



JANUARY 2018

CIP 993 | SYSTEMIC SAFETY ANALYSIS REPORT **CRASH AND ROADWAY DATA ANALYSIS MEMO**

TOWN OF COLMA, CA

TABLE OF CONTENTS

1.0 Introduction	2
1.1 Study Roadway Corridors	2
1.2 Key Findings	4
2.0 Townwide Crash Patterns and Trends	6
2.1 Data and Approach	6
2.2 Findings	6
2.3 Townwide Ranking	10
3.0 Study Corridor-Specific Patterns and Trends	13
3.1 Data and Approach	13
3.2 Findings	13
4.0 Network Screening and Systemic Findings	16
4.1 Data and Approach	16
4.2 Findings	18
5.0 Draft Priority Locations	25
6.0 Next Steps	27

PREPARED FOR: ABDULKADER HASHEM
Contract Project Manager for Town of Colma
CIP993-SSAR - Town of Colma, Transportation Safety Action Plan

PREPARED BY: Kittelson & Associates, Inc.
1161 Mission Street, Office #563
San Francisco, CA 94103
415.579.1778

CONTACT: Erin Ferguson, PE
Matt Braughton
Mike Alston
Anusha Musunuru
Brian Ray

PROTECTION OF DATA FROM DISCOVERY & ADMISSION INTO EVIDENCE

23 U.S.C. 148(h)(4) states "Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for any purpose relating to this section [HSIP], shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location identified or addressed in the reports, surveys, schedules, lists, or other data."

23 U.S.C. 409 states "Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential accident sites, hazardous roadway conditions, or railway-highway crossings, pursuant to sections 130, 144, and 148 of this title or for the purpose of developing any highway safety construction improvement project which may be implemented utilizing Federal-aid highway funds shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data."



1.0

INTRODUCTION

1.0 INTRODUCTION

Kittelson & Associates, Inc. (Kittelson) is supporting the Town of Colma to identify countermeasures to improve roadway safety. This work is being conducted through a Caltrans Systemic Safety Analysis Report Program (SSARP) Grant. This memorandum summarizes the approach and findings for crash analysis. The material below discusses townwide crash patterns and trends; corridor-specific crash patterns and trends; and network screening and systemic safety evaluation. The information and findings in this memorandum will inform subsequent field work and, ultimately, the countermeasures considered.

The following two subsections discuss the study corridors and key findings.

1.1 STUDY ROADWAY CORRIDORS

The Town has identified several roadway corridors to be studied; these corridors are shown in Figure 1 and listed below. Kittelson also collected traffic volume and roadway data along these corridors for the purpose of evaluating safety performance, and for identifying roadway characteristics (i.e., risk factors) associated with locations exhibiting relatively frequent crashes. The roadway corridors identified by the Town for study are:

- ▶ El Camino Real (State Highway 82);
- ▶ Junipero Serra Boulevard;
- ▶ Hillside Boulevard;
- ▶ Mission Road;
- ▶ Serramonte Boulevard;
- ▶ Collins Avenue;
- ▶ Colma Boulevard;
- ▶ Lawndale Boulevard; and,
- ▶ F Street.

IN THIS MEMO>>

- ▶ Townwide crash patterns and trends
- ▶ Study corridor-specific crash patterns and trends
- ▶ Network screening and systemic evaluation
- ▶ Key safety findings and potential risk factors

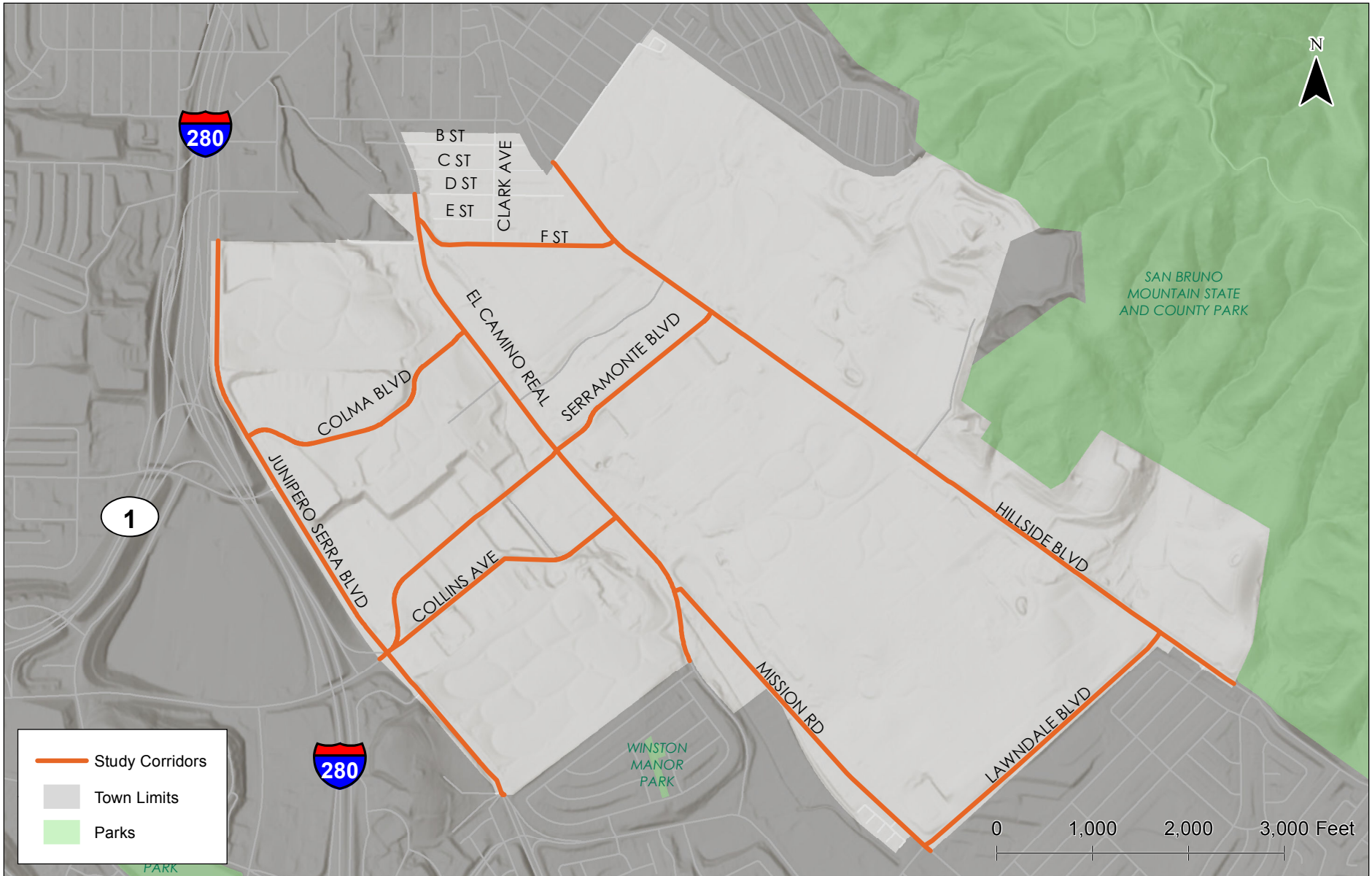


Figure 1

Town of Colma CIP 993 Systemic Safety Analysis Report Project Study Corridors

1.2 KEY FINDINGS

The following are key findings documented in this memo.

- ▶ **Townwide Crash Patterns and Trends**
 - ▶ From 2011 – 2016, there were 121 reported crashes in the Town of Colma and only 46% of these were included in SWITRS database. This is a significant discrepancy that would be beneficial to the Town to resolve. Kittelson also used data from the TIMS database which included the fatal and injury crashes reflected in the SWITRS database.
 - ▶ Pedestrians were involved in 4% of the 121 reported crashes, and bicyclists were involved in 3%.
 - ▶ Rear end (24%) and sideswipe (21%) crashes represent the largest shares of crash types.
 - ▶ Broadside crashes (71%), vehicle/pedestrian crashes (67%), and head-on crashes (50%) resulted in the highest proportion of injuries.
 - ▶ 2 of the 121 reported crashes resulted in fatalities, with one of them being a vehicle/pedestrian crash and the other one being an "other/not stated" crash.
 - ▶ The most frequently cited primary collision factors (PCF) include improper turning (22%) and unsafe speed (19%).
 - ▶ Crashes with the cited primary collision factor automobile right of way were associated with 69% of reported injuries compared to 43% townwide.
 - ▶ Two of five reported pedestrian crashes were coded as occurring on the road (including the shoulder). This indicates the pedestrian was likely walking along the road either in a vehicle lane or on the shoulder rather than on a sidewalk (one may not have been present) and was not trying to cross the street.
- ▶ **Corridor-Specific Findings**
 - ▶ Fifty-eight percent (58%) of reported crashes on Junipero Serra Boulevard and 50% of reported crashes on Hillside Boulevard resulted in injury, compared to a townwide value of 38%.
 - ▶ Both reported fatal crashes took place on Hillside Boulevard.
 - ▶ Sixty-five percent (65%) of reported crashes on Colma Boulevard were rear end crashes, compared to 24% townwide.
 - ▶ Thirty percent (30%) of reported crashes on Serramonte Boulevard and 29% of reported crashes on Colma Boulevard were attributed to unsafe speeds. Nineteen percent (19%) of reported crashes townwide included unsafe speeds as the reported primary collision factor (PCF).
 - ▶ Four of ten reported crashes (40%) on Hillside Boulevard involved a person under the influence of alcohol or drugs, compared to 8% townwide.
- ▶ **Network Screening and Systemic Findings**
 - ▶ The roadway network was screened using: (1) The Equivalent Property Damage Only (EPDO) and Crash Rate safety performance measures; and (2) a systemic risk-based analysis to determine roadway characteristics potentially associated with the more frequent occurrence of crashes.
 - ▶ From the analysis, we identified the following roadway characteristics as risk factors (i.e., potentially associated with more frequency occurrence of crashes: presence of two or more major access points within 1,000 feet; undivided roadways; horizontally curved roadway segments; side-street stop

KEY TERMS>>

- ▶ **Descriptive crash statistics –** Townwide and segment-specific summaries of crash severity, crash type, and contributing factors.
- ▶ **Network Screening –** Evaluating the entire townwide street network to identify high-crash locations based on number of crashes, severity of crashes, and traffic volume.
- ▶ **Systemic analysis –** Identifying risk factors associated with high-crash locations and prioritizing locations based on risk factors and crash history.
- ▶ **Primary Collision Factor –** The element or driving action which, in the police officer's opinion, best describes the primary factor contributing to the collision.

controlled intersections onto a major roadway; closely spaced intersections and/or access points (under 300 feet); and complex or curved roadway geometry at intersections¹.

