TECHNICAL MEMORANDUM

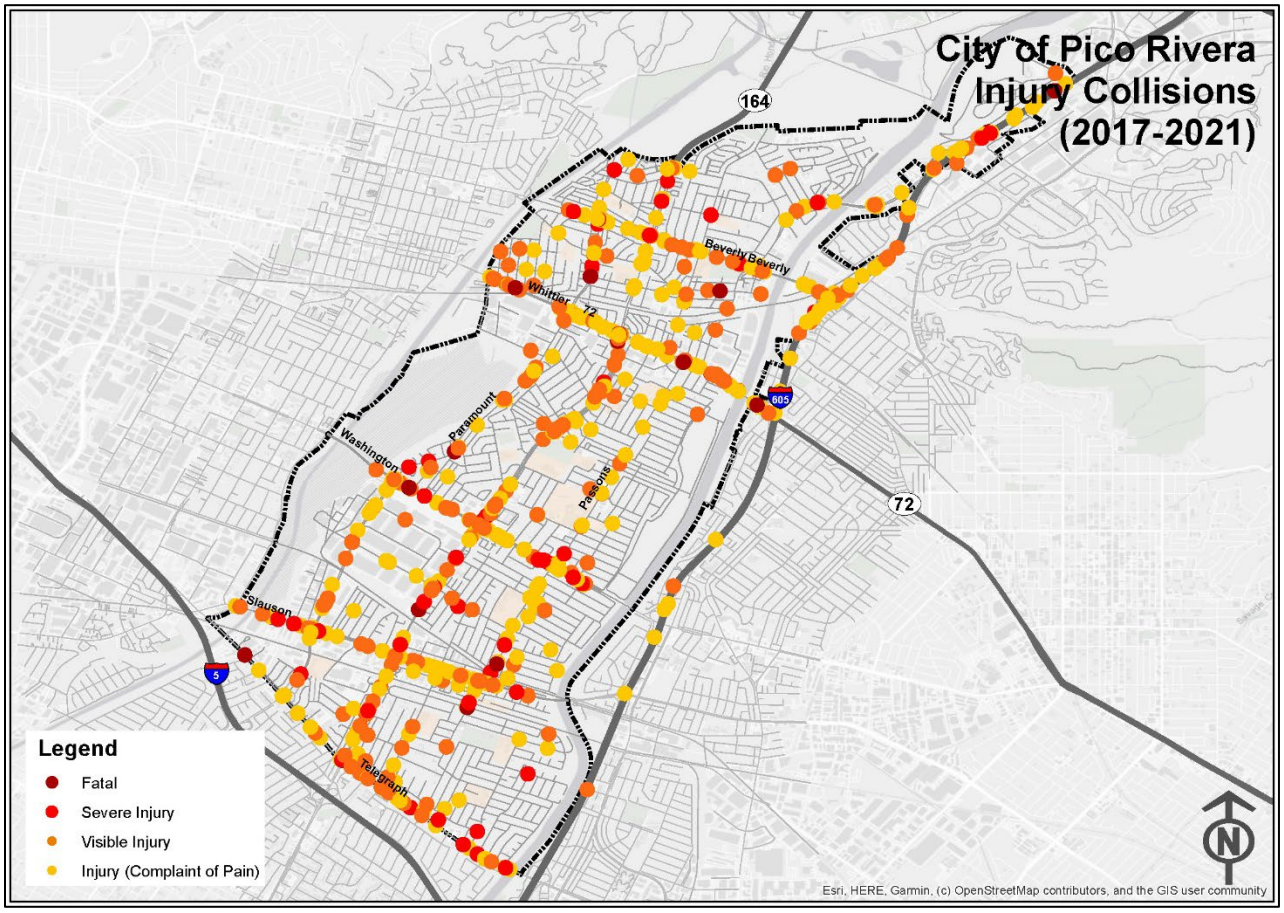
Date:	October 11, 2022
To:	Kenner Guerrero, City of Pico Rivera
From:	Ruta Jariwala, Mark Doty and Utsav Domadia, TJKM
Subject:	Systemic Safety and Trend Analysis, and Identification of High Injury Network for the City of Pico Rivera Local Roadway Safety Plan (LRSP)

This technical memorandum summarizes the results of the collision analysis that have occurred in the City of Pico Rivera between January 1, 2017 and December 31, 2021, as part of the Local Roadway Safety Plan (LRSP). This memorandum includes the following sections:

1. Data Collection
2. Collision Data Analysis
3. Fatal and Severe Injury Collision Analysis
4. Geographic Collision Analysis
5. High Injury Network
6. Summary

The LRSP focuses on systemically identifying and analyzing traffic safety issues and recommends appropriate safety improvements. The memorandum starts with a comprehensive analysis of collisions of all severity types in the City of Pico Rivera and compares this with killed and severe Injury (KSI) collisions. Factors such as collision severity, type of collision, primary collision factor, lighting, weather, and time were analyzed. Following this, a more detailed analysis was conducted for killed and severe injury (KSI) collisions that have occurred on the city's roadways, including analyzing intersection and roadway segment collisions separately. **Figure 1** illustrates all the injury collisions that have occurred in the City of Pico Rivera from 1/1/2017 to 12/31/2021.

Figure 1. Injury Collisions in the City of Pico Rivera (2017-2021)



DATA COLLECTION

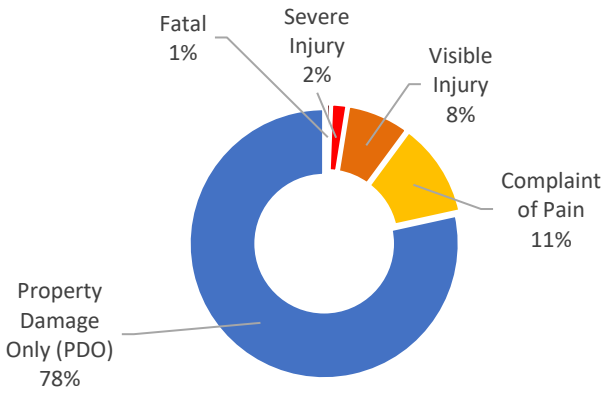
Collision data helps to understand different factors that might be leading to collisions and influencing collision patterns in a given area. For the purpose of this analysis, five-years of jurisdiction-wide collision data (2017 to 2021) was retrieved from Transportation Injury Mapping System (TIMS) and Statewide Integrated Traffic Records System (SWITRS). The collision data was analyzed and plotted in ArcMap to identify high-risk intersections and roadways segments.

COLLISION DATA ANALYSIS RESULTS

Collision Analysis by Severity

There were a total of 3,194 collisions reported on the City of Pico Rivera roads from 2017 to 2021. Out of these, 2,505 were property damage only collisions (78%). 366 collisions led to a complaint of pain injury (11%), and 242 collisions (8%) led to a visible injury. There were 81 KSI (fatal and severe injury) collisions, of which 62 collisions (2%) led to a severe injury and 19 collisions (1%) led to a fatality. **Figure 2** illustrates the classification of all collisions based on severity.

Figure 2. Collisions by Severity (2017 -2021)



The analysis first includes a comparative evaluation between all collisions and KSI collisions, based on various factors including (but not limited to): collision trend, primary collision factor, collision type, facility type, motor vehicle involved with, weather, lighting, and time of the day. Following this, a comprehensive analysis is conducted for only KSI collisions. KSI collisions cause the most damage to those affected and to infrastructure. The aftermath of these collisions can lead to great expenses for jurisdiction administration. The LRSP process thus focuses on these collision locations to proactively identify and counter safety issues leading to these KSI collisions.

The collision data was separated by facility type, i.e. based on collisions occurring on intersections and roadway segments. For the purposes of the analysis and in accordance with HSIP guidelines, a collision was designated to have occurred at an intersection if it occurred within 250 feet of it. The reported collisions categorized by facility type and collision severity are presented in **Table 1**.

Table 1. Collision by Severity and Facility Type

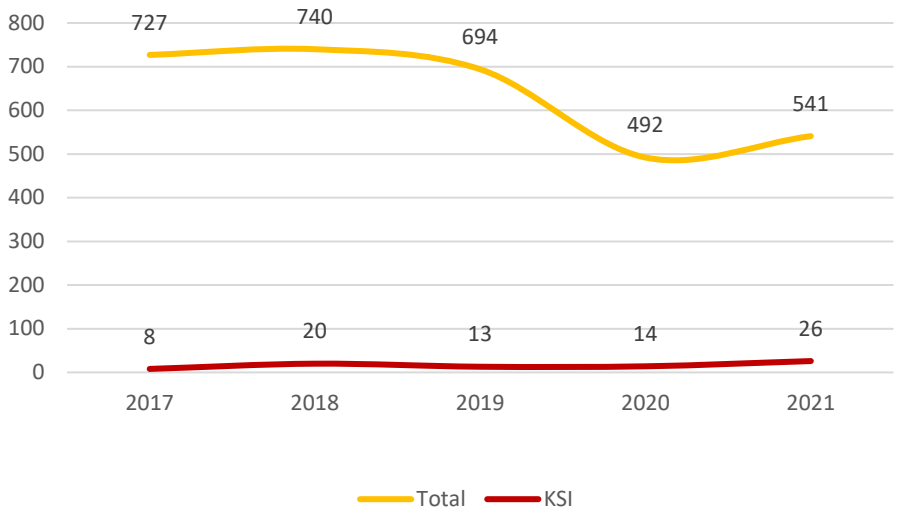
Collision Severity	Roadway Segment	Intersection	Total
Fatal	4	15	19
Severe Injury	16	46	62
Visible Injury	47	195	242
Complaint of Pain	59	307	366
Property Damage Only	370	2,135	2,505
Total	**496**	**2,698**	**3,194**

PRELIMINARY ANALYSIS

Yearly Trend

The number of reported collisions of all severity has overall decreased between 2020 and 2021, with an increase from 2021. The year with the highest number of collisions was 2018 (740 collisions), while the year with the lowest number of collisions was 2021 (492 collisions). A total of 81 KSI collisions occurred in the City of Pico Rivera during the study period, it was observed that KSI collisions percentage was higher during the pandemic years (2020 and 2021). Overall, this shows that during the pandemic the total number of collisions were lower but the severity of collisions higher than normal, which could be lesser number of vehicles within the system. The least number of KSI collisions occurred in 2017 (8 collisions), while the most occurred in 2021 (26 collisions). **Figure 3** illustrates the five-year collision trend for all collisions, and KSI collisions.

