing the total number of KA crashes by the total mileage. This expected crashes per length was then multiplied by each segment's length to determine the expected number of crashes for that segment.
    - The excess number of crashes was found by subtracting the expected number of crashes from the actual number of KA crashes.
    - The percent of excess crashes was also found by dividing the number of excess crashes by the expected number of crashes.

SYSTEMIC-BASED ANALYSIS

Data Preparation

1. Data Loading and Initial Processing
   - Utilized sf to load spatial data for road segments and junctions.
   - Converted data frames to data. tables for efficient data manipulation.
2. Handling of Missing Values and Zero Values
   - Postspeed and lanes with zero values were set to NA to correctly handle missing or unrecorded data.
   - Attributes such as bikefacility_type and excess_speed with NA or zero values were replaced with 'no_bike_facility' and NA, respectively, to accurately represent their absence.
3. Subset and Variable Selection
   - Data were subsetted to exclude 'Interstate' from funcclass to focus on relevant road segments and junctions.
   - Selected variables for analysis based on their relevance to each model's focus.
4. Conversion to Factors
   - Categorical variables like funcclass, sidewalk, bikefacility_type, and various ID-based attributes were converted to factors to enable the Random Forest algorithm to properly interpret these as categorical features rather than numerical values.

Random Forest Model Configurations

1. All Attributes Combined for Segments Model
   - Variables: ka_crashes, postspeed, funcclass, lanes, sidewalk, bikefacility_type, avg_speed, excess_speed, and several ID-based geometric attributes.
   - NA Handling: Removed records with any NA in the selected variables.
   - Factor Conversion: For categorical variables such as funcclass, sidewalk, bikefacility_type, and ID-based attributes.
2. All Attributes Combined for Junctions Model
   - Variables: ka_crashes, int_type, legs, lanes_major, lanes_minor.
   - NA Handling: Excluded records with NA values.
   - Factor Conversion: type was converted to a factor.
3. COMPASS Data Only Model
   - Variables: Focused on ka_crashes, postspeed, funcclass, lanes, sidewalk, bikefacility_type, avg_speed, excess_speed.
   - NA Handling: Similar strategy of removing or converting NAs.
   - Factor Conversion: Applied to funcclass, sidewalk, and bikefacility_type.
4. ITD Data Only (Geometric Attributes) Model
   - Variables: Geometric attributes like ID_MED_TYPE_NAME, ID_MED_WIDTH, and shoulder-related variables.
   - NA Handling: Omitted records with missing values in these attributes.
   - Factor Conversion: Geometric attributes converted to factors.
5. Non-Motorized Crashes Model
   - Variables: Similar to the first model but focuses on non_motorized_sum instead of ka_crashes.
   - NA Handling: Employed the same strategy for handling NAs.
   - Factor Conversion: Same approach in converting categorical variables to factors.

Model Execution

- For each model, the **randomForest** function was used, specifying the dependent variable (e.g., **ka_crashes** or **non_motorized_sum**) and a series of independent variables based on the model's focus.
- The **importance = TRUE** parameter was included to identify the most significant predictors in each model.

Technical Notes

- The approach acknowledges the importance of preprocessing data for machine learning, especially in handling missing values and correctly treating categorical variables for Random Forest analysis.
- By differentiating the models based on data source and crash type focus, the methodology allows for a nuanced analysis of roadway safety, facilitating targeted interventions based on the identified predictors.

APPENDIX D: TIP PROJECTS OVERLAPPING THE HIN

STIP Project Type	STIP Project Name	STIP Project Description
Safety	Railroad Crossing, Lemp Lane, Canyon County	Install signals and gates at the Union Pacific railroad crossing at Lemp Lane in Canyon County between the Cities of Parma and Notus. Local match from State Rail Protection Account.
Safety	Railroad Crossing, Benjamin Lane, Boise	Install crossing signal, including constant warning detection, at the Boise Valley Railroad crossing at Benjamin Lane in the City of Boise. Local match from State Rail Protection Account.
Paved Pathway	Pathway, SH-55 (Eagle Road), Franklin Road to Pine Ave, Meridian	Construct a lighted ten-foot-wide concrete multi-use pathway along the east side of State Highway 55 (Eagle Road), from Franklin Road to Pine Avenue in the City of Meridian. Reconstruct the existing sidewalk adjacent to the Shell gas station to the ten-foot width. The project will include an eight-foot separation between the roadway and pathway where possible.
Paved Pathway	Pathway, SH-55 (Eagle Road), Jasmine to McMillan, West Side, Boise	Design and construct a ten-foot wide multi-use pathway adjacent to State Highway 55 (Eagle Road) on the west side between Jasmine Lane to McMillian Road. Improvements include widening existing pathway and filling gaps where a pathway is missing. The pathway will increase the safety of bicyclists and pedestrians along the corridor.
Paved Pathway	Pathway, SH-55 (Eagle Road), McMillan to US 20/26 (Chinden) West Side, Boise	Design and construct a ten-foot shared pedestrian and bicycle pathway on the west side of State Highway 55 (Eagle Road), from McMillan Road to US 20/26 (Chinden Boulevard) in the City of Boise.
Paved Pathway	Pedestrian Improvements, US 20/26 (Chinden) at 43rd St, Garden City	Install a Pedestrian Hybrid Beacon-controlled crossing on US 20/26 (Chinden Boulevard) at 43rd Street in the City of Garden City.
Widening	US 20/26, Middleton Rd to Star Rd, Eastbound & Westbound, Ada and Canyon Counties	Widen eastbound and westbound US 20 from Middleton Road near the City of Caldwell to Star Road near the City of Star. Improvements include two travel lanes in each direction and a center turn lane with two way left turns. Intersection improvements at the mile will include signalization.
Widening	US 20/26, I-84 to Middleton Road, Canyon County	Widen US 20/26 from Interstate 84 to Middleton Road to six lanes in the City of Caldwell. Work includes a continuous median traffic separator with u-turn opportunities, and installation of two additional traffic signals.

STIP Project Type	STIP Project Name	STIP Project Description
Safety	Railroad Crossing, Lemp Lane, Canyon County	Install signals and gates at the Union Pacific railroad crossing at Lemp Lane in Canyon County between the Cities of Parma and Notus. Local match from State Rail Protection Account.
Widening	SH-55 (Karcher Road), Farmway Rd to Middleton Rd, Canyon County	Widen State Highway 55 (Karcher Road) from Farmway Road to Middleton Road in Canyon County. The project will add one travel lane in each direction to improve mobility and reduce crashes along the corridor. Work includes a continuous median traffic separation, with signalizations intersections at each mile, and u-turn opportunities at the half-mile.
Widening	US 20/26 (Chinden), Phyllis Canal Bridge to SH-16, Ada County	Widen US 20/26 (Chinden Boulevard) from the Phyllis Canal Bridge (just west of Star Road) to State Highway 16 in Ada County. The project will add one additional lane in both directions and add bicycle and pedestrian facilities.
Widening	Ustick Rd, McDermott Rd to Black Cat Rd	Widen Ustick Road from two lanes to five lanes from McDermott Road to Black Cat Road in the City of Meridian including enhanced pedestrian and bicycle facilities on both sides of the roadway.
Widening	Linder Rd, SH-44 (State St) to Floating Feather Rd, Eagle	Widen Linder Road from State Highway 44 (State Street) to Floating Feather Road in the City of Eagle to five lanes with enhanced pedestrian and bicycle facilities on both sides of the roadway. Project includes removing and replacing two bridges (Middleton Canal and Foothills Ditch).
Widening	Linder Rd, US 20/26 (Chinden) to SH-44 (State), Ada County	Widen Linder Road from US 20/26 (Chinden Boulevard) to State Highway 44 (East State Street) in Ada County to five lanes with detached multi-use pathways on Linder Road from Chinden Boulevard to 1,000 feet north of Artesian Road. Right-of-way will be acquired for an ultimate seven-lane buildout. Project includes widening three bridges.
Widening	US 20/26 (Chinden), Linder Rd to Locust Grove, Meridian and Eagle	Widen US 20/26 (Chinden Boulevard) from Linder Road to Locust Grove Road in the Cities of Meridian and Eagle. An additional lane in both directions will improve congestion issues. Work also includes improvements to existing intersections. Project is funded and constructed by a private developer using State Tax Anticipated Revenue (STAR) funds.
Widening	Ustick Road, Ten Mile Road to Linder Road, Meridian	Widen Ustick Road from Ten Mile Road to Linder Road in the City of Meridian to five lanes. The project includes curb, gutter, sidewalk, and a level three bicycle facility. The concept-level design will further clarify the scope of the project.

STIP Project Type	STIP Project Name	STIP Project Description
Safety	Railroad Crossing, Lemp Lane, Canyon County	Install signals and gates at the Union Pacific railroad crossing at Lemp Lane in Canyon County between the Cities of Parma and Notus. Local match from State Rail Protection Account.
Widening	Franklin Road, McDermott Road to Black Cat Road, Ada County	Widen Franklin Road from McDermott Road to Black Cat Road in Ada County including enhanced pedestrian and bicycle facilities on both sides of the roadway.
Widening	Linder Road Overpass, Overland Road to Franklin Road, Meridian	Widen Linder Road from Franklin Road to Overland Road from two lanes to five lanes with curb, gutter, sidewalk, and multi-use pathways for pedestrians and bicyclists. This project will include two pedestrian hybrid beacons at the intersection of Linder Road and Waltman Street and Linder Road and Gander Drive. The Ten Mile Creek and Kennedy Lateral bridges will also be replaced. Work includes construction of a new Interstate Overpass which will include four travel lanes and a separated multi-use pathway.
Widening	Fairview Avenue, Locust Grove Road to SH-55 (Eagle Road), Meridian	Widen Fairview Avenue from Locust Grove Road to State Highway 55 (Eagle Road) to seven lanes in the City of Meridian. Project includes enhanced pedestrian and bicycle facilities on both sides of the roadway.
Widening	Lake Hazel Road, Five Mile Road to Maple Grove Road, Ada County	Widen Lake Hazel Road from Five Mile Road to Maple Grove Road in Ada County to five lanes including enhanced pedestrian and bicycle facilities on both sides of the roadway.
Widening	Five Mile Road Overpass and Widening, Boise	Widen the Five Mile Road overpass over Interstate 84, including widening the bridge from two lanes to four lanes, widening Five Mile Road from two lanes to five lanes from just north of Overland Road to Franklin Road in the City of Boise, and adding curb, gutter, sidewalks, and enhanced bike lanes on both sides of the roadway.
Widening	SH-55, Beacon Light Road to Brookside Lane, Ada County	Widen State Highway 55 from Beacon Light Road just north of the City of Eagle to Brookside Lane in Ada County. The project will reduce congestion and improve safety.
Widening	I-84B (Garrity Boulevard) and Stamm Lane Intersection Improvements, Nampa	Widen Interstate 84B (Garrity Boulevard) at the Stamm Lane intersection in the City of Nampa to improve safety and mobility.

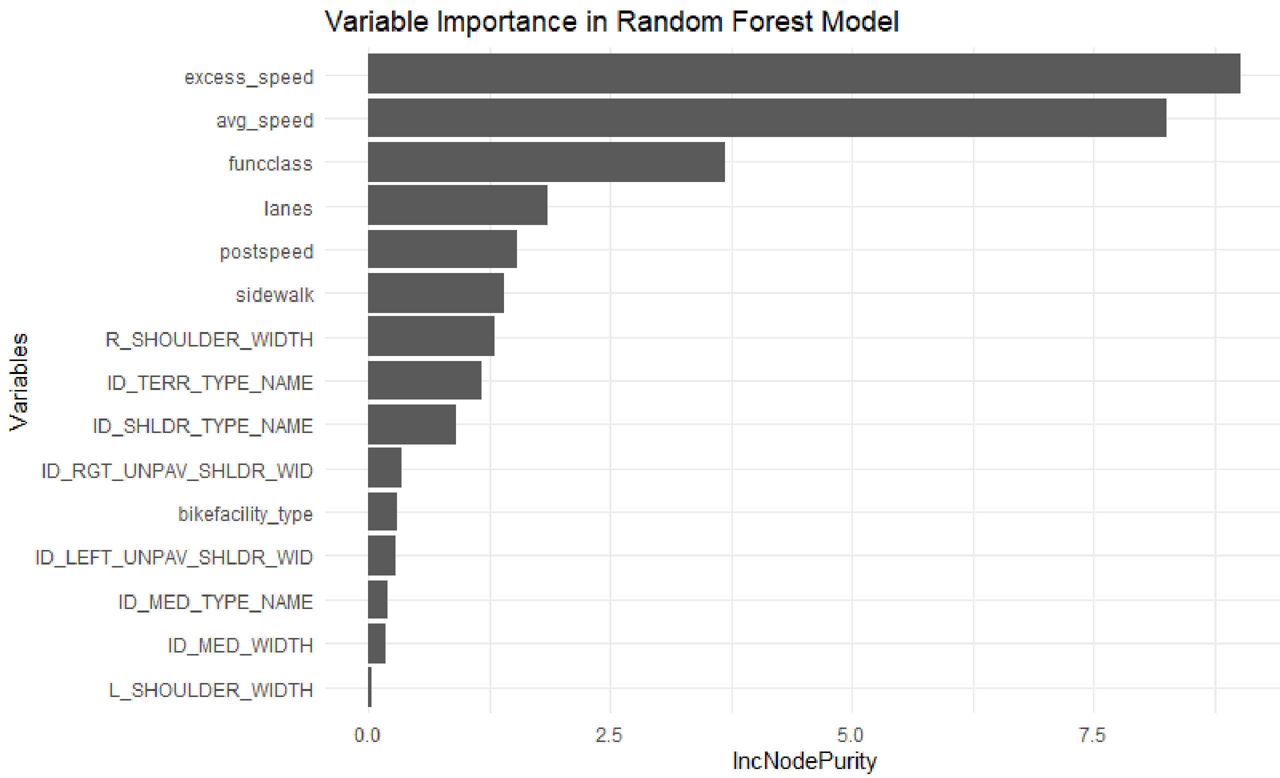
APPENDIX E: SYSTEMIC-BASED RISK ANALYSIS RANDOM FOREST MACHINE LEARNING MODELS

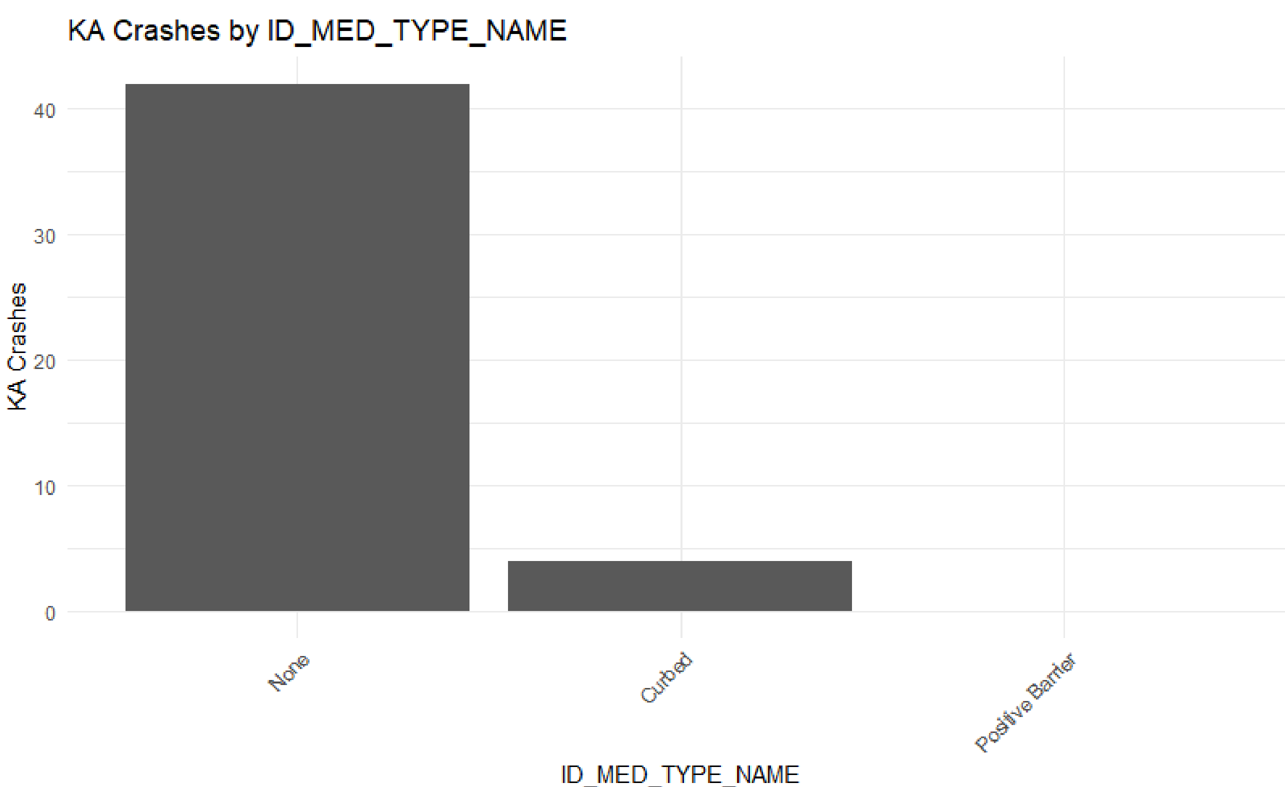
The following plots retained the field names in plot headers, please find the description of each below:

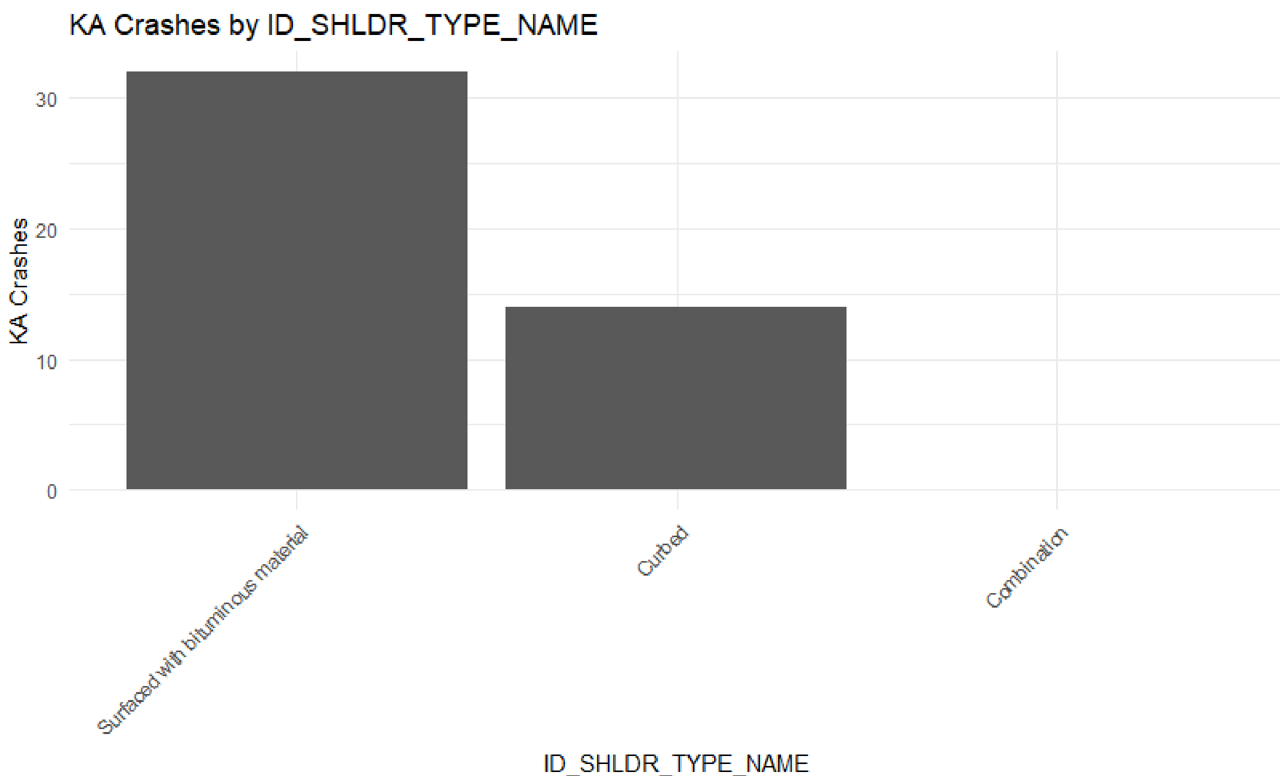
Field Name	Description
excess_speed	Average INRIX Speed is greater than the Posted Speed
avg_speed	Average INRIX Speed
funcclass	Functional Classification
lanes	Number of Lanes
postspeed	Posted Speed Limit
sidewalk	Presence of a sidewalk
bikefacility_type	Bike facility on street type
ID_TERR_TYPE_NAME	Roadway terrain type
ID_RIGHT_UNPAV_SHLDR_WID	Right unpaved shoulder width
ID_LEFT_UNPAV_SHLDR_WID	Left unpaved shoulder width
ID_MED_TYPE_NAME	Median Type
ID_MED_WIDTH	Median Width
L_SHOULDER_WIDTH	Left Shoulder Width
R_SHOULDER_WIDTH	Right Shoulder Width