Based on the analysis findings, Kittelson identified the following locations for further study:

- ▶ Segments
 - ▶ Hillside Boulevard, Serramonte Boulevard to Sand Hill Road;
 - ▶ Colma Boulevard, Junipero Serra Boulevard to El Camino Real;
 - ▶ Serramonte Boulevard, Junipero Serra Boulevard to Hillside Boulevard;
 - ▶ Collins Avenue, Serramonte Boulevard to the Serramonte Ford Body Shop;
 - ▶ El Camino Real, northern town limits to Colma Boulevard; and,
 - ▶ Junipero Serra Boulevard, northern town limits to Colma Boulevard.
- ▶ Intersections
 - ▶ Junipero Serra Boulevard & Serra Center Entrance (North);
 - ▶ El Camino Real & Collins Avenue;
 - ▶ El Camino Real & Mission Road;
 - ▶ Junipero Serra Boulevard & Serra Center (South);
 - ▶ El Camino Real & F Street; and,
 - ▶ Serramonte Boulevard & Junipero Serra Boulevard.

The following sections provide more detail regarding these key findings.

¹ Complex intersections refer to locations with large intersection footprints, atypical approaches, and/or large median islands present for free movements or separating turn lanes from through traffic.



2.0
TOWNWIDE CRASH
PATTERNS AND TRENDS

2.0 TOWNWIDE CRASH PATTERNS AND TRENDS

The following presents townwide descriptive crash statistics (i.e., crash trends and patterns). This information provides a baseline for understanding Town crash patterns. Kittelson will also use patterns and trends to inform considerations for countermeasures and treatments that could be effective at a townwide level (e.g., reviewing and adjusting signal-timing plans on a townwide basis for amount of yellow time to address rear-end crashes).

2.1 DATA AND APPROACH

Kittelson obtained and analyzed the most recent six years of complete crash data available from the California Statewide Integrated Traffic Records System (SWITRS) database and the University of California, Berkeley, Transportation Injury Mapping System (TIMS) database. The crash data used were from January 1, 2011, through December 31, 2016. There were 56 reported crashes in this period. The location data in both data sets were used to geocode the crashes and map them in GIS software. Crashes reported to occur on Interstate 280 within Town limits were excluded from the data set. All other reported crashes for public streets in Colma were included in the database.

IN THIS SECTION >>

- ▶ Data and approach used for the townwide analysis
- ▶ Key insights into townwide crash patterns and trends
- ▶ Townwide crash patterns compared to peer cities

The Town also provided supplementary crash data from October 2014 through 2016. All non-duplicative crashes with a reported severity level were added to the crash database. Kittelson identified these crashes as data entries with unique date and time information when compared to SWITRS and TIMS crashes; there were an additional 65 crashes added to the database as a result of this cross referencing.

This memo includes analysis of the 121 reported crashes in the dataset described above. Of these, 2 resulted in fatal crashes, 50 resulted in injury crashes, and 69 resulted in the property damage only crashes.

2.2 FINDINGS

Kittelson considered crash patterns and trends in the townwide data by evaluating the following crash attributes:

- ▶ Crash severity;
- ▶ Crash type;
- ▶ Primary reported contributing factor;
- ▶ Lighting conditions;
- ▶ Year;
- ▶ Pedestrian crash characteristics ; and,
- ▶ Bicycle crash characteristics.

In the six years of data analyzed, 7% of reported crashes involved pedestrians or bicyclists, with the rest of crashes involved motor vehicles exclusively (Table 1).

Crash Severity

Table 1 summarizes the reported crashes by severity and road user type involved (e.g. pedestrian, bicycle, motor vehicle). Severity is classified as fatal, injury, and property damage only (PDO). Injury crashes include severe injuries, other visible injuries, and injuries involving a complaint of pain but no visible injury.

Table 1: Road Users Involved and Crash Severity, Town of Colma, 2011 - 2016

Road Users Involved in Crashes	Fatal Crash	Injury Crash	Property Damage Only	Total
Bicycle – Vehicle	0 (0%)	4 (3%)	0 (0%)	4 (3%)
Pedestrian – Vehicle	1 (1%)	4 (3%)	0 (0%)	5 (4%)
Vehicle-Vehicle or Vehicle-Other	1 (1%)	42 (35%)	69 (57%)	112 (93%)
Total Crashes	2 (2%)	50 (41%)	69 (57%)	121 (100%)

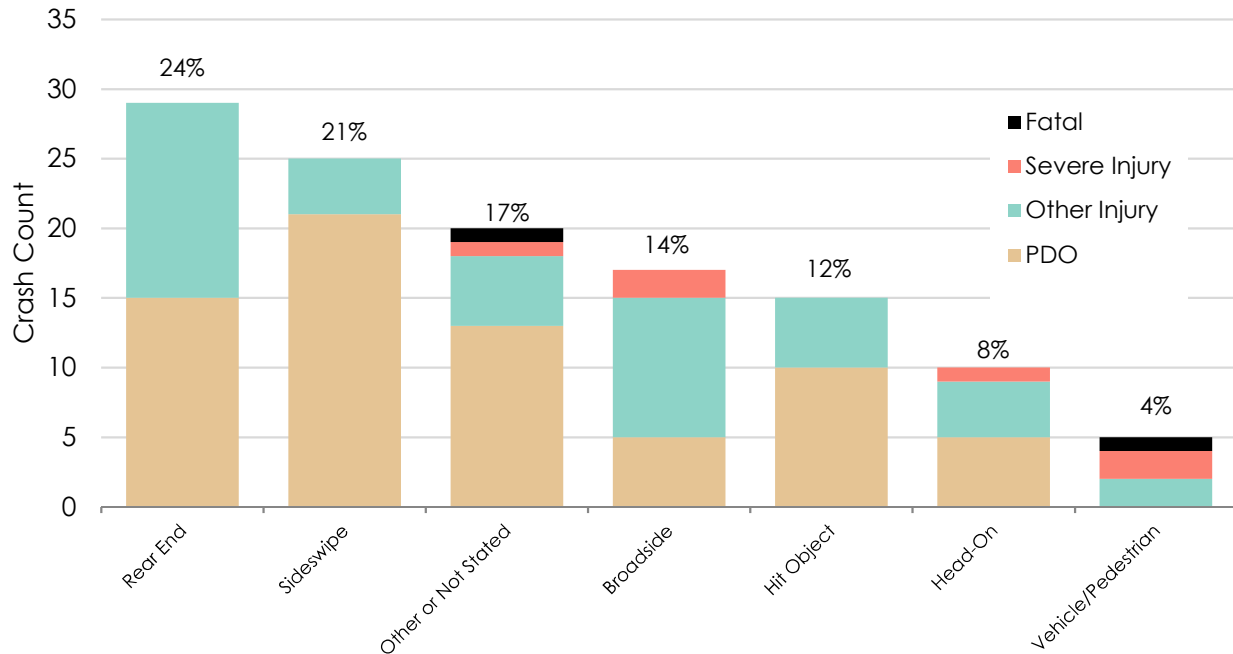
Source: Town of Colma, SWITRS, Kittelson 2018

- ▶ Among crashes involving only motor vehicles, 36% of reported crashes resulted in an injury or fatality. Pedestrian- or bicyclist-involved crashes resulted in some level of injury, with one fatal pedestrian crash.
- ▶ Pedestrians were involved in 4% of reported crashes, and bicyclists were involved in 3% of reported crashes.

Crash Type

Figure 2 presents findings by crash frequency, severity, and type.