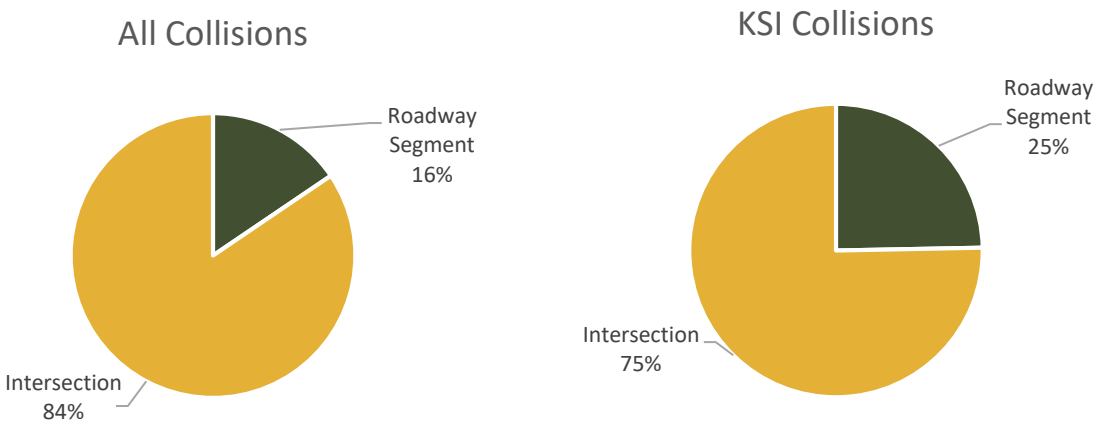
Figure 3. Five Year Collision Trend



Roadway Segment vs. Intersection

When evaluating the locations of collisions, most collisions occurred at intersections and not along roadway segments. In the City of Pico Rivera, 84% of all collisions (2,698 collisions) occurred at intersections whereas 16% (496 collisions) occurred on roadway segments. The proportion of roadway segment collisions is slightly higher (25%) when looking only at KSI collisions. This classification by facility type is illustrated in **Figure 4**.

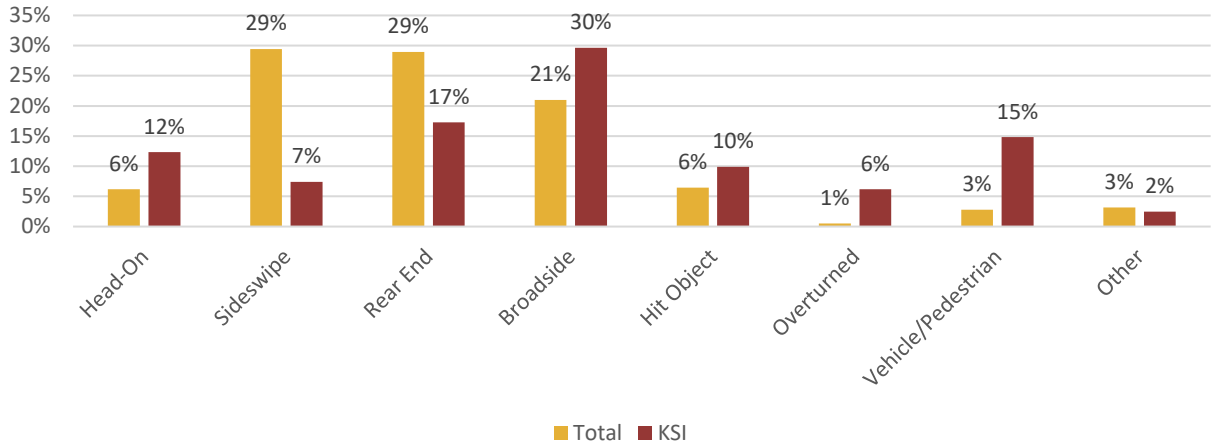
Figure 4. Roadway Segment vs. Intersection: All Collisions vs. KSI Collisions



Collision Type

For all collisions, the most commonly occurring collision types were sideswipe collisions (29%) and rear end collisions (29%). The collision types for KSI collisions follow a different pattern, where the most commonly occurring collision type was broadside collisions (30%), rear end collisions (17%) and vehicle/pedestrian (15%). **Figure 5** illustrates the collision type for all collisions as well as KSI collisions.

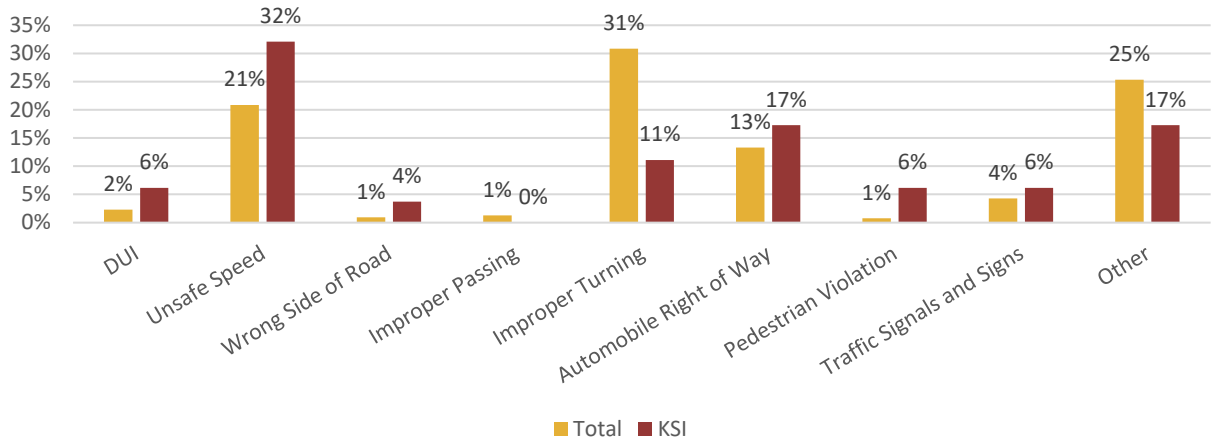
Figure 5. Collision Type - All Collisions vs KSI Collisions



Primary Violation Category

For all collisions, the top three primary violation categories were observed to be improper turning (31%), unsafe speed (21%), and automobile right of way (13%). The top two primary violation categories for KSI collisions were unsafe speed (32%), and automobile right of way (17%). **Figure 6** illustrates the violation category for all collisions and KSI collisions.

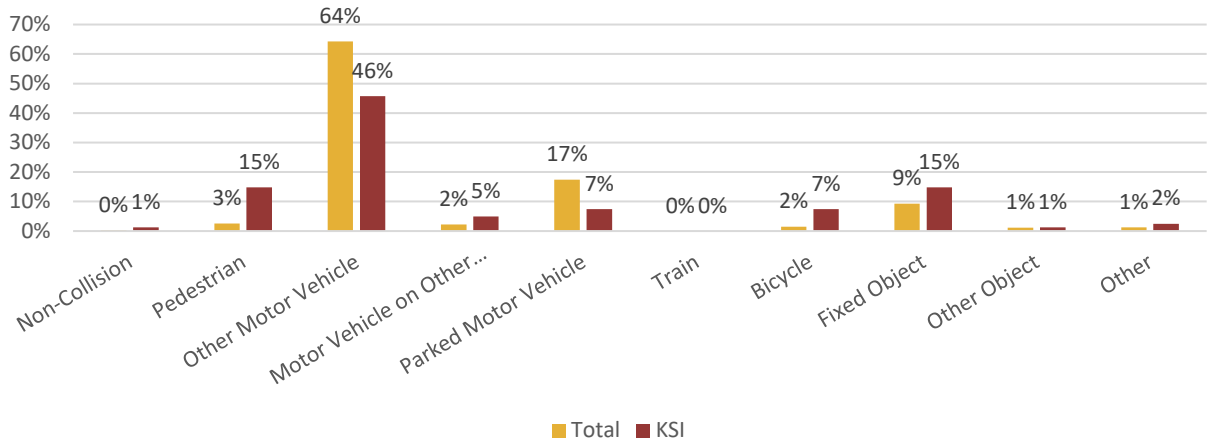
Figure 6. Primary Violation Categories: All Collisions vs KSI



Motor Vehicle Involved With

For all collisions, 64% of the collisions occurred by motor vehicles colliding with other vehicles. This was followed by motor vehicles involved with parked motor vehicle (17%) and fixed object (9%). For KSI collisions, 46% involved other motor vehicle, 15% of the collisions involved a fixed object and 15% involved pedestrian. **Figure 7** illustrates the motor vehicle involved with category for all collisions as well as KSI collisions.

