FEHR PEERS

Memorandum

Date: March 18, 2025

To: Max Navarro, City of Modesto

From: Sean Reseigh and Ashlee Takushi, RSP$_1$, Fehr & Peers

Subject: Final Collision Landscape Summary, High Injury Network, and Safety Profiles

WC24-4104.00

Conventional safety practice has focused on reacting to collisions and recommendations based on the siloed categories of the Es (engineering, enforcement, education, and emergency services). Since collision reports focus on the moment of impact and time immediately preceding it, and because the purpose of the report is to determine "fault" among the involved parties (such as for insurance claims or criminal prosecution), the "cause" of the collision is often attributed to the behavior of one of both parties. This can miss the factors that preceded the collision by five hours, five years, or even five decades, especially as relates to built environment (street design and operations) and exposure conditions (why and where travel occurs, where people live and work and why, what modes they have access to and why, etc.).

Additionally, while collision data can give historical knowledge on collision trends, a reactive approach to safety based on collision data alone can miss other areas of the City that may have similar risk factors for severe and fatal injuries if a collision occurs there. Because the root cause of fatalities and serious injuries occurring on the City's roadways is the result of kinetic energy exceeding the human body's tolerable amount of force, identifying locations with high kinetic energy risk potential can be an important proactive approach to safety. An object's mass and speed, as well as the angle of collision impact, determines how much force is applied to a vulnerable human body and the severity of the resulting injury. Kinetic energy risk is a combination of exposure to the risk, presence of conflicts (likelihood), and level of severity (based on speed, mass, and angle).

This memo summarizes the collision landscape summary and risk methodologies developed by Fehr & Peers and Alta for the reactive High Injury Network and proactive High Risk Network, and accompanying Safety Profiles developed across both assessments, as part of the City of Modesto Safe Streets and Roads for All Safety Action Plan.

Collision Data

Collision data for the Modesto Safe Streets and Roads for All (SS4A) Safety Action plan studies an eight (8)-year collision dataset from 2016-2023, available through the Transportation Injury Mapping System (TIMS) database. TIMS reports injury collisions from the Statewide Integrated Traffic Records System (SWITRS) but excludes collisions that cause property damage only (PDO) and no injuries. When the TIMS dataset was pulled in August 2024, 2022 and 2023 data sets were identified as preliminary data. Although not yet final, these years of collisions were included to show Modesto's most recent trends in collisions.

Geographically, the data includes all collisions within the City of Modesto. The data excludes collisions that occur on limited-access roadways (i.e., freeways) but includes collisions on all other roadways, including State highways and other Caltrans-maintained roadways and privately-maintained roadways.

While collision databases like TIMS remain the best source of collision data, it has been found to have certain reporting biases, including:

- Collisions involving people walking, on bicycles, or on motorcycles are less likely to be reported than collisions with people driving.
- Younger victims are less likely to report collisions.
- Alcohol-involved collisions may be underreported.

Collision data may also include bias as reports are based on a number of different factors, such as an officer's perception of the race of those involved, the accuracy of bystander witness reports, and emergency service arrival. However, there is currently limited research on the frequency and effect of reporting biases.

Key Considerations of Collision Data-based Analyses

It is important to note that collision data is inherently limited in two ways:

1. The variables provided on the report form are focused on those that help assign "fault" for the purpose of insurance payouts or criminal proceedings. As such, they are skewed to both behavioral factors and factors associated with the moment of the collision and the receding/subsequent brief periods of time.
2. Contextual elements associated with the collision, including roadway design (those elements both present and not present in the design) and socioeconomic and land use characteristics (the who, where, when, where, and why elements of transportation, many of which are determined hours, years, or decades before the collision) are typically not apparent in collision reports)

Thus, while insights from this analysis are key inputs to understanding the safety issues and opportunities in Modesto, they are not sufficient for understanding or addressing the full scope of safety considerations and interventions.

Collision Landscape Summary

In the past eight years (2016-2023), 9,397 injury collisions were reported in Modesto, as shown in **Figure 1**. This captures pre- and post-COVID-19 conditions and reflects existing roadway conditions, including any recent street improvements from the past eight years.

Over the last eight years, the data shows an annual average of 1,400 collisions. Of that total number collisions, around seven percent of those collisions resulted in KSIs.

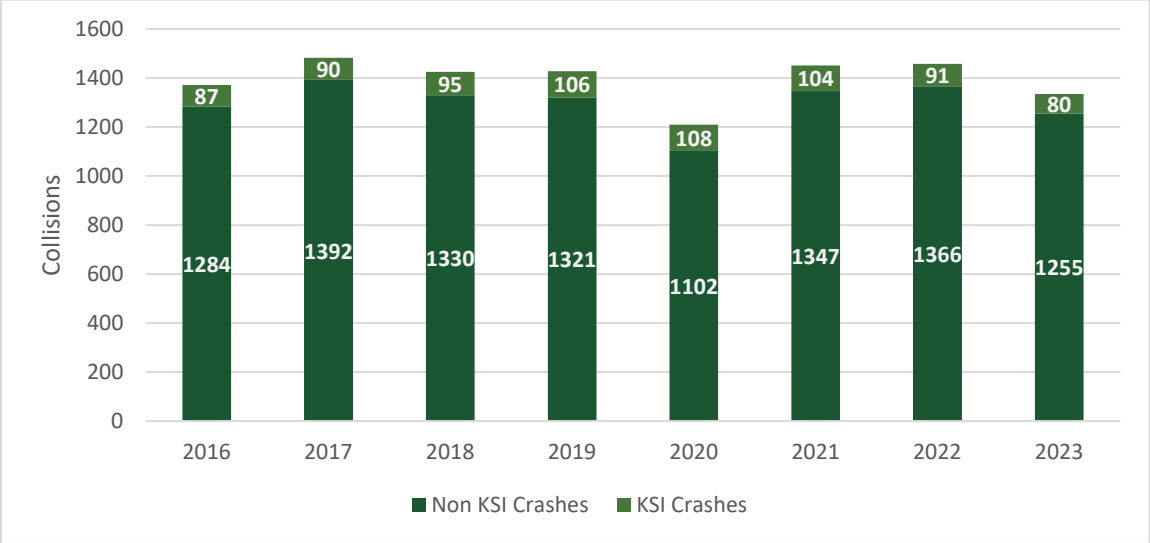


Figure 1: Modesto Injury Collisions from 2016-2023
Notes: 2022 and 2023 data is still preliminary and is subject to change.
Source: TIMS, 2016-2023; Fehr & Peers 2024

In Modesto, **Figure 2** illustrates how crashes involving users not traveling inside of a vehicle, such as pedestrians, bicyclists, and motorcyclists, are disproportionately vulnerable to severe and fatal outcomes than vehicle-vehicle collisions.