Figure 2: Crashes by Type and Severity, Town of Colma 2011 - 2016



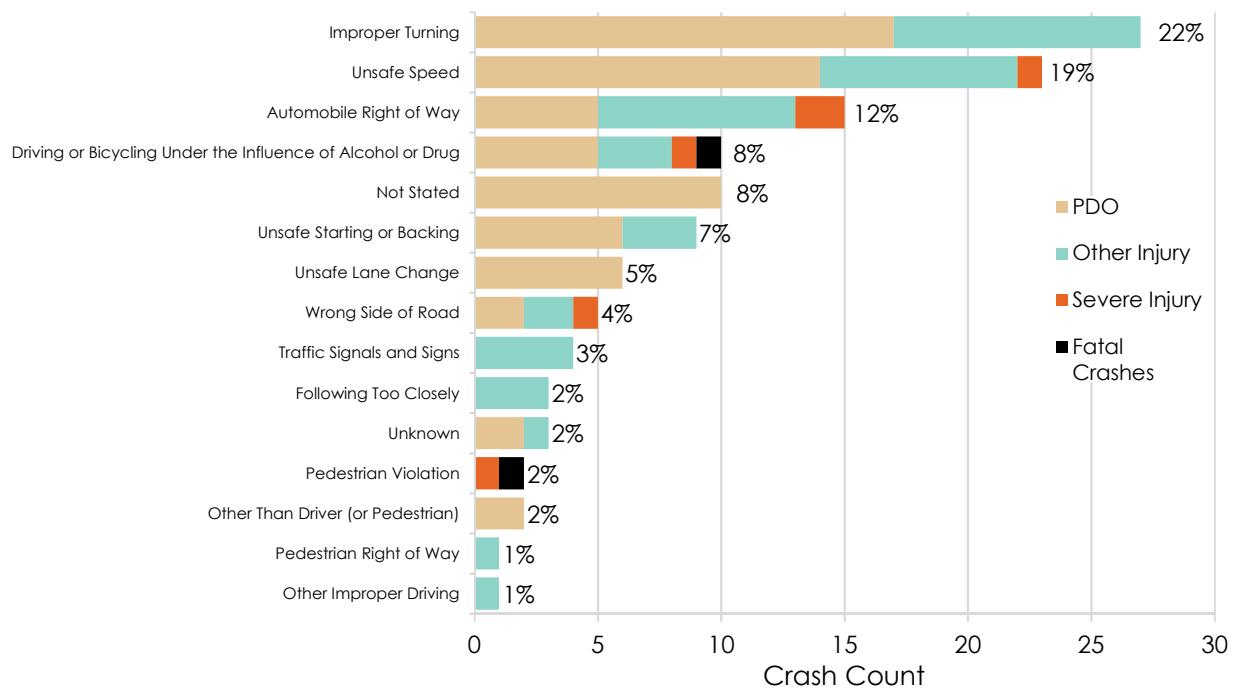
Sources: Town of Colma, SWITRS, Kittelson 2018

- ▶ Seventeen percent (17%) of crash types were either coded with crash type "Other" (including one fatal crash) or were not stated. These crashes were present in both SWITRS and town-provided crash data and relate to crashes that cannot be categorized into the other crash types (shown in the figure above) or do not have enough information to categorize it to a specific crash type.
- ▶ Rear end (24%), sideswipe (21%), and broadside crashes (14%) represent the largest shares of reported crash types.
- ▶ Broadside crashes (71%), vehicle/pedestrian crashes (67%), and head-on crashes (50%) resulted in the highest proportion of injuries.
- ▶ The reported crash types resulting in fatalities were vehicle/pedestrian crashes (1) and "other or not stated"(1) crashes. Severe injury crashes were associated with broadside (2), head-on (1), vehicle/pedestrian (2), and "other or not stated"(1) crash types.

Contributing Factors

Figure 3 presents findings by reported primary collision factor and severity.

Figure 3: Crashes by Reported Primary Collision Factor, Town of Colma, 2011 - 2016



Automobile Right of Way refers to a crash resulting from one motorist's failure to yield to another motorist who had the right of way.

Pedestrian Violation refers to a crash in which a pedestrian violated a motor vehicle's right of way.

Traffic Signals and Signs refer to a crash resulting from a motorist's failure to comply with a traffic control device (traffic signal, yield sign, or stop sign).

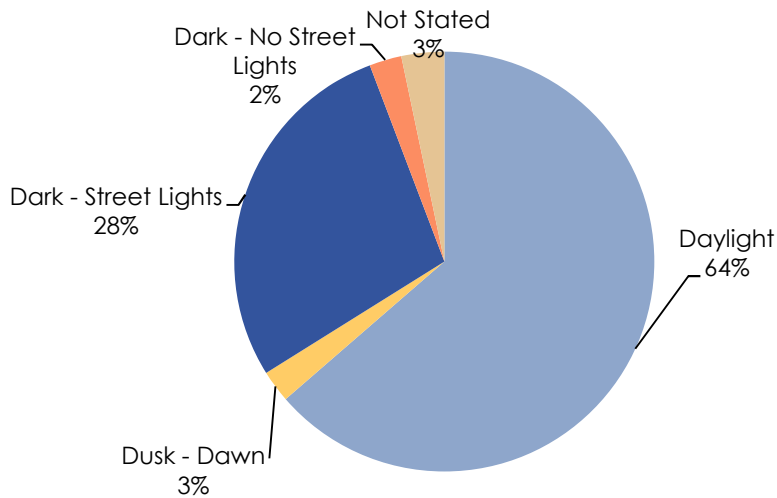
Sources: Town of Colma, SWITRS, Kittelson 2018

- ▶ The most frequently cited primary collision factors include improper turning (22%), unsafe speed (19%), and automobile right of way (12%).
- ▶ The two fatal crashes included the following primary contributing factors: driving or bicycling under the influence and pedestrian violation.
- ▶ Among PCFs cited in ten or more crashes, automobile right of way crashes exhibited the highest proportion of injuries, at 69%. The proportion injury crashes for total reported crashes was 42%.
- ▶ The PCFs associated with multiple fatal or severe injury crashes include automobile right of way, driving or bicycling under the influence of alcohol or drugs, and pedestrian violation.

Lighting Conditions

Figure 4 presents findings by reported lighting conditions.

Figure 4: Crashes by Reported Lighting Conditions, Town of Colma, 2011-2016



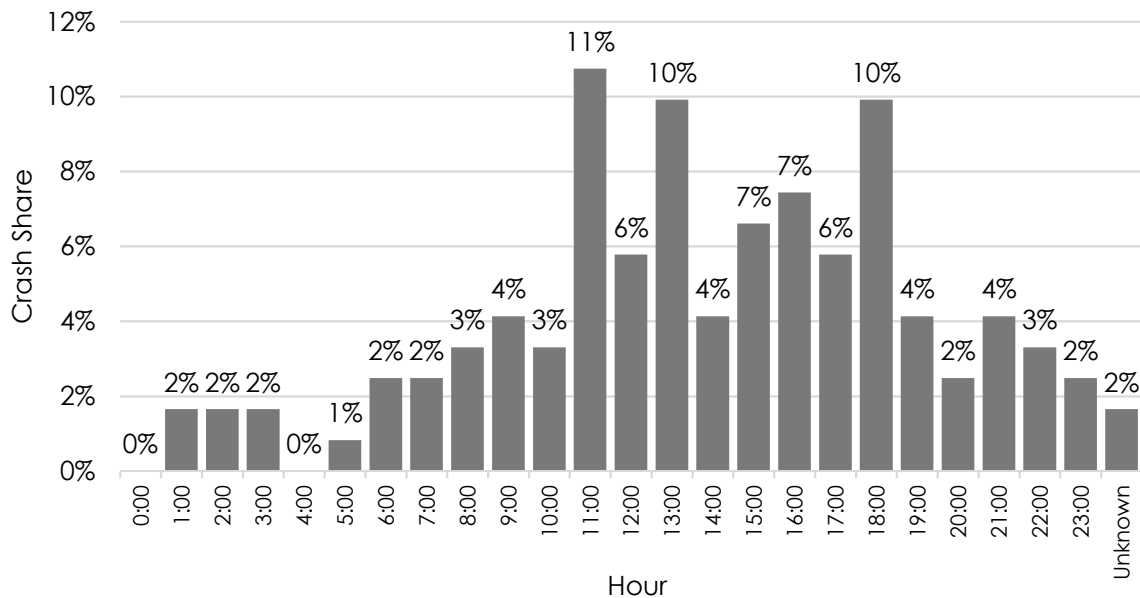
Source: Town of Colma, SWITRS, Kittelson 2018.

- ▶ The majority of crashes occurred in daylight conditions (64%). Of the 38 crashes reported to have occurred in the dark, two percent (2%) occurred where no street lights were present.
- ▶ Kittelson reviewed pedestrian- and bicycle- related crashes, as well as crash severity by lighting conditions, and found no notable differences from the overall trends above.

Time-of-Day

Figure 5a and Figure 5b present time-of-day findings.