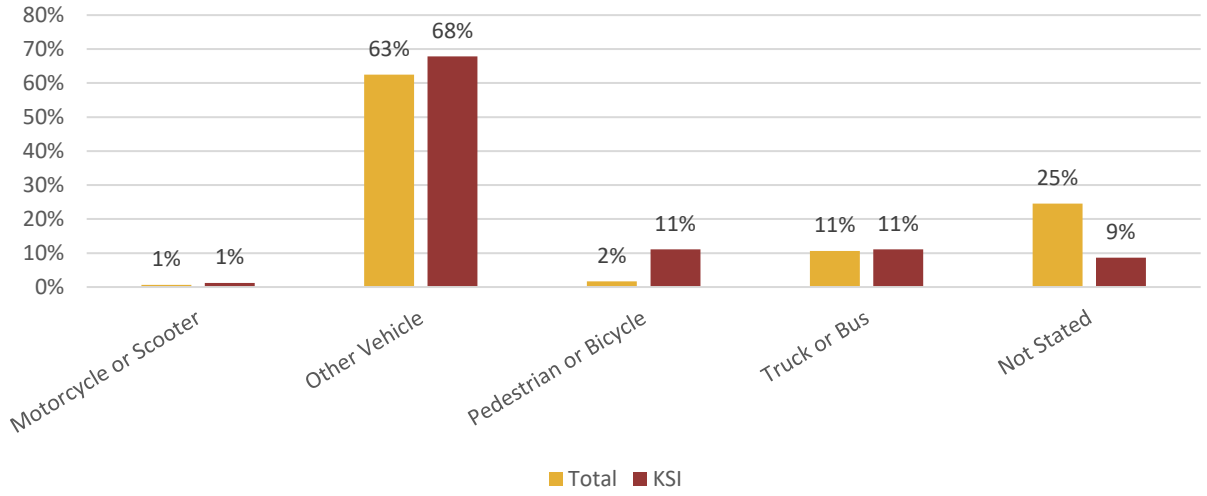
Figure 7. Motor Vehicle Involved With: All Collisions vs KSI Collisions



Transportation Modes

The modes category provides a more detailed breakdown of the vehicle type at fault in the collision. For all collisions, the majority were caused by motor vehicles (63%). Collisions caused by motor vehicles (68%) also makes up the majority of KSI collisions, but pedestrian or bicycle caused collisions and truck or bus were both the same percentage (11%). **Figure 8** illustrates the percentage for all collisions as well as KSI collisions by mode.

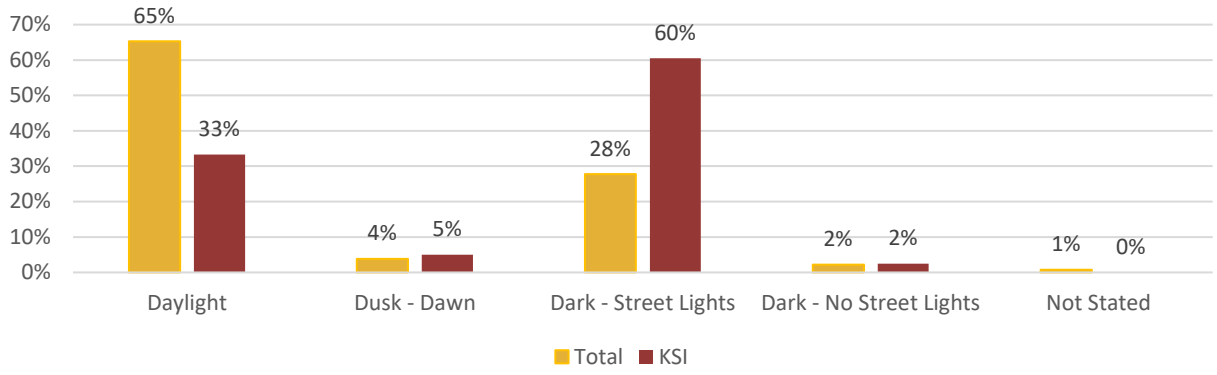
Figure 8. Modes: All Collisions vs KSI Collisions



Lighting

For all collisions, 65% of collisions occurred in daylight, while 28% of collisions occurred in the dark on streets with streetlights. For KSI collisions, a higher percentage of crashes occurred in nighttime conditions, with 33% of collisions having occurred in daylight and 60% of collisions occurred in the dark on streets with street lights. **Figure 9** illustrates the lighting condition for all collisions and KSI collisions.

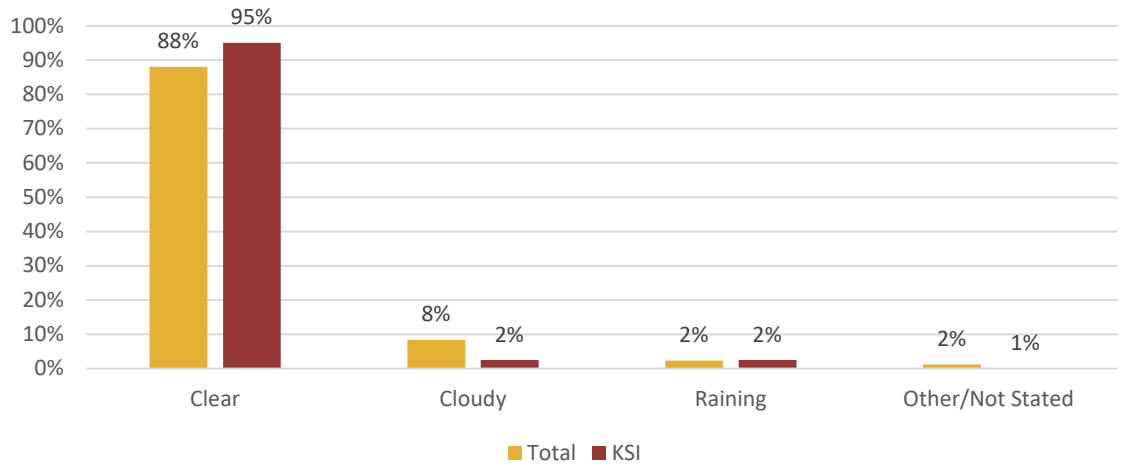
Figure 9. Lighting Conditions: All Collisions vs KSI Collisions



Weather

For all collisions, the vast majority occurred during clear weather conditions (88%). For KSI collisions similar trends have been observed, with 95% of the collisions having occurred during clear weather conditions. **Figure 10** illustrates the percent distribution of weather conditions during occurrence of collisions of all severity as well as KSI collisions.

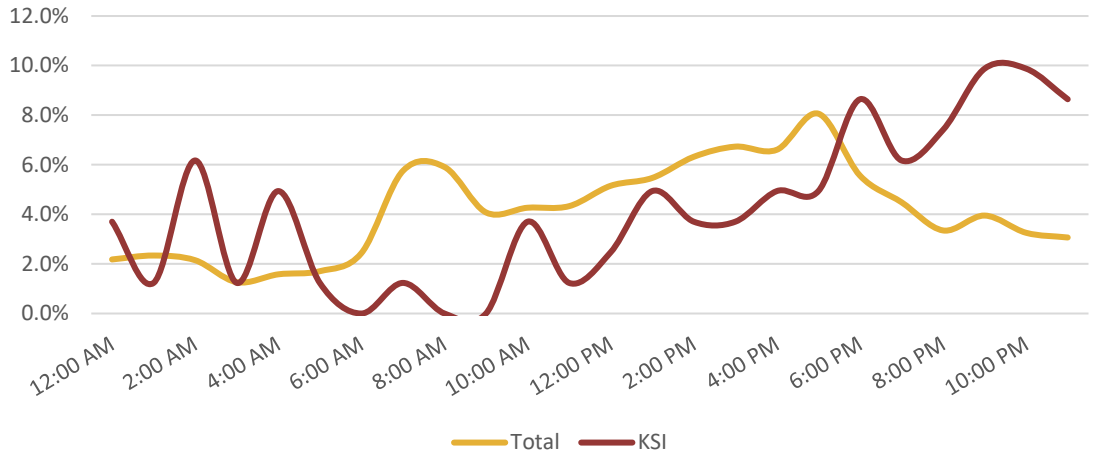
Figure 10. Weather Conditions: All Collisions vs KSI Collisions



Time of the Day

For all collisions, the time period with the most number of collisions was between 4:00 p.m. to 6:00 p.m. (25%), while the time period with the fewest number of collisions was between 3:00 a.m. to 6:00 a.m. (2%). For all KSI collisions, the maximum number of collisions occurred between 9:00 p.m. to 11:00 p.m., and while the time period with the fewest number of collisions was between 8:00 a.m. to 10:00 a.m. **Figure 11** illustrates the percentage of collisions occurring during each hour of the day for all collisions as well as KSI collisions.

Figure 11. Time of the Day: All Collisions vs KSI



Fatal and Severe Injury Collisions

This section describes a detailed collision analysis performed for KSI collisions occurring at roadway segments and intersections in the City of Pico Rivera. Of the total 81 KSI collisions that occurred during the study period, 20 collisions (25%) occurred on roadway segments and 61 collisions (75%) occurred at intersections. This distribution is illustrated in Figure 12 below.

