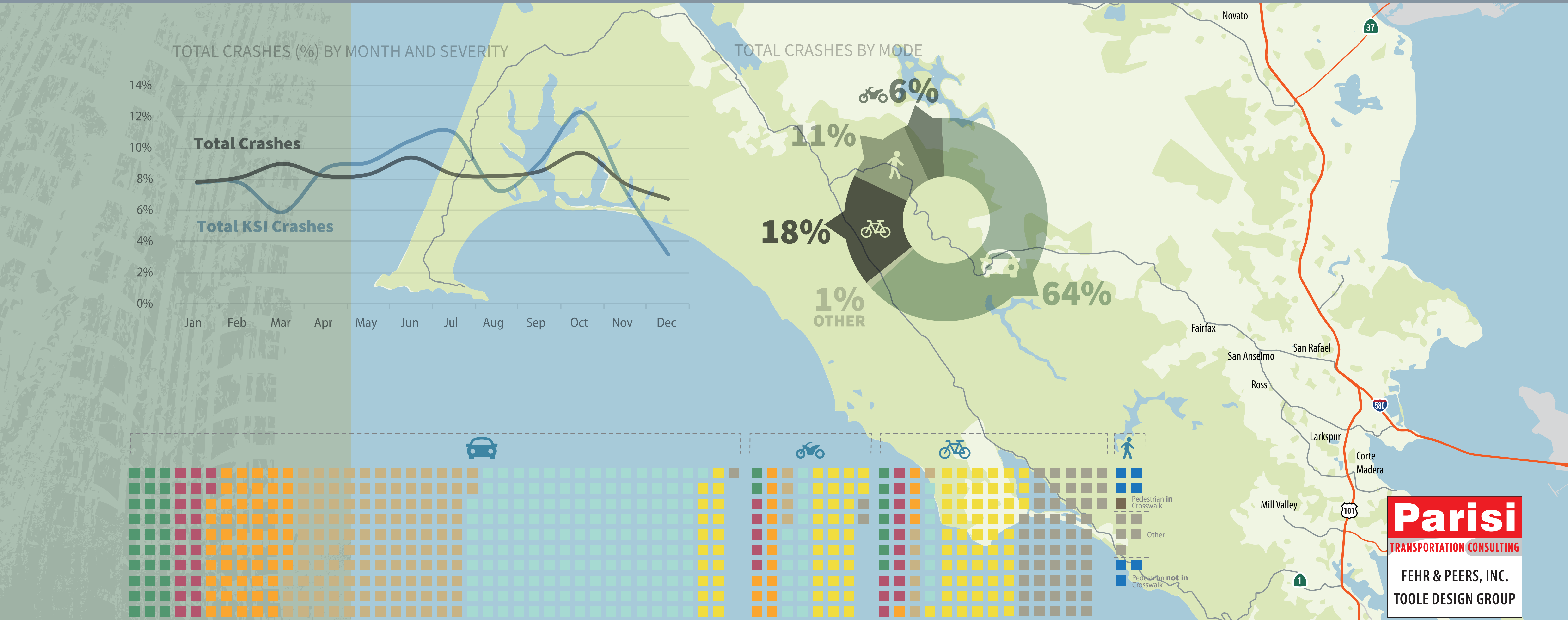
NOVEMBER 2018

2018 MARIN COUNTY TRAVEL SAFETY PLAN

Systemic Safety Analysis



One square = One Collision

* "Other" is one of the eight crash type options for police officers to designate on collision reports. Collisions designated as "Other" are included in the auto portion of the collisions by mode chart above.

2018 MARIN COUNTY TRAVEL SAFETY PLAN

Systemic Safety Analysis

COUNTY OF MARIN

Undertaken by the County of Marin with Support from the 11 Cities and Towns in Marin County

Prepared by:

11/19/2018

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Signed for Approval:

11/19/2018

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By signing and stamping this Systemic Safety Analysis Report, the engineer is attesting to this report's technical information and engineering data upon which local agency's recommendations, conclusions, and decisions are made.

Section 148 of Title 23, United States Code

REPORTS DISCOVERY AND ADMISSION INTO EVIDENCE OF CERTAIN REPORTS, SURVEYS, AND INFORMATION — Notwithstanding any other provisions of law, reports, surveys, schedules, lists, or data compiled or collected for any purpose relating to this section, 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 the location identified or addressed in the reports, surveys, schedules, lists, or other data.