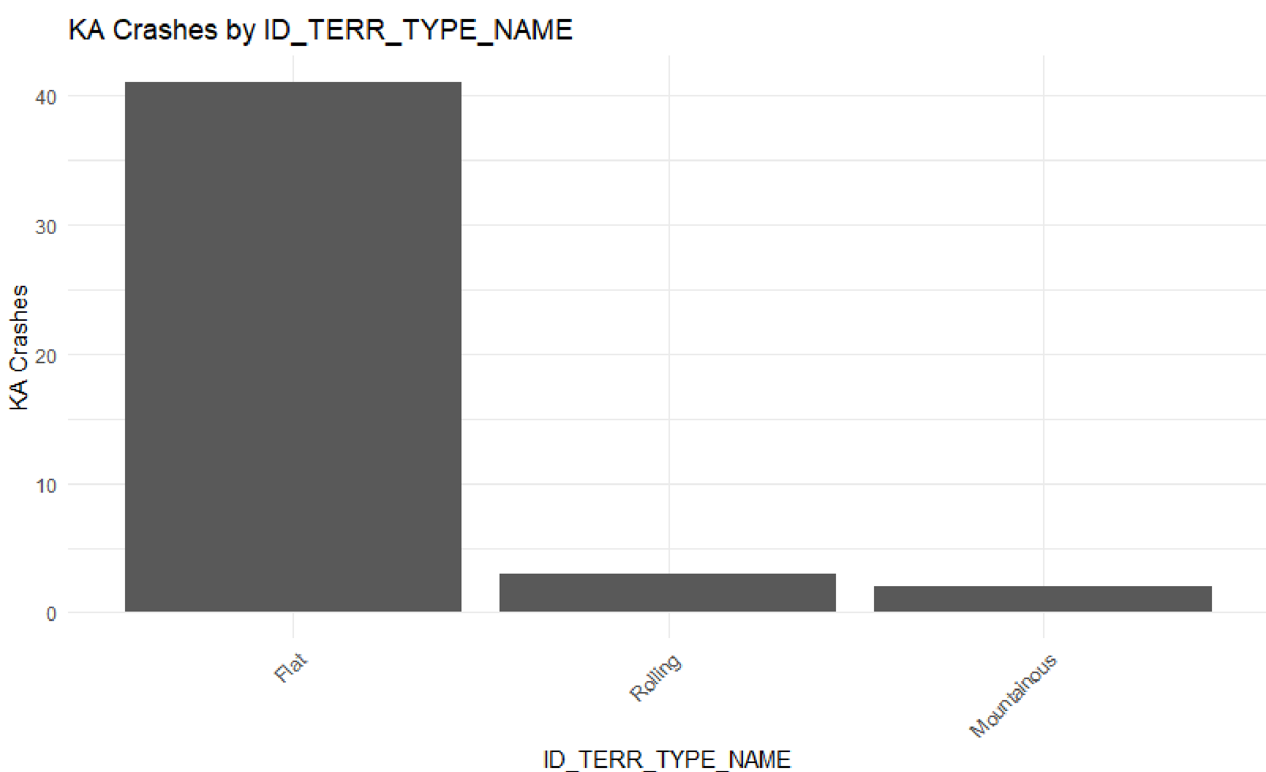
RANDOM FOREST MODEL 1 – COMBINED

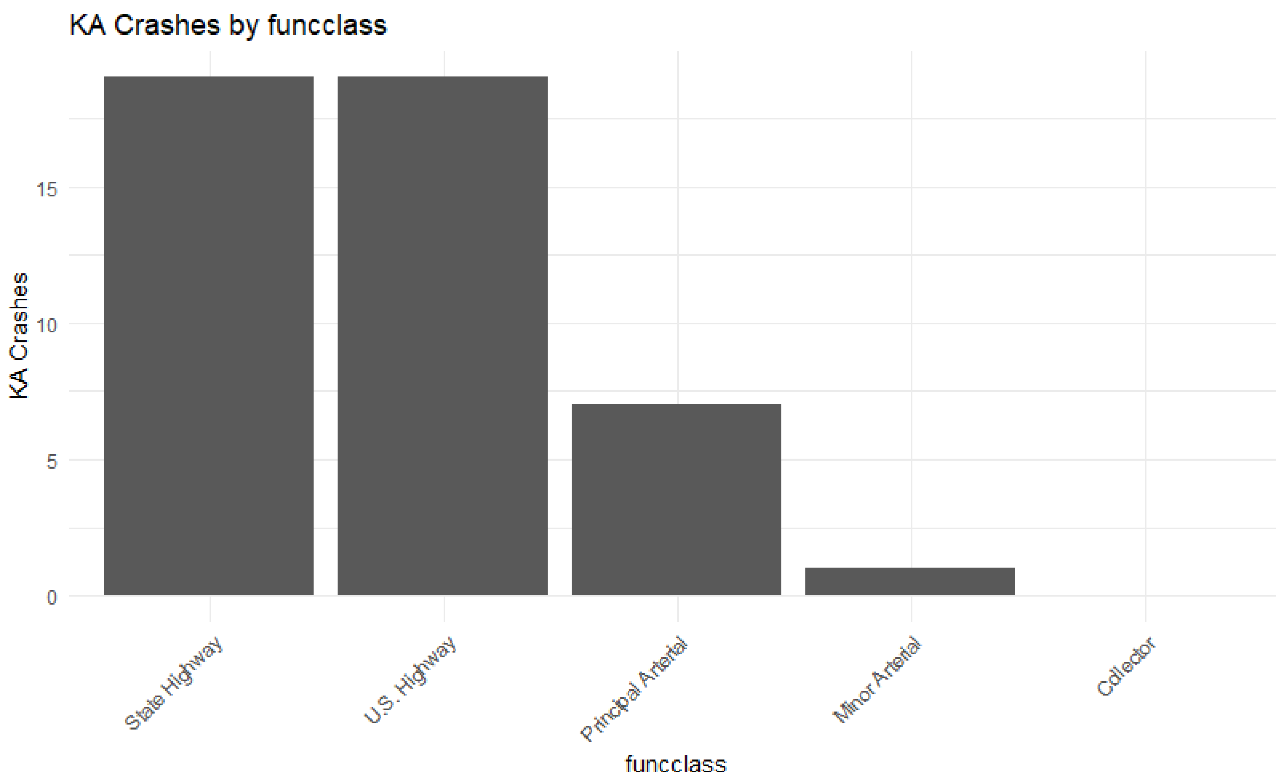
Segments

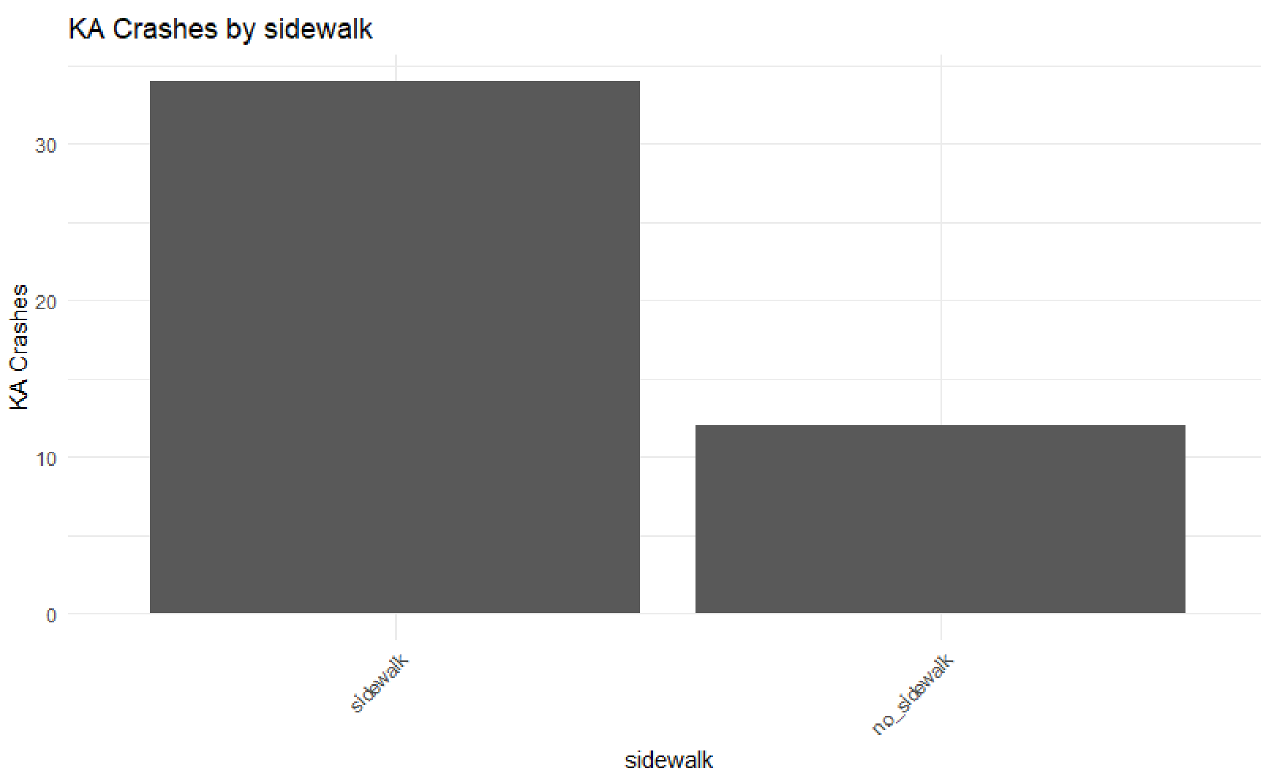


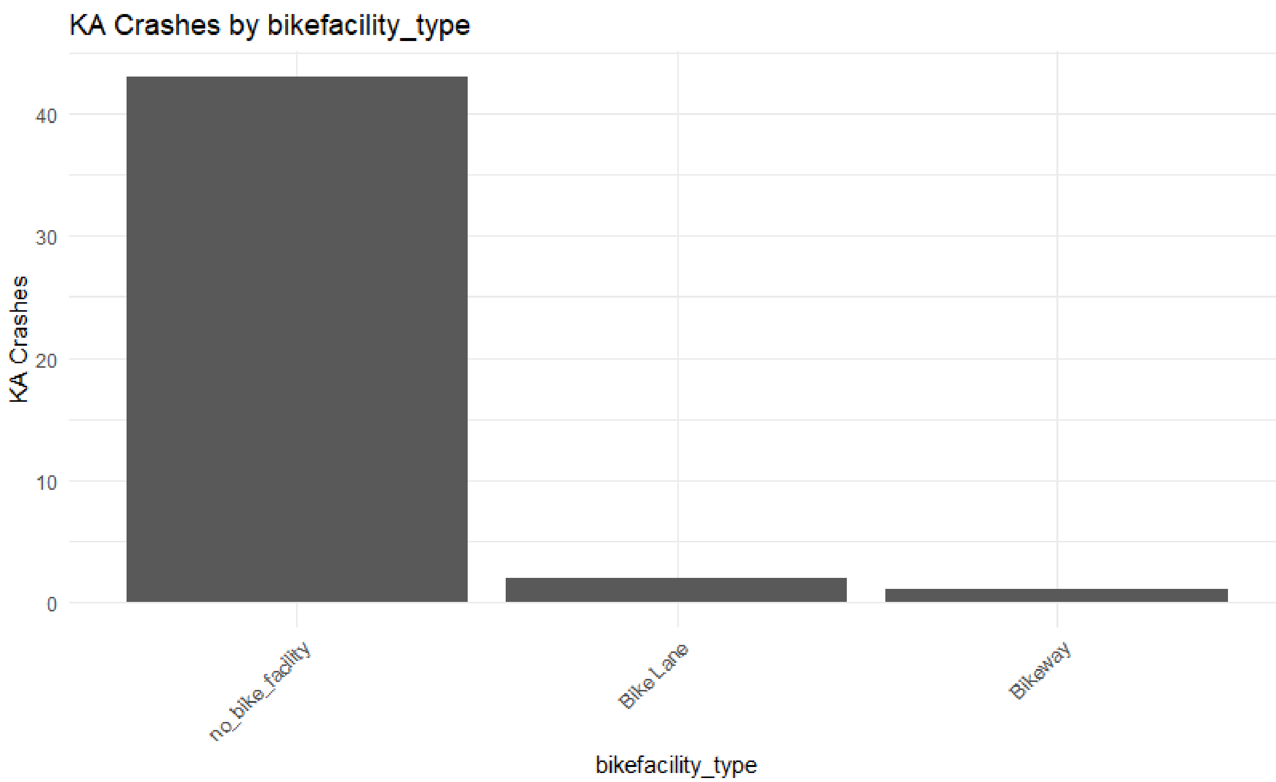


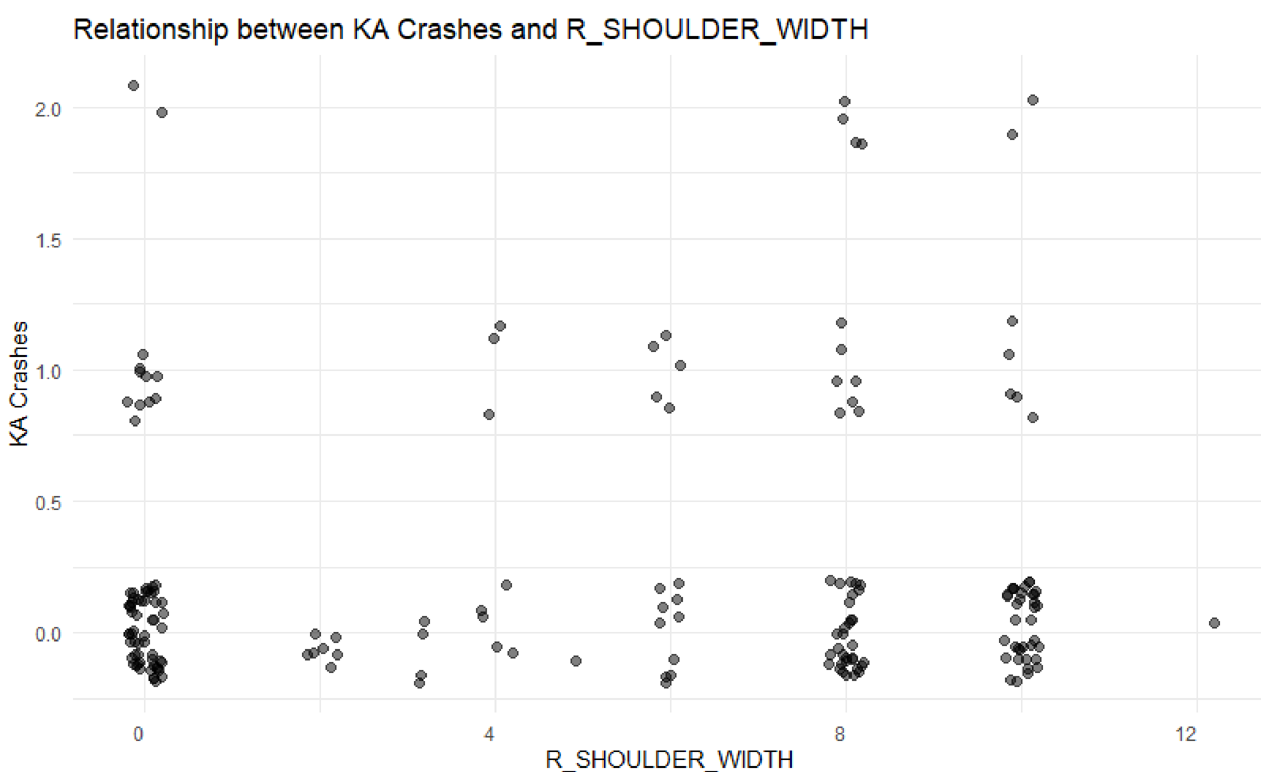

KA Crashes by ID_SHLDR_TYPE_NAME
KA Crashes
30
20
10
0
Surfaced with bituminous material
Curbed
Combination
ID_SHLDR_TYPE_NAME

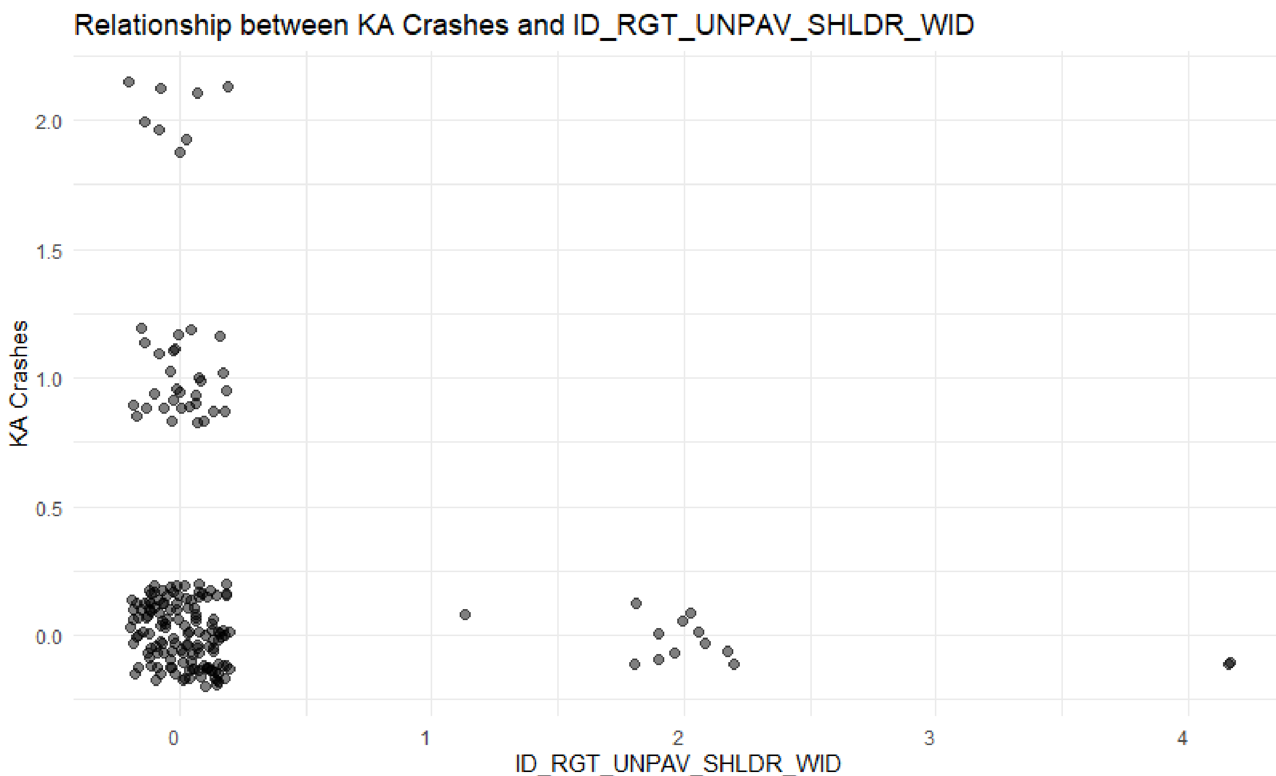

KA Crashes by ID_TERR_TYPE_NAME
KA Crashes
40
30
20
10
0
Flat
Rolling
Mountainous
ID_TERR_TYPE_NAME


KA Crashes by funcclass
KA Crashes
0
5
10
15
State Highway
U.S. Highway
Principal Arterial
Minor Arterial
Collector
funcclass


KA Crashes by sidewalk
KA Crashes
0
10
20
30
sidewalk
no_sidewalk
sidewalk


KA Crashes by bikefacility_type
KA Crashes
40
30
20
10
0
no_bike_facility
Bike Lane
Bikeway
bikefacility_type


Relationship between KA Crashes and R_SHOULDER_WIDTH
KA Crashes
2.0
1.5
1.0
0.5
0.0
0
4
8
12
R_SHOULDER_WIDTH


Relationship between KA Crashes and ID_RGT_UNPAV_SHLDR_WID
KA Crashes
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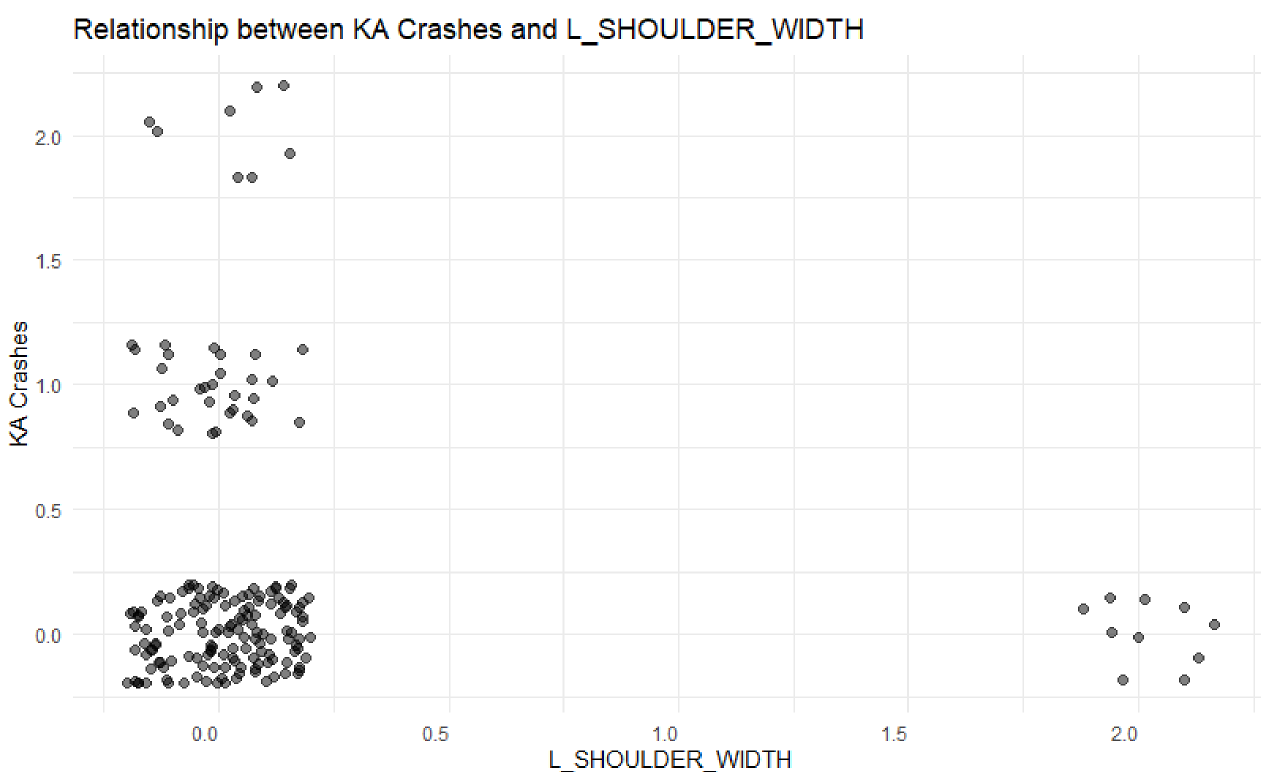
1.5
1.0
0.5
0.0
0
1
2
3
4
ID_RGT_UNPAV_SHLDR_WID