Figure 12. Intersection vs. Roadway Segment Collisions – KSI Collisions

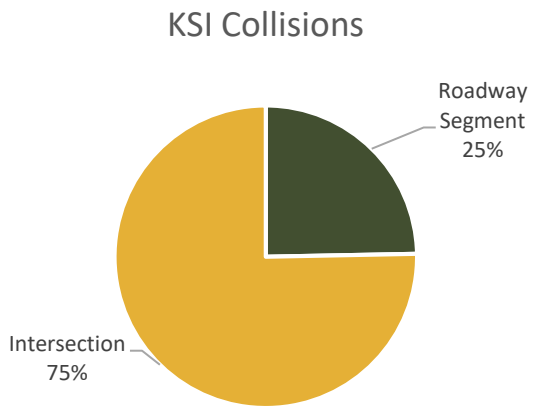
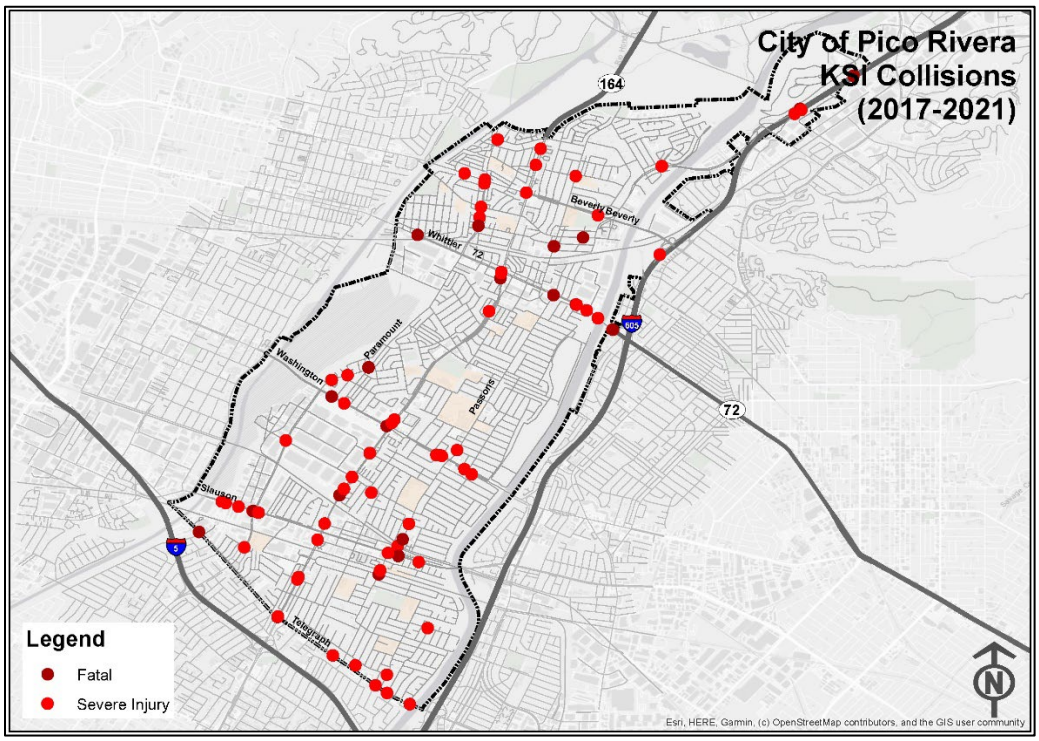


Figure 13 maps the KSI collisions that occurred the City of Pico Rivera during the study period.

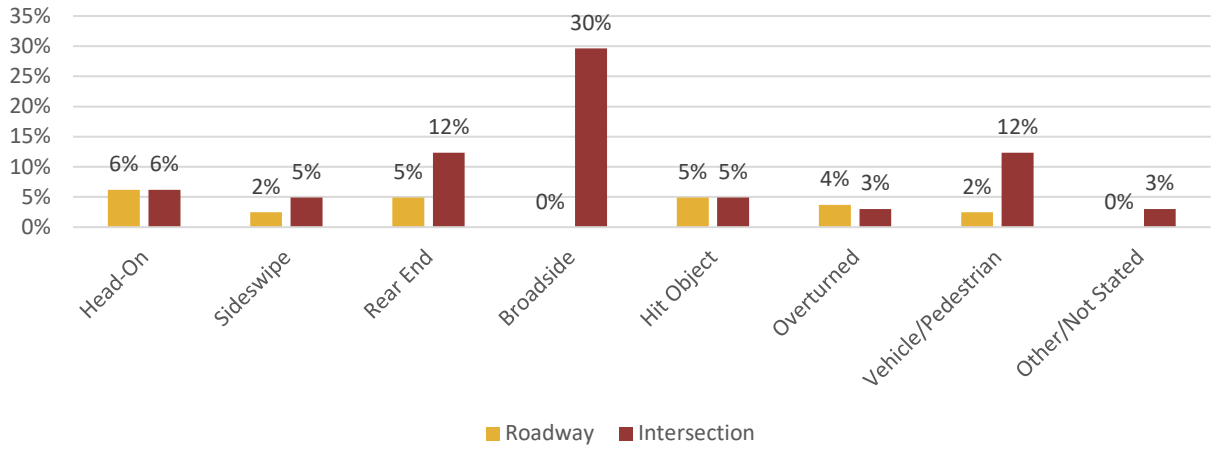
Figure 13. Fatal and Severe Injury Collisions (2017 - 2021)



Collision Type and Location Type

The most common KSI collision types were broadside (30%) and rear end collisions (17%). These collisions were most likely to occur at intersections, along with vehicle/pedestrian collisions (14%). **Figure 14** shows fatal and severe injury collisions by locations as well as the collision type.

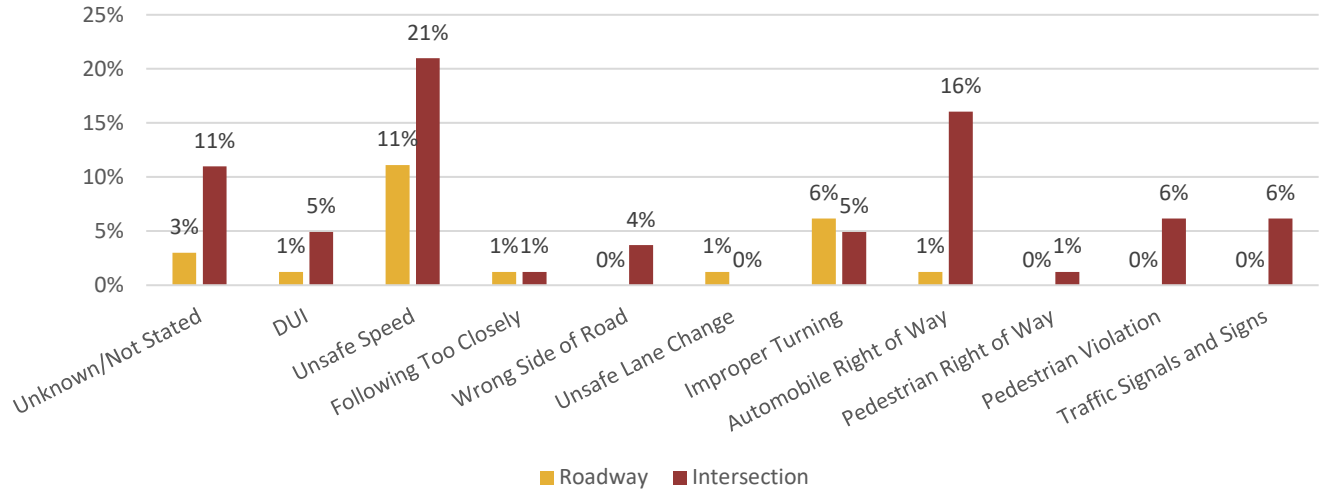
Figure 14. KSI Collision Type vs Location Type



Primary Violation Category and Location Type

The most common primary violation types among KSI collisions were unsafe speed (32%), automobile right of way (17%) and improper turning (11%). These KSI collisions majorly occurred at intersections. Unsafe speed was the most common violation category along intersections, as well as at roadway segments. **Figure 15** shows fatal and severe injury collisions as well as the location type and violation category.

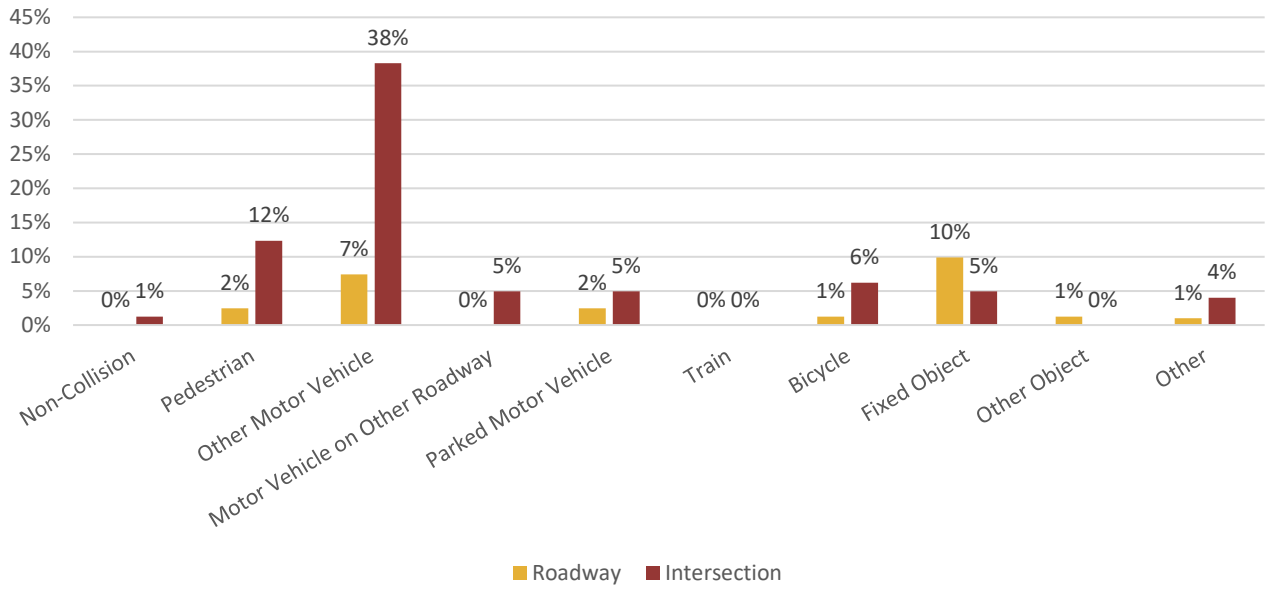
Figure 15. KSI Collisions: Violation Category vs Location Type



Motor Vehicle Involved With and Location Type

KSI collisions involving another vehicle (46% of all KSI collisions) was the most common type majorly occurring at intersections. The second most common collisions were collision with pedestrian (15%) and fixed objects (15%). **Figure 16** shows fatal and severe injury collisions locations as well as the collision type.