ACKNOWLEDGEMENTS

The 2018 Marin County Travel Safety Plan was funded through a Systemic Safety Analysis Report Program (SSARP) grant provided by the California Department of Transportation (Caltrans). The County of Marin, in coordination with all the Marin incorporated cities and towns (Belvedere, Corte Madera, Fairfax, Larkspur, Mill Valley, Novato, Ross, San Anselmo, San Rafael, Sausalito and Tiburon) with the Transportation Authority of Marin (TAM) serving as the Congestion Management Agency (CMA), collaborated to develop a plan to evaluate travel safety for motorists, bicyclists, and pedestrians within Marin County. The study was managed by Bob Goralka and Reuel Brady of the Marin County Department of Public Works, in coordination with a Technical Advisory Committee comprised of agency staff and other study partners (TAC members indicated with * to the right). Input was sought from the Marin Public Works Association (MPWA) throughout the study process. A consulting team led by Parisi Transportation Consulting, and supported by Fehr & Peers and Toole Design Group, assisted County of Marin staff and the partner agency staff in preparing the plan.

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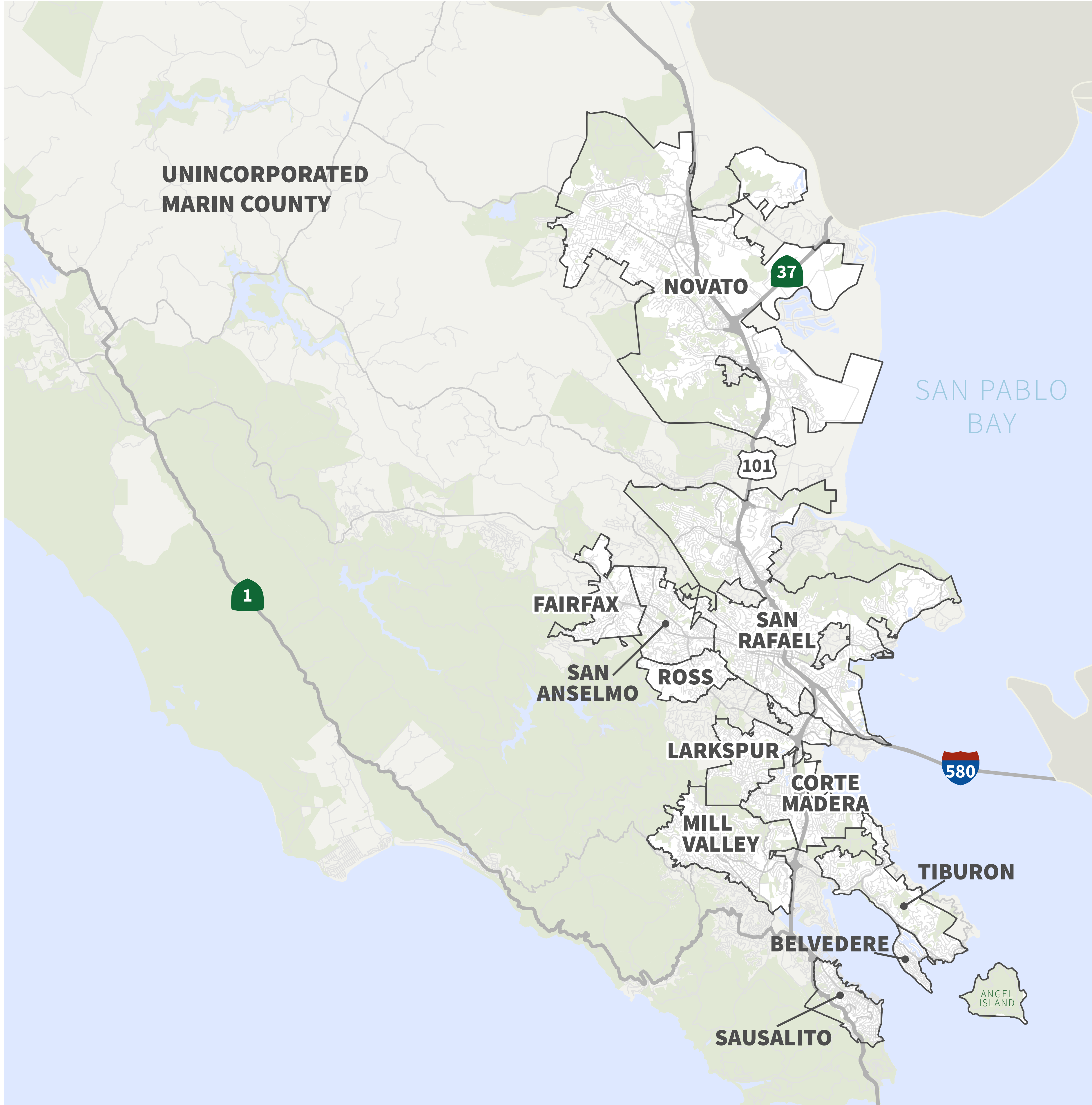