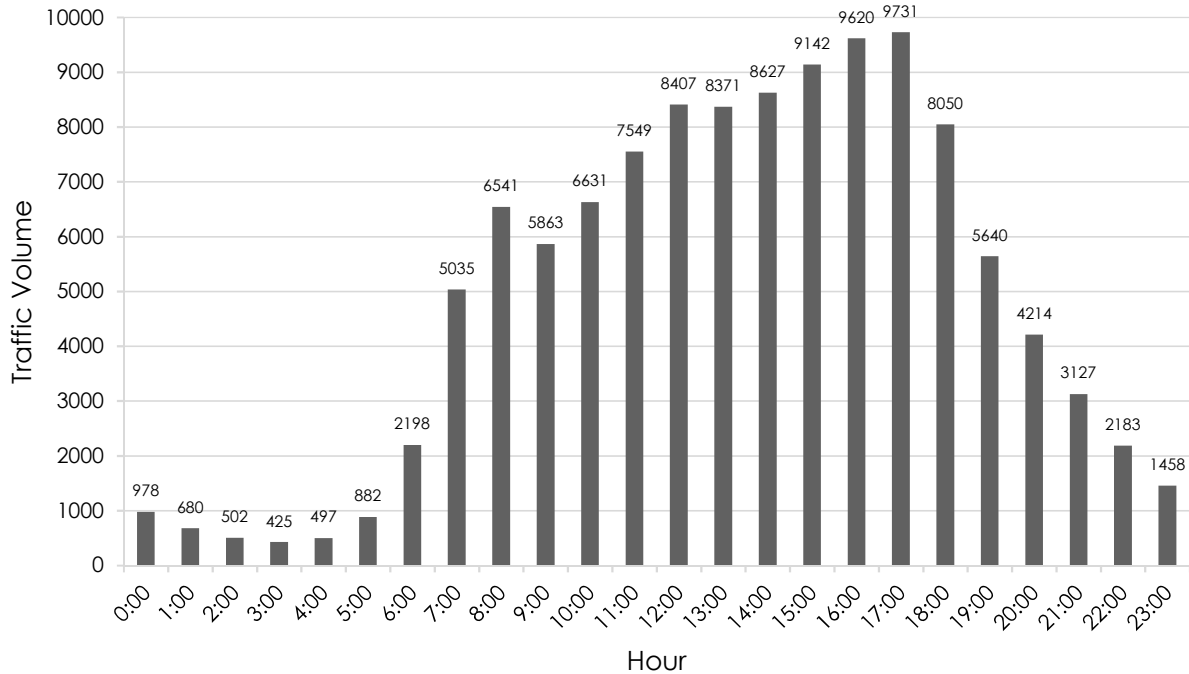
Figure 5a: Crashes by Hour of Day, Town of Colma, 2011 - 2016



Source: Town of Colma, SWITRS, Kittelson 2018.

- ▶ Crashes peaked from 11:00 AM through 6:00 PM, with higher crash frequency around the midday hours and again during the 6:00 PM hour. This trend corresponds to expected levels of traffic throughout the day, shown in Figure 5b.

Figure 5b: Traffic Volume by Hour of Day, Town of Colma, 2017²



Source: Quality Counts Data, 2017.

Pedestrian Crashes

Of the five reported pedestrian crashes in the data set, four resulted in injuries and one in a pedestrian death. Two pedestrian crashes were coded as occurring in the road (including the shoulder), indicating the pedestrian was likely walking along the road or on the shoulder rather than trying to cross.

Bicycle Crashes

The four reported bicycle crashes in the data set resulted in injuries. Three bicycle crashes were coded as associated with “other/not stated” crash type, and one crash was coded as the sideswipe crash. The primary contributing factors for these crashes were biking on the wrong side of the road, automobile right-of-way, improper turning, and driving or biking under the influence of alcohol or drugs.

2.3 TOWNWIDE RANKING

California's Office of Transportation Safety (OTS) maintains a ranking system to compare traffic safety statistics among similarly sized California cities and towns. The comparison allows cities to identify local safety performance relative to peers. Townwide (or citywide) rankings are based on population, daily vehicle miles traveled, crash records, and crash trends. OTS uses data from from SWITRS, Caltrans, California Department of

² The traffic volume information by hour of day was collected by KAI from October 31, 2017 to November 6, 2017 at all the study segments and intersections. The average values for traffic volumes throughout the week were shown in Figure 5b.

Justice, and the Department of Finance. A number 1 in ranking in a category is the worst performer relative to other peers in the group. This section presents findings from the most recently published OTS rankings, from 2015. Given of the 121 reported crashes in Colma for this study only 46% were included in SWITRS, the OTS ranking for Colma is likely to show Colma performing better among its peers than the Town may actually be performing. OTS rankings are limited to consider crash data from SWITRS.

In 2015, Colma was one of twelve “Group G” towns/cities, which have a population of 1,000 – 2,500 people.

Findings

The Town of Colma has a composite OTS ranking of 12 out of the 12 cities in its grouping from 2015, ranking it the relative best in its category of peer cities. This composite ranking shows improvement over 2013, when the Town was ranked eleventh (out of 12 cities) among peer cities. This composite score, i.e. relative ranking is an aggregate of several rankings and indicates overall traffic safety. However, as noted above, there is an underreporting of crash issue in Colma that is greater than Kittelson has encountered for other jurisdictions. Therefore, actual performance relative to peers could be worse than what is shown in Table 2.

Table 2: Town of Colma California Office of Traffic Safety Rankings

2015 OTS Category	2013 OTS Ranking out of 19	2014 OTS Ranking out of 14	2015 OTS Ranking out of 12
Composite	9/19	13/14	12/12
Total Fatal and Injury	19/19	11/14	11/12
Pedestrians	6/19	8/14	9/12
Pedestrians <15	7/19	8/14	10/12
Pedestrians 65+	18/19	13/14	11/12
Bicyclists	19/19	2/14	12/12
Bicyclists <15	14/19	11/14	11/12
Motorcycles	18/19	14/14	12/12
Alcohol Involved	2/19	12/14	12/12
Had Been Drinking, Driver <21	17/19	13/14	12/12
Had Been Drinking, Driver 21-34	2/19	14/14	12/12
Speed Related	18/19	13/14	12/12
Nighttime (9:00pm – 2:59am)	9/19	11/14	12/12
Hit and Run	5/19	5/14	12/12

Source: California Office of Traffic Safety

- ▶ Based on SWITRS data only, in 2015, the Town of Colma performed better than peer cities per the California OTS composite ranking, and performed in the 25th percentile of peer cities in every category included in OTS rankings.
- ▶ From 2013 to 2015, the Town of Colma ranked in the lower third of peer cities in the following categories:
 - ▶ Bicyclist safety (2014)
 - ▶ Drivers aged 21-34 under the influence of alcohol (2013)
 - ▶ Hit and run (2013 and 2014)

SUMMARY>>

The following are key insights from the Townwide analysis:

- ▶ From 2011 – 2016, there were 121 reported crashes in the Town of Colma and only 46% of these were included in SWITRS database. This is a significant discrepancy that would be beneficial to the Town to resolve.
- ▶ Pedestrians were involved in 4% of the 121 reported crashes, and bicyclists were involved in 3%.
- ▶ Rear end (24% and sideswipe (21%) crashes represent the largest shares of crash.
- ▶ Broadside crashes (71%), vehicle/pedestrian crashes (67%), and head-on crashes (50%) resulted in the highest proportion of injuries.
- ▶ The most frequently cited primary collision factors include improper turning (22%) and unsafe speed (19%).
- ▶ Crashes with the cited primary collision factor automobile right of way resulted in a higher proportion of injury crashes at 69% compared to 42% for reported crashes Townwide.
- ▶ Two of five reported pedestrian crashes were coded as occurring in the road (including the shoulder), indicating the pedestrian was likely walking along the road or on the shoulder rather than trying to cross the street.



3.0

**STUDY CORRIDOR-SPECIFIC
PATTERNS AND TRENDS**

3.0 STUDY CORRIDOR-SPECIFIC PATTERNS AND TRENDS

The Town has placed a priority on identifying systemic low-cost treatments for the study corridors presented in Figure 1. The following section discusses the data and approach used to identify crash patterns and trends along the corridors.

IN THIS SECTION >>

- ▶ Data and approach used for the study corridor analysis
- ▶ Key insights into study corridor crash patterns and trends

3.1 DATA AND APPROACH

Kittelson identified reported crashes on the study corridors; crashes at an intersection of two corridors were coded as occurring on the reported primary road to avoid double counting. That extraction process yielded 117 crashes, with the highest crash frequencies on the following corridors:

- ▶ Junipero Serra Boulevard – 33 reported crashes (27% of total);
- ▶ Serramonte Boulevard – 23 reported crashes (19% of total); and,
- ▶ El Camino Real – 22 reported crashes (18% of total).

3.2 FINDINGS

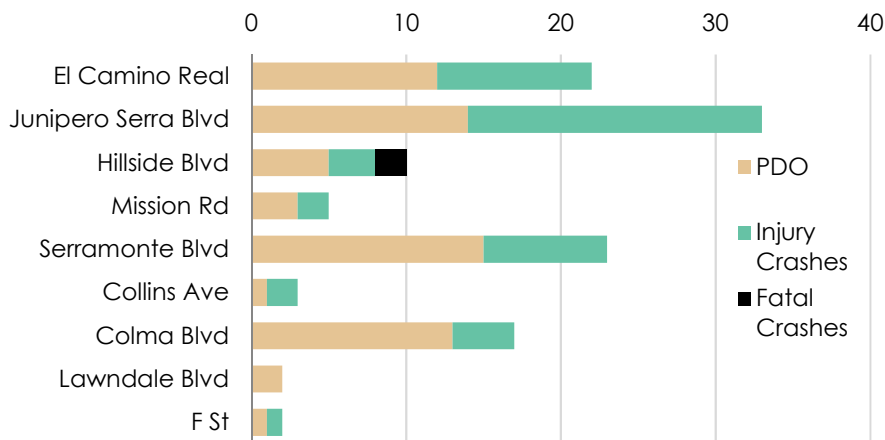
This section discusses crash trends along the key study corridors and highlights differences between patterns on a specific corridor and the townwide patterns already discussed. The analysis includes the following considerations:

- ▶ Crash severity;
- ▶ Crash type; and
- ▶ Crash contributing factor.