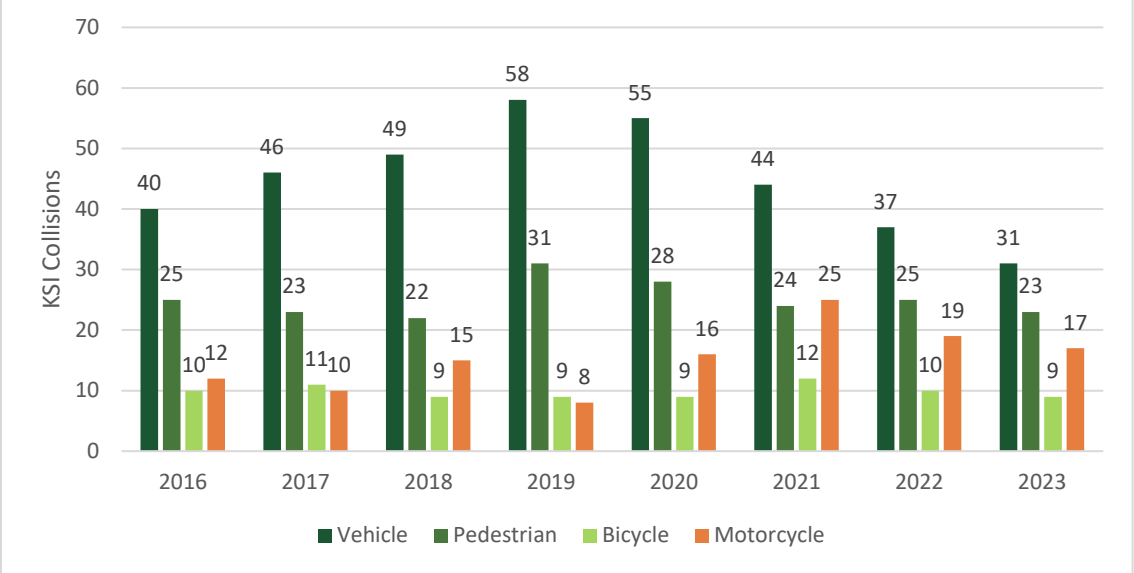


Figure 2: Modesto KSI Collisions by Mode from 2016-2023
Notes: 2022 and 2023 data is still preliminary and is subject to change.
Source: TIMS, 2016-2023; Fehr & Peers 2024

Injury Collisions by Type

Collision types describe how a collision is reported by law enforcement based on the parties involved and generally describe how contact was made between the involved parties, as shown in **Figure 3**. The top three crash types are further describes as:

- **BROADSIDE COLLISIONS** are between two vehicles on conflicting paths where the front of one vehicle contacts the side of another
- **VEHICLE-PEDESTRIAN COLLISIONS** are any collision involving both a motor vehicle and a pedestrian
- **HIT OBJECT COLLISIONS** are between a vehicle and a non-vehicular object in or near the roadway

The top three crash types account for 70% of KSI collisions between 2016 and 2023. As expected, collisions associated with higher kinetic energy risk (mass and speed), along with the angle of collision impact (e.g. broadside), tend to have a higher percentage of KSI collisions.

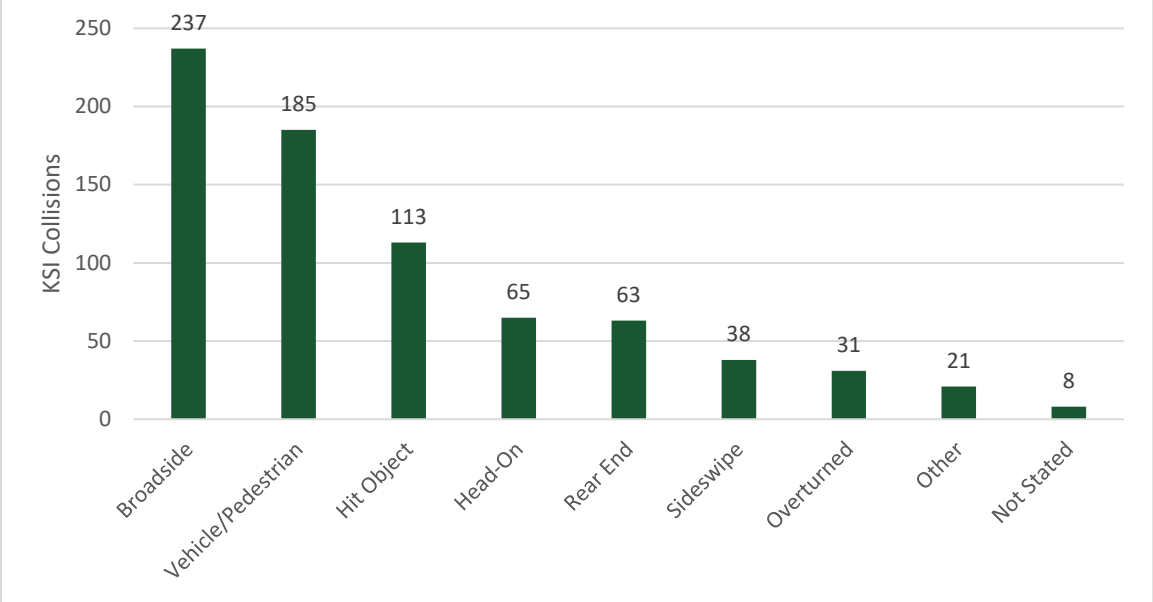


Figure 3: Modesto Shares of Collisions by Collision Type
Notes: 2022 and 2023 data is still preliminary and is subject to change.
Source: TIMS, 2016-2023; Fehr & Peers 2024

Primary Collision Factors (PCF)

Primary collision factors (PCFs) are cited by the responding officer and based on their judgment of what contributed to the collisions. PCFs do not include contextual information related to the design of the location that could have been a primary or secondary contributor to the collision, or any upstream factors as noted previously. The most common PCFs in Modesto for KSIs, as shown in **Figure 4**, are driving under the influence, pedestrian related, vehicle right of way violation, improper turning, traffic signal and signs, and unsafe speeds.

- **DRIVING UNDER THE INFLUENCE** identifies a collision where a driver is found to have been operating a vehicle while impaired by a substance – typically alcohol – in violation of CVC 23152
- **PEDESTRIAN VIOLATION** refers to incidents where pedestrians are not following a rule of the road. In 2022, the Freedom to Walk Act (AB-2147) was passed, which allows people to cross outside of an intersection without being ticketed, provided there is no immediate danger of a collision occurring. Pedestrian Violations also include pedestrians crossing improperly during the flashing "Don't Walk" or red phase of a signal, pedestrians suddenly leaving the curb, and pedestrians walking in the roadway on the right-hand side of the road.
- **VEHICLE RIGHT OF WAY VIOLATION** refers to a driver infringing upon the right-of-way of another party or the driver observing their right-of-way improperly. A common citation

under this category is for drivers who do not yield to oncoming traffic during a left turn or U-turn. Other citations include not yielding properly at a stop sign and not yielding when entering a road from a property. While the title specifies vehicle, a vehicle hitting a person on a bicycle and not yielding to pedestrians for right turns on red can also be cited.

- **IMPROPER TURNING** identifies a collision where a vehicle turns at intersections and off of a road and improper signaling during lane changes. A common citation under this category is for drivers who move left or right on a roadway when it is not safe or without signaling. It also covers drivers making an illegal U-turn, turning from a lane that does not allow turns, or making a turn that is signed as prohibited.
- **TRAFFIC SIGNAL AND SIGNS** describes a party not observing the rules of a particular signal or sign. Common citations under the category involve a vehicle not stopping at the limit line or stop bar at a signal or stop sign, respectively, or the crosswalk if neither is present. This includes running red lights. If a vehicle stops but then does not yield properly to another vehicle in the intersection, it is included under the Vehicle Right of Way Violation category.
- **UNSAFE SPEED** refers to a collision where a party is identified to be traveling "at a speed greater than is reasonable or prudent having due regard for weather, visibility, the traffic on, and the surface and width of" the roadway, and driving at a speed that endangers others. It does not necessarily imply that someone has driven above the speed limit or that the speed limit is contextually appropriate. Even in collisions where "Unsafe Speed" is not the primary violation type, speed is often a factor in severe and fatal collisions given the exponential role of speed in kinetic energy risk.