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CHAPTER 1: INTRODUCTION

EXECUTIVE SUMMARY

The purpose of the 2018 Marin Travel Safety Plan is to provide a systemic safety analysis for motorists, motorcyclists, bicyclists, and pedestrians on non-state arterial and collector roadways in Marin County, including roads in unincorporated Marin County and the 11 incorporated cities and towns. The Travel Safety Plan was funded through a Systemic Safety Analysis Report (SSAR) program grant provided by the California Department of Transportation (Caltrans).

The intent of the Travel Safety Plan is to:

1. Provide a proactive collision analysis of the Marin County region's arterial and collector road network, excluding state highways
2. Identify high risk locations and collision patterns
3. Develop a list of systemic low-cost and longer-term countermeasures
4. Develop a Travel Safety Plan to help secure funding to address key safety issues

This plan is consistent with the Strategic Highway Safety Plan (SHSP), a statewide coordinated safety plan that provides a comprehensive framework for reducing fatalities and severe injuries on all public roads. The SHSP vision is that California will have a safe transportation system for all users. Its mission is that California will ensure a safe and sustainable transportation system for all motorized and non-motorized users on all public roads in California. The SHSP goal is for California to move towards zero deaths.

The SSAR program was initiated by Caltrans to help local agencies take a more proactive approach to identifying safety improvement projects by completing a system-wide, data-driven analysis of collisions. The SSAR evaluation includes collision database development, review of local collision data, safety data analysis, High Collision Network development, collision profile analysis, safety countermeasures identification, prioritization, and preparation of Highway Safety Improvements Program grant applications.

As part of this plan, a collision database was developed to identify locations with a history of collisions, as described in Chapter 2. The analysis found that overall there were 2,756 injury crashes reported between January 1, 2012 and December 31, 2016 on the study network in Marin County. Of these, 219 resulted in fatalities or severe injuries ("KSI" crashes), which represent nearly eight percent of all crashes. The most common type of violation for KSI crashes was unsafe speeds which represent 26 percent of KSI crashes, followed by improper turning representing 20 percent of KSI collisions. The collision analysis also found that crashes involving vulnerable road users, including people walking, bicycling, and riding motorcycles, are disproportionately likely to result in severe outcomes. For instance, while pedestrian crashes represent just 11 percent of crashes, they represent 20 percent of KSI crashes. These disproportionate effects indicate a need to focus on improvements for these road users.

In addition to identifying locations with a history of collisions, this plan also evaluated the systemic nature of crashes in the study area, focusing on trying to understand where crashes are likely to occur in the future, rather than where they have occurred in the past. Blending the historic crash network with the systemic crash network, the Marin Travel Safety Plan identified 68 road segments and 93 intersections within Marin's high collision network that have a higher potential risk for future KSI collisions. This network is identified in Chapter 2. Countermeasures for each intersection and corridor are listed in the individual jurisdiction chapters, Chapter 4 through Chapter 14.

As part of this plan, three Highway Safety Improvements Program (HSIP) grants were prepared for HSIP Cycle 9. The projects selected for HSIP Cycle 9 funding were identified as San Rafael's Third Street corridor project, Novato's De Long Avenue/Diablo Avenue corridor project, and a Countywide traffic signal enhancements project. The process involved in selecting these applications are detailed in Chapter 15.