Relationship between KA Crashes and L_SHOULDER_WIDTH
KA Crashes
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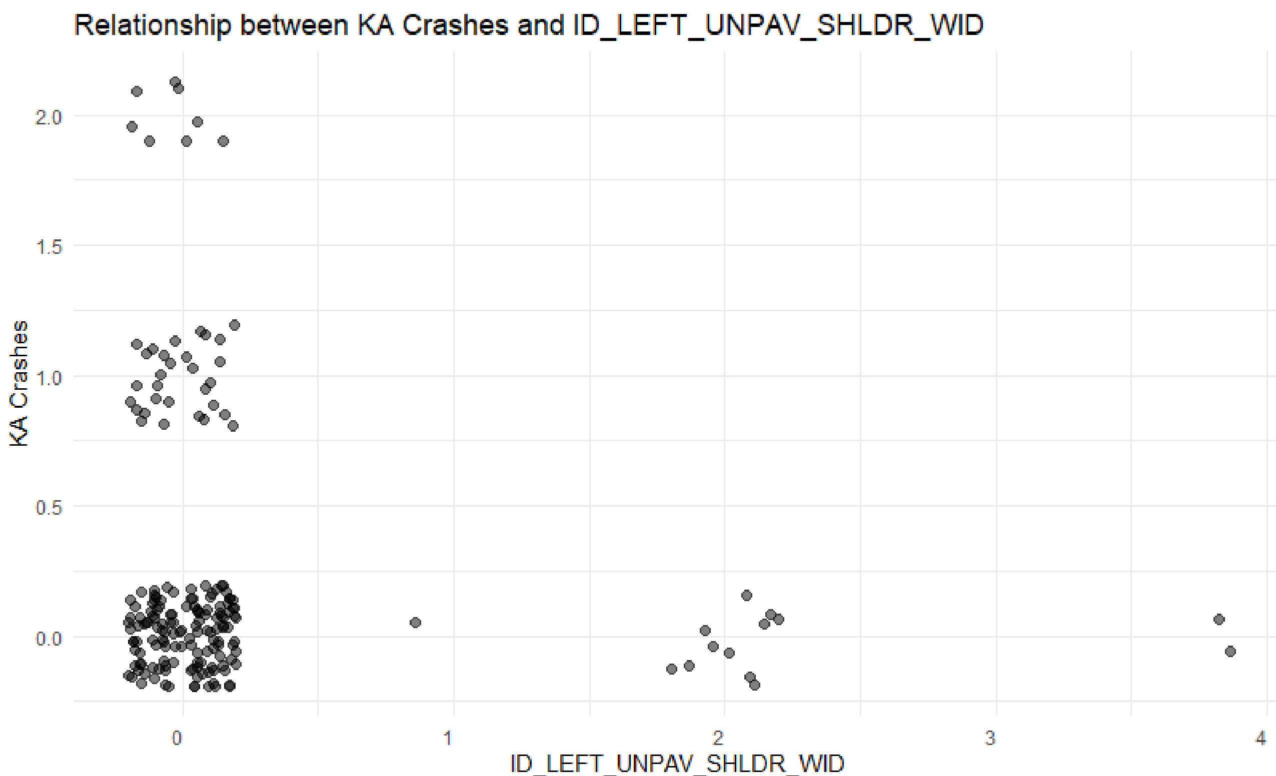
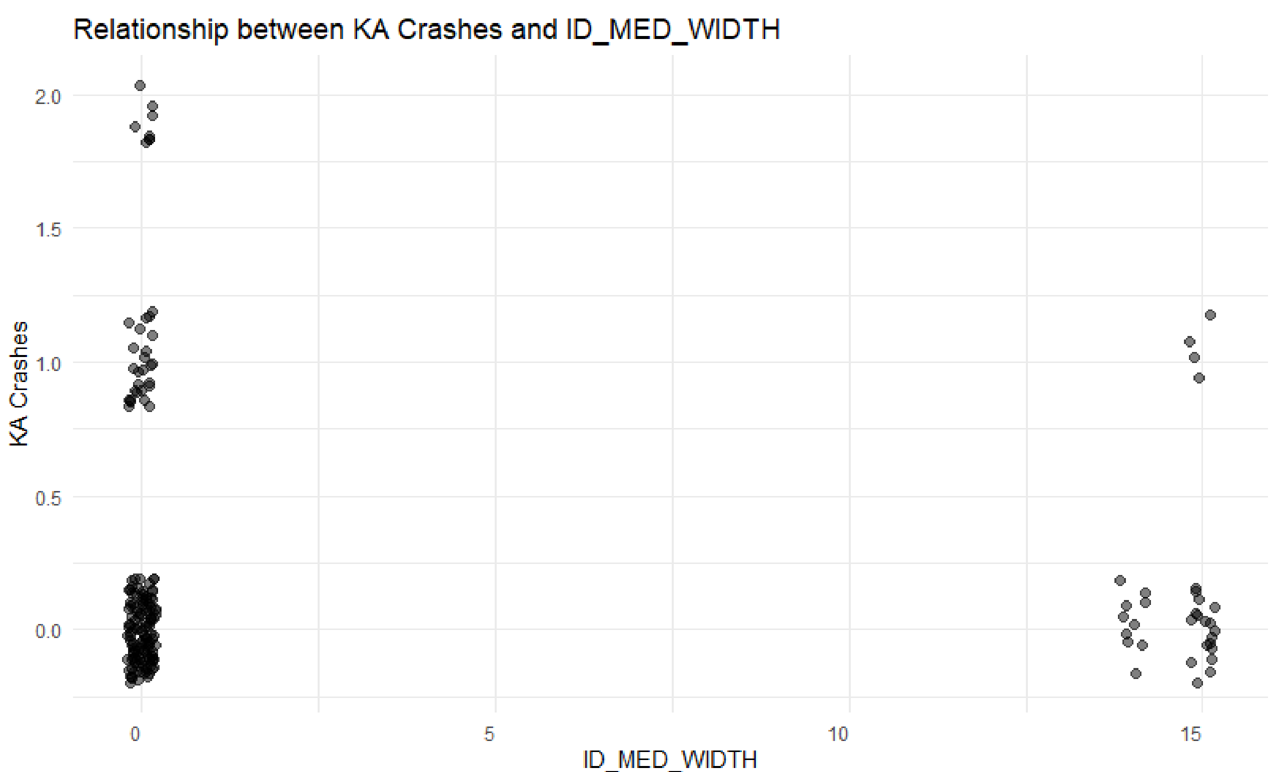
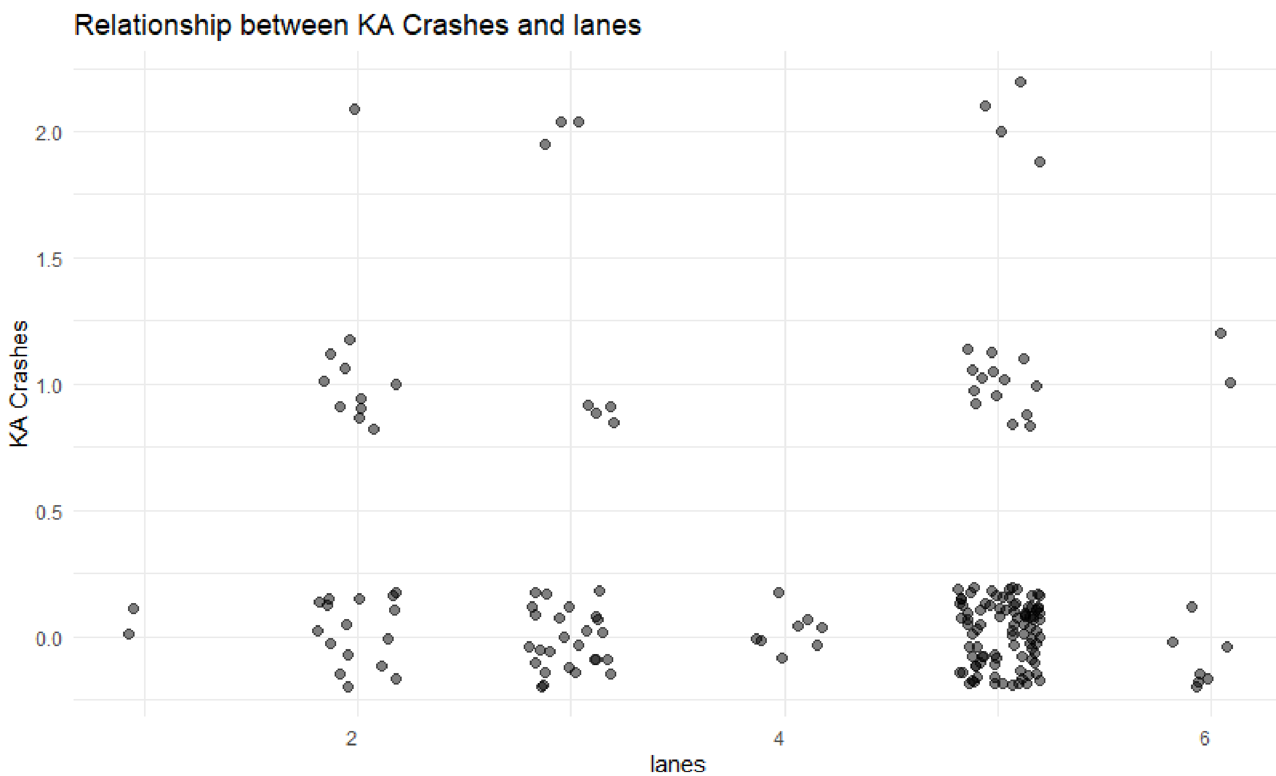
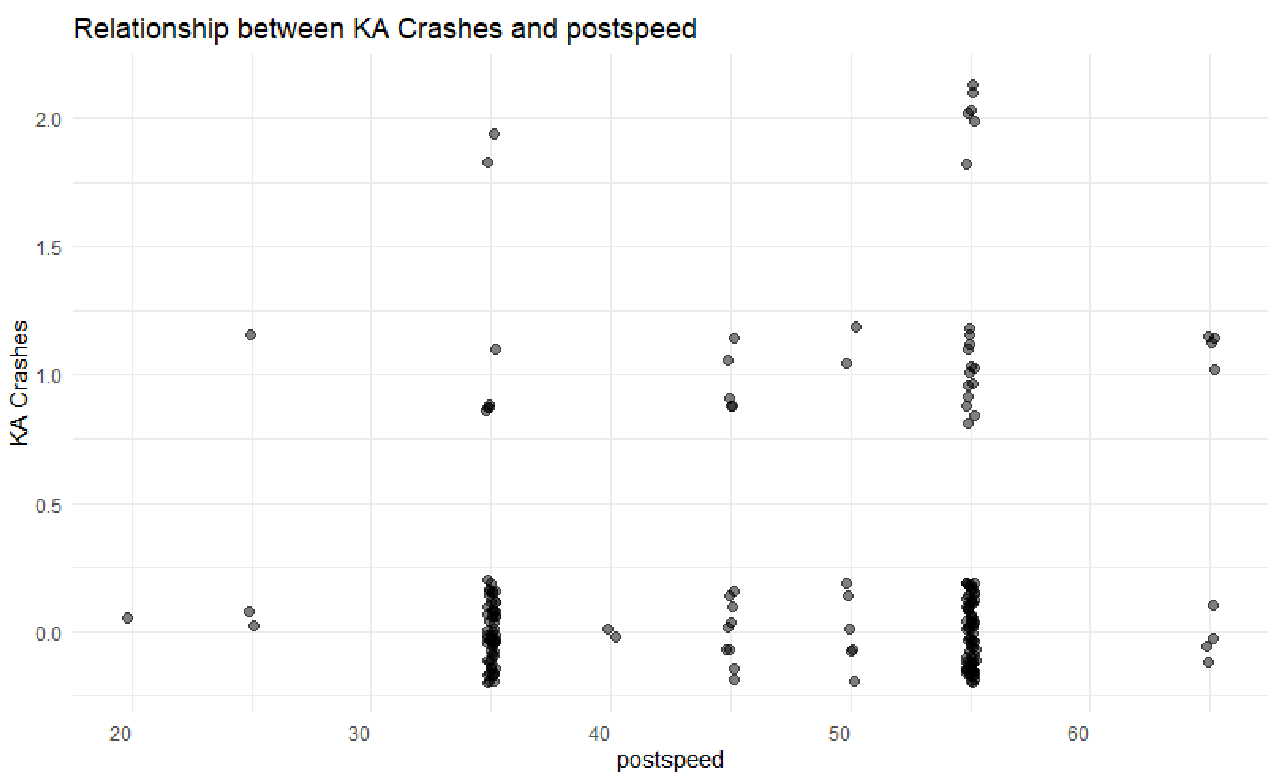
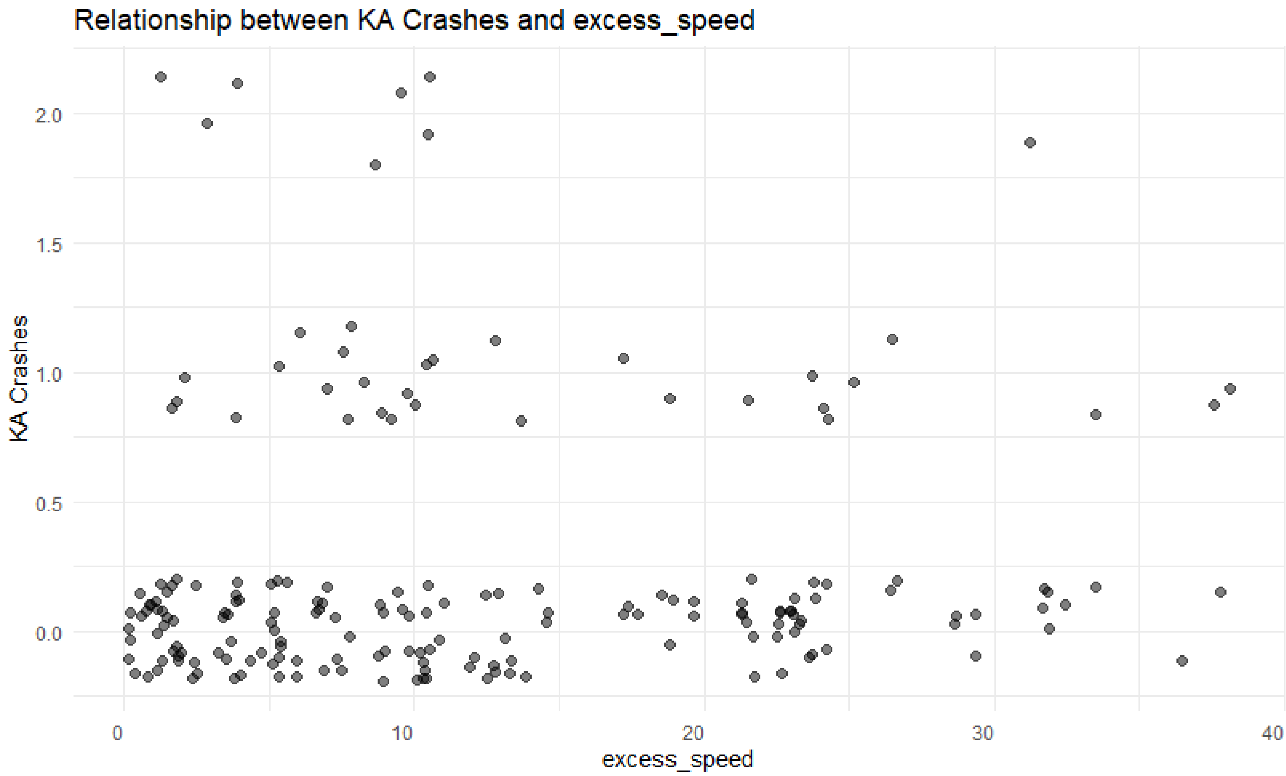
1.5
1.0
0.5
0.0
0.0
0.5
1.0
1.5
2.0
L_SHOULDER_WIDTH

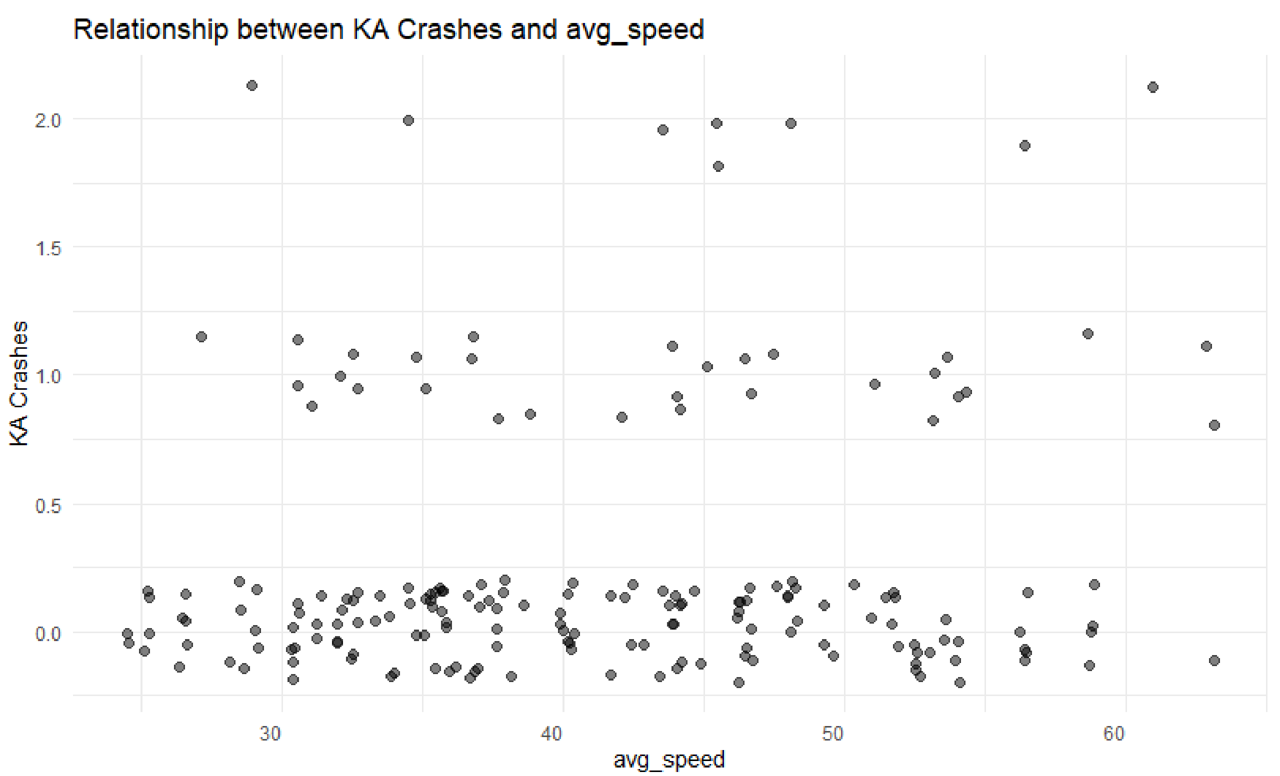

Relationship between KA Crashes and ID_LEFT_UNPAV_SHLDR_WID
KA Crashes
2.0
1.5
1.0
0.5
0.0
0
1
2
3
4
ID_LEFT_UNPAV_SHLDR_WID


Relationship between KA Crashes and ID_MED_WIDTH
KA Crashes
2.0
1.5
1.0
0.5
0.0
0
5
10
15
ID_MED_WIDTH

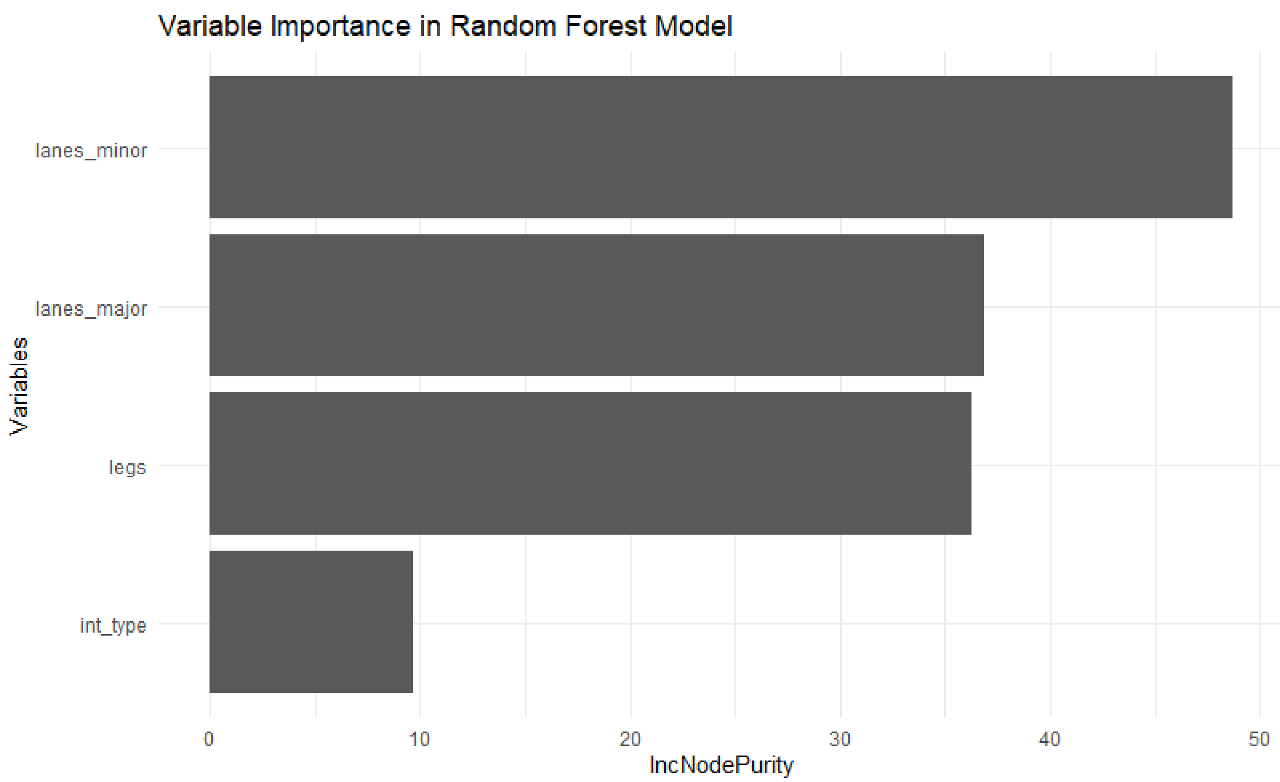

Relationship between KA Crashes and lanes
KA Crashes
2.0
1.5
1.0
0.5
0.0
2
4
6
lanes

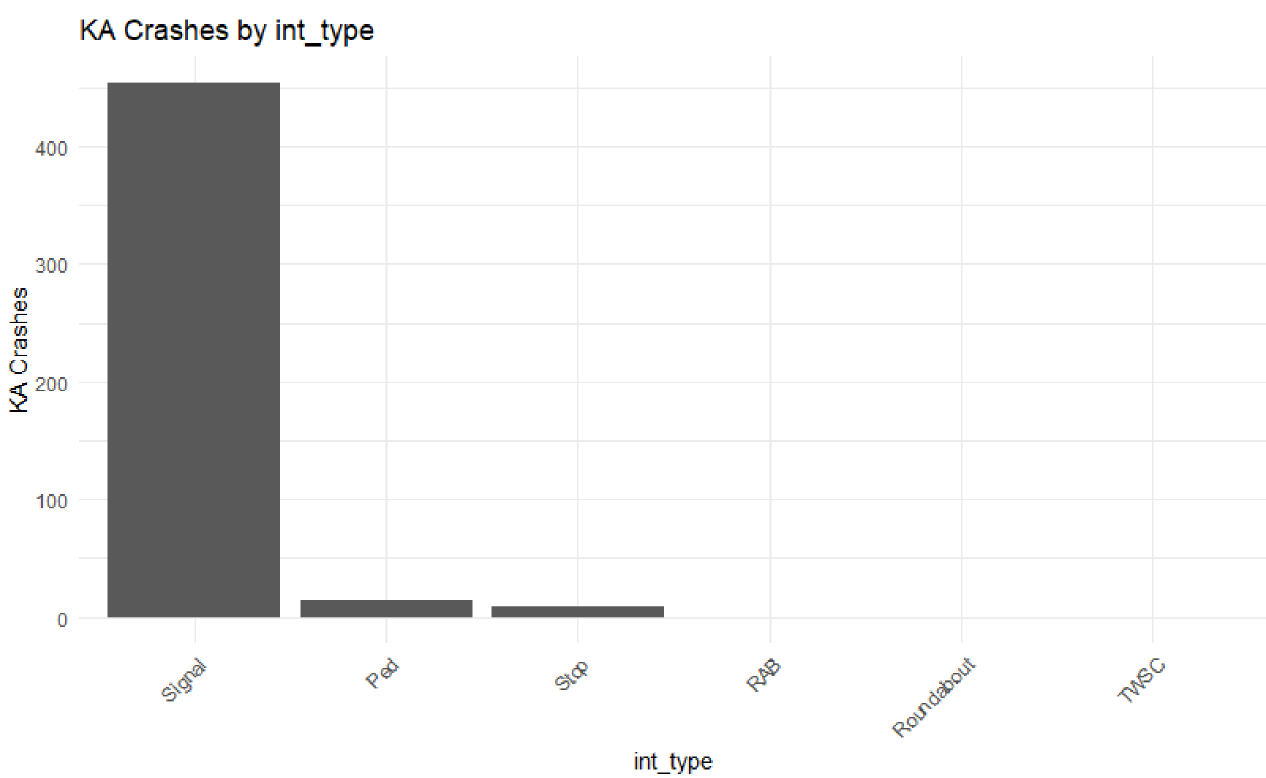

Relationship between KA Crashes and postspeed
KA Crashes
2.0
1.5
1.0
0.5
0.0
20
30
40
50
60
postspeed

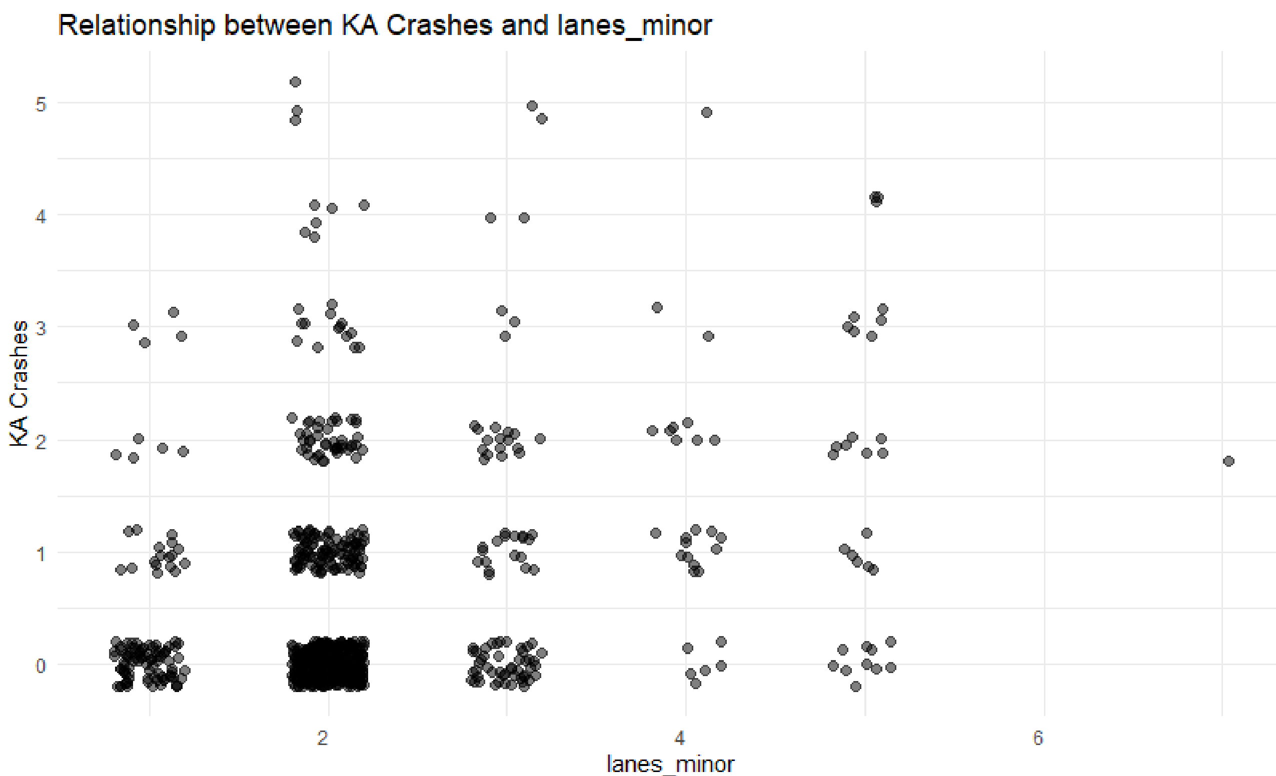

Relationship between KA Crashes and excess_speed
KA Crashes
0.0
0.5
1.0
1.5
2.0
0
10
20
30
40
excess_speed

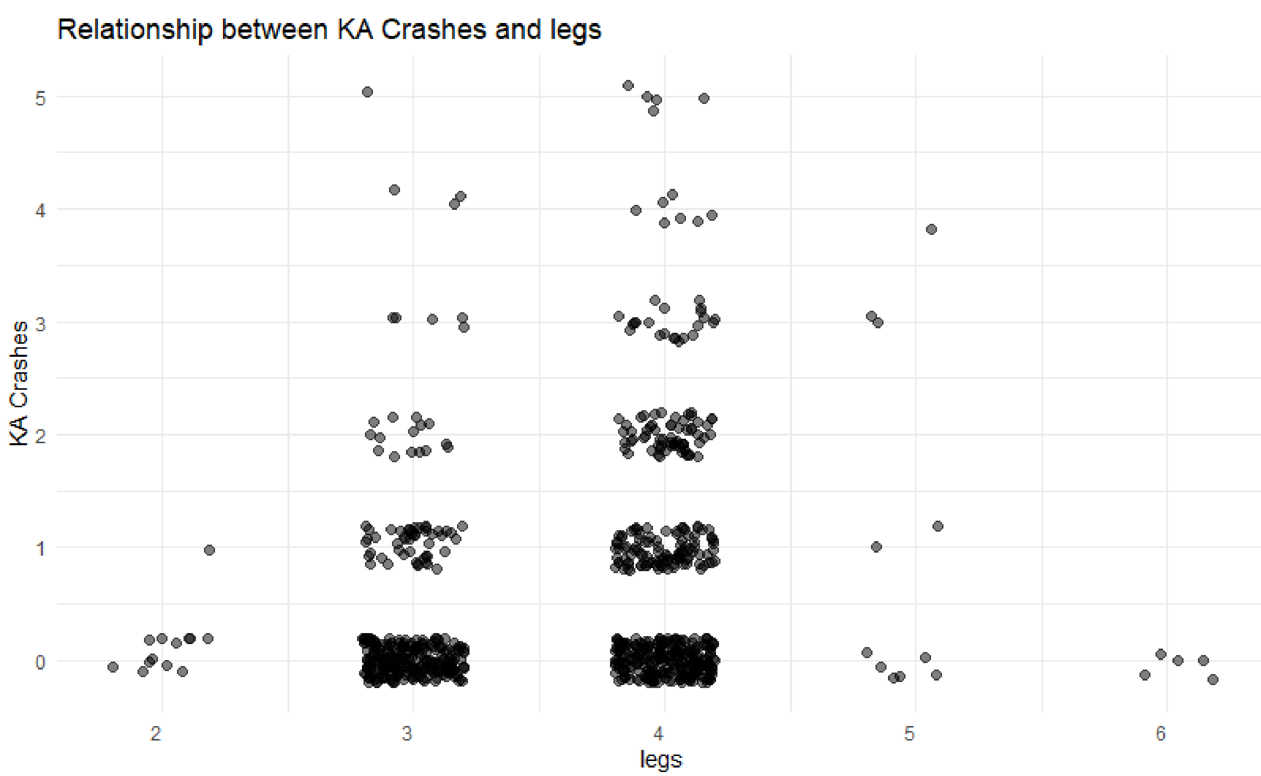

Relationship between KA Crashes and avg_speed
KA Crashes
0.0
0.5
1.0
1.5
2.0
30
40
50
60
avg_speed