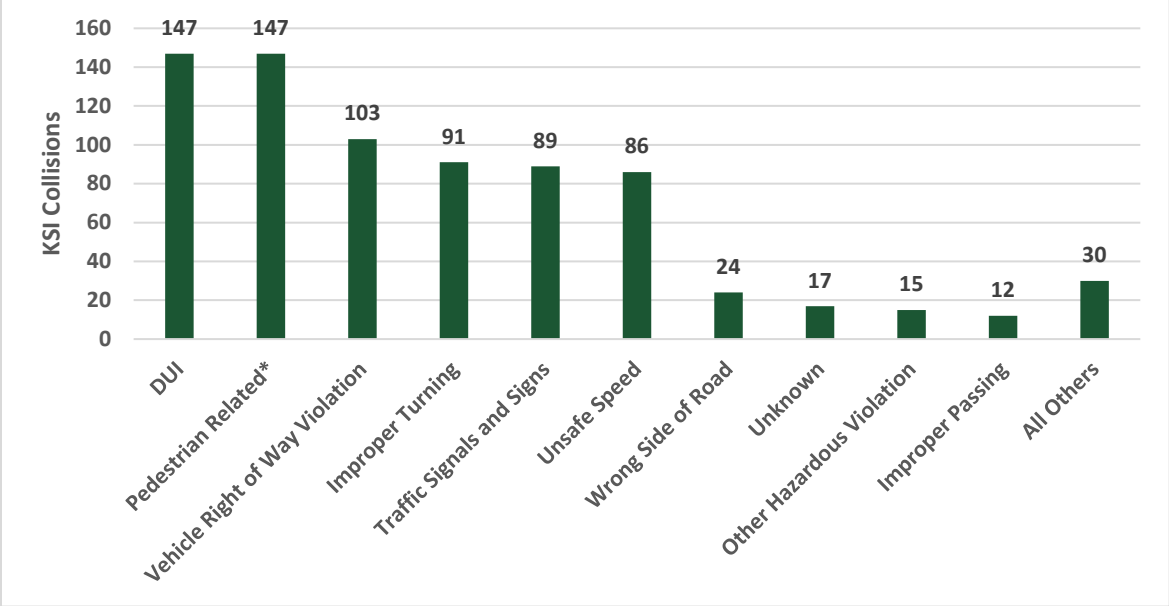


Figure 4: Modesto Shares of Collisions by Primary Collision Factors
Notes: 2022 and 2023 data is still preliminary and is subject to change.
*The "Pedestrian Related" category shown here combines two PCF categories: Pedestrian Violation and Pedestrian Right of Way Violation. The former indicates that the pedestrian violated a rule of the road, such as crossing outside of a crosswalk. In contrast, the latter indicates the driver of a vehicle violated the pedestrian's right of way. The Pedestrian Violation category may be overrepresented due to a lack of clear information related to collision circumstances and the increased likelihood that the pedestrian party may be unable to provide their side of the incident at the time of the collision. For this reason, we have elected not to show the distinction in these tallies but instead show all pedestrian-related collisions in one single category.
Categories representing fewer than 3% are grouped into "All Others"
Source: TIMS, 2016-2023; Fehr & Peers 2024

High Injury Network (HIN) Methodology

HIN Guidance Considerations

The HIN methodology developed for this project is based the *Recommendations for California Statewide Guidance for High Injury Networks* report from the California Strategic Highway Safety Plan Pedestrian and Bicycle Challenge Area teams.

HIN Data

Collision Data

The HIN was developed using the eight (8) year collision dataset from 2016-2023, as noted above.

Contextual Data

The HIN basemap network is derived from the County of Stanislaus Centerline Feature Class (FC). The network was clipped using a 250-foot buffer around the City of Modesto Boundary. This is to ensure that roadways that traverse along the edge of the City boundary are considered in the development of the HIN.

Collision Severity Weighting

Collision weighting used two methodologies, but both focus on **collision severity** as the main collision factor criteria for HIN development. The first methodology (full collision weights) puts a strong emphasis on fatal and severe injury (KSI) collisions. This prioritizes segments where these collisions occur. The second methodology (square root collision weights) puts less of an emphasis on KSIs, capturing locations where there are a high number of injury (non-KSI) collisions along a segment and not overstating the role of one-off collisions. Combining these methodologies allows for a comprehensive look at locations with high rates of collision history over the eight-year period.

The first methodology used collision weights derived from the 2024 California Local Road Safety Manual (LRSM) collision costs for each collision severity. This method is similar to the Highway Safety Manual (HSM) Equivalent Property Damage Only (EPDO) weighting method but uses the "Complaint of Pain" severity level as its baseline because Property Damage Only (PDO) collisions are not included in the HIN.

Cost assumptions from the 2024 Caltrans LRSM are based on costs included in the HSM First Edition, with costs adjusted to 2024 dollars. The HSM uses "comprehensive" or "societal" collision costs to associate costs with each collision severity level. Comprehensive costs include both economic costs and monetized pain and suffering costs. Economic costs are monetary costs associated with emergency services deployment, medical services, productivity loss due to victim injury, insurance and legal costs, costs as a result of congestion impacts as a result of the collision, and property damage costs. Monetized pain and suffering costs are an assumption of the costs associated with lost quality-of-life (or Quality-Adjusted Life Years [QALY]), accounting for reductions in life expectancy and quality-of-life changes because of a collision.

Table 1: Full Collision Weights Approach

Severity	Collision Cost	Collision Weight
Fatal and Severe Injury (KSI)	$2,860,000*	26
Evident Injury – Other Visible	$193,000	2
Possible Injury – Complaint of Pain	$110,000	1

*The fatal and severe injury (KSI) collision cost is an average of the location type costs (signalized intersections, non-signalized intersections, roadway).
**Rounded to nearest whole number.

The second methodology uses the same cost assumptions from the 2024 Caltrans LRSM detailed above. Similarly, the weight of each collision is based on the most serious injury sustained by any individual involved in the collision. The key difference in this methodology is that the proportions are based on the ratio of the square root of the average cost to society from fatal and serious injury collisions and uses the "Complaint of Pain" severity as its baseline.

Table 2: Square Root Collision Weights Approach

Severity	Sq. Rt. Collision Cost	Collision Weight
Fatal and Severe Injury (KSI)	$1,691*	5.1
Evident Injury – Other Visible	$439	1.3
Possible Injury – Complaint of Pain	$332	1

*The fatal and severe injury (KSI) collision cost is an average of the location type costs (signalized intersections, non-signalized intersections, roadway).
**Rounded to nearest tenth.

High Injury Network (HIN) Development Methodology

HIN Scoring

Three separate HINs were created using the average of the collision weights mentioned above. Using these two methodologies, additional factors were analyzed, including the mode involved in the collision and whether a victim is in a vulnerable population. These two factors help to prioritize vulnerable road users into safety considerations further. By applying specific weights to vulnerable road users (those 65 years of age or older or 17 years of age and younger), the analysis identified locations with a high concentration of vulnerable road user collisions even if they do not show a high concentration of KSI collisions.

The cumulative score for a single collision can range from 1 to 32 for the full collision weight and from 1 to 13.4 for the square root collision weight. **Table 3** presents the variables and their associated scores. Scores were assigned to roadway segments based on the eight-year collision history for that segment, as noted in the following section.

Table 3: HIN Scoring

Variable	Value	Score (Full Collison Weight)	Score (Square Root Collison Weight)
Collision Factors			
Collision Severity (factors are mutually exclusive) – applied to collision			
Fatal and Severe Injury (KSI)	0 or 1	26	5.1
Evident Injury – Other Visible	0 or 1	2	1.3
Possible Injury – Complaint of Pain	0 or 1	1	1
Additional Factors (factors not mutually exclusive) – applied to collision			
Mode: involves bicyclist or pedestrian	0 or 1	3	3
Vulnerable population: Injury and fatality victims age 65+ or 17 and under	0 or 1	3	3

Associating Collisions to Roadways

The following section outlines the major steps of the methodology for associating collisions with roadway segments.