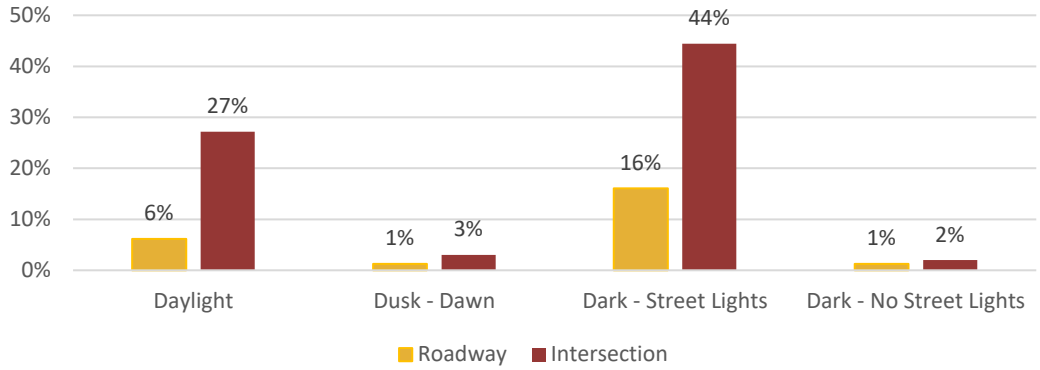
Figure 16. KSI Collisions: Motor Vehicle Involved With vs Location Type



Lighting vs and Location Type

Most KSI collisions occurred in the dark with street lights (60%). The second most common lighting for fatal and severe injury collisions was collisions that occurred at intersections in daylight (27%). **Figure 17** shows fatal and severe injury collisions locations as well as lighting conditions.

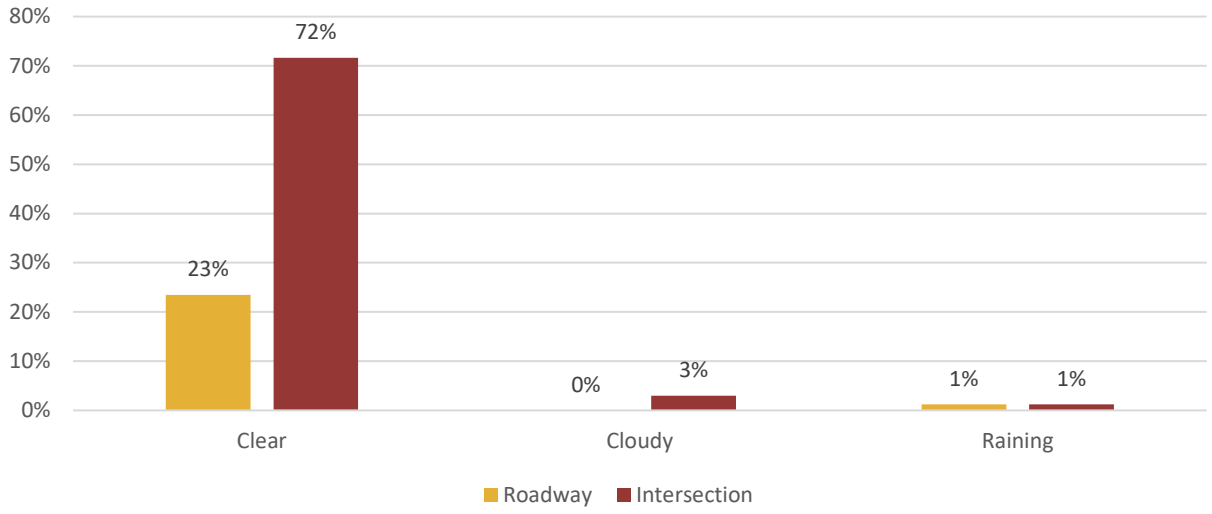
Figure 17. KSI Collisions: Lighting vs and Location Type



Weather and Location Type

The majority of KSI collisions occurred during clear weather primarily at intersections (72%). **Figure 18** shows fatal and severe injury collisions locations as well as weather conditions.

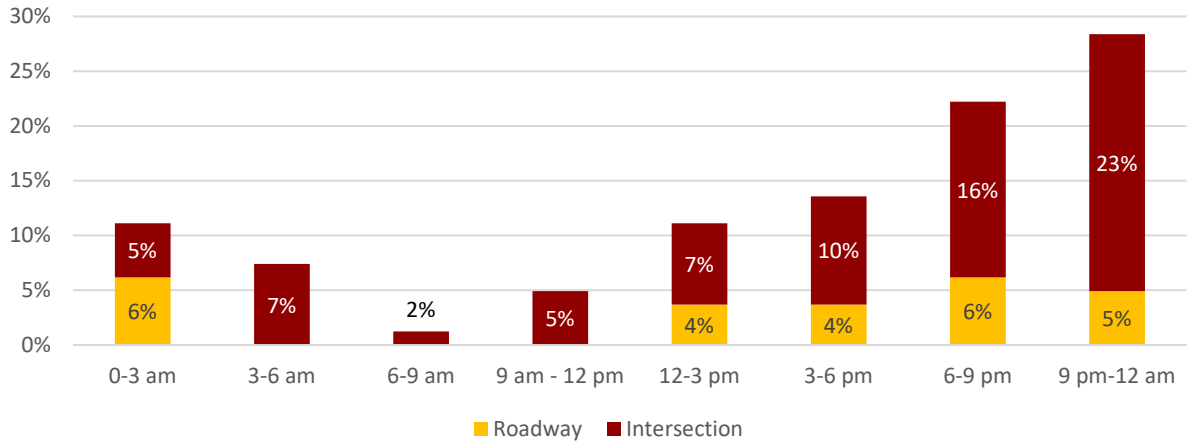
Figure 18. KSI Collisions: Weather vs Location Type



Time of the Day vs and Location Type

The time duration with the most KSI collisions was during 9:00 p.m. to 12:00 a.m. These primarily occurred at intersections, though the most number of roadway segment KSI collisions also occurred between 12:00 a.m. and 3:00 a.m. and 6:00 p.m. and 9:00 p.m. **Figure 19** shows fatal and severe injury collisions by location type and time of day.

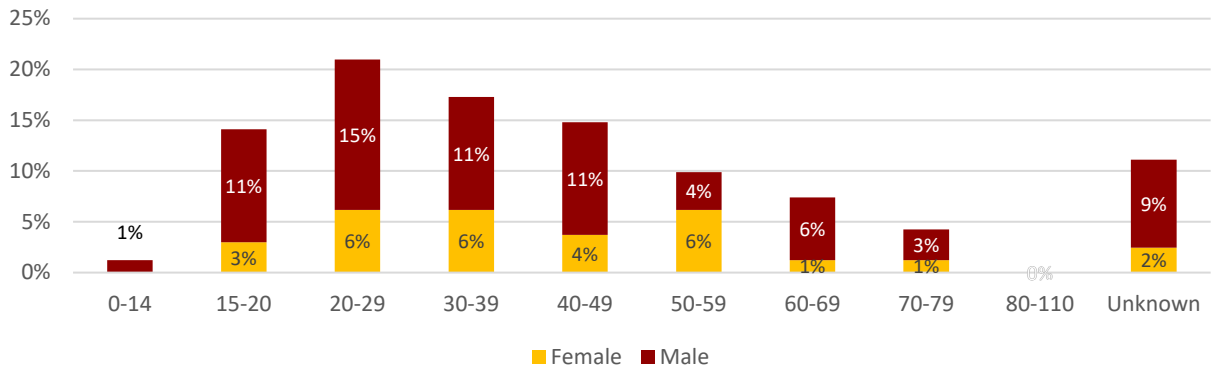
Figure 19. KSI Collisions: Time of Day vs Location Type



Gender vs Age

For KSI collisions, the gender of the party at fault was split between female and male. Parties at fault from the age group of 20-29 years accounts for the largest percentage (21%) of all KSI collisions. Parties at fault under 40 years of age accounts for slightly more than half (54%) of all KSI collisions. **Figure 20** illustrates the gender and age of the party at fault for KSI collisions.

Figure 20. KSI Collisions by Gender and Age



Geographic Collision Analysis

This section describes a detailed geographic collision analysis performed for injury collisions occurring on roadway segments and at intersections in the City of Pico Rivera. The collision analysis of all injury collisions was used to identify five main collision factors that highlight the top trends among collisions in the City of Pico Rivera. These five collision factors were identified to be broadside collisions, unsafe speed violations, nighttime collisions, rear end collisions, and improper turning violations.

Broadside Collisions

Broadside collisions represented the highest proportion of all injury collisions (28%), and similar trend for KSI collisions (30%). **Figure 22** shows the distribution of broadside collisions throughout the City of Pico Rivera between 2017 and 2021. The intersections of Paramount Blvd/Whittier Blvd and Passons Blvd and Slauson Avenue have a higher concentration of broadside collisions.

Unsafe Speed Violations

14% of all injury collisions in Pico Rivera were caused by unsafe speed. However, 32% of all KSI collisions were due to unsafe speed violation. **Figure 23** shows the distribution of unsafe speed collisions throughout the City of Pico Rivera between 2017 and 2021. Paramount Blvd, Whittier Blvd, Slauson Ave and Telegraph Rd have a higher concentration of unsafe speed collisions.

Nighttime Collisions

Collisions occurring at night represented 36% of all injury collisions, but rose significantly to 67% for KSI only collisions, indicating that lighting may be a factor in fatal and sever injury collisions. **Figure 24** shows the distribution of nighttime collisions throughout the City of Pico Rivera between 2017 and 2021. Beverly Blvd, Paramount Blvd, Rosemead Blvd and Whittier Blvd have a higher concentration of nighttime collisions.

Rear End Collisions

Rear end collisions caused 29% of all injury collisions, and 17% when considering only KSI collisions. **Figure 25** shows the distribution of rear end collisions throughout the City of Pico Rivera between 2017 and 2021. Telegraph, Slauson, Washington, and Whittier have a higher concentration of rear end collisions.