Crash Severity by Corridor

Figure 6 presents corridor findings by crash severity.

Figure 6: Crash Severity by Corridor, Town of Colma, 2011 - 2016



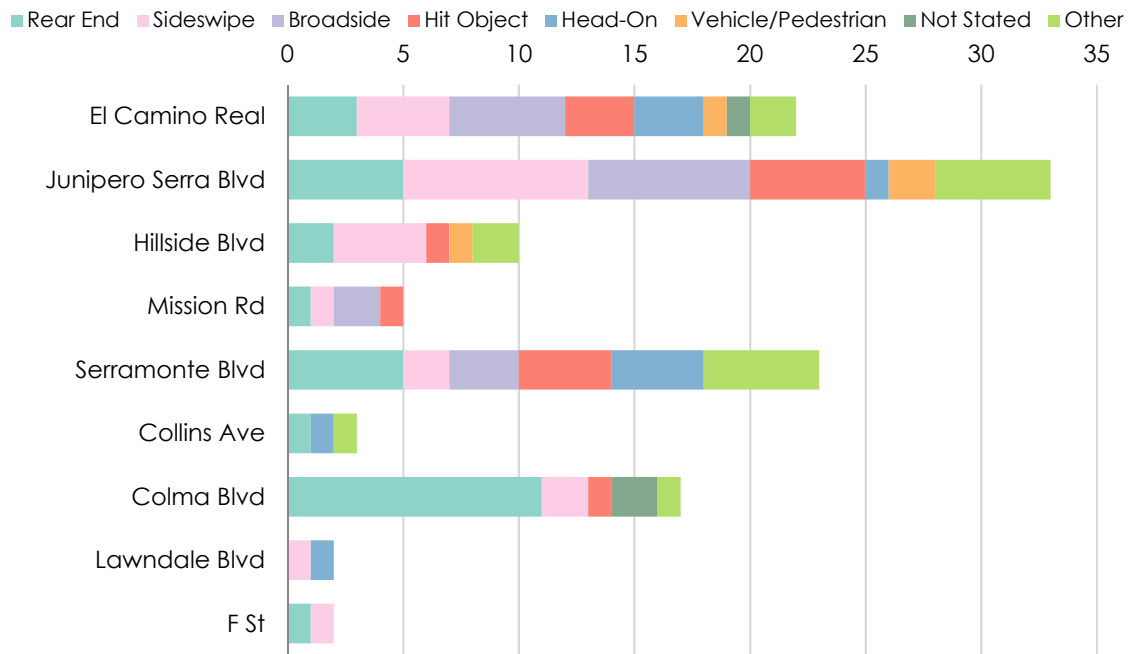
Source: Town of Colma, SWITRS, Kittelson 2018.

- ▶ Fifty-eight percent (58%) of reported crashes on Junipero Serra Boulevard and 50% of reported crashes on Hillside Boulevard resulted in injury, compared to 43% of a townwide reported crashes.
- ▶ The two reported fatal crashes took place on Hillside Boulevard.

Crash Type by Corridor

Figure 7 presents corridor findings by reported crash type.

Figure 7: Crash Type by Corridor, Town of Colma, 2011 - 2016



Source: Town of Colma, SWITRS, Kittelson 2018.

- ▶ Sixty-five percent (65%) of reported crashes on Colma Boulevard were rear end crashes, compared to 24% townwide.
- ▶ Four of ten reported crashes (40%) on Hillside Boulevard were sideswipe crashes, compared to 21% townwide.

Contributing Factor by Corridor

Table 3 presents corridor findings by primary contributing factors.

Table 3: Contributing Factors Rates by Study Corridor

Study Corridor	Reported Primary Collision Factor as Percent of Reported Crashes			
	Driving or Bicycling under the Influence of Alcohol or Drugs	Automobile Right of Way ¹	Unsafe Speed	Improper Turning
Junipero Serra Boulevard (33 crashes)	3%	18%	9%	39%
Serramonte Boulevard (23 crashes)	4%	22%	30%	9%
El Camino Real (22 crashes)	14%	18%	14%	18%
Colma Boulevard (17 crashes)	0%	0%	29%	18%
Hillside Boulevard (10 crashes)	40%	0%	20%	0%
Townwide Trends (121 crashes)	8%	12%	19%	22%

¹Automobile Right of Way refers to a crash resulting from one motorist's failure to yield to another motorist who had the right of way.

Note: Corridors with ten or more crashes are included in this comparison. Similarly, the most frequently cited contributing factors townwide are presented. **Shaded cells** represent considerable deviation from the townwide rate.

Source: Town of Colma, SWITRS, Kittelson 2018

- ▶ Thirty-nine percent (39%) of reported crashes on Junipero Serra Boulevard included improper turning as the PCF, compared to 22% townwide.
- ▶ Thirty percent (30%) of reported crashes on Serramonte Boulevard and 29% of reported crashes on Colma Boulevard were attributed to unsafe speeds. Serramonte Boulevard has a posted speed of 30 miles per hour throughout, and Colma Boulevard has a posted speed of 25 miles per hour.
- ▶ Four of ten reported crashes (40%) on Hillside Boulevard involved a person under the influence of alcohol or drugs, compared to 8% townwide. This might be because of the presence of a casino west of Hillside Boulevard near the intersection of Serramonte Boulevard and Hillside Boulevard.

SUMMARY>>
 The following are key insights from the corridor analysis:

- ▶ Fifty-eight percent (58%) of reported crashes on Junipero Serra Boulevard and 50% of reported crashes on Hillside Boulevard resulted in injury, compared to a townwide fatal/injury rate of 43%.
- ▶ Two reported fatal crashes took place on Hillside Boulevard.
- ▶ Sixty-five percent (65%) of reported crashes on Colma Boulevard were rear end crashes, compared to 24% townwide.
- ▶ Thirty percent (30%) of reported crashes on Serramonte Boulevard and 29% of reported crashes on Colma Boulevard were attributed to unsafe speeds.



4.0

**NETWORK SCREENING AND
SYSTEMIC FINDINGS**

4.0 NETWORK SCREENING AND SYSTEMIC FINDINGS

This section describes the network screening and systemic evaluation of the Town of Colma roadway network.

4.1 DATA AND APPROACH

Kittelson identified the high-priority safety intersections and roadway segments using the Equivalent Property Damage Only (EPDO) and Crash Rate network screening performance measures from the *Highway Safety Manual* (HSM). The EPDO screening was performed for reported crashes at intersections and along roadway segments. The Crash Rate screening was performed for the roadway segments where vehicle volume data was collected as part of this project. The two performance measures are described below.

IN THIS SECTION>>

- ▶ Data and approach used for the network screening and systemic analysis
- ▶ Identification of potential risk factors and additional locations for consideration.

Equivalent Property Damage Only

The EPDO performance measure assigns weighting factors to crashes by severity relative to property damage only (PDO) crashes. The weighting factors used for the network screening are based on the crash costs by severity used for Caltrans' Highway Safety Improvement Program Benefit Calculator Tool. The crash costs vary based on the location type: signalized intersection, unsignalized intersection, or roadway. The weights for each crash severity by location type are shown in Table 4.

Table 4: Crash Weights by Severity and Location Type

Location Type	Crash Weights by Severity				
	Fatal	Severe Injury	Other Visible Injury	Complaint of Pain Injury	Property Damage Only
Signalized Intersection	126	126	10.86	6.13	1
Unsignalized Intersection	200	200	10.86	6.13	1
Roadway	173	173	10.86	6.13	1

Source: Caltrans Highway Safety Improvement Program Benefit Calculator Tool, 2016

The weights generally reflect an order of magnitude difference between the societal costs of fatal and severe injury collisions versus non-severe injury collisions. The weighting factors intentionally weigh fatal and severe injuries equally to recognize that the difference between a severe injury crash versus a fatal crash are often more of a function of the individuals involved – therefore, both represent locations where the Town may want to prioritize improvements. The crash weights vary by location type due to the relative costs associated with the crash severity at those location types. Hence, fatal or severe crashes at an unsignalized intersection location result in more persons injured or more severely injured in a fatal or severe injury crash and, as a result, have a higher average cost than at a signalized intersection or roadway location. As a result, unsignalized intersections have higher weights for those severities than the other two location types.

Crash Rate

The crash rate performance measure normalizes the number of crashes relative to traffic volume. This performance measure is calculated by dividing the total number of crashes by the traffic volume, typically measured in crashes per million vehicle miles for segments and for total entering volume for intersections.

Intersection Analysis Methodology

Kittelton first coded reported crashes by severity. Crashes within 250 feet of an intersection were then spatially joined and summarized in ArcGIS to develop the total number of crashes by severity at each intersection. Where intersections were less than 500 feet from each other, we assigned crashes to the nearest intersection. Crashes occurring more than 250 feet from any intersection were held out for the segment analysis discussed below.