1) **Associating collisions to roadway segments:** Collisions were associated with roadway segments using a 60-foot roadway segment buffer. Roadways were split into quarter-mile equidistant segments, defined as "windows," shifted every one-tenth of a mile. This is known as the "moving window" method. Collisions within 60' of multiple roadway segments (e.g., at an intersection) were assigned to each segment and were double-counted (applied to each intersecting roadway).
2) **Calculate HIN Index:** A score for each roadway and/or intersection (known as the HIN Index) was calculated by aggregating the weighted collision factor sum, which was joined to the network in the previous step.
3) **HIN Building:** The top 95th percentile scoring windows, defined as "high scoring windows", were identified and connected to form the HIN. If the distance between 95th percentile scoring segments was a quarter mile or less and segments had the same roadway name, they were connected. Additionally, if the distance between a 95th percentile scoring segment and the end of the roadway was a quarter mile or less, the segment was extended to the end of the roadway. The result of this step defines HIN "corridors."
4) **HIN Check and Refinement:** A final check was performed to verify that the HIN accurately incorporates the 95th percentile scoring segment gap threshold into the final HIN. This check involves overlaying high-scoring windows with the HIN corridors and measuring the distances between unclosed gaps to ensure that they exceed the segment gap threshold. Additionally, adjustments to the scoring percentile were made to ensure a desirable KSI capture was achieved without capturing an exorbitant proportion of the City's centerline miles. This

refinement process is built on the foundation of the "Pareto Principle," which states that roughly 80% of outcomes come from 20% of causes, which in HIN terms is translated to 80% of KSI collisions occurring on 20% of roadways. Refinements were made until a 10% or less roadway capture was achieved while still capturing 75% of KSI collisions.

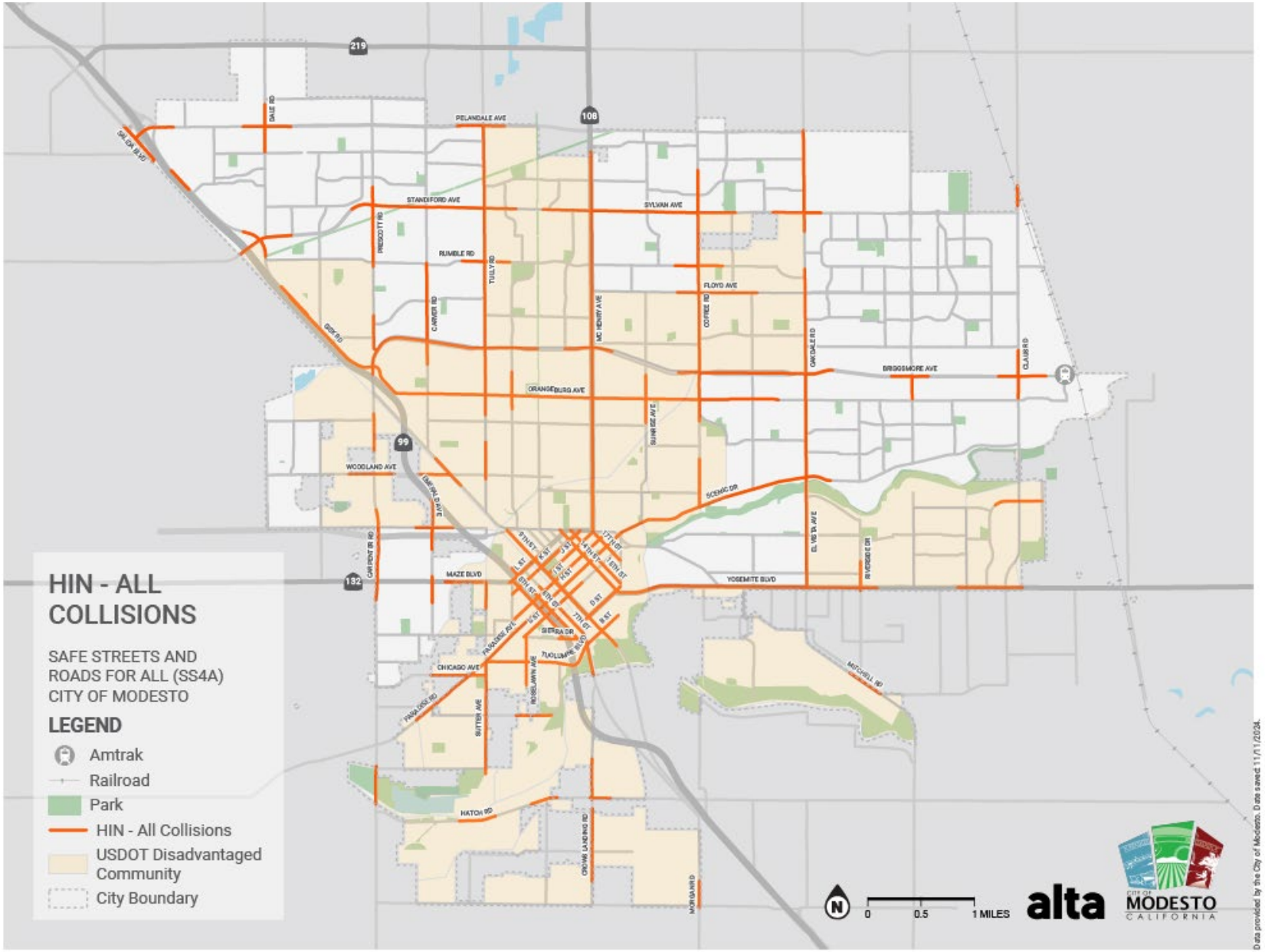
5) **Repeat for Bicycle and Pedestrian HINs:** The process described in steps 1-4 was repeated for each of the vulnerable road user (VRU) HINs: bicycle and pedestrian. A final HIN for all travel modes was also prepared using injury collisions for all modes.