Improper Turning Violations

Improper turning violations accounted for 9% of all injury collisions, and nearly similar trend of 11% was observed when considering only KSI collisions. **Figure 26** shows the distribution of injury collisions due to improper turning throughout the City of Pico Rivera between 2017 and 2021.

The following figures detail concentrations of each of the above five collision factors on roadways throughout Pico Rivera. All injury collisions, whether they occurred at an intersection or roadway segment, are considered in these maps (for example, roads where a particular collision factor is more concentrated may have collisions that occurred at an intersection within the segment, or along the segment itself away from an intersection). Note that below maps were created using all injury collisions and does not include PDO collisions.

Figure 21. City of Pico Rivera Broadside Collisions (2017 - 2021)

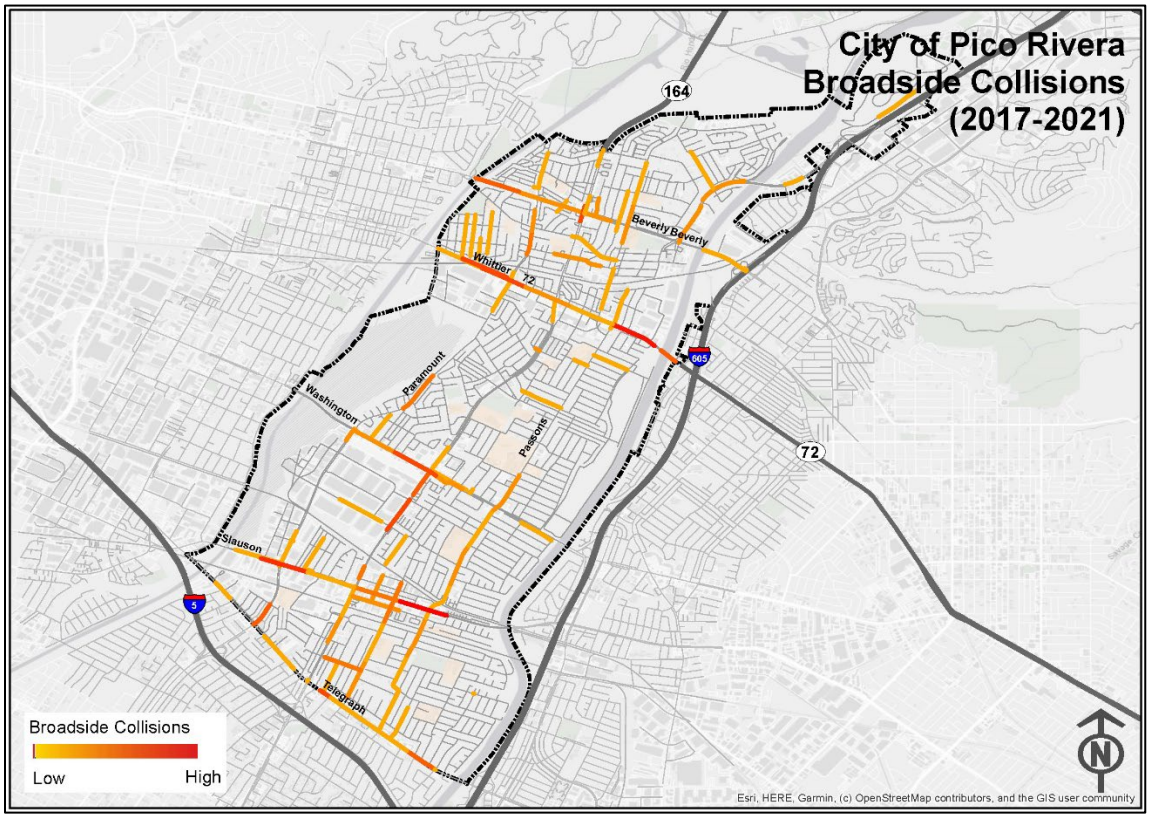


Figure 22. City of Pico Rivera Unsafe Speed Violations (2017-2021)

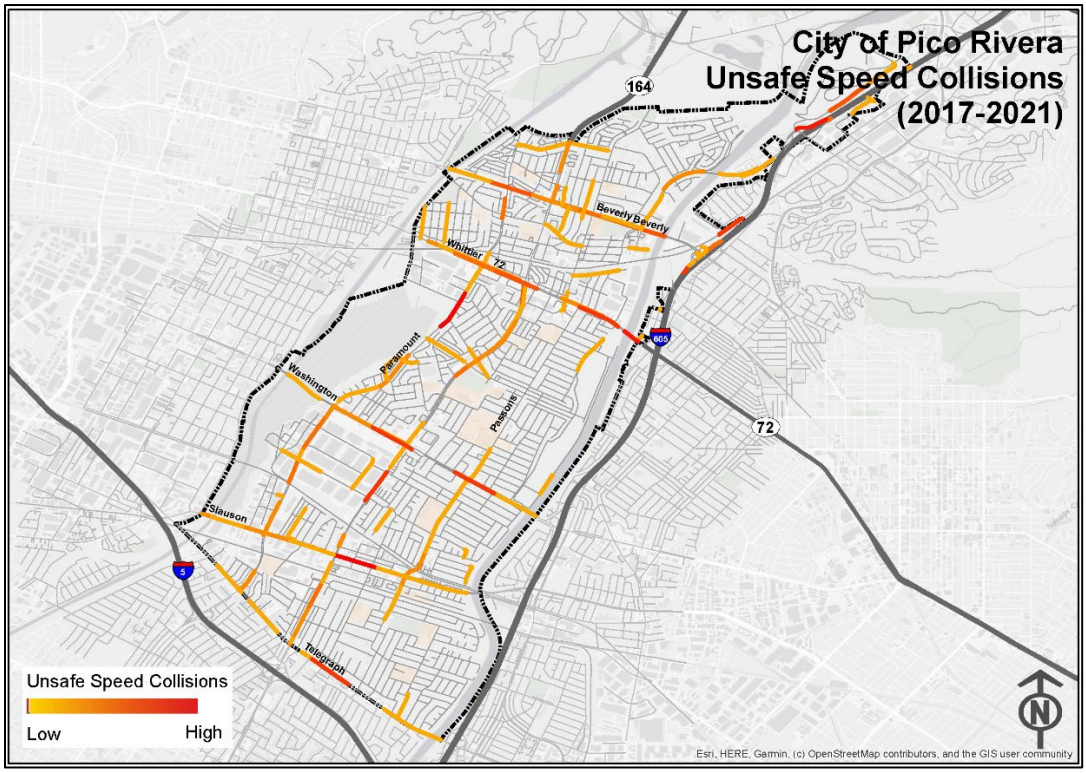


Figure 23. City of Pico Rivera Nighttime Collisions (2017 - 2021)

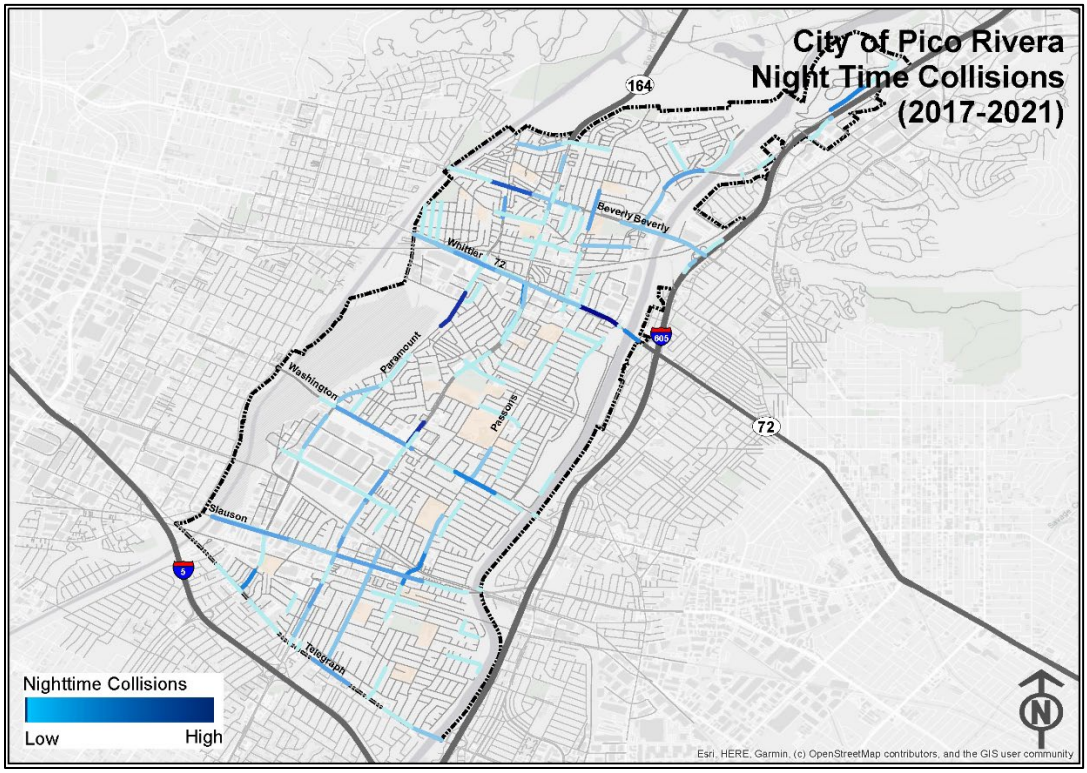


Figure 24. City of Pico Rivera Rear End Collisions (2017 - 2021)