Kittelton calculated the EPDO score for intersections by multiplying each crash severity total by its associated weight (by intersection type) and summing the results, using the following formula:

$$\begin{aligned} \text{EPDO Score} = & \text{Fatal weight} * \# \text{ of fatal crashes} + \text{severe injury weight} * \# \text{ of severe injury crashes} \\ & + \text{other visible injury weight} * \# \text{ of other visible injury crashes} + \text{complaint of pain injury weight} * \\ & \# \text{ of complaint of pain injury weight crashes} + \text{PDO crashes} \end{aligned}$$

We annualized the EPDO score by dividing the score by the number of years (6) of crash data used in the analysis. Similarly, we determined the crash rate for each by dividing the spatially joined crashes associated with each intersection by the total entering vehicular traffic in the PM peak hour at that location.

Segment Analysis Methodology

Following the approach used for intersection analysis, Kittelson first coded reported crashes by severity using a Python script in ArcGIS. This segmented the Town of Colma street network into one-fourth (1/4) of a mile segments, incrementing the segments by one-tenth (1/8) of a mile. This methodology helps to identify portions of roadways with the greatest potential for safety improvements.

Once the roadway segments were created, the script spatially joined crashes to the corridor segment (excluding those identified with intersections as described above). Similar to the intersection methodology above, we summarized the crashes by severity, and multiplied the totals by the EPDO weights for roadway segments. The weighted crashes were then summed and annualized by dividing the score by the number of years of crash data (6) to generate an annualized EPDO score. Additionally, for the corridors where volume data was available, we calculated crash rates (per million vehicle miles).

Risk Factor Identification

Kittelton applied a risk-based analysis of the top quartile of locations identified through the intersection and roadway segment network screening. Risk is defined in this instance as common traffic or physical characteristics shared by the top quartile of corridors and intersections. Based on this commonality, their presence is indicative of a potentially higher risk for crashes within the Town of Colma³. The risk factors will be

³ Note: This commonality does not prove causality; it suggests a potential connection or contributing factor.

used during the field visit to confirm the previously identified program areas and assist in identifying treatments to reduce the frequency and severity of crashes within the Town. These risk factors can also be used to identify additional locations where crashes have not yet been reported to make proactive low-cost improvements to those locations to further reduce the potential for future crashes.

Kittelton reviewed the following roadway characteristics for top quartile sites to help determine potential risk factors for intersections and roadway corridors:

- ▶ Roadway geometry;
- ▶ Number of vehicle lanes;
- ▶ Posted speed;
- ▶ On-street parking presence;
- ▶ Median presence;
- ▶ Driveway and curb cut presence;
- ▶ Traffic signal locations;
- ▶ Dedicated left- or right-turn lane presence;
- ▶ Intersection density (i.e., closely spaced intersections or access points);
- ▶ Transit stop presence;
- ▶ Intersection geometry (e.g., presence of offset approaches, intersection skew); and,
- ▶ Presence of marked crosswalks.

The roadway characteristic data was obtained via a combination of data provided by the Town of Colma and SamTrans (e.g., roadway alignment, transit stop location) as well as characteristics identified by field review and review of aerial imagery of the high-scoring segments and intersections (e.g., median presence, posted speed, driveways, on-street parking presence, number of approaches, right- and left-turn lane configuration). The combination of these sources provides a strong basis for determining common characteristics across sites.

Kittelton identified trends that were consistently present across the top locations and could be tied to a roadway characteristic. That characteristic was identified and documented as a risk factor. Segment and intersection potential crash risk factors are discussed in the Findings section.

4.2 FINDINGS

Kittelton identified priority intersections and segments using the annualized EPDO scores as well as crash rates for segments where volumes were available. For intersection locations, the EPDO scores ranged from zero (no crashes occurring during the six-year time frame analyzed) to 36.8. For roadway segments, the EPDO scores ranged from zero (no reported crashes occurred during the six-year time frame analyzed) to 61.3. Figure 8 and Figure 9 show the results of the EPDO scoring by quartile for roadway segment and intersection locations, respectively. Figure 10 shows the crash rate by quartile for roadway corridors where volume data was available. Intersections or segments shown as not falling within one of the quartiles indicates that there were no reported crashes at that location.

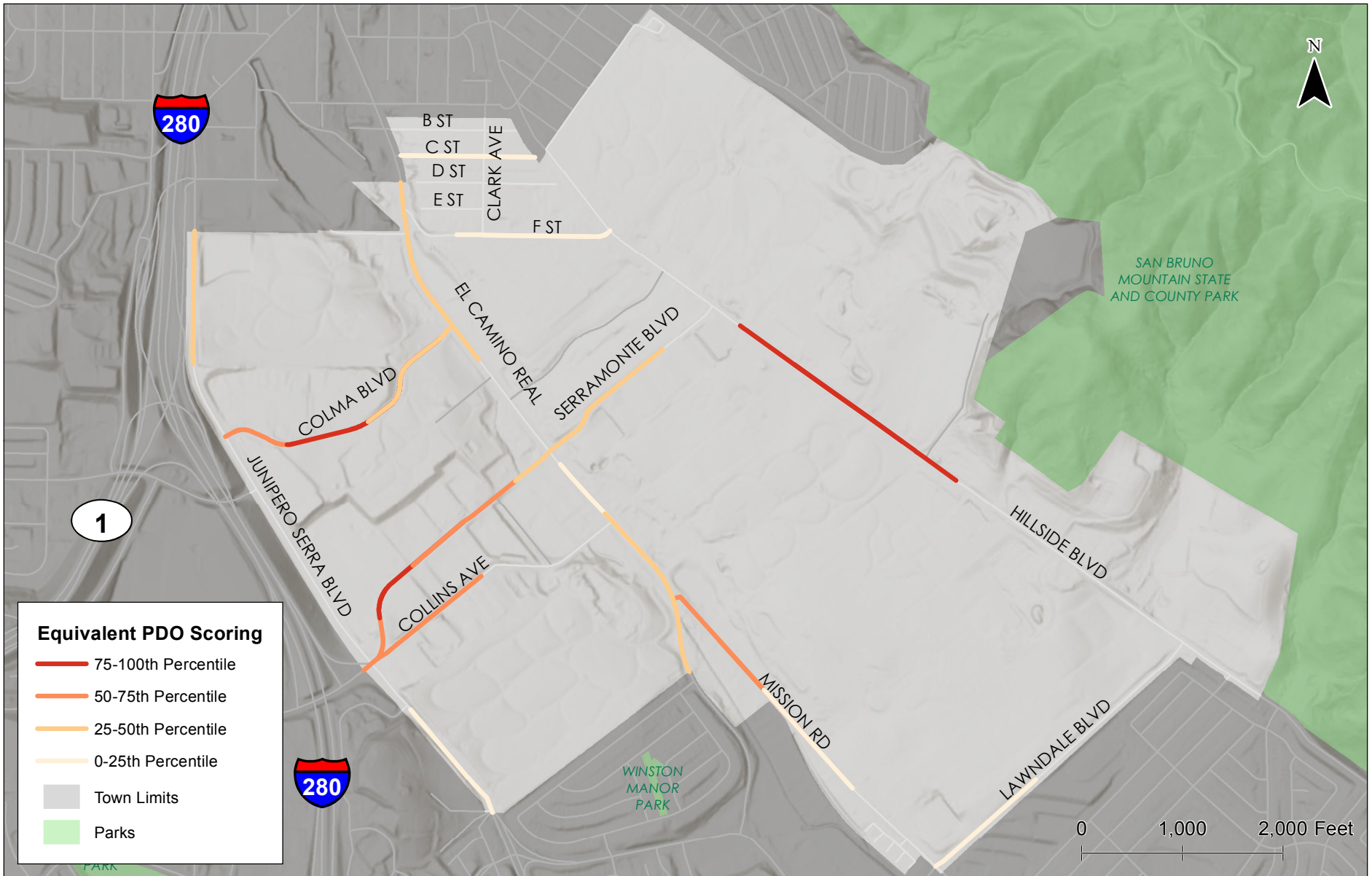


Figure 8

Town of Colma
CIP 993 Systemic Safety Analysis Project
Roadway Segment Equivalent PDO Score