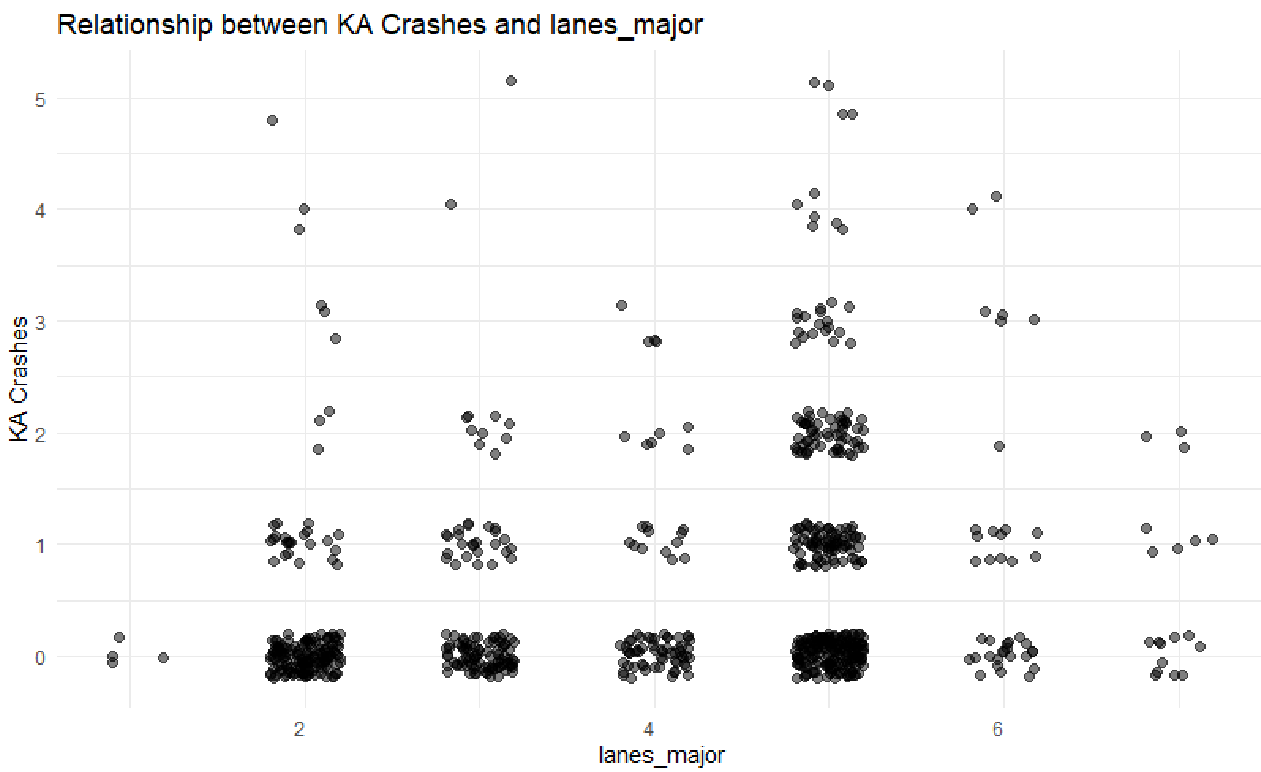
Junctions


Variable Importance in Random Forest Model
lanes_minor
lanes_major
legs
int_type
Variables
0
10
20
30
40
50
IncNodePurity

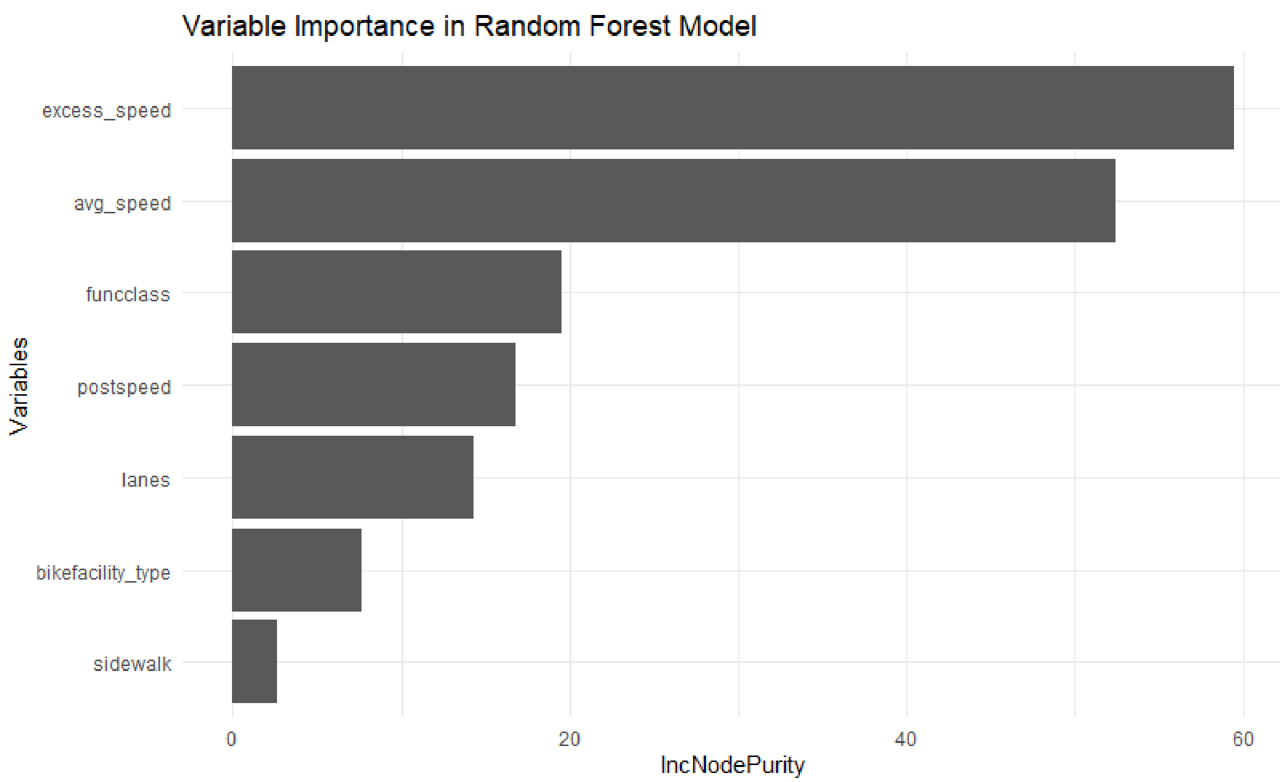

KA Crashes by int_type
400
300
200
100
0
KA Crashes
Signal
Ped
Stop
RAB
Roundabout
TWSC
int_type

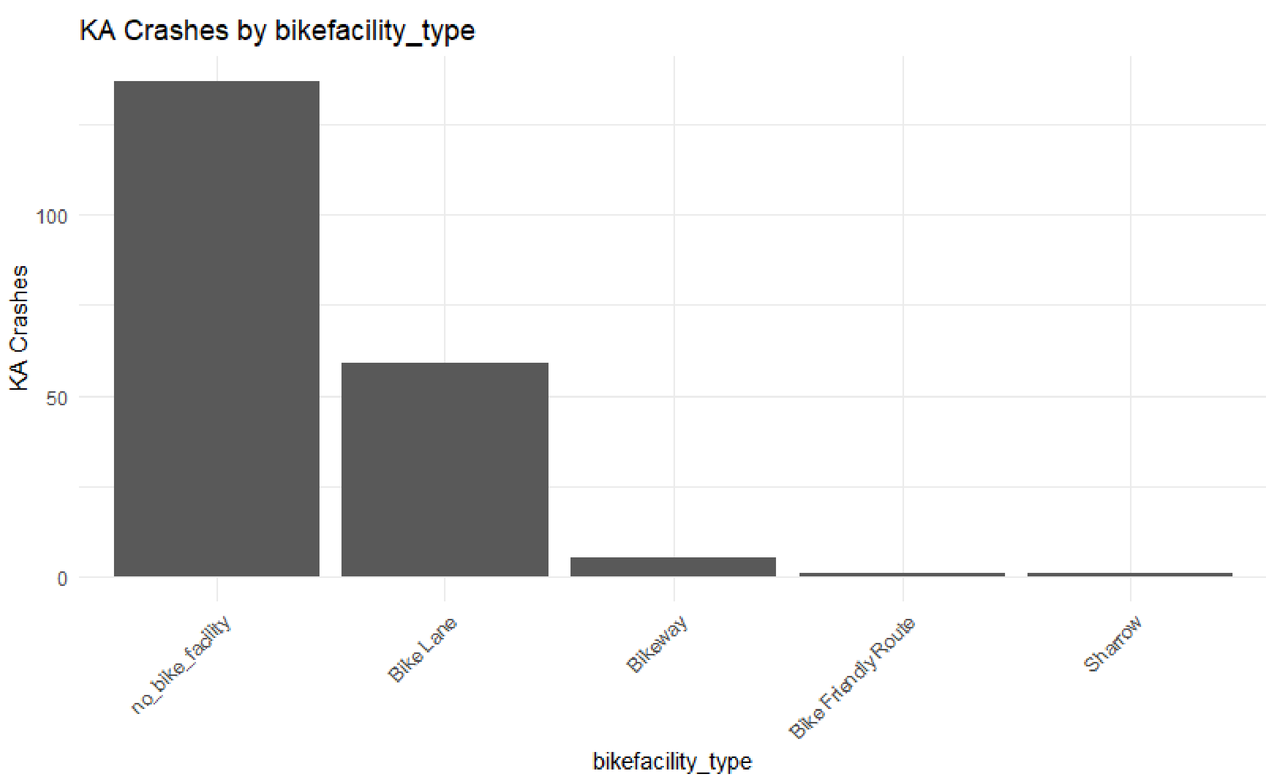

Relationship between KA Crashes and lanes_minor
KA Crashes
5
4
3
2
1
0
2
4
6
lanes_minor

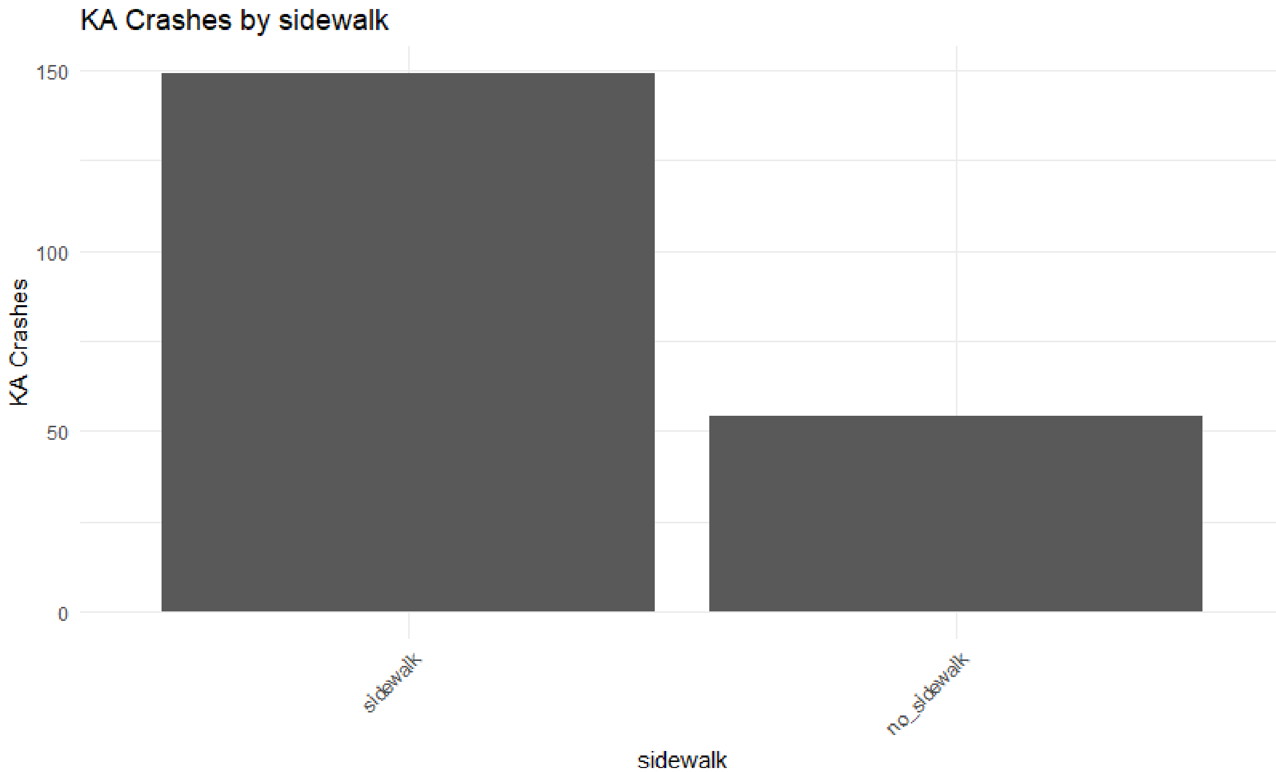

Relationship between KA Crashes and legs
KA Crashes
5
4
3
2
1
0
2
3
4
5
6
legs

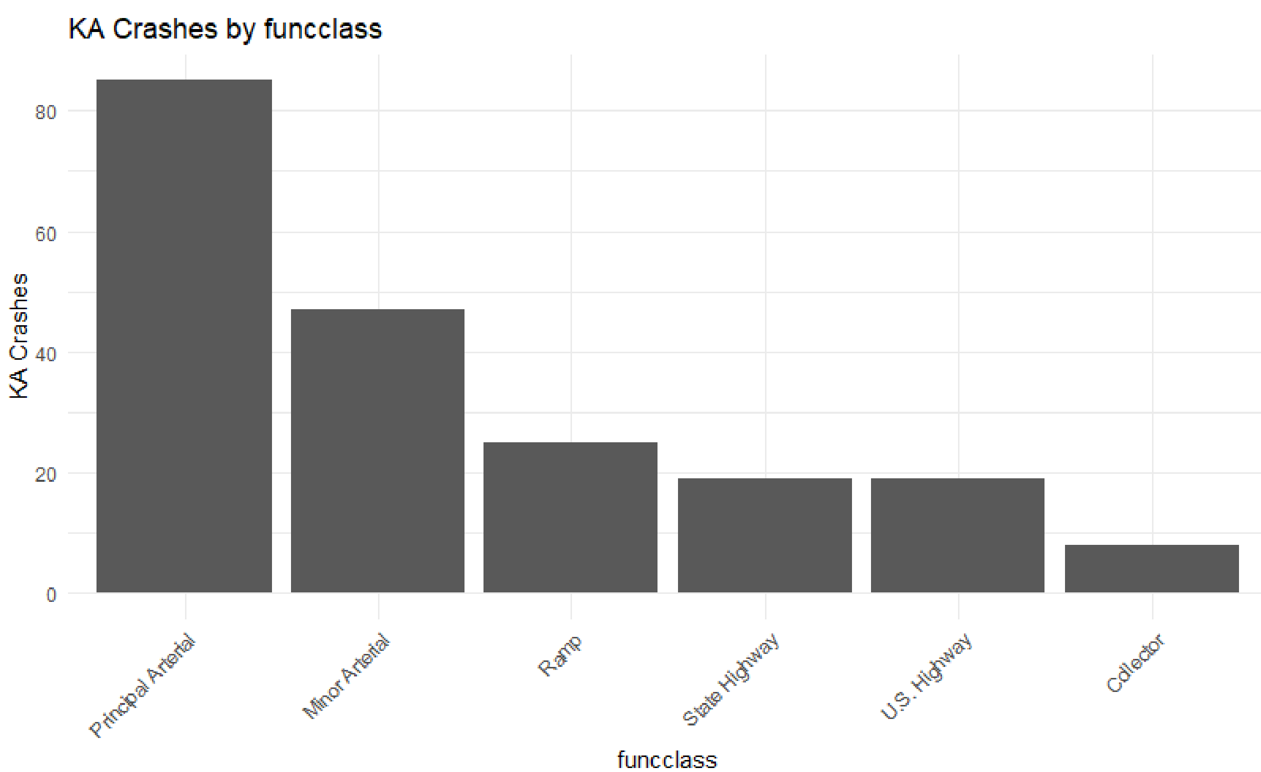

Relationship between KA Crashes and lanes_major
KA Crashes
0
1
2
3
4
5
2
4
6
lanes_major

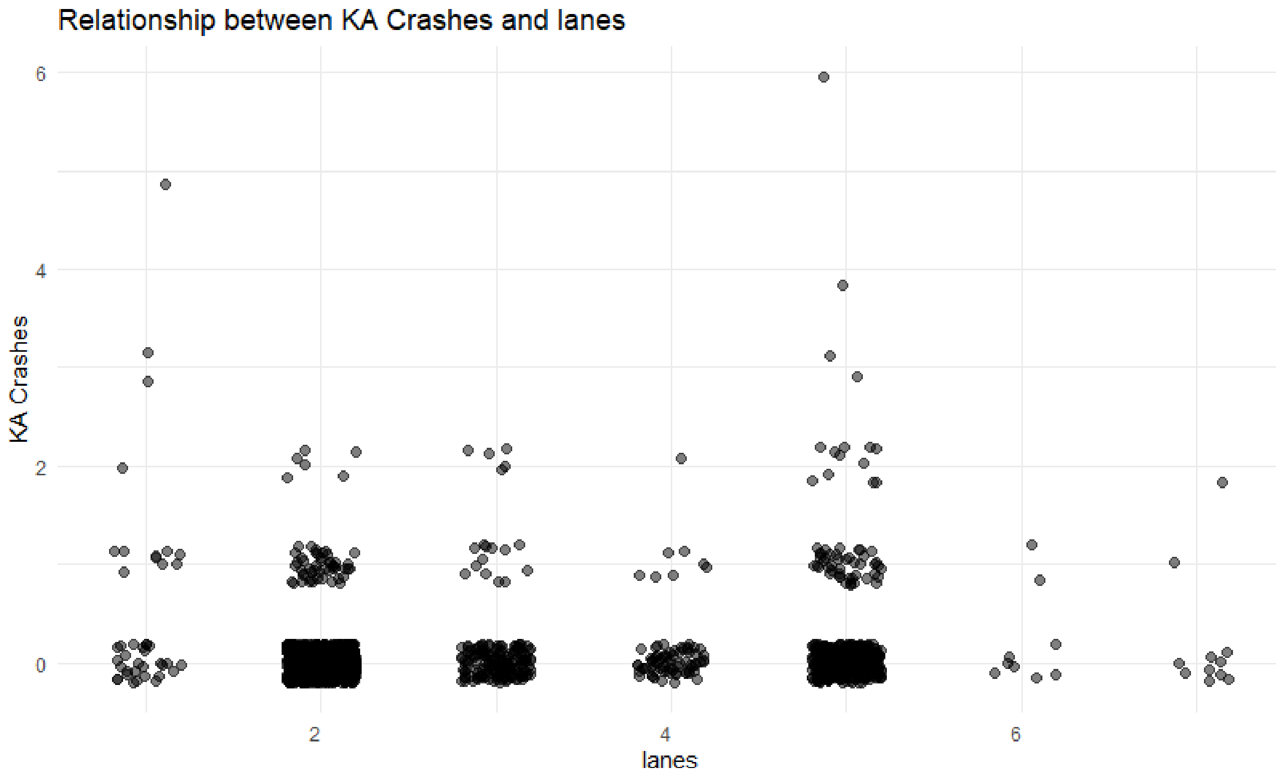
RANDOM FOREST MODEL 2 – COMPASS SEGMENT ATTRIBUTES

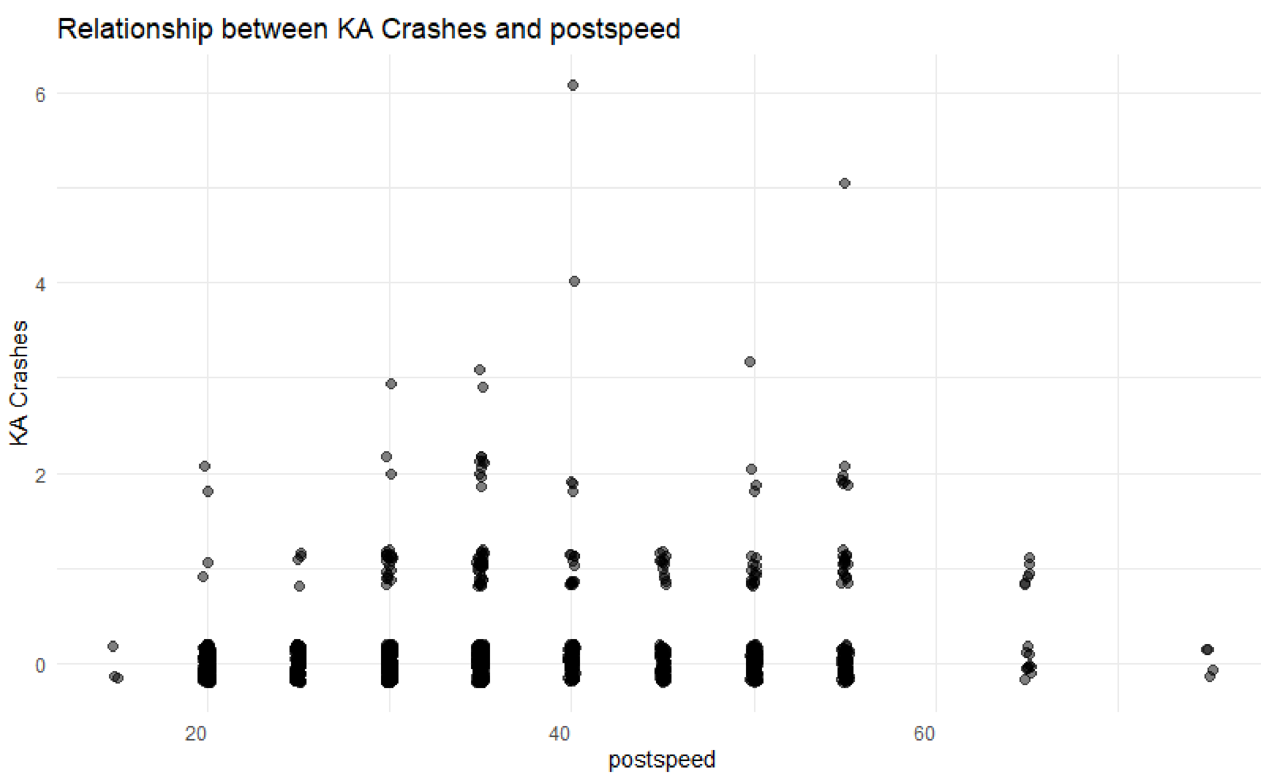


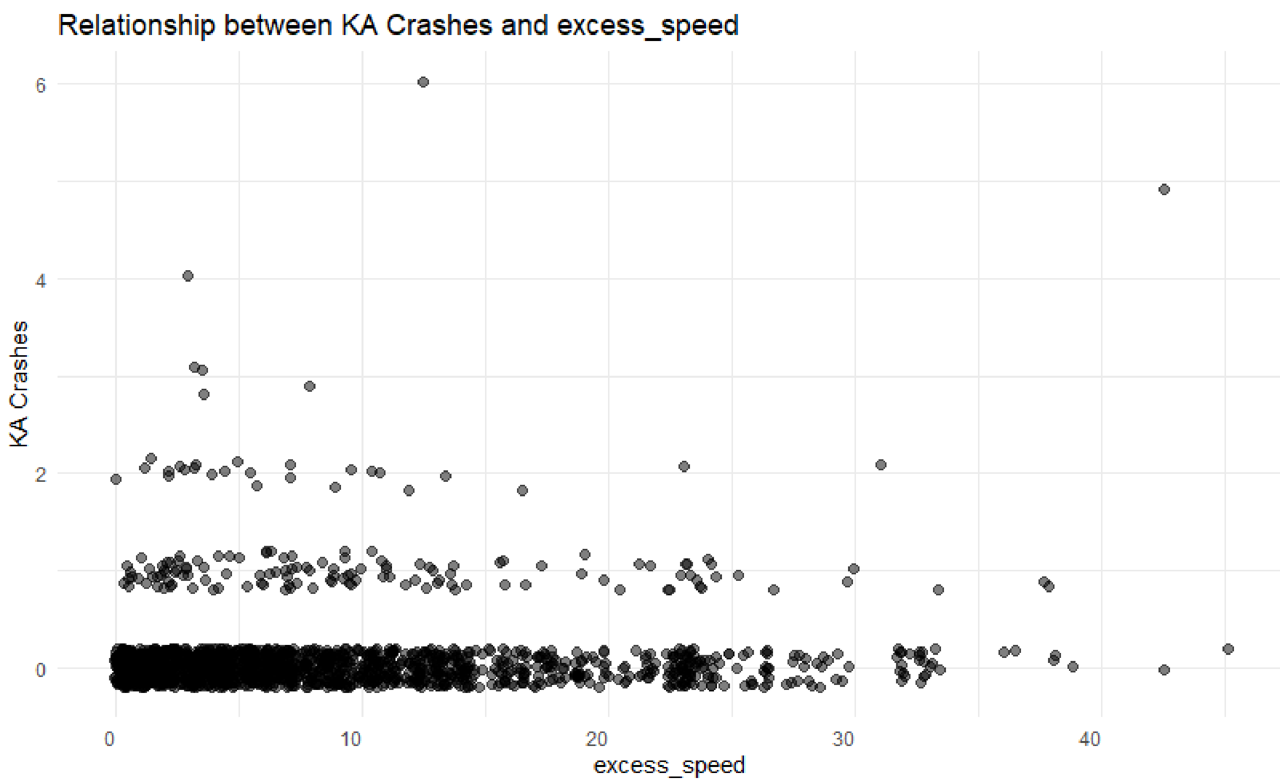


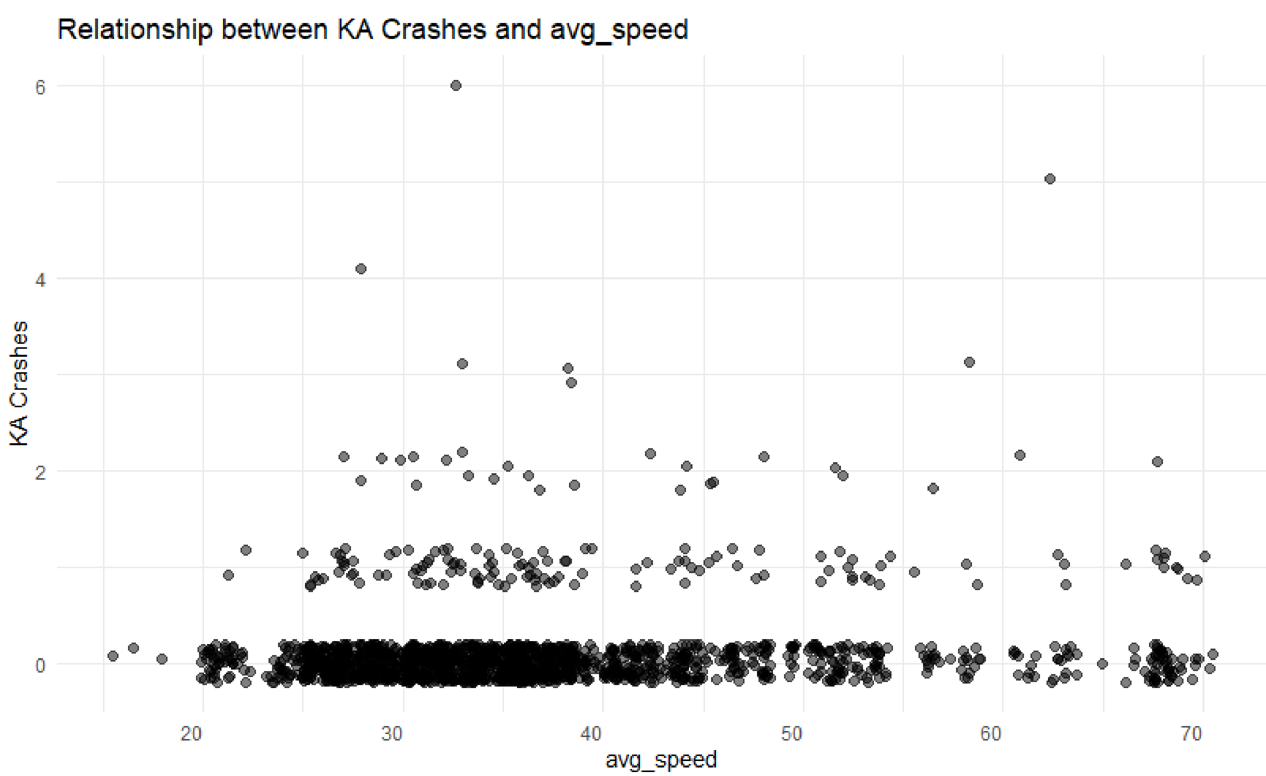

KA Crashes by sidewalk
150
100
50
0
KA Crashes
sidewalk
no_sidewalk
sidewalk


KA Crashes by funcclass
80
60
40
20
0
KA Crashes
Principal Arterial
Minor Arterial
Ramp
State Highway
U.S. Highway
Collector
funcclass