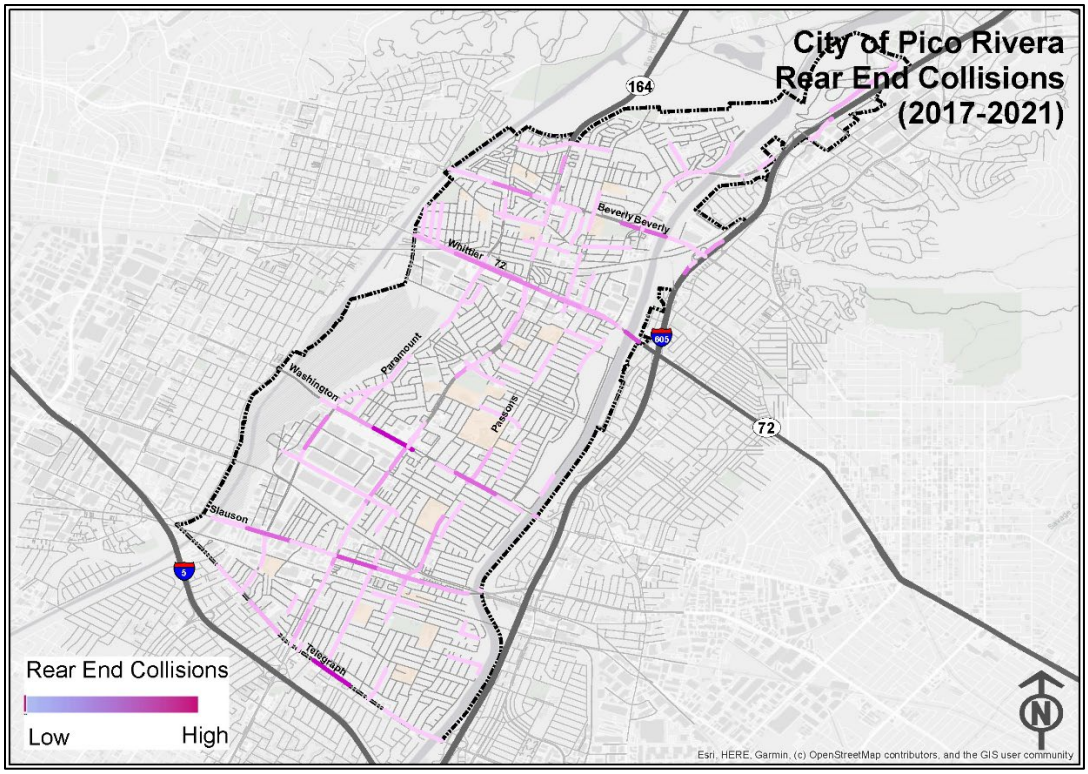
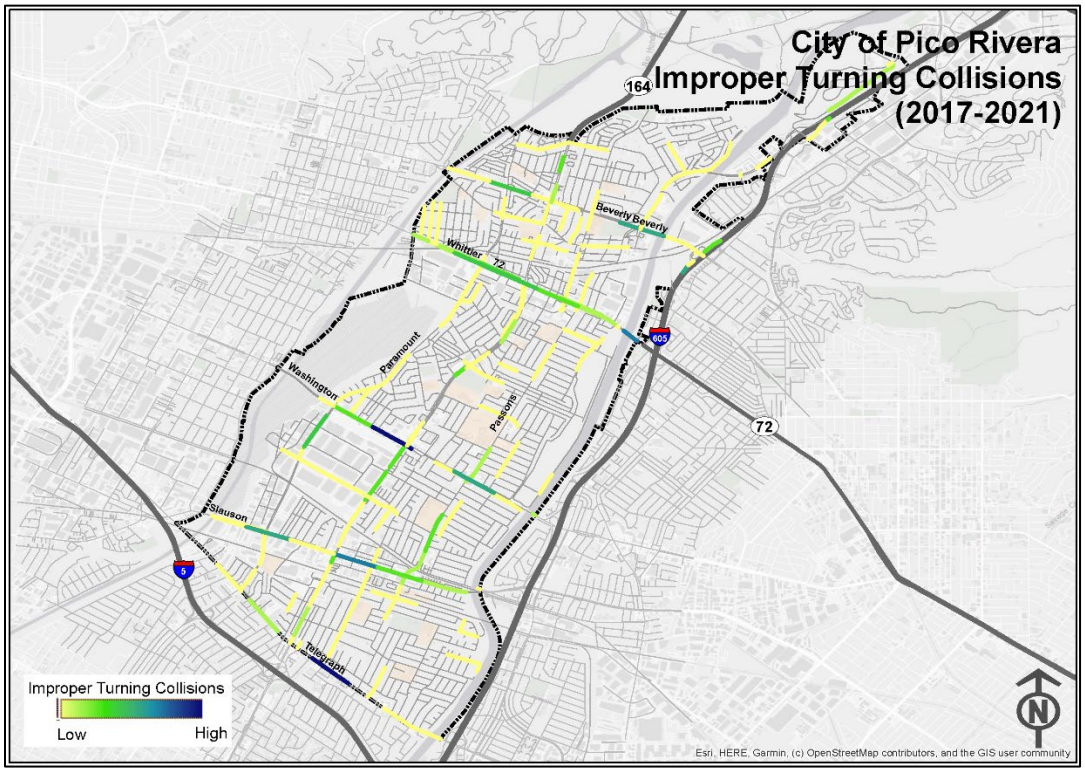


Figure 25. City of Pico Rivera Improper Turning Violations (2017 - 2021)



COLLISION SEVERITY WEIGHT

Equivalent Property Damage Only (EPDO) method was used to identify the high severity collision network. The EPDO method accounts for both the severity and frequency of collisions by converting each collision to an equivalent number of property damage only (PDO) collisions. The EPDO method assigns a crash cost and score to each collision according to the severity of the crash weighted by the comprehensive crash cost. These EPDO scores are calculated using a simplified version of the comprehensive crash costs per HSIP Cycle 10 application. The weights used in the analysis are shown below in **Table 2**.

Table 2. EPDO Score used in HSIP Cycle 10

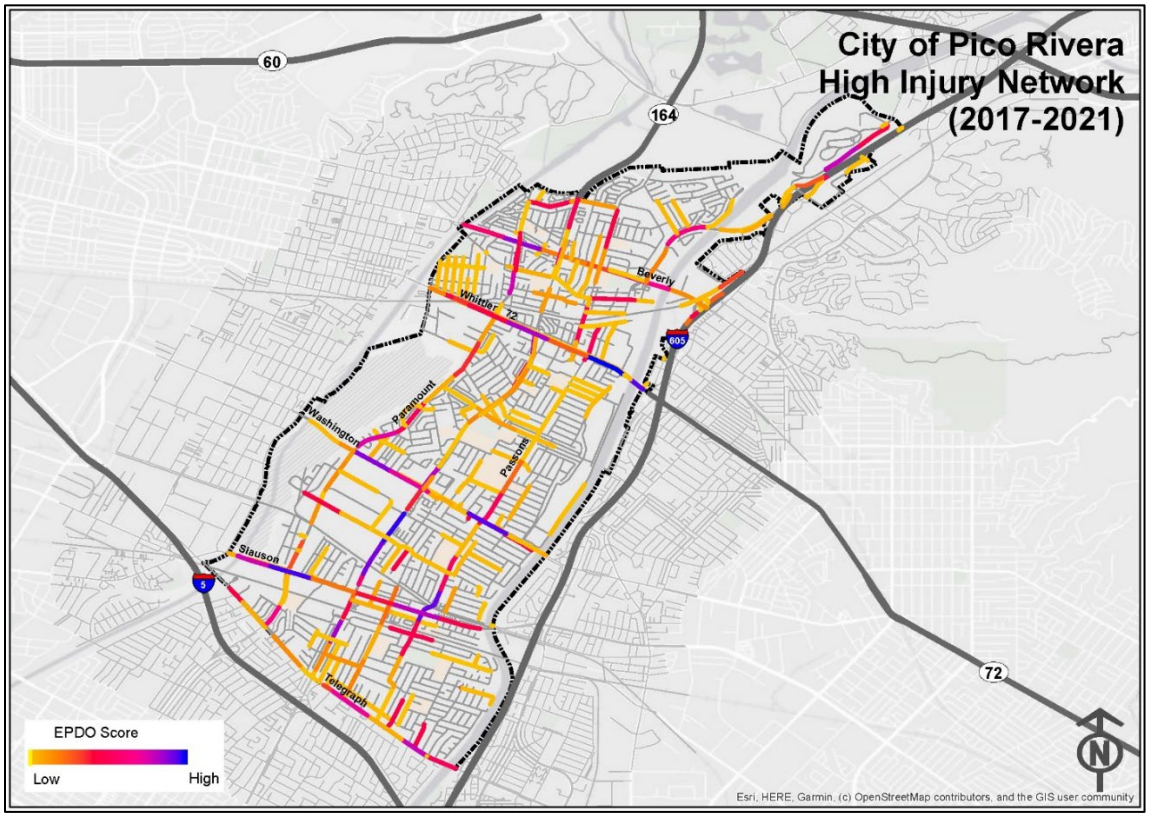
Collision Severity	EPDO Score
Fatal and Severe Injury Combined	165*
Visible Injury	11
Possible Injury	6
PDO	1

*This is the score used in HSIP Cycle 10 for collisions on roadways segments, to simplify the analysis this study uses the same score for all KSI collisions regardless of location.

EPDO is used because it provides a methodology for the project team to understand the locations in Pico Rivera that are experiencing the most severe crashes. Because of the high score given to fatal and severe injury crashes, locations that have these types of crashes are more likely to receive a higher EPDO score than other locations that may have more collisions, but fewer fatal or severe injury collisions. Locations that have the highest EPDO scores are selected for inclusion in the High Collision Network, shown in the next section. Identified intersections are scored based on collisions occurring at or within 250 feet of the intersection, while roadway segment locations are identified based on collisions that occur along the segment, except directly at an intersection (0 feet from intersection per SWITRS and TIMS data). Identifying the locations with the most severe crashes allows the team to focus recommended solutions and countermeasures at these locations.