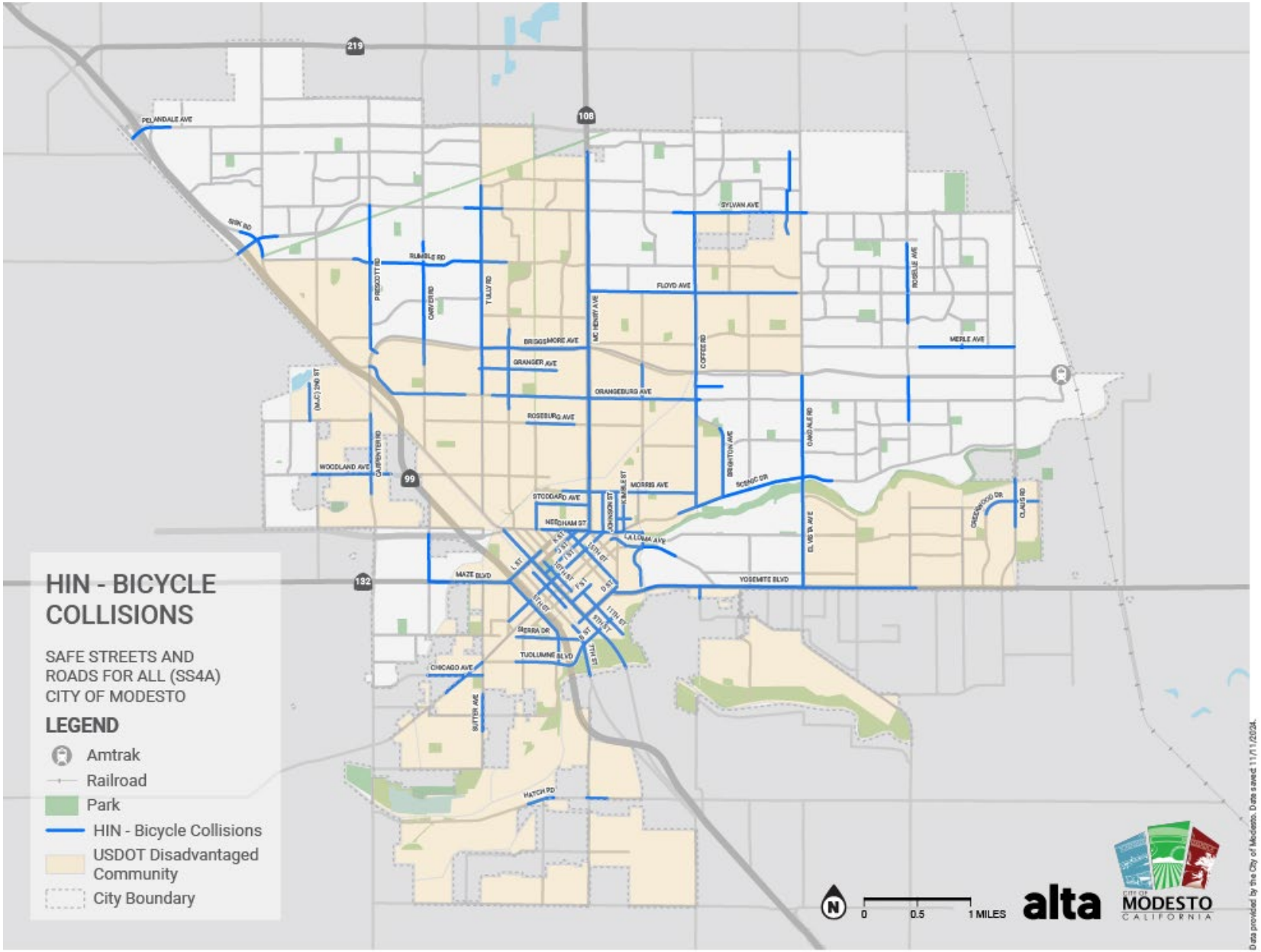
High Injury Network

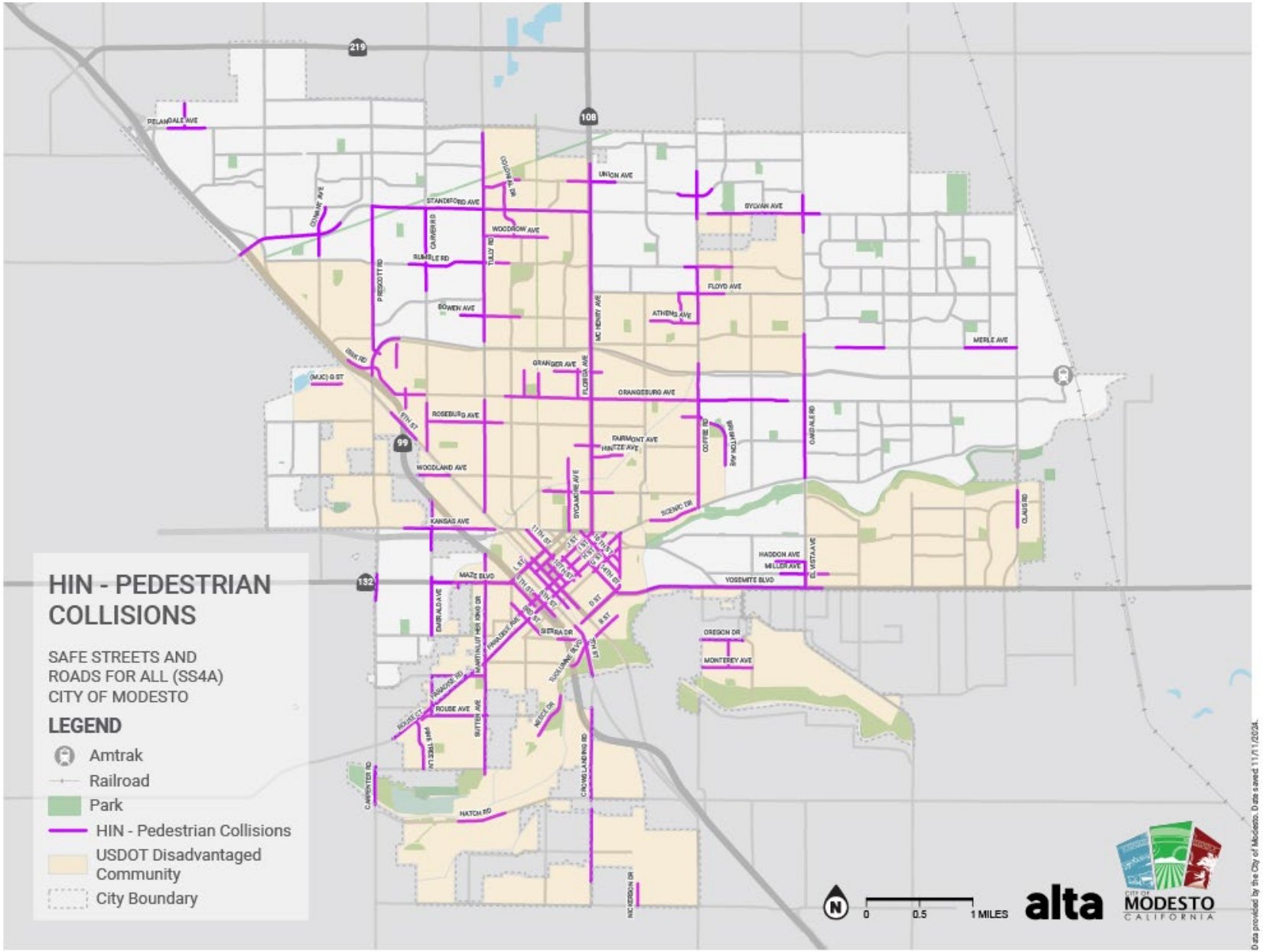
The City's High Injury Network (HIN) identifies and prioritizes roadways with the highest levels of injury collisions. The All Collisions HIN consists of just 7% of the City's roadway network, but accounts for 66% of the citywide KSI collisions. The Bicycle-Involved HIN consists of 6% of the City's roadway network, but accounts for 92% of citywide bicycle-involved KSI collisions. The Pedestrian-Involved HIN consists of 7% of the City's roadway network, but accounts for 87% of citywide pedestrian-involved KSI collisions. All maps are provided below and include an overlay of US DOT's Equitable Transportation Communities within the City of Modesto.

All HIN networks have concentrations in the downtown area, along Orangeburg Avenue and Yosemite Boulevard as east-west connections, and along Tully Road, McHenry Avenue, and Oakdale Road as north-south connections. For segments that interface with Caltrans-owned facilities, coordination between the City and Caltrans will need to occur for recommendations and implementation of improvements.

Appendix A includes additional details of the three HINs and additional information regarding relationship to Equitable Transportation Communities, distance to a school, roadway classification, and posted speed.


HIN - ALL COLLISIONS
SAFE STREETS AND ROADS FOR ALL (SS4A)
CITY OF MODESTO
LEGEND
Amtrak
Railroad
Park
HIN - All Collisions
USDOT Disadvantaged Community
City Boundary
0
0.5
1 MILES
alta
MODESTO
CALIFORNIA


HIN - BICYCLE COLLISIONS
SAFE STREETS AND ROADS FOR ALL (SS4A)
CITY OF MODESTO
LEGEND
Amtrak
Railroad
Park
HIN - Bicycle Collisions
USDOT Disadvantaged Community
City Boundary
0
0.5
1 MILES
alta
CITY OF MODESTO CALIFORNIA
Data provided by the City of Modesto. Data saved 11/11/2024.