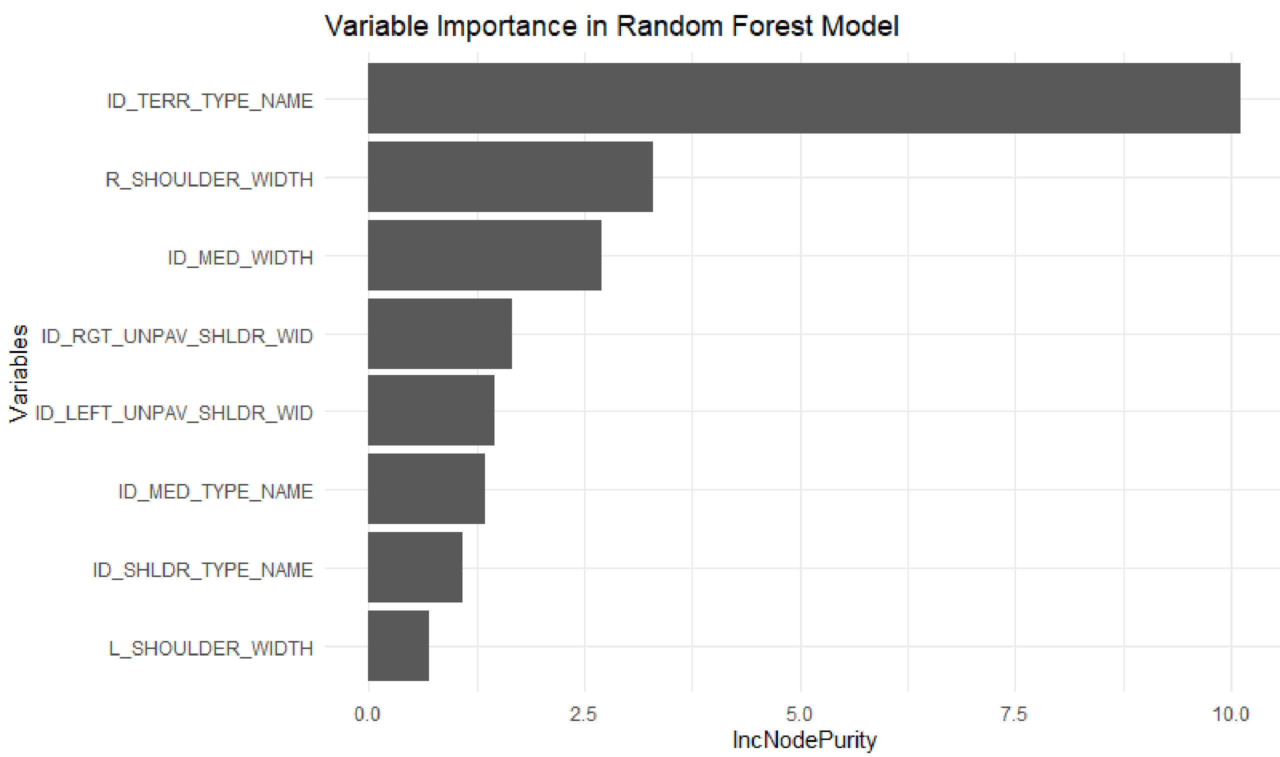

Relationship between KA Crashes and lanes
KA Crashes
6
4
2
0
2
4
6
lanes

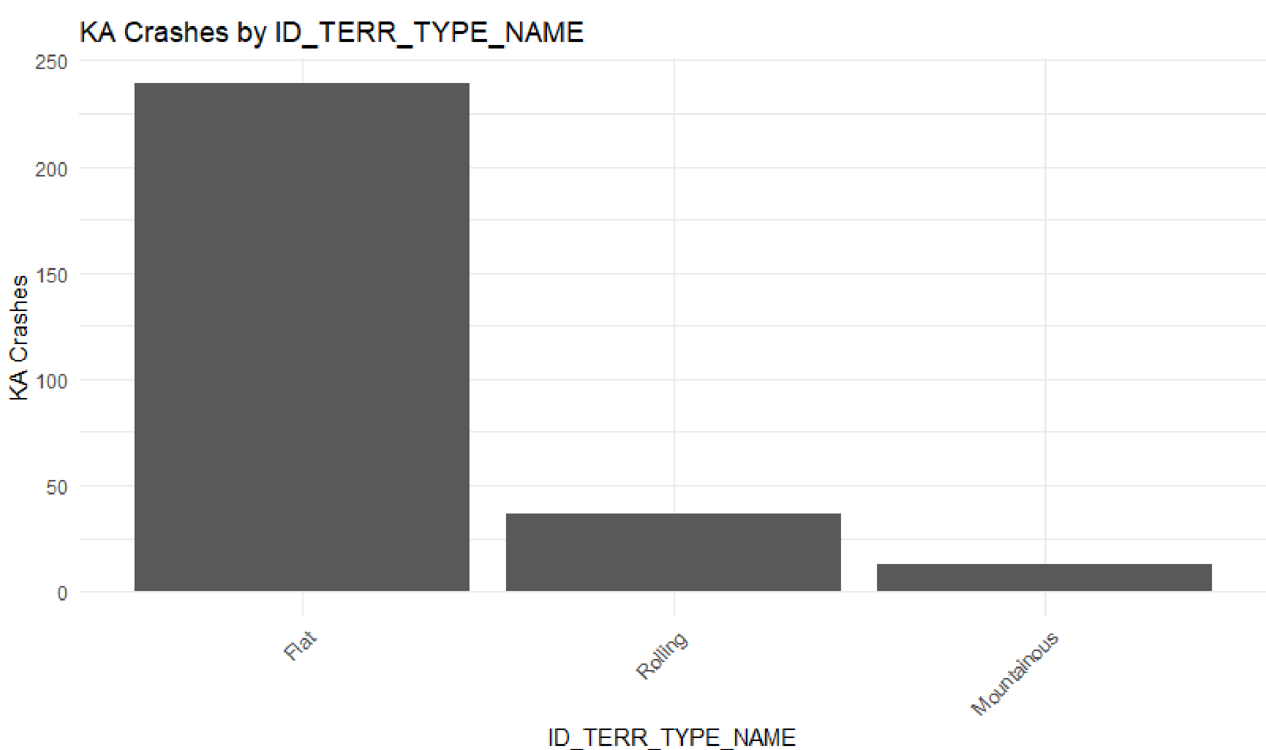

Relationship between KA Crashes and postspeed
KA Crashes
6
4
2
0
20
40
60
postspeed

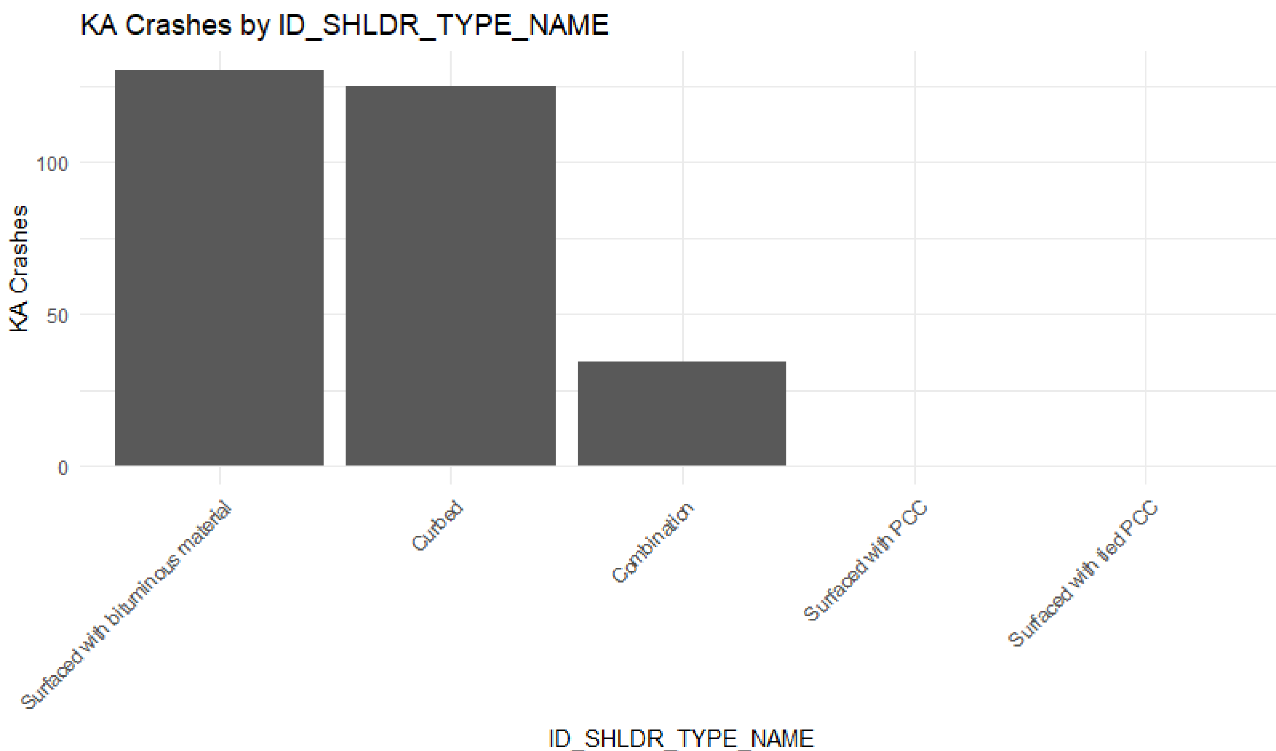

Relationship between KA Crashes and excess_speed
KA Crashes
6
4
2
0
0
10
20
30
40
excess_speed

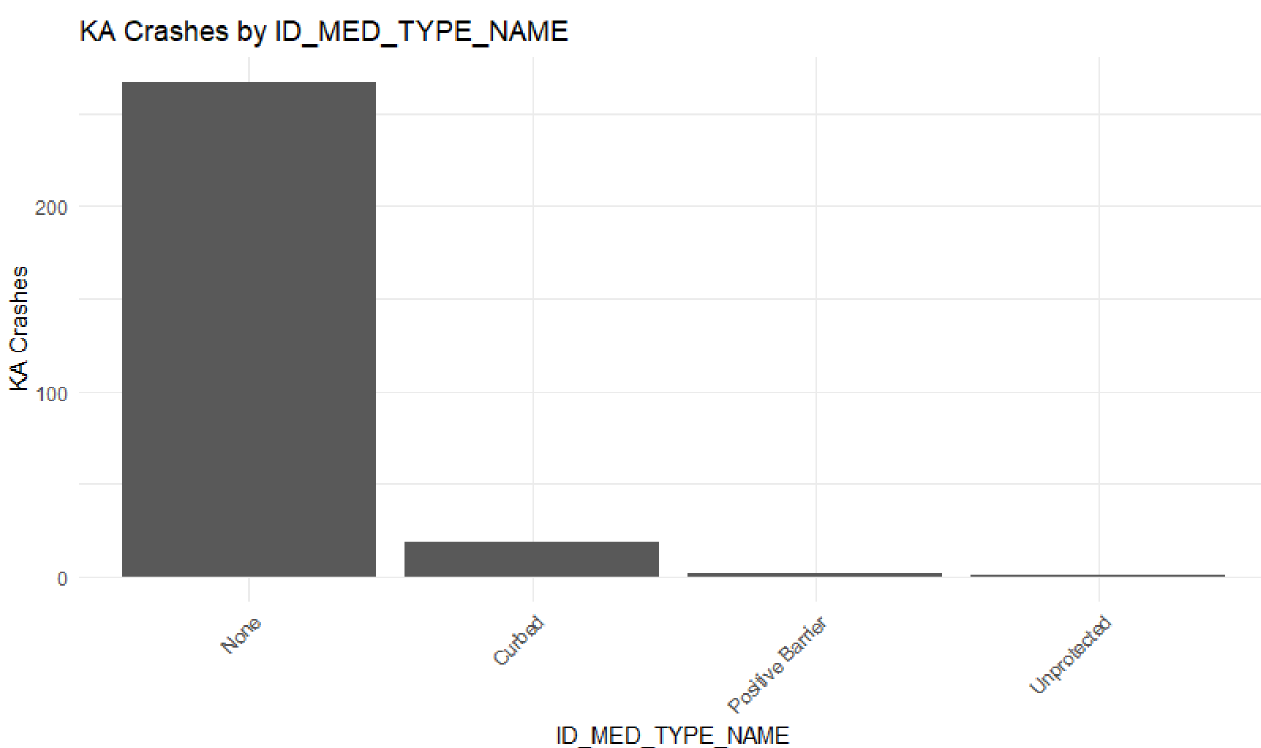

Relationship between KA Crashes and avg_speed
KA Crashes
6
4
2
0
20
30
40
50
60
70
avg_speed

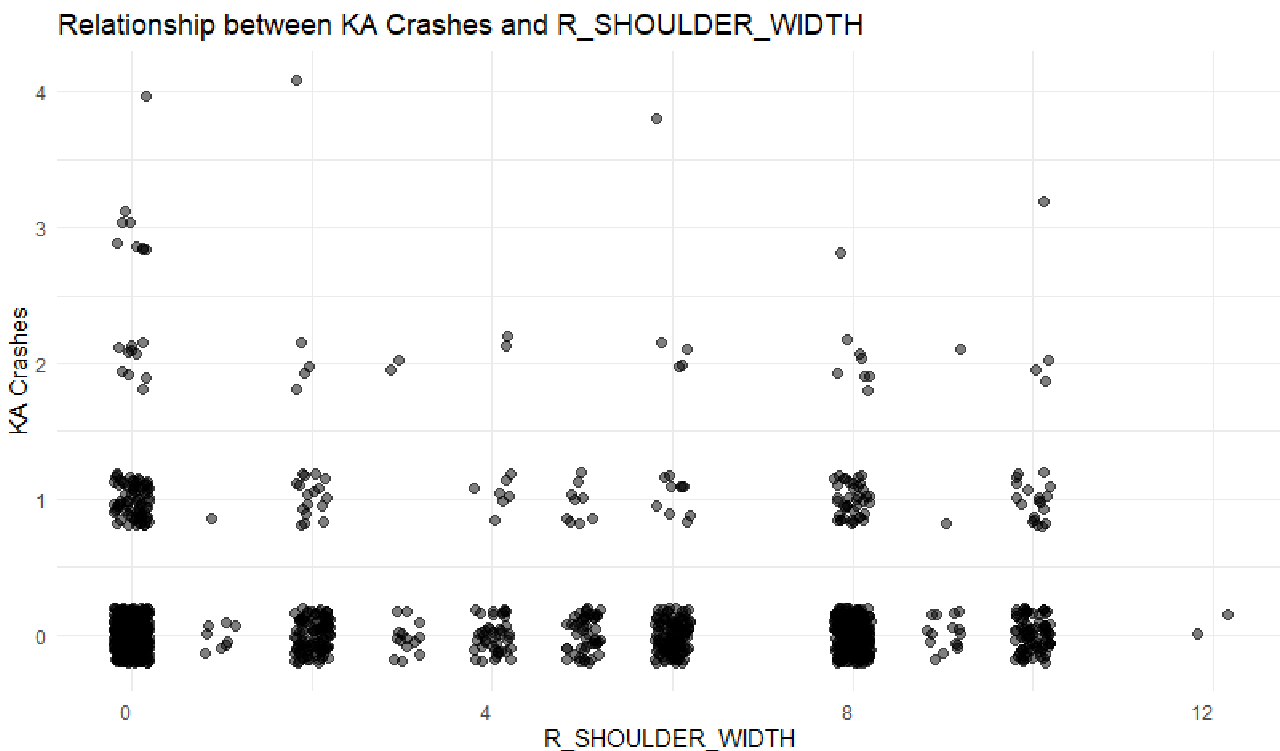
RANDOM FOREST MODEL 2 – ITD SEGMENT ATTRIBUTES

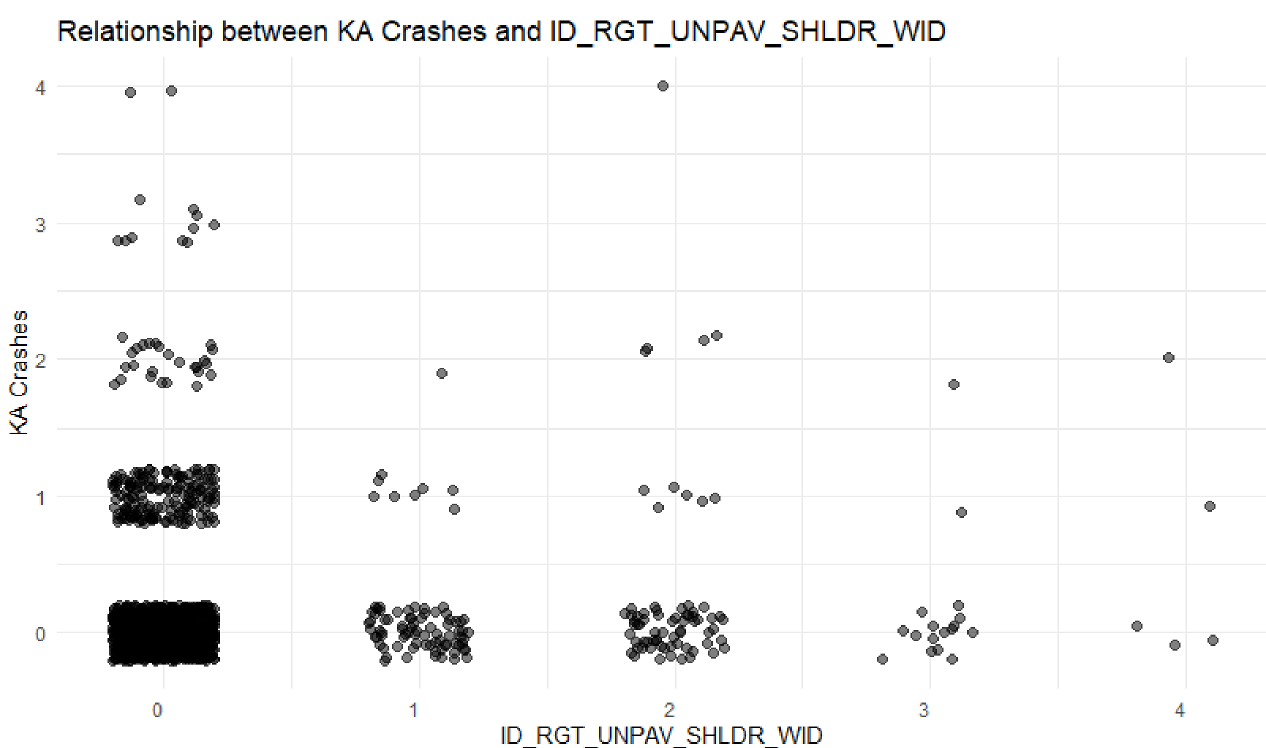




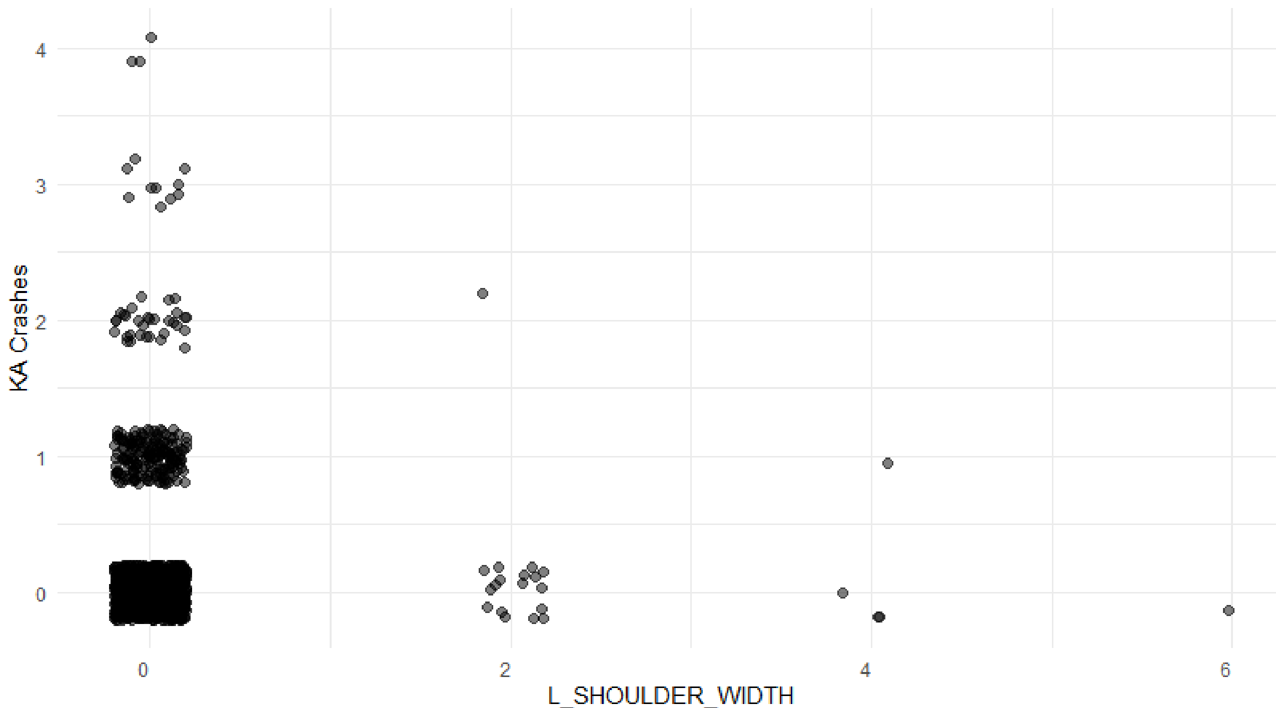

KA Crashes by ID_SHLDR_TYPE_NAME
KA Crashes
100
50
0
Surfaced with bituminous material
Curbed
Combination
Surfaced with PCC
Surfaced with tied PCC
ID_SHLDR_TYPE_NAME


KA Crashes by ID_MED_TYPE_NAME
KA Crashes
200
100
0
None
Curbed
Positive Barrier
Unprotected
ID_MED_TYPE_NAME