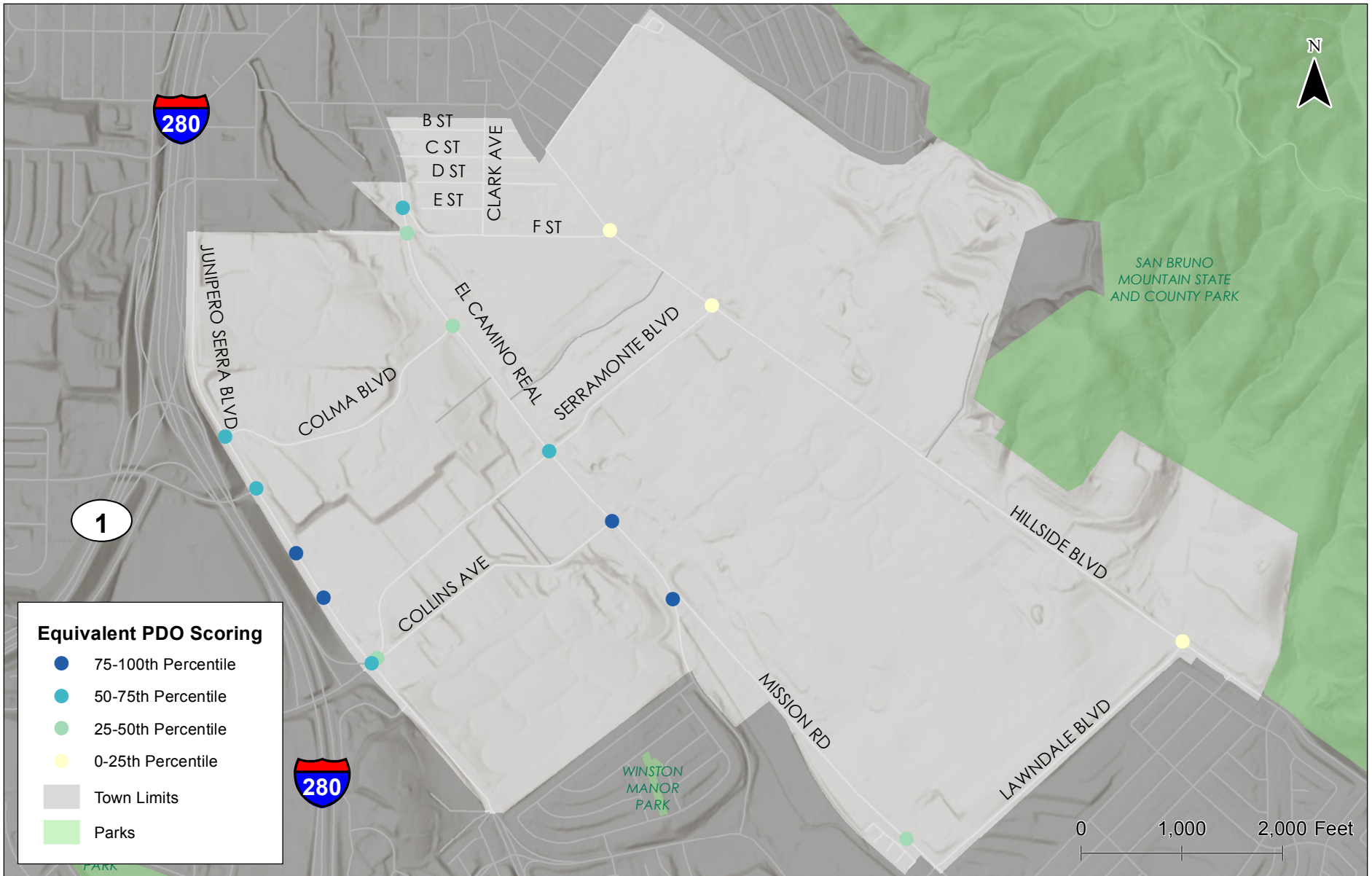


Figure 9 **Town of Colma**
CIP 993 Systemic Safety Analysis Project
Intersection Equivalent PDO Score

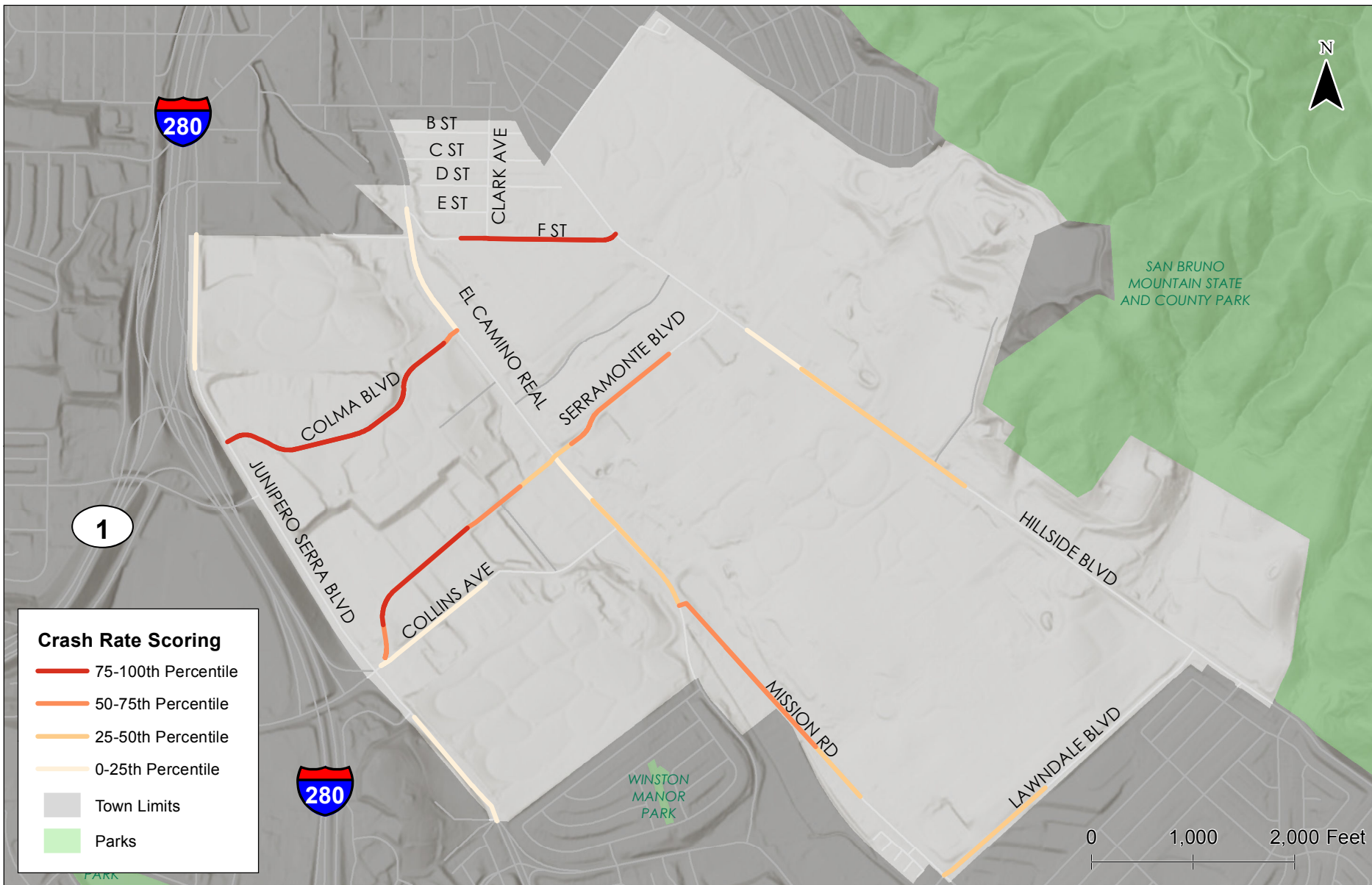


Figure 10

Town of Colma
 CIP 993 Systemic Safety Analysis Project
 Roadway Segment Crash Rates

Roadway Segment Screening Findings

Based on the EPDO scoring results shown in Figure 8, the top quartile of roadway segments with a reported crash history are located on the study corridors identified by the Town of Colma in their SSARP grant application. Table 5 indicates segments that may be considered for safety improvements.

Table 5: Network Screening Segment Results, Ranked

Roadway Segment and Extents	Highest Annualized Equivalent PDO Score Along Segment	Equivalent PDO Percentile Among Segments with Crashes	Crash Rate Percentile Among Segments with Crashes
Hillside Boulevard, Serramonte Boulevard to Sand Hill Road	61.3	Top 25 th	Top 75 th
Colma Boulevard, Junipero Serra Boulevard to El Camino Real	30.5	Top 25 th	Top 25 th
Serramonte Boulevard, Junipero Serra Boulevard to Hillside Boulevard	4.62	Top 25 th	Top 25 th
Collins Avenue, Serramonte Boulevard to Serramonte Ford Body Shop	1.8	Top 50 th	Bottom 25 th
Mission Road, El Camino Real to Holy Cross Catholic Cemetery	1.2	Top 50 th	Top 50 th
El Camino Real, northern town limits to Colma Boulevard	1.0	Top 75 th	Bottom 25 th
Junipero Serra Boulevard, northern town limits to Colma Boulevard	1.0	Top 75 th	Bottom 25 th
F Street, west of Clark Avenue to Hillside Boulevard	0.2	Bottom 25 th	Top 25 th
Southern half of Lawndale Boulevard	0.2	Bottom 25 th	Top 50 th
El Camino Real, Serramonte Boulevard to Mission Road	0.2	Bottom 25 th	Top 75 th

¹Traffic volumes not collected for this segment; thus, no crash rate analysis was conducted.
 Source: Town of Colma, SWITRS, Kittelson 2018

Roadway Segment Risk Factors

Kittelson identified the following characteristics as risk factors:

- ▶ Relatively high density of major access points⁴ (greater than 2 per 1,000 feet);
- ▶ Undivided roadways; and,
- ▶ Horizontally curved roadway segments.

The risk factors identified for intersections and roadway corridors will be used as part of the field reviews to help better understand potential contributing factors to crashes and treatments.

Intersection Screening Findings

Based on the EPDO scoring and crash rate results, the top quartile of intersections segments with a reported crash history are located on the study corridors identified by the Town of Colma in their SSARP grant application. Table 6 indicates intersections that may be considered for safety improvements.

⁴ Major driveways or access points, as defined by the *Highway Safety Manual*, serve sites with 50 or more parking spaces.