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SSAR Reporting Requirements listed above are sourced from Caltrans Division of Local Assistance Systemic Safety Analysis Report Program (SSARP) Guidelines, February 2016.

STUDY PARTNERS

The Marin County Travel Safety Plan was funded through a Systemic Safety Analysis Report Program (SSARP) grant provided by the California Department of Transportation (Caltrans). The County of Marin, in coordination with all the Marin incorporated cities and towns (Belvedere, Corte Madera, Fairfax, Larkspur, Mill Valley, Novato, Ross, San Anselmo, San Rafael, Sausalito and Tiburon) with Transportation Authority of Marin (TAM) serving as the Congestion Management Agency (CMA), collaborated to develop the plan to address travel safety for motorists, bicyclists, and pedestrians within Marin County. Marin General Hospital staff also provided data and input as members of the Technical Advisory Committee for the study.

STUDY PARAMETERS

The Travel Safety Plan evaluates collision history and provides countermeasures for local arterial and collector roads in Marin County. The Plan does not include analysis of state highway facilities or roadways within Caltrans right-of-way with one exception. A separate evaluation of State Route 131 (Tiburon Boulevard) is provided in the Town of Tiburon chapter, as a majority of collisions that occur within the town are on that roadway.

The following is a summary of the collision database:

- The database is a compilation of reported collisions from 2012–2016 on all local arterial and collector roads
- The primary source of the collision database was the Transportation Injury Mapping System (TIMS), a statewide collision database funded by the California Office of Traffic Safety (OTS), that was developed and is maintained by the Safe Transportation Research and Education Center (SafeTREC) at UC Berkeley
- After a review of the TIMS collision database with local agencies identified some data gaps, the TIMS database was supplemented through the addition of collision records provided by California Highway Patrol (CHP) and local police department staff.

TRAVEL SAFETY PLAN ORGANIZATION

The 2018 Marin Travel Safety Plan includes this introductory chapter, two global chapters that describe the collision assessment at a countywide level and a toolbox of countermeasures, respectively, separate chapters for each of the 12 jurisdictions in Marin County, and a concluding chapter on next steps.

Chapter 1 Introduction

Chapter 2 Countywide Collision Data

Chapter 3 Countermeasure Toolkit

Chapter 4 Town of Corte Madera

Chapter 5 Town of Fairfax

Chapter 6 City of Larkspur

Chapter 7 City of Mill Valley

Chapter 8 City of Novato

Chapter 9 Town of Ross

Chapter 10 Town of San Anselmo

Chapter 11 City of San Rafael

Chapter 12 City of Sausalito

Chapter 13 Town of Tiburon/City of Belvedere

Chapter 14 Unincorporated Marin County

Chapter 15 Highway Safety Improvements Program

The jurisdiction chapters include a description of local collision data and how that local data compares to countywide totals, a collision index map, jurisdiction collision profiles, a map showing study corridors and intersections, and countermeasures for the study locations.

CHAPTER 2: COUNTYWIDE DATA COLLECTION

DATA COLLECTION

This section presents a description of the safety approach for the Marin Travel Safety Plan, a summary of countywide collision data, and a description of the predictive model developed to support the systemic evaluation of crash countermeasures.

The Marin Travel Safety Plan is based on a blending of a crash-based approach and a systemic approach to diagnosing collision factors and arterial and collector roadway patterns in order to select the most appropriate countermeasures for designated study corridors and intersections. The Travel Safety Plan evaluates conditions on the arterial and collector network in Marin County.

The crash-based safety assessment is based on five years of collision data obtained from the Transportation Injury Mapping System (TIMS) crash database that was developed and is maintained by SafeTREC, a University of California, Berkeley research center. The database is comprised of CHP and local police-reported crashes from the Statewide Integrated Traffic Records System (SWITRS) between 2012 and 2016. An initial screening of the data indicated that some collision records were missing from the SWITRS system. The TIMS database was supplemented for this study to add those missing records.

A comprehensive evaluation of the records provided a descriptive analysis of crash data at the countywide level, a matrix of total collisions by local intersections and corridors, and crash density and index maps for all jurisdictions.

The intersection and corridor matrix, as well as the index maps, form the basis for identifying of study intersections and corridors. More detailed crash data was extracted for those study intersections and corridors, including by mode and crash type, forming the basis for crash-based countermeasures that are listed in each jurisdiction's section of this plan.