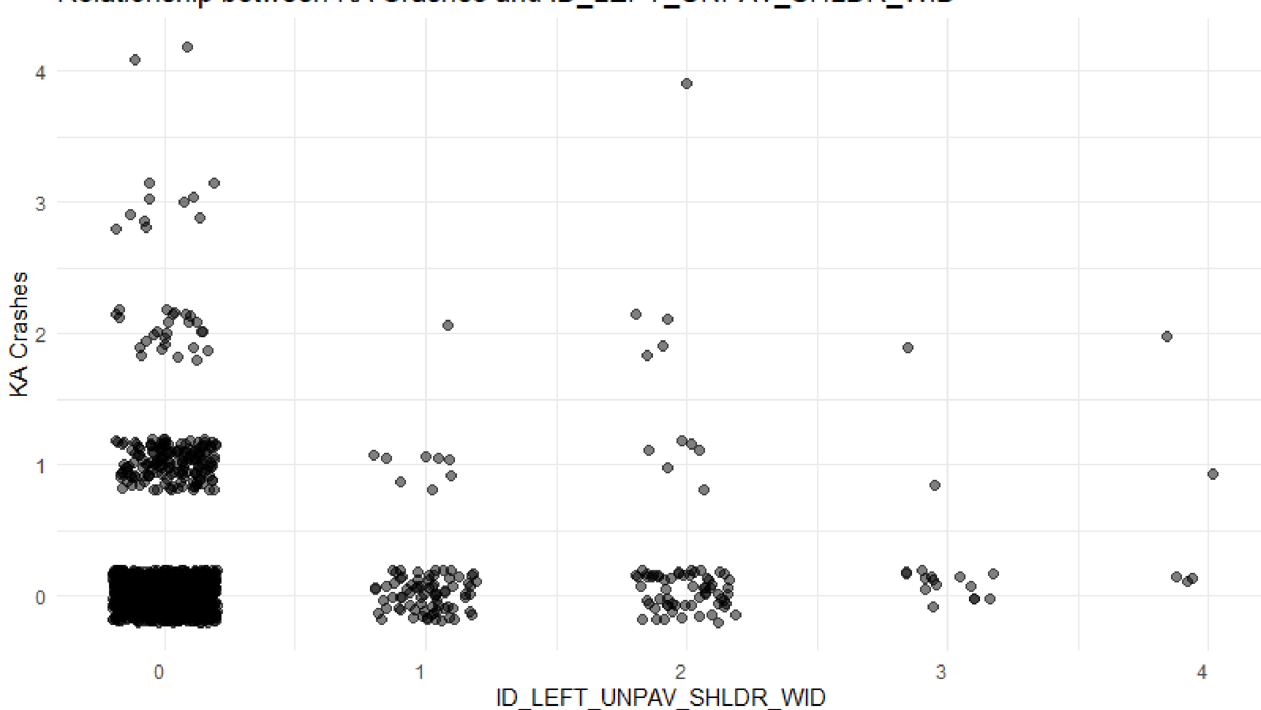

Relationship between KA Crashes and R_SHOULDER_WIDTH
KA Crashes
0
1
2
3
4
0
4
8
12
R_SHOULDER_WIDTH

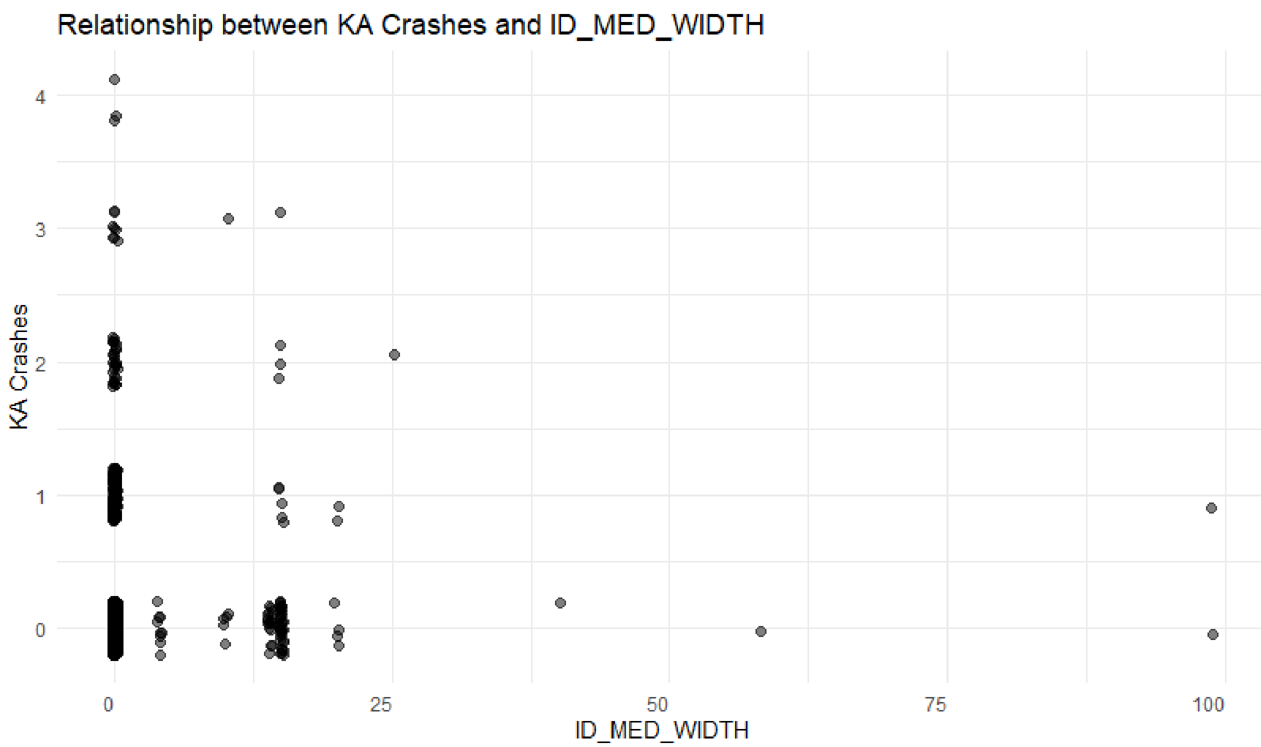

Relationship between KA Crashes and ID_RGT_UNPAV_SHLDR_WID
KA Crashes
0
1
2
3
4
0
1
2
3
4
ID_RGT_UNPAV_SHLDR_WID

Relationship between KA Crashes and L_SHOULDER_WIDTH

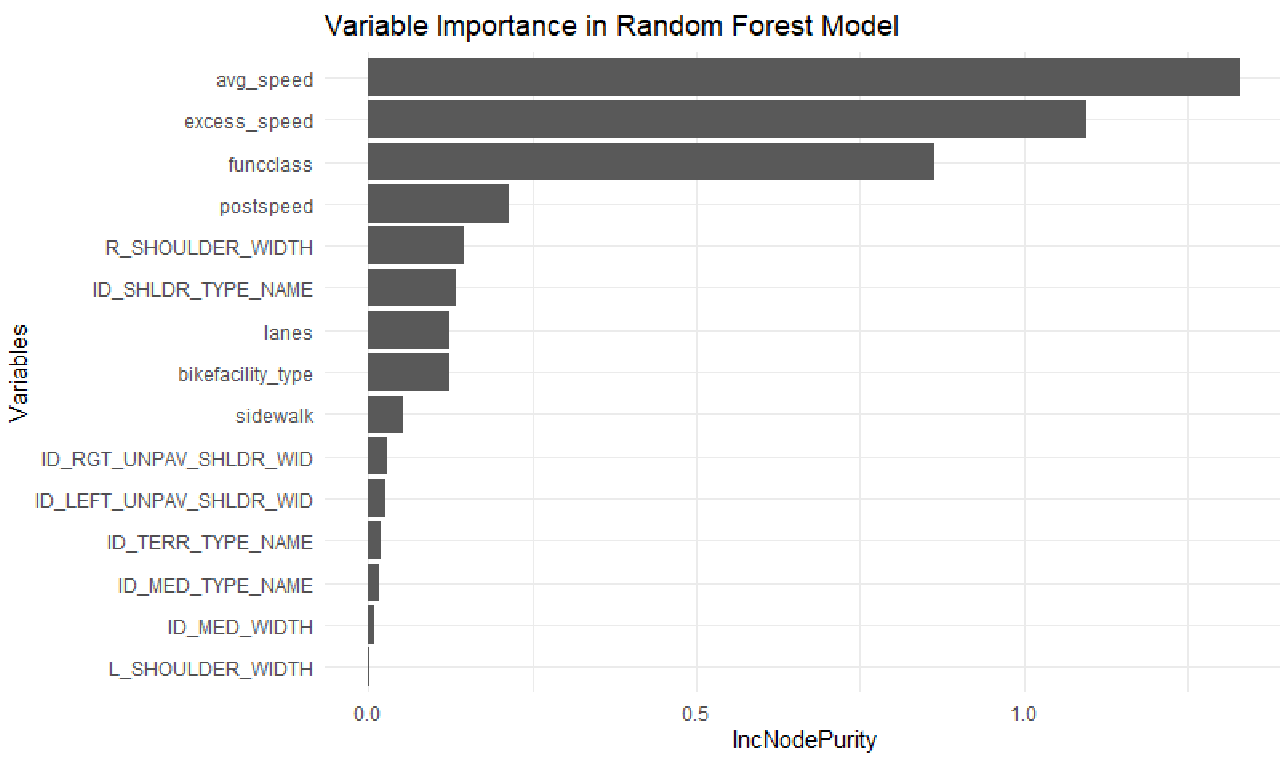


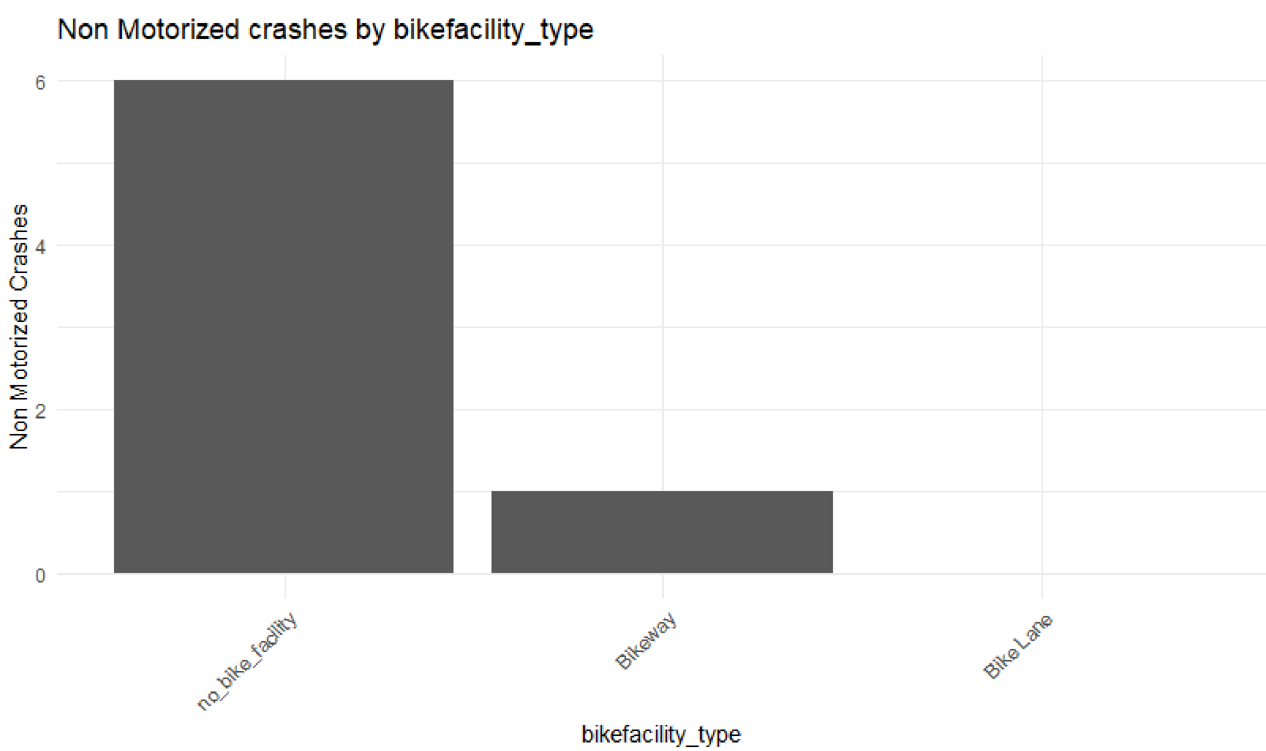
Relationship between KA Crashes and ID_LEFT_UNPAV_SHLDR_WID

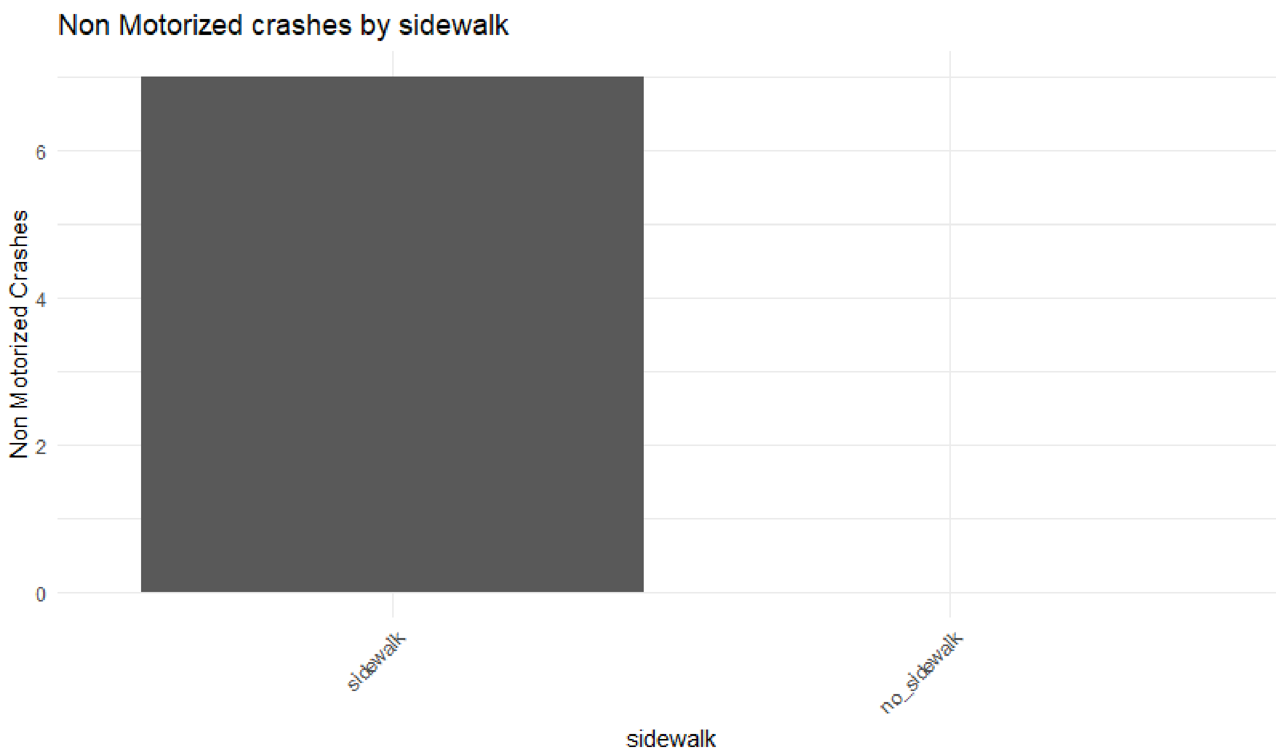


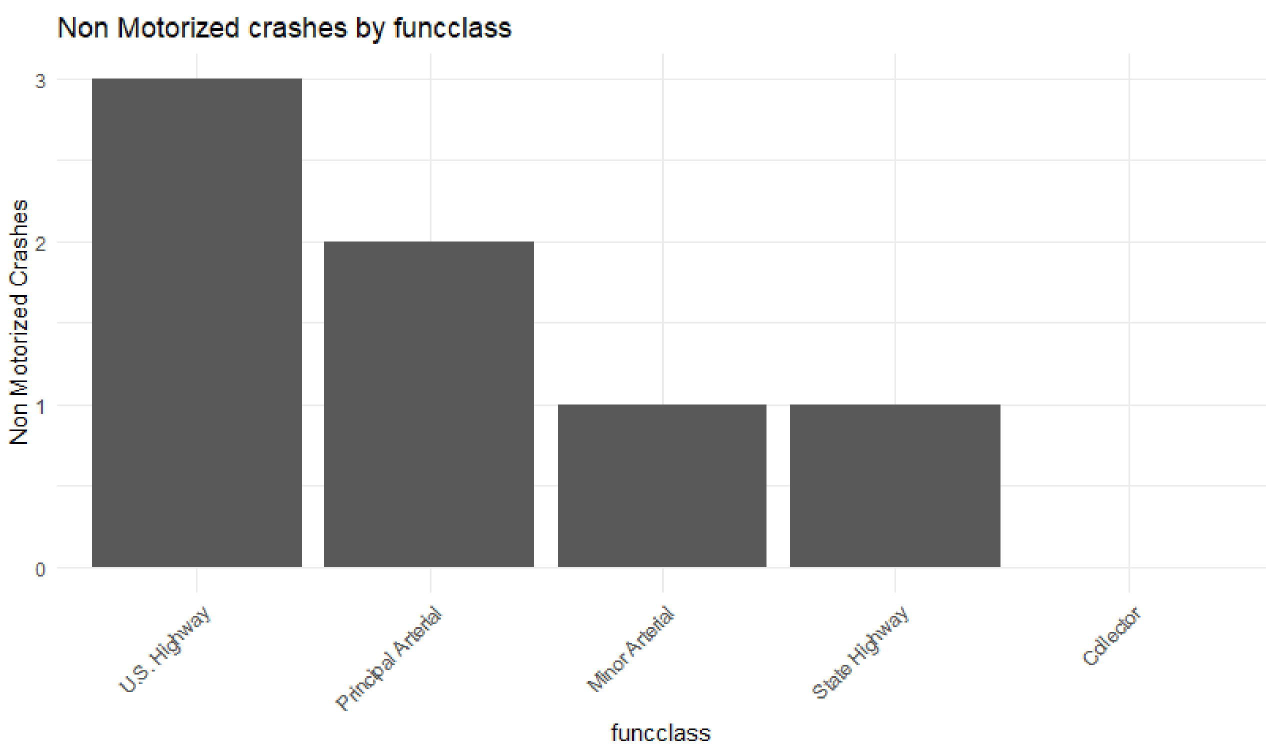

Relationship between KA Crashes and ID_MED_WIDTH
KA Crashes
ID_MED_WIDTH
0
1
2
3
4
0
25
50
75
100

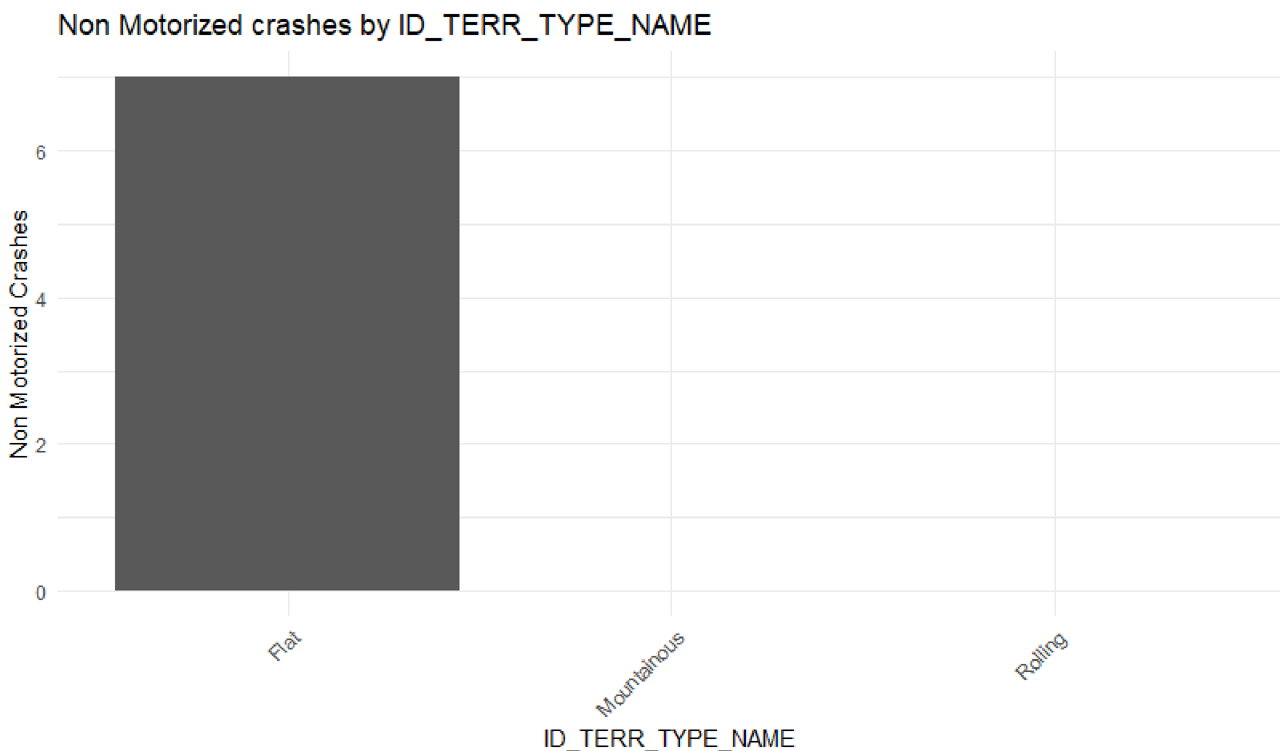
RANDOM FOREST MODEL 4 – NON-MOTORIZED ALL CRASHES