Table 6: Network Screening Intersection Results, ranked

Intersection	Signalized	Annualized Equivalent PDO Score	Equivalent PDO Percentile Among Intersections with Crashes	Crash Rate Percentile Among Intersections with Crashes
Junipero Serra Boulevard & Serra Center (North)	No	36.8	Top 25 th	N/A ¹
El Camino Real & Collins Avenue	No	34.5	Top 25 th	Top 75 th
El Camino Real & Mission Road	No	33.3	Top 25 th	Bottom 25 th
Junipero Serra Boulevard & Serra Center	Yes	28.3	Top 25 th	N/A ¹
El Camino Real & F Street	Yes	24.0	Top 50 th	Top 75 th
Junipero Serra Boulevard & Serramonte Boulevard	Yes	11.8	Top 50 th	Top 25 th
El Camino Real & Serramonte Boulevard	Yes	6.0	Top 50 th	Top 50 th
Junipero Serra Boulevard & Colma Boulevard	Yes	5.3	Top 50 th	Top 25 th
Junipero Serra Boulevard & Southgate Avenue	Yes	4.8	Top 50 th	Top 50 th
El Camino Real & Colma Boulevard	Yes	3.6	Top 75 th	Bottom 25 th
Collins Avenue & Serramonte Boulevard	No	2.0	Top 75 th	Bottom 25 th
Mission Road & Isabelle Way	No	2.0	Top 75 th	N/A ¹
Serramonte Boulevard & Hillside Boulevard	Yes	0.7	Bottom 25 th	Top 25 th
Hillside Boulevard & F Street	No	0.3	Bottom 25 th	Top 50 th

¹Turning movement counts not collected for this intersection; thus, no crash rate analysis was conducted.

Source: Town of Colma, SWITRS, Kittelson 2018

Intersection Risk Factors

Kittelson identified the following risk factors based on roadway characteristics that were consistently present across the top quintile of intersection locations:

- ▶ Side-street stop control onto a major (4+ lane) roadway;
- ▶ Closely spaced intersections, or intersections close to major access points (under 300 feet); and,
- ▶ Complex geometry or horizontally curved roadway segment at an intersection⁵.

⁵Complex intersections refer to locations with large intersection footprints, atypical approaches, and/or large median islands present for free movements or separating turn lanes from through traffic.

SUMMARY>>

The following are key insights from the Network Screening and Systemic Analysis:

Kittelson has identified the following potential roadway segments for further study:

- ▶ Hillside Boulevard, Serramonte Boulevard to Sand Hill Road;
- ▶ Colma Boulevard, Junipero Serra Boulevard to El Camino Real;
- ▶ Serramonte Boulevard, Junipero Serra Boulevard to Hillside Boulevard;
- ▶ Collins Avenue, Serramonte Boulevard to the Serramonte Ford Body Shop;
- ▶ El Camino Real, northern town limits to Colma Boulevard; and,
- ▶ Junipero Serra Boulevard, northern town limits to Colma Boulevard.

Kittelson identified the following potential intersections for further study:

- ▶ Junipero Serra Boulevard & Serra Center Entrance (North);
- ▶ El Camino Real & Collins Avenue;
- ▶ El Camino Real & Mission Road;
- ▶ Junipero Serra Boulevard & Serra Center (South);
- ▶ El Camino Real & F Street; and,
- ▶ Serramonte Boulevard & Junipero Serra Boulevard.

Risk factors identified through analysis of the potential priority locations include:

- ▶ Presence of at least two major access points within 1,000 feet;
- ▶ Two- and four-lane undivided roadways;
- ▶ Horizontally curved roadway segments;
- ▶ Side-street stop controlled intersections onto a major roadway;
- ▶ Closely spaced intersections and/or access points (under 300 feet); and,
- ▶ Complex or curved roadway geometry at intersections (large intersection footprints, atypical approaches, and/or large median islands present for free movements or separating turn lanes from through traffic.).



5.0
DRAFT PRIORITY
LOCATIONS

5.0 DRAFT PRIORITY LOCATIONS

After identifying the top locations and reviewing their associated roadway characteristics, Kittelson aggregated these sites to identify the roadway segments and intersections that are candidates for field review and potential improvements. Kittelson has identified the following candidate priority locations for field review based on the locations where multiple roadway segments and/or intersections scored in the top quartile or top half of analyzed locations.

The following segments (including intersections along the segment) are draft priority locations:

- ▶ Hillside Boulevard, Serramonte Boulevard to Sand Hill Road;
- ▶ Colma Boulevard, Junipero Serra Boulevard to El Camino Real;
- ▶ Serramonte Boulevard, Junipero Serra Boulevard to Hillside Boulevard;
- ▶ Collins Avenue, Serramonte Boulevard to the Serramonte Ford Body Shop;
- ▶ El Camino Real, northern town limits to Colma Boulevard; and,
- ▶ Junipero Serra Boulevard, northern town limits to Colma Boulevard.

Kittelson identified the following intersections as candidates for further evaluation. The intersections **in bold** are located along a segment above:

- ▶ Junipero Serra Boulevard & Serra Center Entrance (North);
- ▶ El Camino Real & Collins Avenue;
- ▶ El Camino Real & Mission Road;
- ▶ Junipero Serra Boulevard & Serra Center (South);
- ▶ **El Camino Real & F Street**; and,
- ▶ **Serramonte Boulevard & Junipero Serra Boulevard.**

These candidate priority locations are shown in Figure 11.

IN THIS SECTION>>

Recommendations for priority locations for additional analysis and field reviews

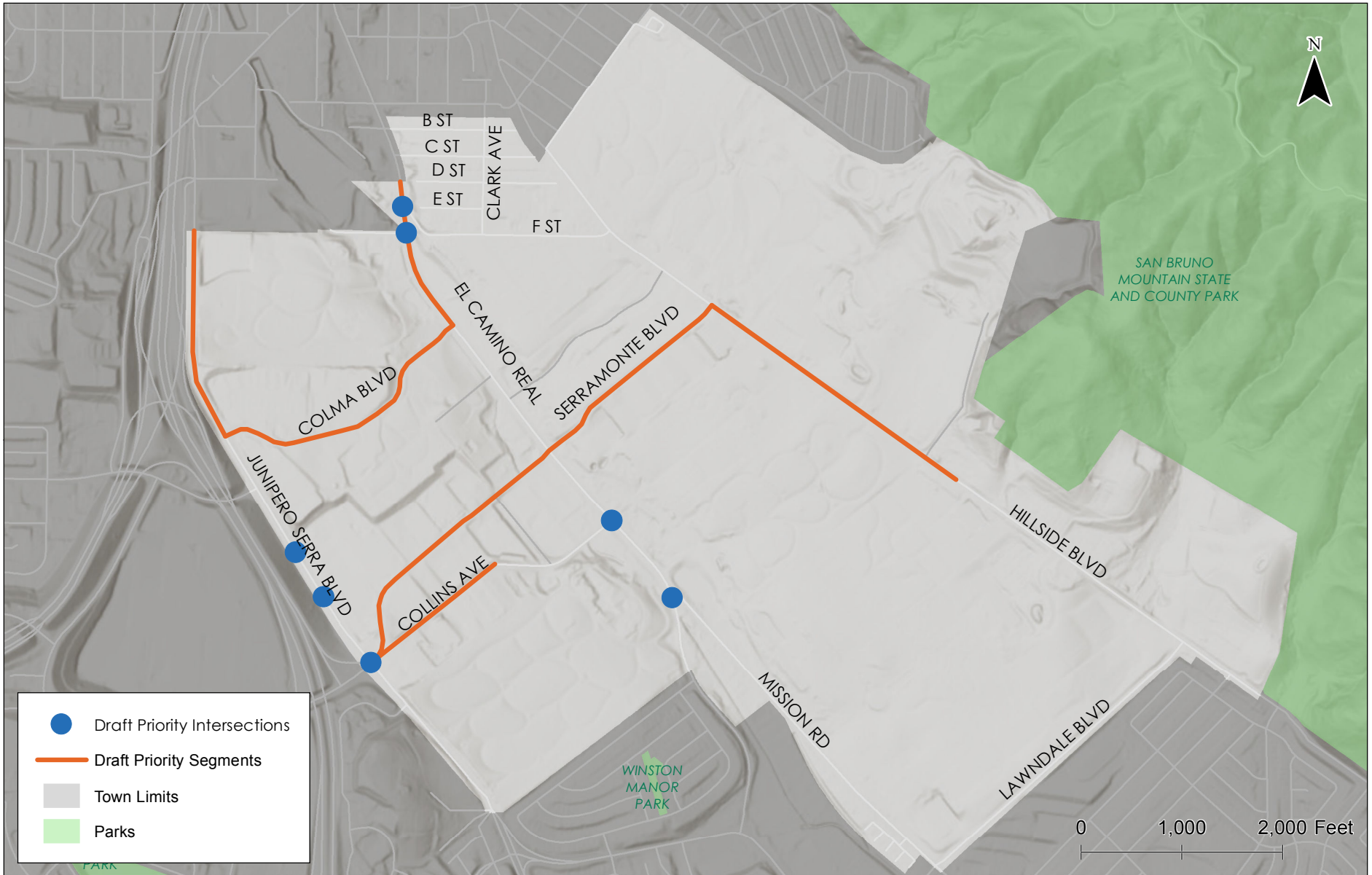


Figure 11

Town of Colma
CIP 993 Systemic Safety Analysis Project
Draft Priority Locations



6.0
NEXT STEPS

6.0 NEXT STEPS

The findings presented above are used to inform field reviews of the priority locations and ultimately determine the locations and project most likely to provide the greatest potential crash reduction. Grant applications and project scopes will be developed for the locations and projects considered to be most competitive for funding and most likely to improve roadway safety.