HIN - PEDESTRIAN COLLISIONS
SAFE STREETS AND ROADS FOR ALL (SS4A)
CITY OF MODESTO
LEGEND
Amtrak
Railroad
Park
HIN - Pedestrian Collisions
USDOT Disadvantaged Community
City Boundary
0
0.5
1 MILES
alta
MODESTO
CALIFORNIA

Safety Profiles

To create Safety Profiles, all modes - collisions involving bicycles, collisions involving pedestrians, and collisions involving motorcycles – and all crashes were reviewed. The inputs from the risk analysis were used to identify locations that were contextually similar to those with a history or collisions involving severe and fatal injuries. By merging adjacent road and intersection features with collision data, relationships were uncovered between contextual factors and the likelihood of frequent and severe collisions. Priority factors identified used a collision counts and KSI severity threshold that is further detailed in **Appendix B**. The seven Safety Profiles cutsheets were refined and are as follows:

1. Pedestrian-Involved Collisions Near Transit Stops and Within Disadvantaged Communities
2. DUI Overnight Collisions
3. Broadside Collisions at Signalized Major-Minor Intersections
4. Bicycle-Involved Collisions at Intersections Without On-Street Bicycle Facilities
5. Broadside Collisions Near Unsignalized Intersections Involving Bicycles
6. Bicycle and Pedestrian-Involved Collisions at Signalized Intersections Downtown
7. Midblock Overnight Hit Object Collisions

The Safety Profile cutsheets include the following information:

- Description and associated information about each profile such number of total collisions or vulnerable road user KSI collisions
- A map of the intersections or corridors where collisions have occurred (note that profiles are not mutually exclusive; collisions can fall under multiple profiles, and totals will exceed 100%)
- Potential primary and secondary countermeasures to address the risk factors associated with the safety profiles

The countermeasures included in each Safety Profile are not intended to be a comprehensive list. Key roadway design countermeasures applicable to address the focus areas were included to align with the Safe System Design Hierarchy, which focuses on eliminating conflicts, reducing speed, separating users in space and time, and increasing awareness.

Countermeasures in the *Local Roadway Safety Manual: A Manual for California's Local Road Owners* (April 2024) includes a collision reduction factor (CRF) that helps decision makers understand the anticipated decrease in collisions after implementing the countermeasure. The CRF is included for each Safety Profile when available.

Engineering countermeasures are tools to enhance safety and can range from quick-build demonstration projects to larger improvements such as the installation of a roundabout. Higher

cost countermeasures typically require longer planning and design processes and thus have a higher associated cost. They may also require right-of-way acquisition and supplemental grant funding. Lower cost countermeasures assume that sufficient right-of-way is available, can be implemented as part of near-term, planned projects such as repaving projects.

Next Steps

We recognize that the Safety Profiles prepared for the project used historic crash data and are reactive in nature. As a next step in the project process, the Safety Profiles will be overlayed with the high risk network, public comment heat maps, and other data sources to prepare a list of proactive intersections and corridors for safety enhancements throughout the City.

Profile 1

Pedestrian-Involved Collisions Near Transit Stops and Within Disadvantaged Communities

Those in disadvantaged communities often face transportation barriers that limit their access to services and opportunities. This profile highlights areas where there is a correlation between pedestrian-related collisions and transit stops, and countermeasures that aim to proactively improve access to transportation services.

Overall Collisions
379
4% of total injury collisions

379
46% of pedestrian collisions

KSI Collisions
88
12% of total KSI collisions

88
44% of KSI pedestrian collisions

Key Trends

Top Crash Type

90% of Crashes for this profile are of type Vehicle/Pedestrian

Top KSI Crash Type

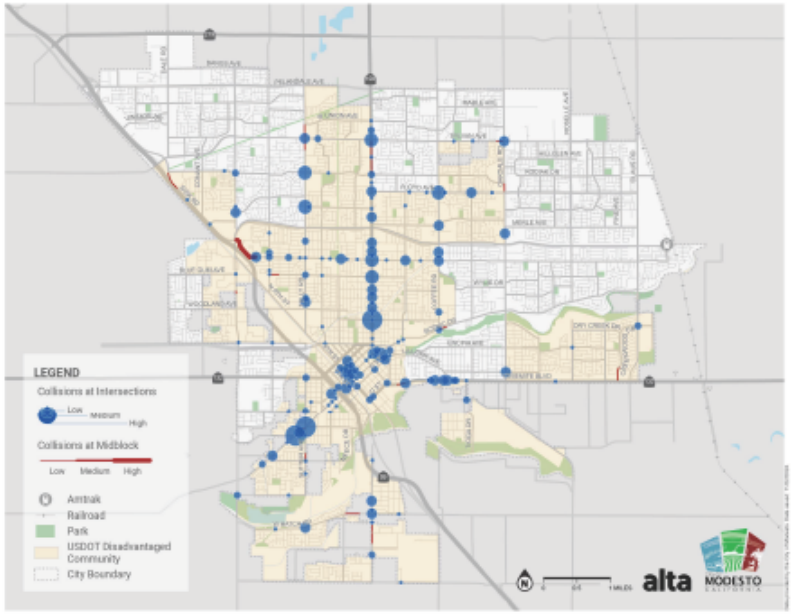
85% of KSI Crashes for this profile are of type Vehicle/Pedestrian

Top Violation Category

49% of Violations for this profile are of category Pedestrian Right of Way

Top KSI Violation Category

40% of Violations for KSI Collisions in this profile are of category Pedestrian Violation



Primary Countermeasures

Countermeasure	Crash Reduction Factor	Cost
High Visibility Crosswalk	35%	Low
Straighten Crosswalk	35%	Low
Leading Pedestrian Interval	60%	Low
New Pedestrian Crossing	35%	Medium
RRFB	35%	Medium
Relocate Bus Stops	N/A	Medium
Pedestrian Hybrid Beacon	55%	High

Secondary Countermeasures

- Curb Extensions
- Segment Lighting
- Refuge Island

Profile 2

DUI Overnight Collisions

Driving Under the Influence (DUI) collisions account for over a quarter of all KSI collisions in Modesto. Non-engineering interventions will need to be the primary means of addressing these challenges, but may be supplemented with the listed engineering countermeasures that aim to make roadway designs more forgiving in general.

Overall Collisions	483	4	9
	5% of total injury collisions	**1%** of bike collisions	**1%** of pedestrian collisions
KSI Collisions	83	1	5
	11% of total KSI collisions	**1%** of KSI bike collisions	**2%** of KSI pedestrian collisions

Key Trends

Top Crash Types

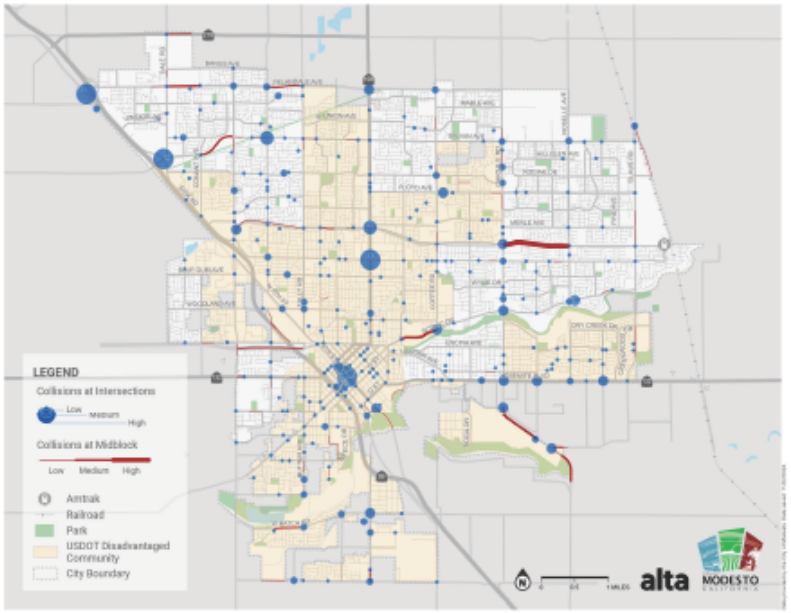
33% of Crashes for this profile are of type Hit Object