The EPDO scores for all collisions can then be aggregated in a variety of ways to identify collision patterns, such as location hot-spots. The weighted collisions for the City of Pico Rivera were geolocated onto Pico Rivera's road network. GIS is then used to calculate the EPDO score for each roadway segment and intersection citywide, which is then ranked according to its score. **Figure 27** shows the location and geographic concentration of all collisions (those that occurred at intersections and along roadway segments) by their EPDO score.

Figure 26. City of Pico Rivera EPDO Score

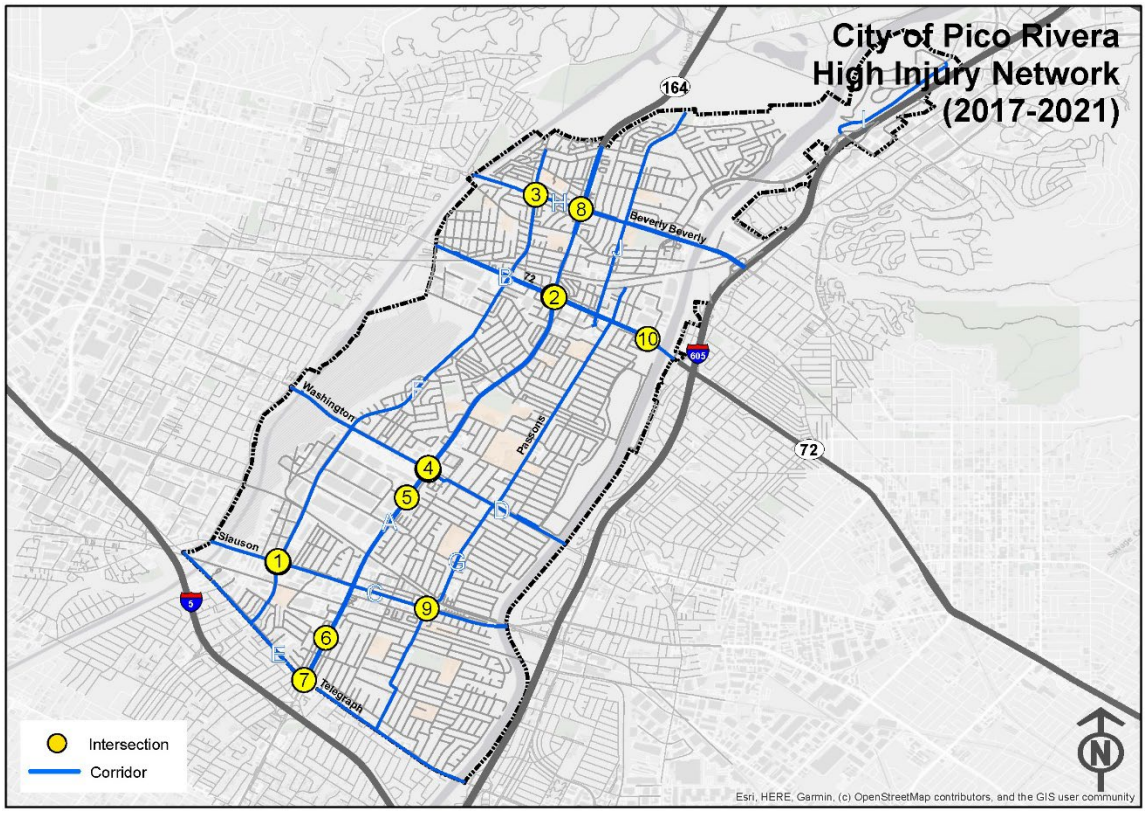


HIGH INJURY NETWORK

Following the detailed collision analysis, the next step was to identify the high-injury roadway segments and intersections in Pico Rivera. The methodology for scoring the high injury locations is the same method as used in the collision severity weight section. **Figure 28** shows the top 10 high-injury roadway segments, and top 10 high-injury intersections.

For the purposes of the high injury network analysis, intersections include collisions that occurred within 250 feet of it, and roadway segments include all collisions that occurred along the roadway except for collisions that occurred directly at an intersection. Such collisions are assigned a 0 value in distance from intersection value column in the Statewide Integrated Traffic Records System (SWITRS).

Figure 27. City of Pico Rivera High Injury Network



Intersection Rankings

10 intersections were identified as high collision intersections. There were a total of 85 injury collisions and 20 KSI collisions that occurred at these intersections during the five-year study period (2017-2021). The intersection of Slauson Ave and Paramount Blvd had the highest number of KSI collisions.

Table 3 lists the top 9 identified high-risk intersections along with the number of injury collisions, the number of KSI collisions, and the severity weight for each intersection.

Table 3. High Injury Intersections

ID	Intersection	Total Injury Collisions	Severity Weight
1	Slauson Ave and Paramount Blvd	14	581
2	Rosemead Blvd and Whittier Blvd	8	535
3	Beverly Blvd and Paramount Blvd	14	530
4	Rosemead Blvd and Washington Blvd	10	422
5	Rosemead Blvd and Danbridge St	7	365
6	Rosemead Blvd and Maxine St	5	358
7	Rosemead Blvd and Telegraph Rd	4	342
8	Beverly Blvd and Rosemead Blvd	9	248
9	Slauson Ave and Passons Blvd	10	244
10	Gregg Rd and Whittier Blvd	8	227

Corridor Rankings

10 corridors were identified as high injury corridors. There was a total 369 injury collisions and 48 KSI collisions on these corridors during the five-year study period (2017-2021). The Rosemead Blvd corridor had the highest number of KSI collisions with eighteen.

Table 4 lists the top 10 identified high-collision corridors along with the number of injury collisions, the number of KSI collisions, corridor length, and the severity weight for each corridor.

Table 4. High Injury Corridors

ID	Corridor	Total Injury Collisions	Length (miles)	Severity Weight
A	Rosemead Blvd: From/To City Limits	90	4.4	2,777
B	Whittier Blvd/ SR 72: From/To City Limits	63	1.6	1,452
C	Slauson Ave: From/To City Limits	55	1.8	1,379
D	Washington Blvd: From/To City Limits	38	2.0	1,237
E	Telegraph Rd: From/To City Limits	29	2.5	850
F	Paramount Blvd: Gallatin Rd to Telegraph Road	24	4.0	820
G	Passons Blvd: Stephens St to City Limit	26	3.6	648
H	Beverly Blvd: From/To City Limits	32	1.8	560
I	Rooks Rd: Sports Arena Dr to San Gabriel River Pkwy	7	0.9	519
J	Durfee Ave: Kruse Road to Jackson St	8	1.6	205

SUMMARY

Between 2017 and 2021, a total of 689 injury collisions occurred within the City of Pico Rivera, of which 81 resulted in a fatality or severe injury. Among all injury collisions, the most prominent collision types were broadside and rear end collisions, while unsafe speed and improper turning were the most common violation types. The corridor with the most number of KSI crashes was Rosemead Blvd, while the intersection with the most KSI crashes was Slauson Blvd and Paramount Blvd.

Five prominent collision factors that emerged were: **broadside collisions, unsafe speed violation, nighttime collisions, rear-end collisions, and improper turning violations.** Each of these is described in turn.

Broadside collisions represented the highest proportion of all injury collisions (28%), and similar trend for KSI collisions (30%). The intersections of Paramount Blvd/Whittier Blvd and Passons Blvd and Slauson Avenue have a higher concentration of broadside collisions. Broadside collisions can potentially be mitigated by improving the signal timing and phasing, improving the visibility of traffic control device, providing protected left turn phase.

14% of all injury collisions in Pico Rivera were caused by unsafe speed. Higher numbers of these collisions were experienced on Paramount Blvd, Whittier Blvd, Slauson Ave and Telegraph Rd. Speeding can be mitigated through the introduction of traffic calming, which can be a combination of street narrowing, medians, bulb outs at intersections, or Complete Streets elements like high visibility crosswalks, bike lanes, and wider sidewalks. Driver education and speed enforcement, either through radar trailers or officer patrols, can also help to mitigate instances of unsafe speed violations.

Collisions occurring at night represented only 36% of all injury collisions, but rose significantly to 67% for KSI collisions. Higher numbers of these collisions occurred on Beverly Blvd, Paramount Blvd and Rosemead Blvd. Many different factors can contribute to nighttime collisions, such as low lighting levels that can be targeted with countermeasure, but extraneous factors can also contribute to nighttime injury such as alcohol use or sleepiness/fatigue. Improvements such as installing new lighting, upgrading existing lighting to a higher lumen, installing and upgrade signs with new fluorescent sheeting and installing pedestrian improvements with lighting elements such as RRFBs (rectangular rapid flashing beacons) and HAWKs can help make these locations safer for all road users.

Rear end collisions caused 29% of all injury collisions, and 17% when considering only KSI collisions. Telegraph, Slauson, Washington, and Whittier have a higher concentration of rear end collisions. Rear-end collisions can be mitigated by improving curb radii, providing special phase for left- turning traffic, improving advance warning devices, reducing speed on approaches and adding all red-clearances.

Improper turning violations accounted for 9% of all injury collisions and nearly similar trend of 11% was observed when considering only KSI collisions. Improper turning collisions can be reduces by upgrading intersection pavement markings, installing flashing beacons at intersections, improving sight distance to intersection, providing directional median openings for left and right turns and adding a right lane.

The next steps in the LRSP will be to identify Emphasis Areas based on the collision analysis presented in this memo. The most prominent collision types, violations, and human behaviors will be selected for inclusion as an Emphasis Area, as these represent the most prominent traffic safety issues in Pico Rivera. Each Emphasis Area will be accompanied with strategies corresponding to the four E's of safety (Engineering, Enforcement, Education and EMS) to comprehensively make the City of Pico Rivera safer for all modes of transportation.

The trends presented in the memo will help the project team to refine the recommendations for Pico Rivera LRSP countermeasures.