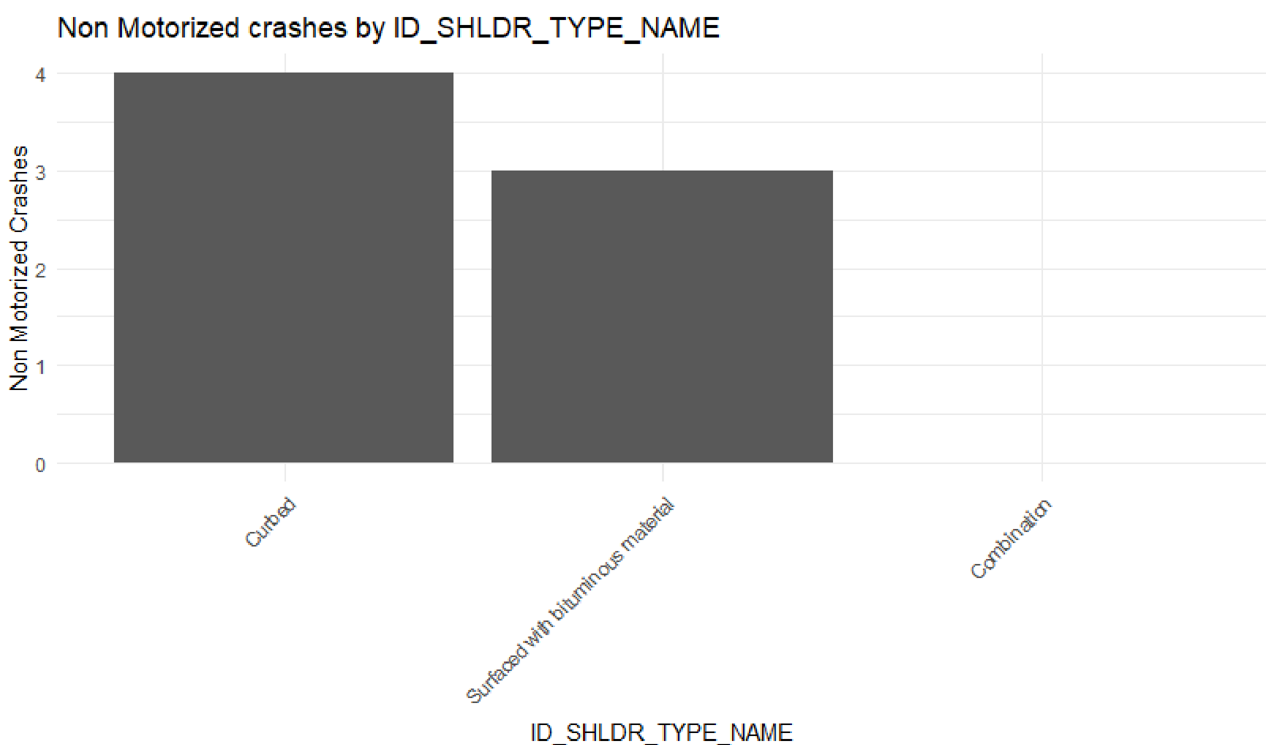


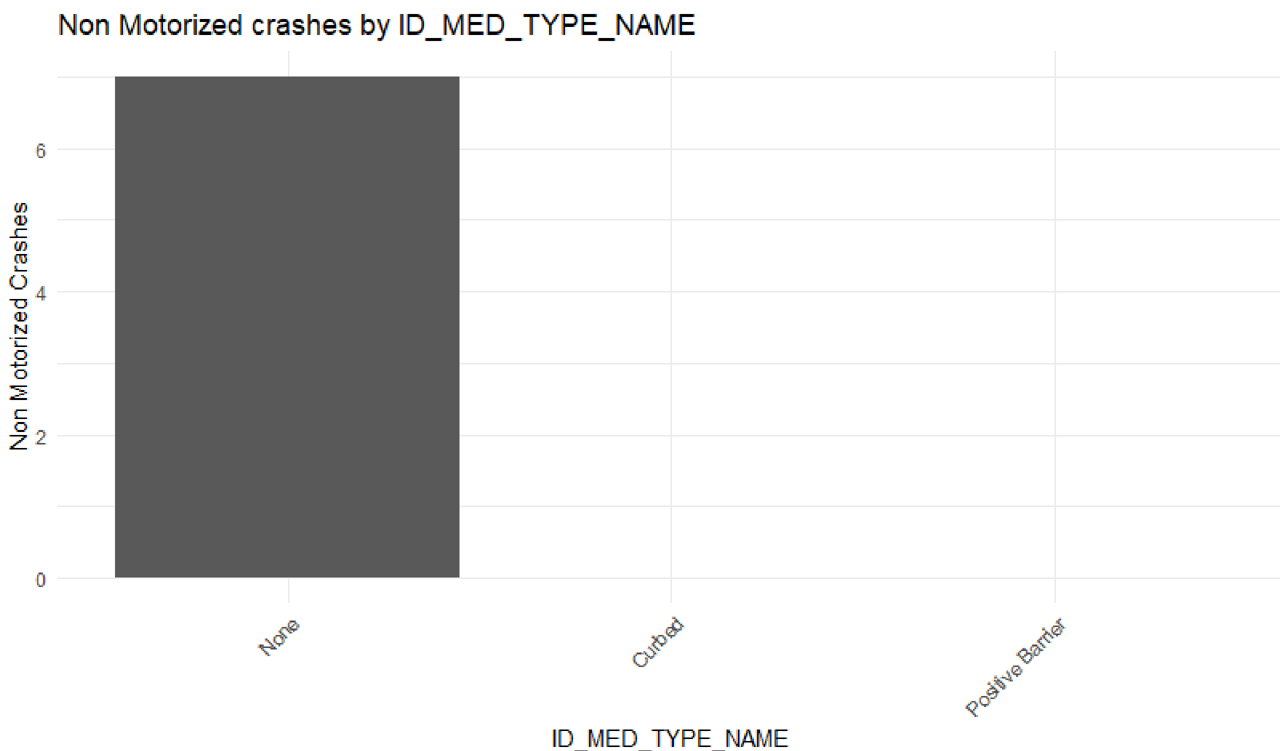


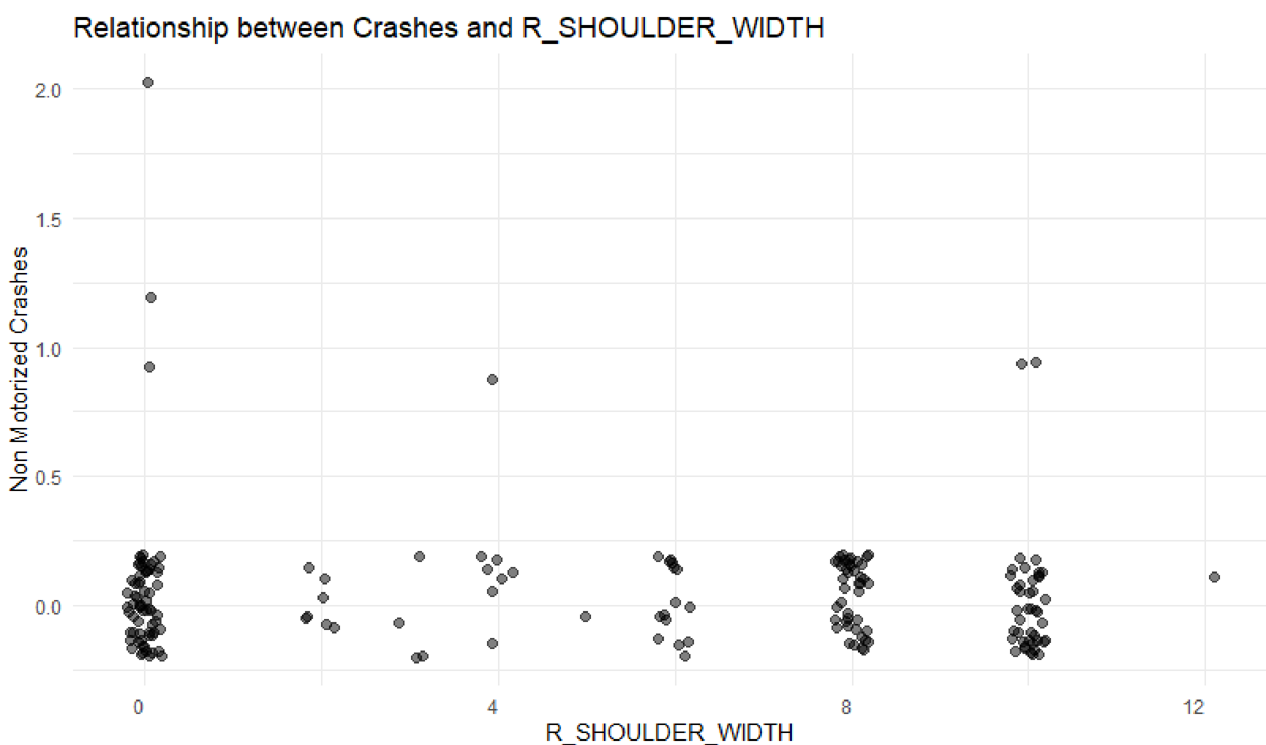

Non Motorized crashes by sidewalk
Non Motorized Crashes
0
2
4
6
sidewalk
no_sidewalk
sidewalk


Non Motorized crashes by funcclass
Non Motorized Crashes
0
1
2
3
U.S. Highway
Principal Arterial
Minor Arterial
State Highway
Collector
funcclass

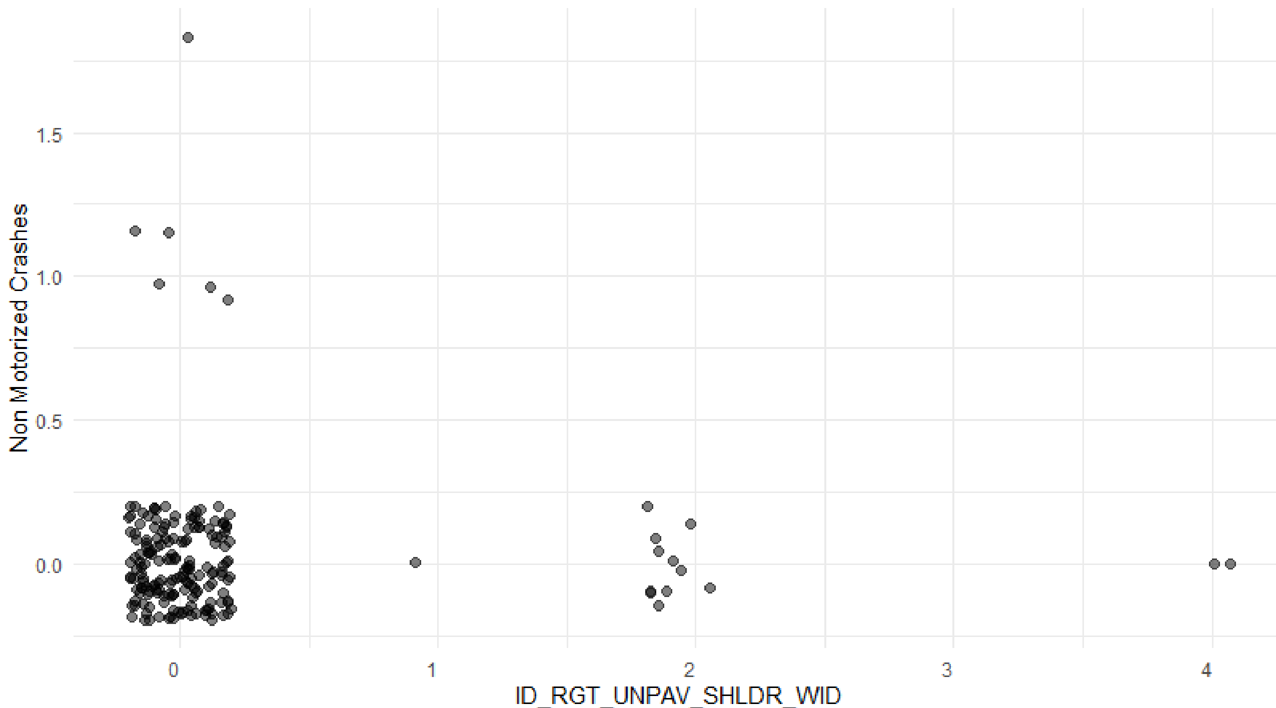

Non Motorized crashes by ID_TERR_TYPE_NAME
Non Motorized Crashes
0
2
4
6
Flat
Mountainous
Rolling
ID_TERR_TYPE_NAME


Non Motorized crashes by ID_SHLDR_TYPE_NAME
Non Motorized Crashes
0
1
2
3
4
Curbed
Surfaced with bituminous material
Combination
ID_SHLDR_TYPE_NAME

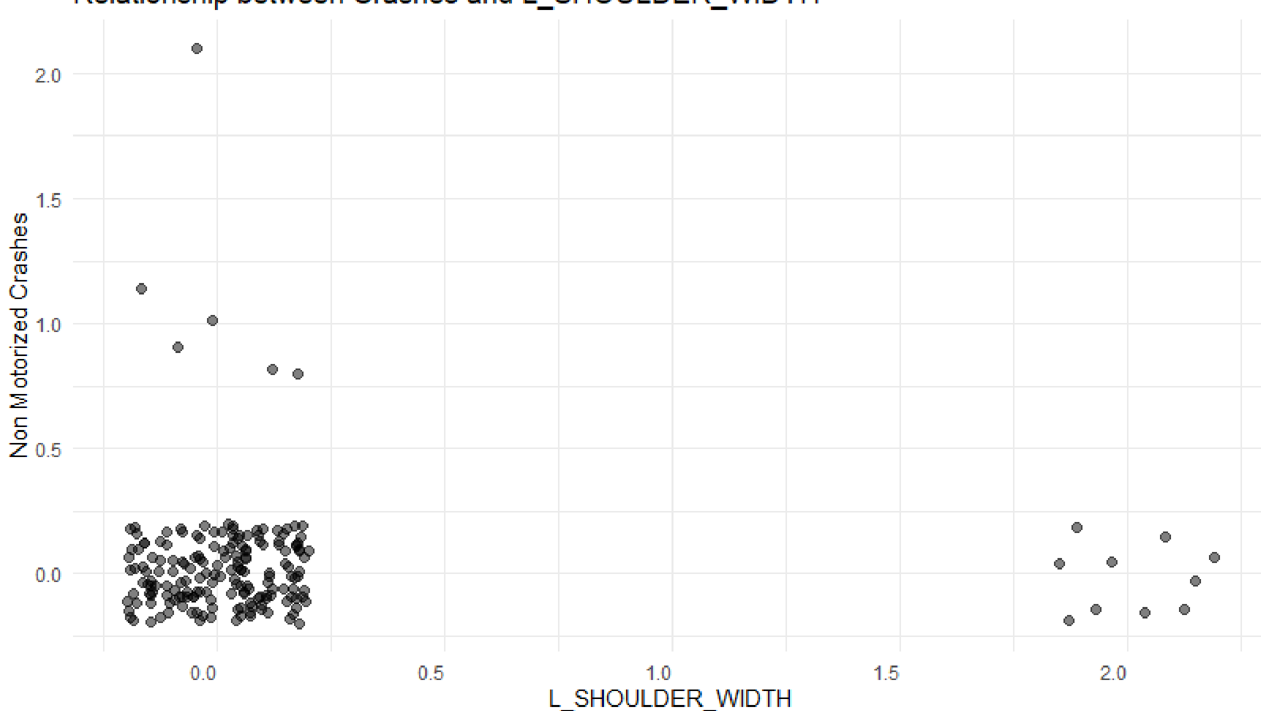

Non Motorized crashes by ID_MED_TYPE_NAME
Non Motorized Crashes
0
2
4
6
None
Curbed
Positive Barrier
ID_MED_TYPE_NAME

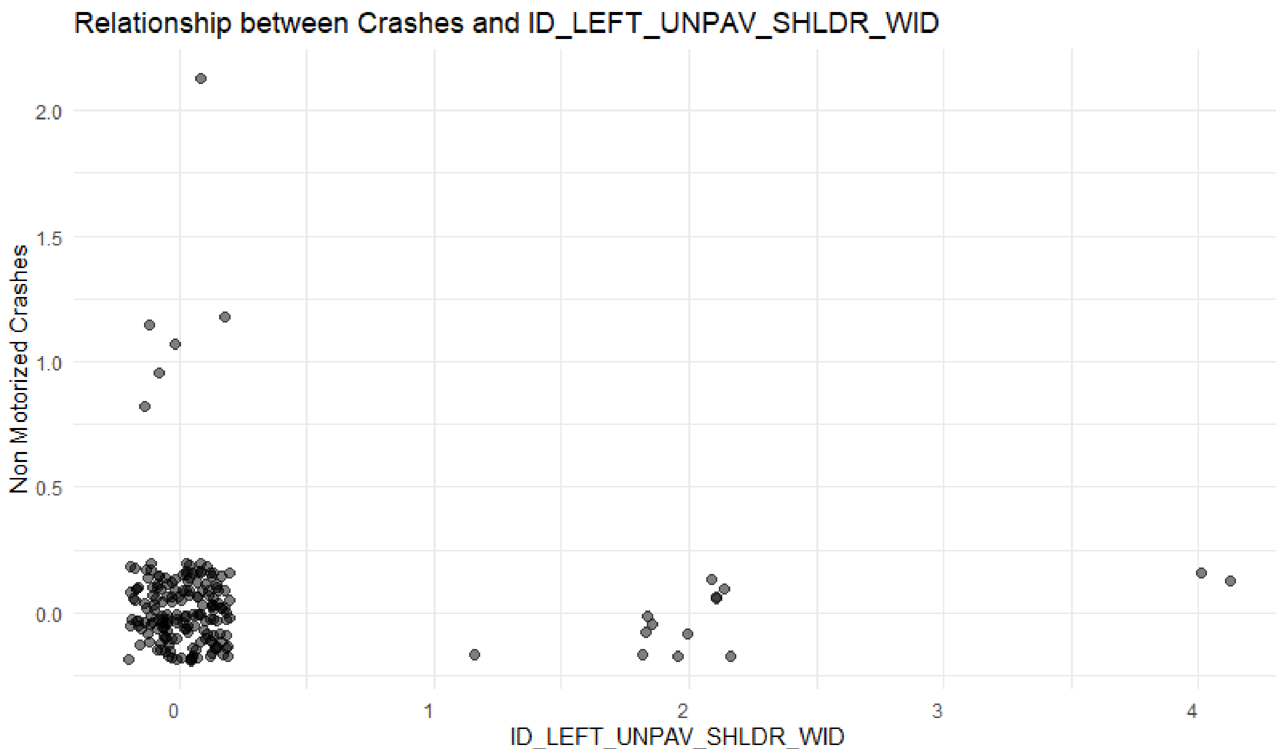

Relationship between Crashes and R_SHOULDER_WIDTH
Non Motorized Crashes
0.0
0.5
1.0
1.5
2.0
0
4
8
12
R_SHOULDER_WIDTH

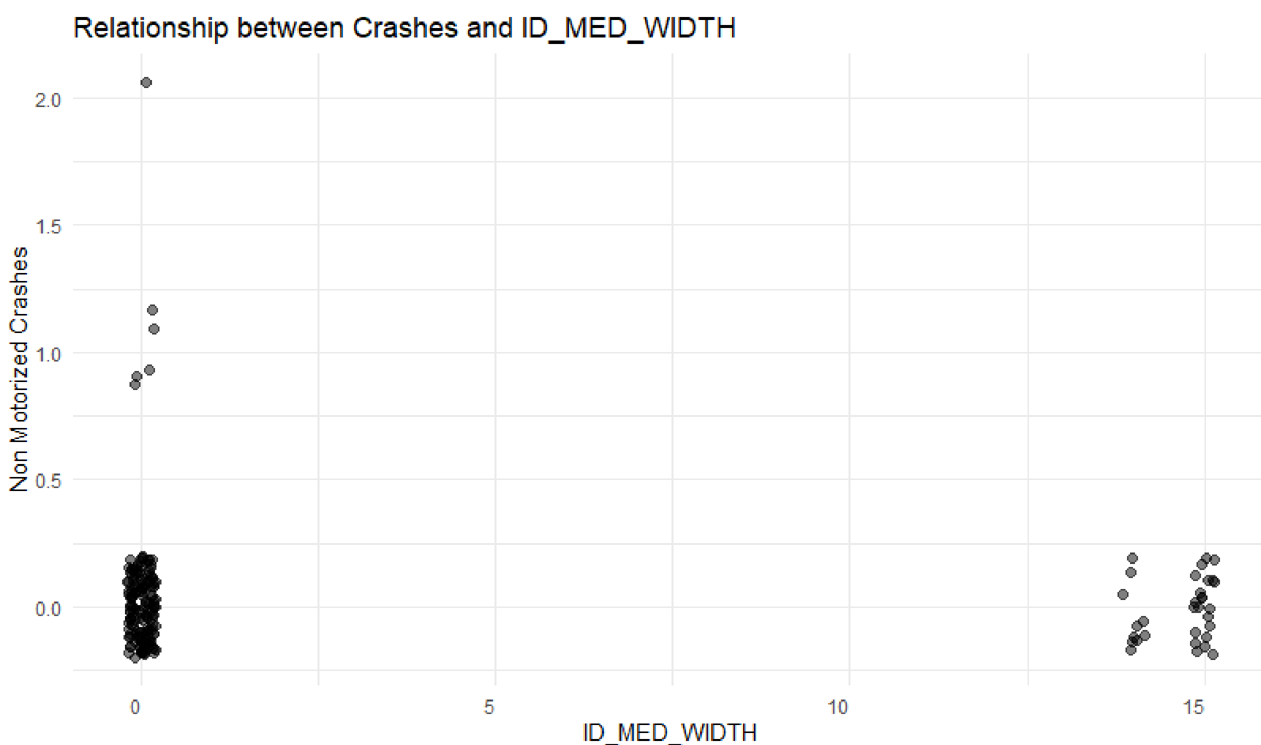
Relationship between Crashes and ID_RGT_UNPAV_SHLDR_WID

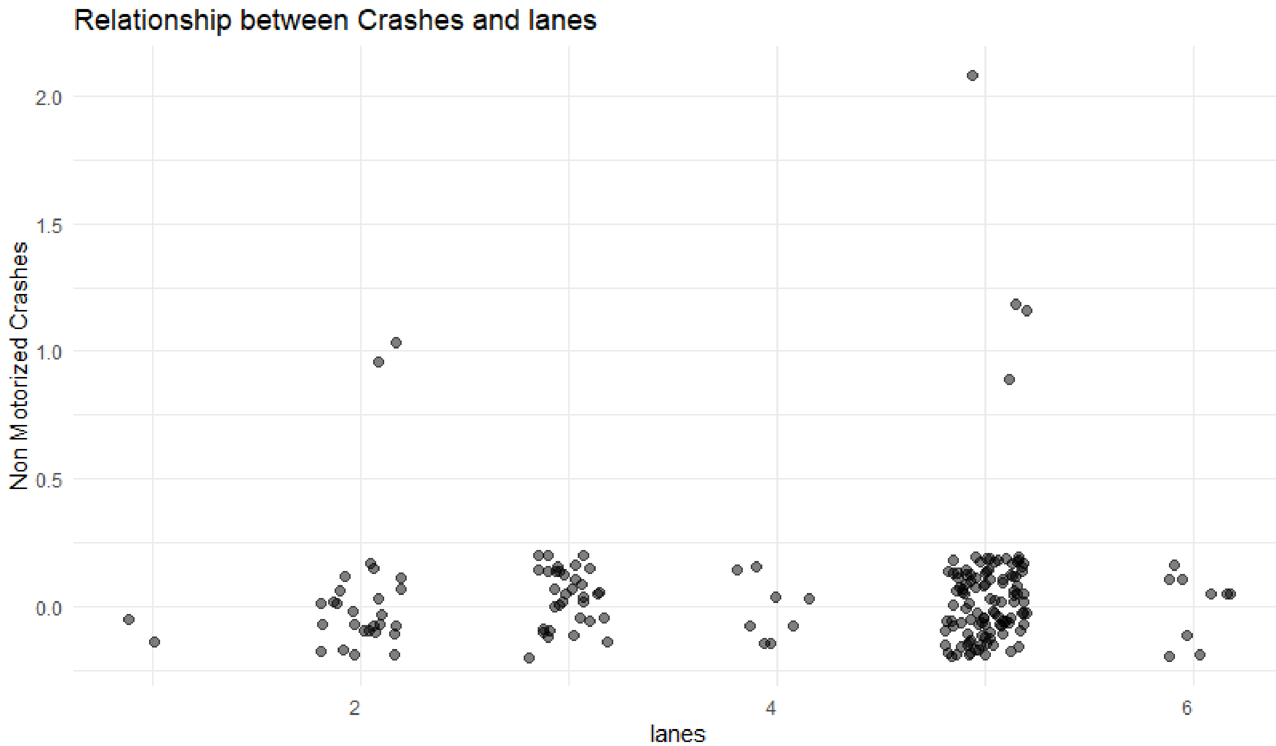


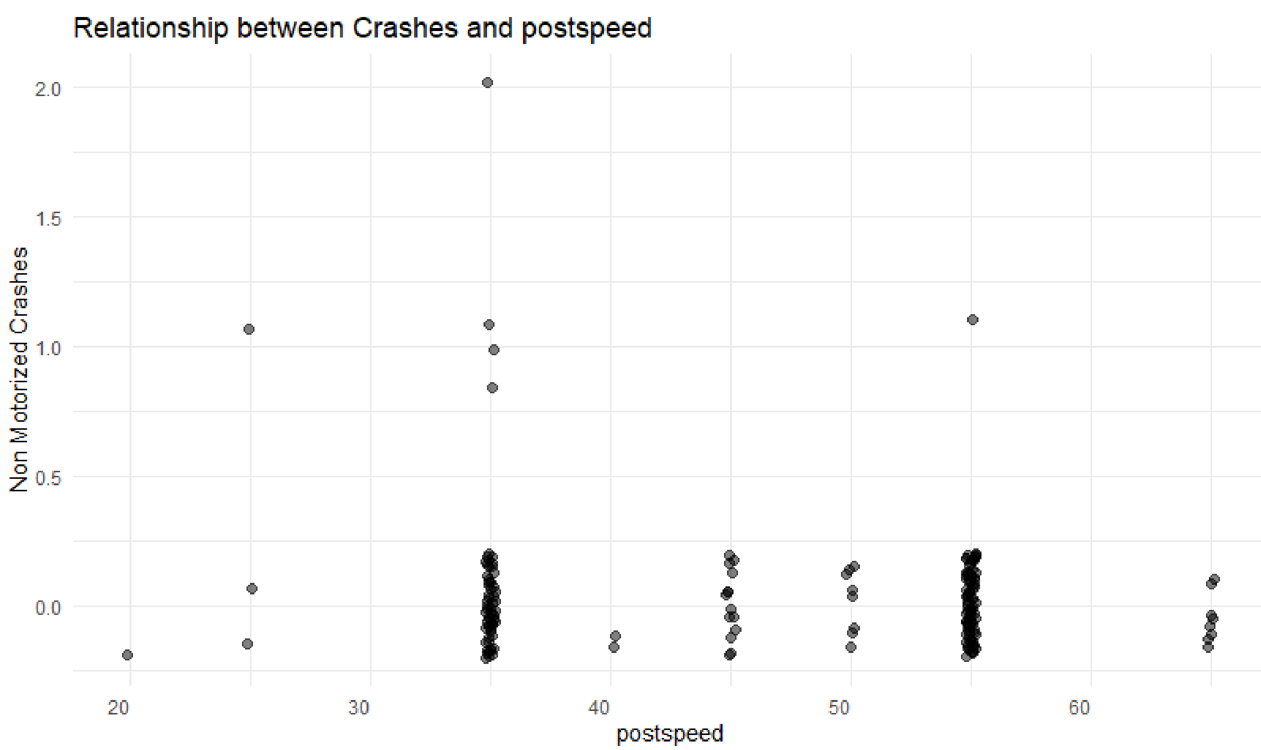
Relationship between Crashes and L_SHOULDER_WIDTH