24% of KSI Crashes for this profile are of type Rear End

Top KSI Crash Types

39% of KSI Crashes for this profile are of type Hit Object

20% of KSI Crashes for this profile are of type Broadside



Primary Countermeasures

Countermeasure	Crash Reduction Factor	Cost
Rumble Strips	15-20%	Low
Reflectors, and/or Object Markers	N/A	Low
Guardrail	N/A	Low

Non-Infrastructure:

- Speed Limit Reduction
- Travel Demand Management Policies
- Public Information Campaigns
- Targeted Enforcement and Deterrence

Secondary Countermeasures

- Widen Shoulder
- Speed Feedback Sign
- Safety Edge
- Improved Pavement Friction

Profile 3

Broadside Collisions at Signalized Major-Minor Intersections

Broadsides are one of the collision types most likely to cause death or severe injury due to the high amount of kinetic energy transfer. Locations and roadway contexts of particular concern include intersections of minor roadways with major roadways or highways and intersections with unprotected lefts. The listed countermeasures are aimed to reduce or separate turning movement conflicts and slow vehicles upon approach to and through intersections.

Overall Collisions
1218
12% of total injury collisions

76
12% of bike collisions

4
<1% of pedestrian collisions

KSI Collisions
55
7% of total KSI collisions

5
6% of KSI bike collisions

Key Trends

Top Violation Categories

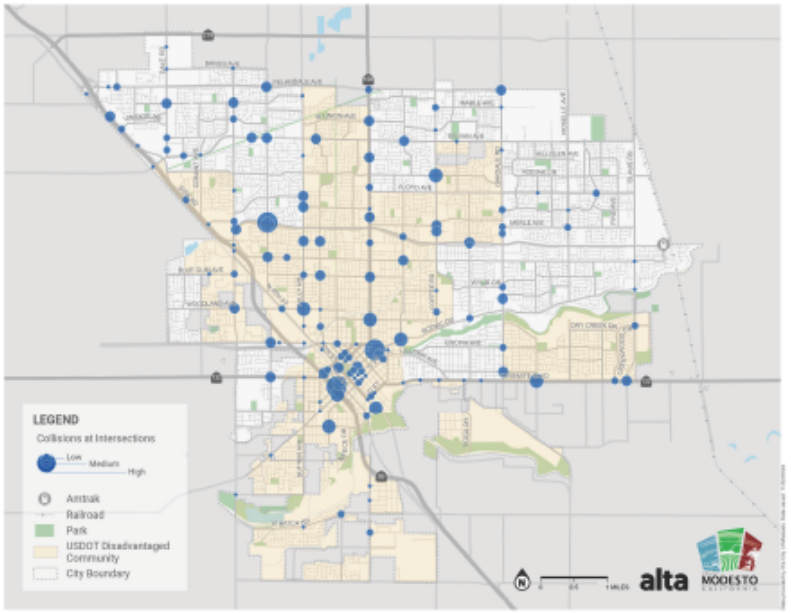
55% of Violations for this profile are of category Traffic Signals and Signs

21% of Violations for this profile are of category Automobile Right of Way

Top KSI Violation Categories

47% of Violations for KSI Collisions in this profile are of category Traffic Signals and Signs

18% of Violations for KSI Collisions in this profile are of category Automobile Right of Way



Primary Countermeasures

Countermeasure	Crash Reduction Factor	Cost
Extended Yellow and All-Red Time	15%	Low
Leading Pedestrian Interval	60%	Low
Protected Left Turns	30-55%	Medium
Red Light Camera	N/A	Medium
Protected Intersection	N/A	High
Road Diet, Roundabout	Varies	High
Bike Signal/Exclusive Bike Phase	15%	High

Non-Infrastructure:

- Speed Limit Reduction

Secondary Countermeasures

- Remove Sight Obstructions
- Centerline Hardening

Profile 4

Bicycle-Involved Collisions at Intersections Without On-Street Bicycle Facilities

The region has a large number of roadways without confortable and continuous bicycle facilities. People biking are vulnerable on roadways where they do not have designated facilities, especially when interacting with vehicles at intersections. The listed countermeasures aim to increase bike visibility at the intersection and slow down vehicles as they approach and travel through intersections.

Overall Collisions		KSI Collisions	
365	**365**	**41**	**41**
4% of total injury collisions	**56%** of bike collisions	**5%** of total KSI collisions	**52%** of KSI bike collisions

Key Trends

Top Crash Type

60% of Crashes for this profile are of type Broadside

Top KSI Crash Type

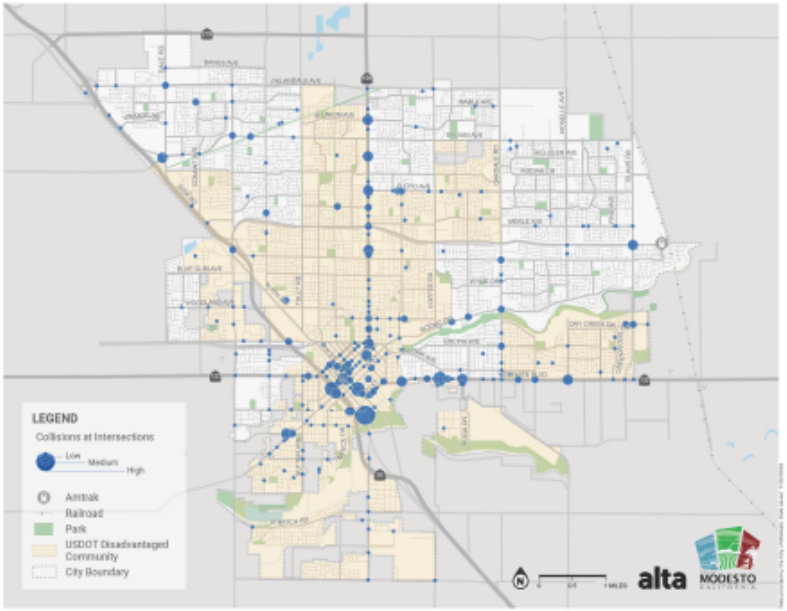
54% of KSI Crashes for this profile are of type Broadside

Top Violation Category

29% of Violations for this profile are of category Wrong Side of Road

Top KSI Violation Category

29% of Violations for KSI Collisions in this profile are of category Traffic Signals and Signs



Primary Countermeasures

Countermeasure	Crash Reduction Factor	Cost
Extend Bike Lane to Intersection	15%	Low
Bike Box	N/A	Low
Mixing Zone	N/A	Low
Prohibit Right Turn on Red	N/A	Low
Road Diet	35%	Medium
Bike Signal/Exclusive Bike Phase	15%	High
Protected Intersection	N/A	High

Secondary Countermeasures

- Pavement Reflectors
- Widen Shoulder
- Provide Appropriate Sightlines

Profile 5 Broadside Collisions Near Unsignalized Intersections Involving Bicycles

People biking are vulnerable on roadways, especially when interacting with vehicles at intersections. Unsignalized intersection add add an additional layer, as it is not always clear who has the right of way. Countermeasures are focused on improving the visibility of bicyclists at intersections, shortening the distance of unsignalized crossings,and other geometric changes which slow vehicle speeds through conflict zones.

Overall Collisions
222
2% of total injury collisions

222
34% of bike collisions

KSI Collisions
26
3% of total KSI collisions

26
33% of KSI bike collisions

Key Trends

Top Violation Categories

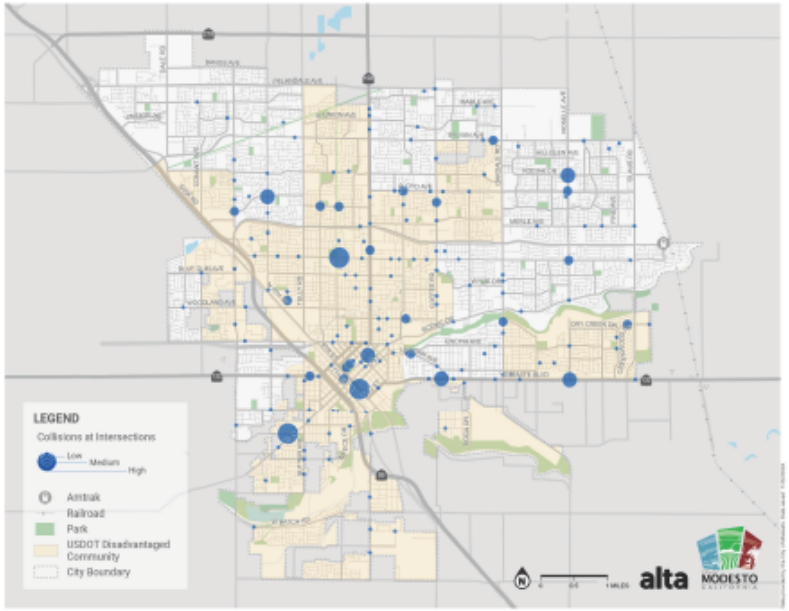
34% of Violations for this profile are of category Automobile Right of Way

31% of Violations for this profile are of category Wrong Side of Road

Top KSI Violation Categories

42% of Violations for KSI Collisions in this profile are of category Automobile Right of Way

23% of Violations for KSI Collisions in this profile are of category Traffic Signals and Signs



Primary Countermeasures

Countermeasure	Crash Reduction Factor	Cost
All-Way Stop Control	50%	Low
Intersection Lighting	40%	Medium
Raised Median	25%	Medium
Roundabout	Varies	High
Signal	30%	High

Secondary Countermeasures

- High Friction Surface Treatment
- Improve Sightlines

Profile 6

Bicycle and Pedestrian-Involved Collisions at Signalized Intersections Downtown

This profile highlights the need for enhanced pedestrian and bicycle safety at interections. Countermeasures are focused on improving the visibility of vulnerable road users at intersections, shortening the distance of unsignalized crossings, improving signal phasing to reduce conflicts with pedestrians and bicyclists, and other geometric changes which slow vehicle speeds through conflict zones.

Overall Collisions	**131**	**54**	**77**
	1% of total injury collisions	**8%** of bike collisions	**9%** of pedestrian collisions
KSI Collisions	**11**	**3**	**8**
	1% of total KSI collisions	**4%** of KSI bike collisions	**4%** of KSI pedestrian collisions

Key Trends

Top Crash Type

53% of Crashes for this profile are of type Vehicle/Pedestrian

Top KSI Crash Type

64% of KSI Crashes for this profile are of type Vehicle/Pedestrian

Top Violation Category

31% of Violations for this profile are of category Pedestrian Right of Way

Top KSI Violation Category

36% of Violations for KSI Collisions in this profile are of category Pedestrian Right of Way

Primary Countermeasures

Countermeasure	Crash Reduction Factor	Cost
Bike Box	15%	Low
High-Visibility Crosswalk	35%	Low
Prohibit Right Turn on Red	N/A	Low
Leading Pedestrian Interval	60%	Low
Protected Left Turns	30-55%	Medium
Red Light Camera	N/A	Medium
Bike Signal/Exclusive Bike Phase	15%	High
Protected Intersection	N/A	High

Secondary Countermeasures

- Curb Extensions
- Segment Lighting
- Refuge Island

Profile 7

Midblock Overnight Hit Object Collisions

Collisions during the nighttime are a serious concern, as many of the roadways in the City are not well lit, and streetlights that do exist vary in their efficacy. The listed countermeasures are aimed to improve visibility for and of all modes in dark conditions and creating safety redundancies in anticipation of impaired visibility.

Overall Collisions
74
1% of total injury collisions

KSI Collisions
11
1% of total KSI collisions

Key Trends

Top Violation Categories

41% of Violations for this profile are of category Under the Influence of Alcohol or Drug

32% of Violations for this profile are of category Improper Turning

Top KSI Violation Categories

36% of Violations for KSI Collisions in this profile are of category Under the Influence of Alcohol or Drug

36% of Violations for KSI Collisions in this profile are of category Unsafe Speed

Primary Countermeasures

Countermeasure	Crash Reduction Factor	Cost
Delinerators, Reflectors, and/or Object Markets	15%	Low
Rumble Strips	15-20%	Low
Guardrail	25%	Medium
Segment Lighting	35%	Medium

Secondary Countermeasures

- Pavement Reflectors
- Widen Shoulder
- Provide Appropriate Sightlines

Appendix A

The overall statistics for the HINs include:

- **All Collisions:** 7% of Modesto's roadways account for 66% of citywide KSI collisions
    - **Within an ETC:** 79% of the All Collisions HIN
    - **Within 0.25 Miles of a School:** 20% of the All Collisions HIN
    - **Roadway Classification:** 85% of the All Collisions HIN is on a major or minor arterial
    - **Posted Speed:** 50% of the All Collisions HIN is on roadways with a posted speed of 35 or 45 miles per hour
- **Bicycle-Involved Collisions:** 6% of Modesto's roadways account for 92% of citywide bicycle-involved KSI collisions
    - **Within an ETC:** 82% of the Bicycle Collisions HIN
    - **Within 0.25 Miles of a School:** 22% of the Bicycle Collisions HIN
    - **Roadway Classification:** 70% of the Bicycle Collisions HIN is on a major or minor arterial
    - **Posted Speed:** 50% of the Bicycle Collisions HIN is on roadways with a posted speed of 35 or 45 miles per hour
- **Pedestrian-Involved Collisions:** 7% of Modesto's roadways account of 87% of citywide pedestrian-involved KSI collisions
    - **Within an ETC:** 81% of the Pedestrian Collisions HIN
    - **Within 0.25 Miles of a School:** 29% of the Pedestrian Collisions HIN
    - **Roadway Classification:** 64% of the Pedestrian Collisions HIN is on a major or minor arterial
    - **Posted Speed:** 55% of the Pedestrian Collisions HIN is on roadways with a posted speed of 30 miles per hour or lower

Appendix B

The collision analysis was used to develop a list of profiles which are disproportionately reflected in collision records. The initial refinement of profiles used a collision count and KSI severity threshold as follows:

- **Profiles involving All Modes:**
  - Minimum collision/contextual pair count: 50
  - KSI % share of collision/contextual count: 20% (3x the KSI % citywide)
- **Profiles involving Pedestrians:**
  - Minimum collision/contextual pair count: 10
  - KSI % share of collision/contextual count: 50% (2x the KSI % citywide)
- **Profiles involving Bicycles:**
  - Minimum collision/contextual pair count: 10
  - KSI % share of collision/contextual count: 30% (3x the KSI % citywide)
- **Profiles involving Motorcycles:**
  - Minimum collision/contextual pair count: 10
  - KSI % share of collision/contextual count: 50% (2x the KSI % citywide)