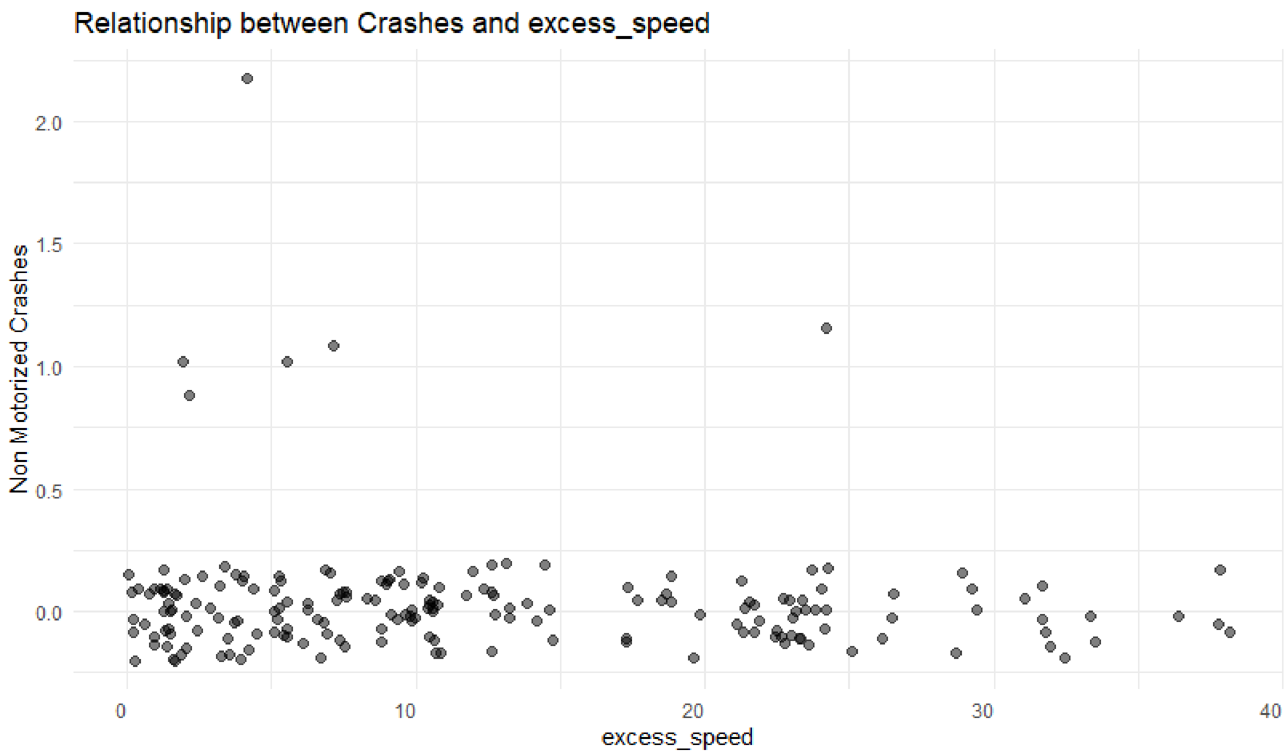


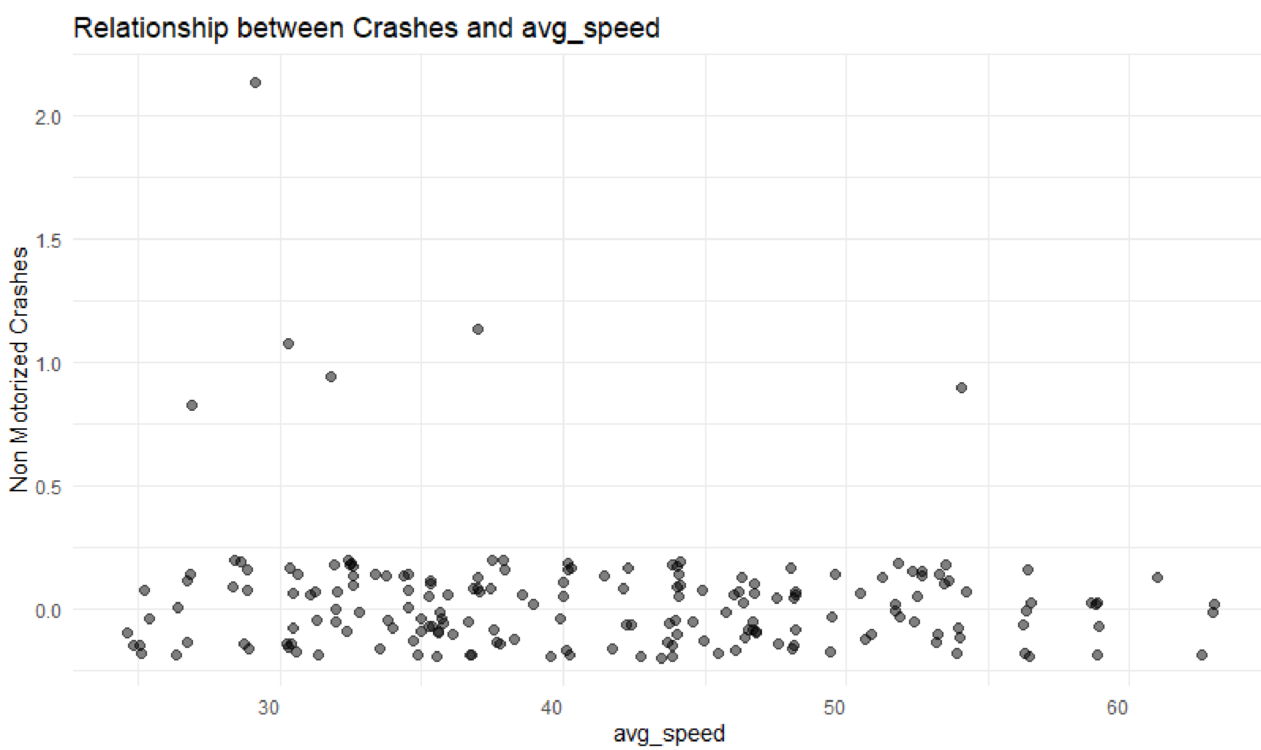

Relationship between Crashes and ID_LEFT_UNPAV_SHLDR_WID
Non Motorized Crashes
2.0
1.5
1.0
0.5
0.0
0
1
2
3
4
ID_LEFT_UNPAV_SHLDR_WID


Relationship between Crashes and ID_MED_WIDTH
Non Motorized Crashes
2.0
1.5
1.0
0.5
0.0
0
5
10
15
ID_MED_WIDTH


Relationship between Crashes and lanes
Non Motorized Crashes
2.0
1.5
1.0
0.5
0.0
2
4
6
lanes


Relationship between Crashes and postspeed
Non Motorized Crashes
2.0
1.5
1.0
0.5
0.0
20
30
40
50
60
postspeed


Relationship between Crashes and excess_speed
Non Motorized Crashes
2.0
1.5
1.0
0.5
0.0
0
10
20
30
40
excess_speed


Relationship between Crashes and avg_speed
Non Motorized Crashes
2.0
1.5
1.0
0.5
0.0
30
40
50
60
avg_speed

APPENDIX F: TESTING THE RELATIONSHIP BETWEEN SPECIFIC DEMOGRAPHICS VARIABLES AND TAZS IN THE HIN

PAIRED T-TEST RESULTS

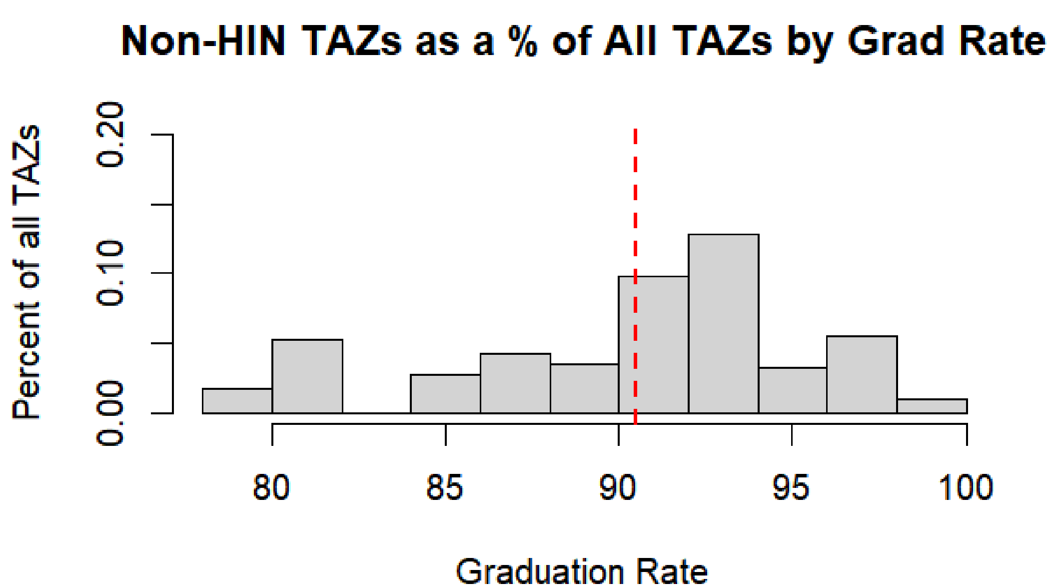
Of the five Equity Index variables tested, only the unemployment rate variable is significant at a 95% confidence level. TAZs that overlap with the HIN have a slightly higher unemployment rate (0.3%) compared to the TAZs outside of the HIN.

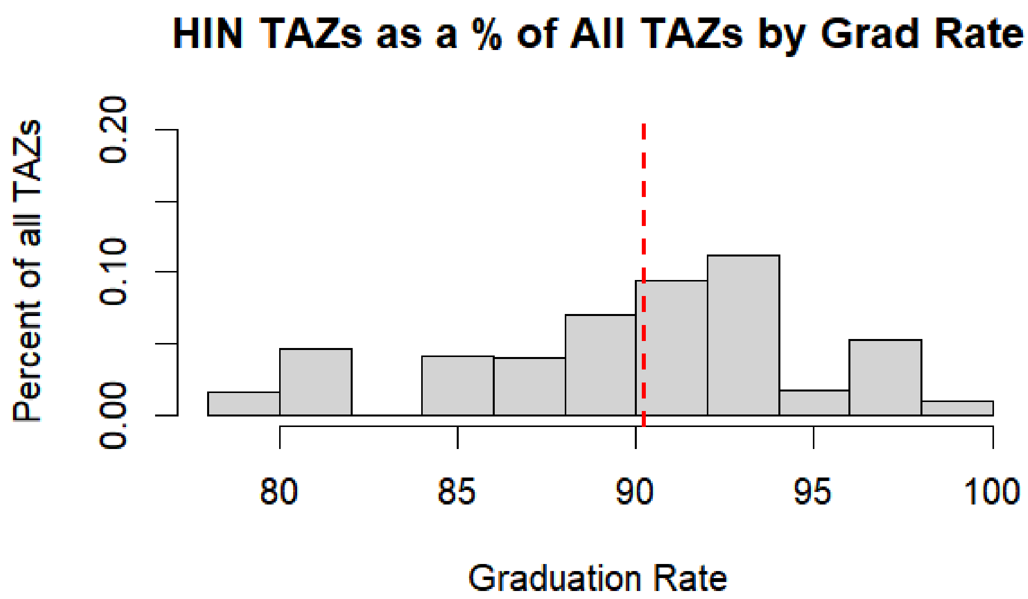
Equity Index Variable	HIN TAZ Mean	Non-HIN TAZ Mean	P-Value
Graduation Rate	90.2%	90.5%	0.1804
Unemployment Rate	**4.6%**	**4.3%**	**0.0364**
% No Car	4.2%	3.8%	0.1577
% No Health Insurance	10.9%	10.5%	0.0838
Median Rent as % of Income	29.2%	28.8%	0.2624

Variable Comparisons

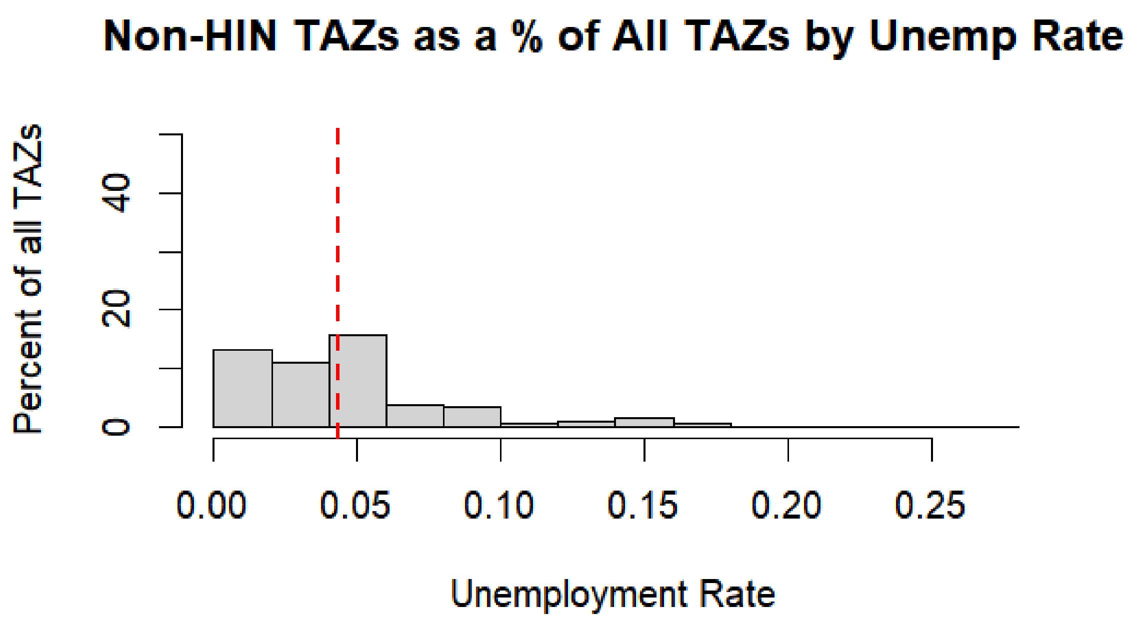
For each variable, there is a histogram that shows its distribution relative to percentage of total TAZs in the region for TAZs on the HIN and TAZs not on the HIN. The red dotted line represents the mean of the dataset.

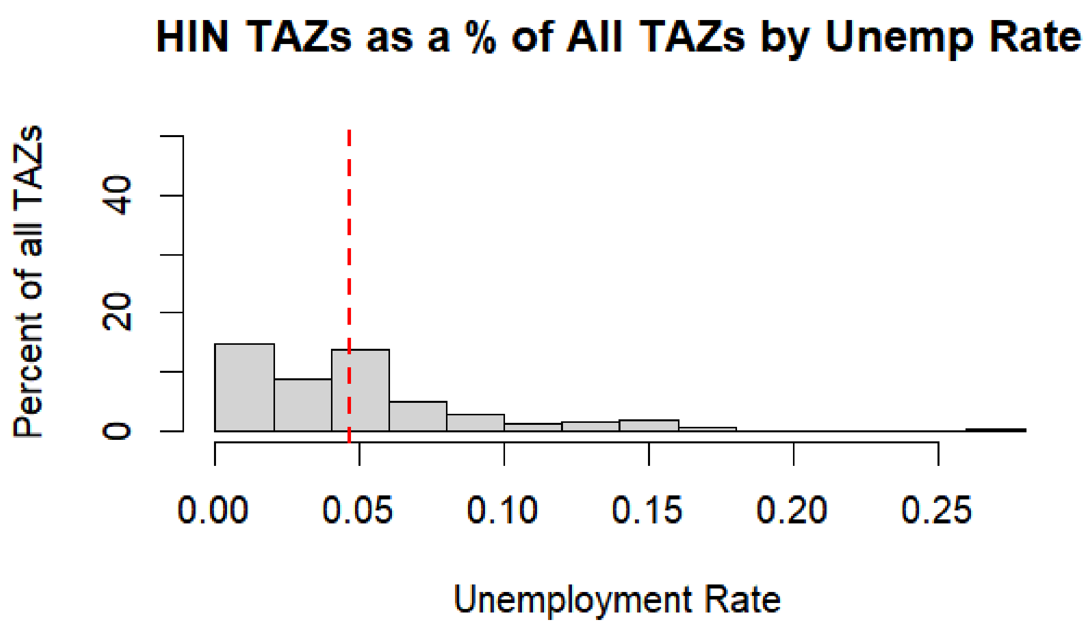
<u>Graduation Rate</u>



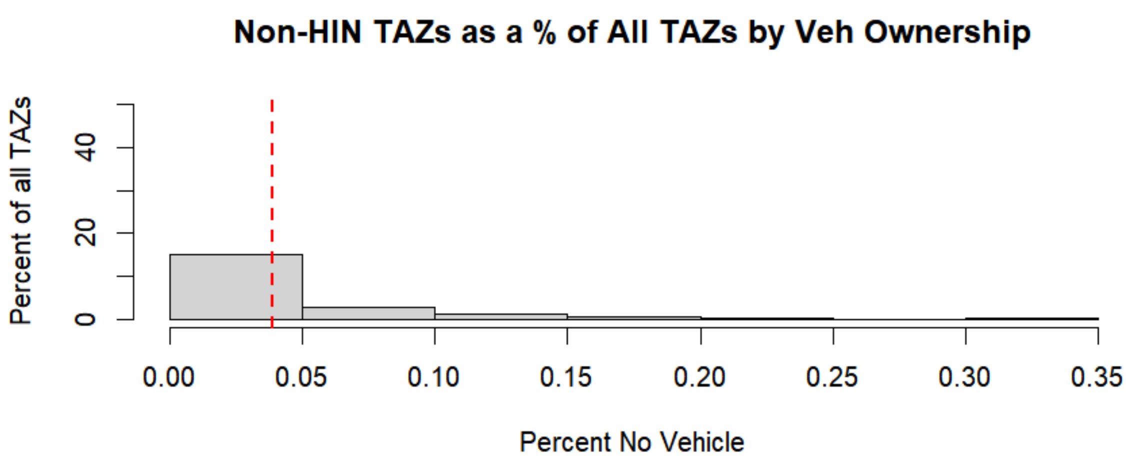


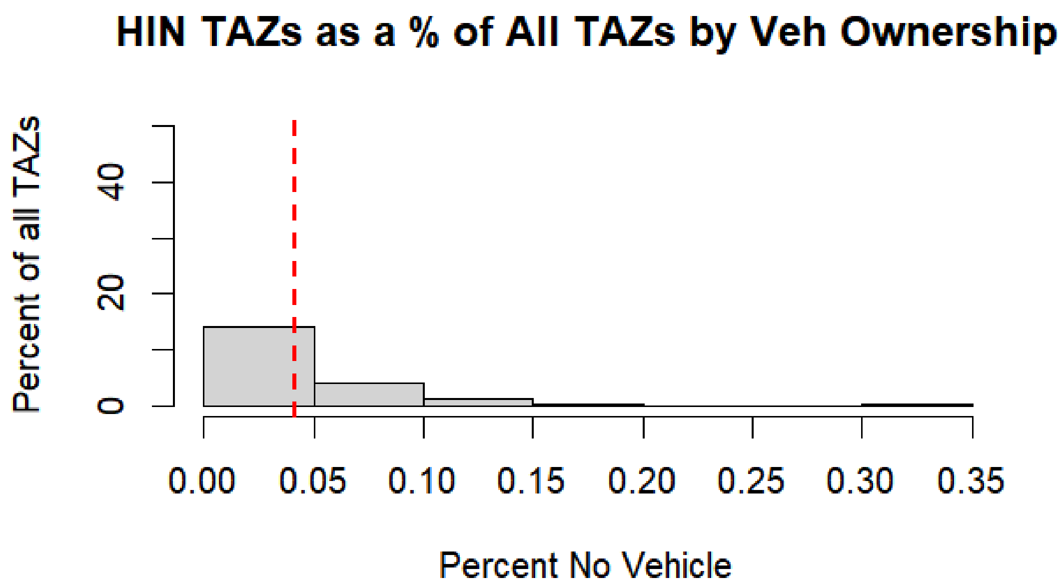
<u>Unemployment Rate</u>



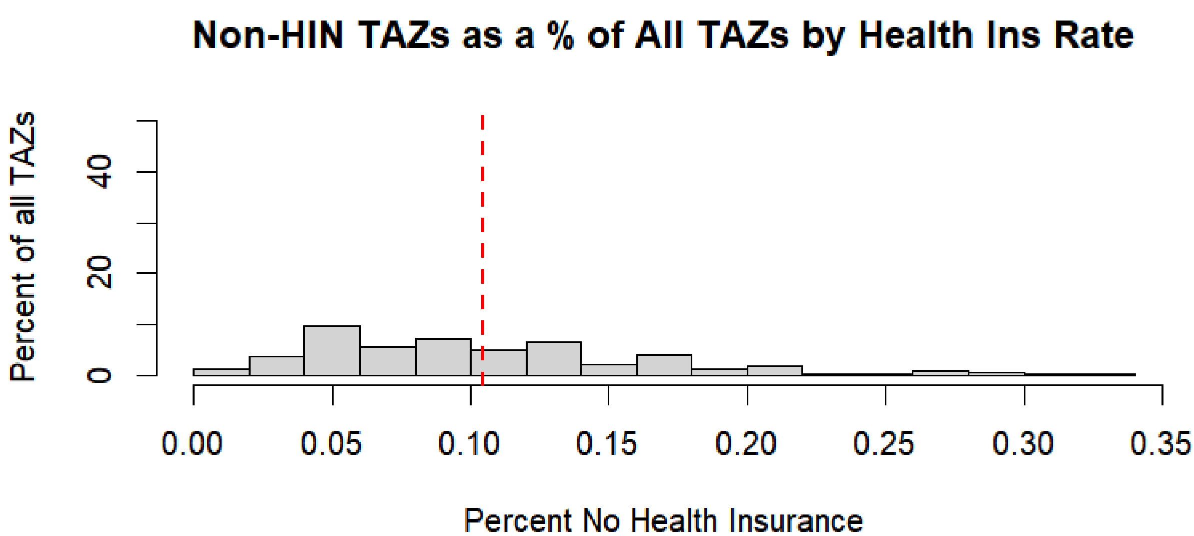


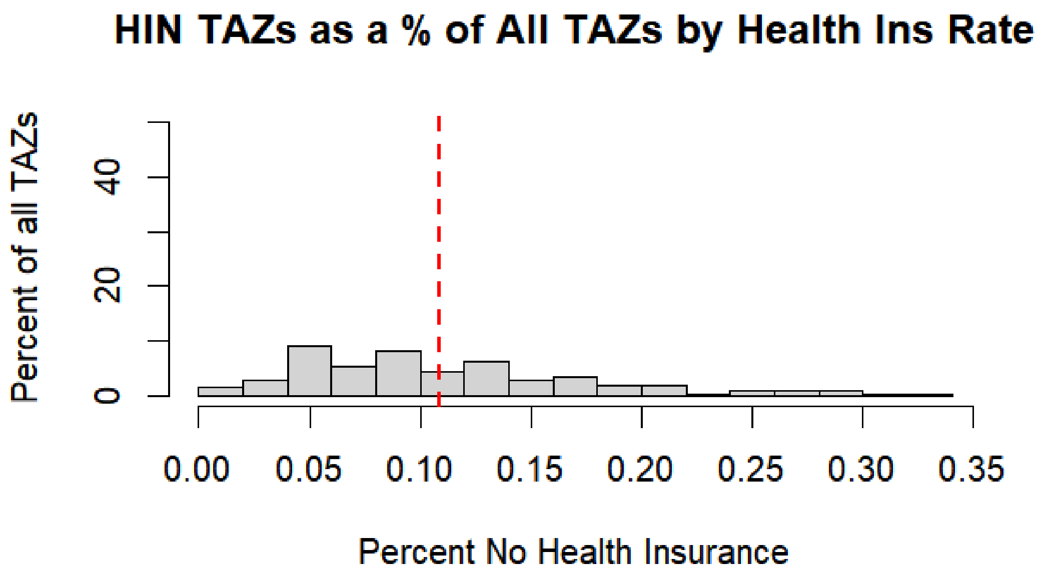
<u>Percent No Car</u>



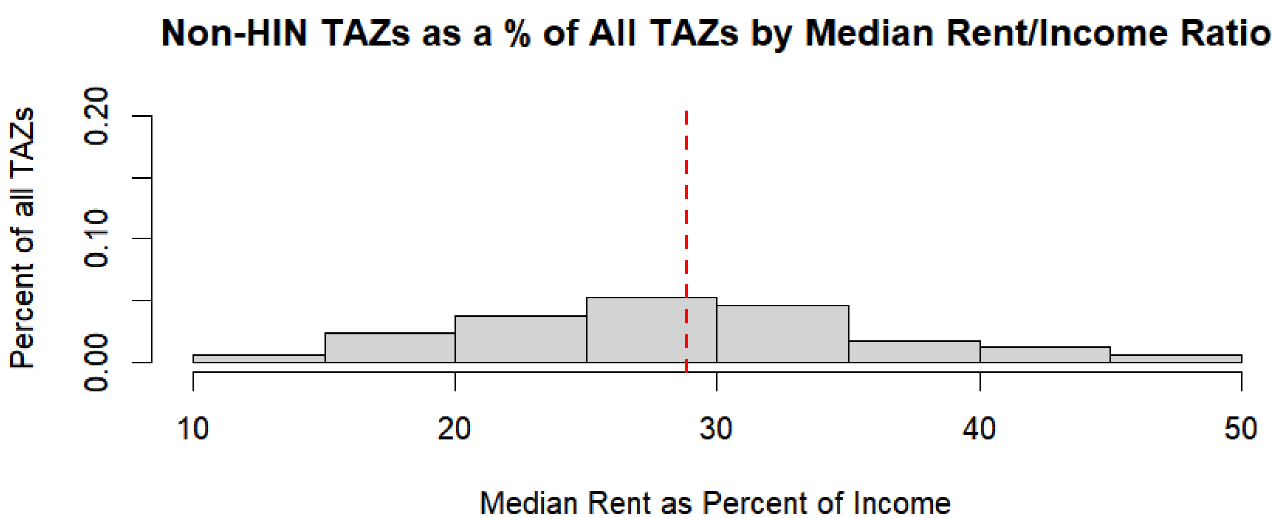


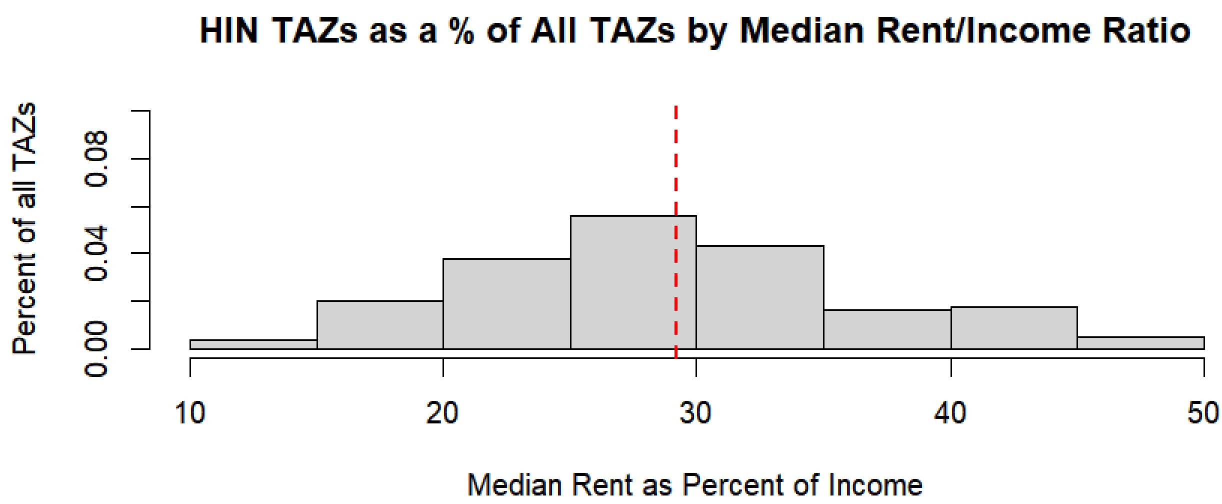
<u>Percent No Health Insurance</u>





Median Rent as Percent of Income




HIN TAZs as a % of All TAZs by Median Rent/Income Ratio
Percent of all TAZs
0.00
0.04
0.08
10
20
30
40
50
Median Rent as Percent of Income