Evaluating the systemic safety of the study area network entails studying the contextual characteristics of crashes as well as combinations of features that are particularly likely to be associated with crashes. The latter differs from descriptive crash analysis because it focuses on trying to understand where crashes are likely to occur in the future, rather than where they have occurred in the past.

The objective of the systemic analysis is to identify locations on Marin's arterial and collector roads that have a high potential for collisions, based on historic crash patterns and identified predictors of crashes. Crash prediction models, or Safety Performance Functions (SPFs), were developed based on a series of variables related to exposure, roadway geometric, and contextual factors.

OFFICE OF TRAFFIC SAFETY COLLISION RANKINGS

Additional information on collisions in Marin County is provided by the California Office of Traffic Safety (OTS). OTS is designated by the Governor to receive federal traffic safety funds for coordinating California's highway safety programs.

Each year OTS develops a Highway Safety Plan (HSP) identifying the key highway safety problems in the state and the most effective countermeasures to address them. OTS then solicits proposals statewide to address the identified problems and allocates funds to state and local governmental agencies to implement traffic safety programs and grants.

OTS develops annual collision rankings for all California jurisdictions. The OTS rankings are developed so that individual cities can compare their city's traffic safety statistics to those of other cities with similar-sized populations. Cities could use these comparisons to see what areas they may have problems in and which they were doing well in. Rankings are also developed for each of the state's 58 counties. The rankings are based on the Empirical Bayesian Ranking Method. This method uses population and daily vehicle miles traveled as well as crash records, crash trends and other weighing factors to arrive at a single ranking.

OTS rankings from 2015, the latest year available, indicate that Marin County as a whole ranks in the top 10 (out of 58 counties throughout the state), meaning higher collision rates, in the following collision types.

- Collisions involving bicyclists - 2nd highest
- Collisions involving pedestrians 65 or older – 3rd highest
- Collisions involving pedestrians – 10th highest

Marin County ranked 11th highest among counties in collisions where speed was a major contributing factor.

Marin County ranked 48th in total fatal and injury collisions, among the lowest rates of the state's 58 counties. The county also ranked in the bottom 15 in the following collision types.

- Collisions involving alcohol – 56th (out of 58)
- Collisions occurring at night (9 pm–3 am) – 55th
- Hit and run collisions – 49th
- Collisions involving pedestrians younger than 15 – 46th

Highlights of key OTS rankings for each of the 11 cities and towns in Marin County are provided in the individual jurisdiction chapters.

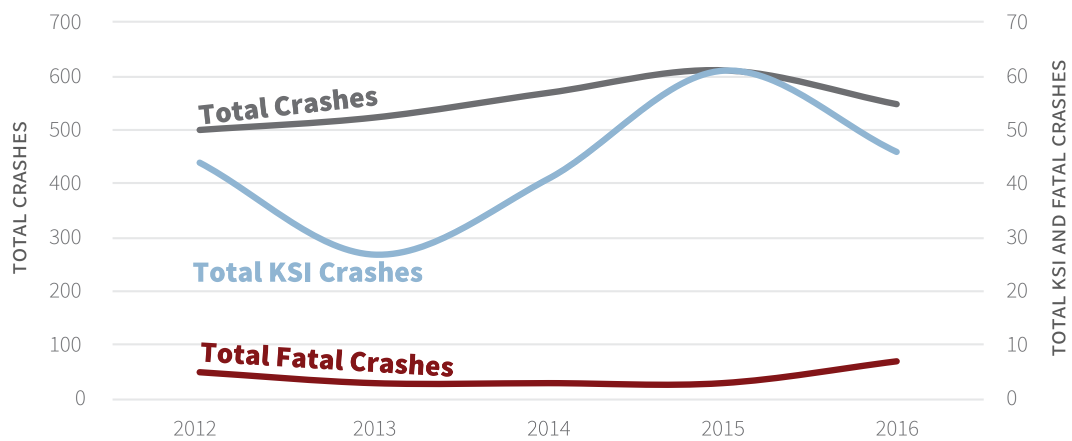
COUNTYWIDE FINDINGS

The following is a summary of the key findings of the evaluation of all collision data for Marin County jurisdictions:

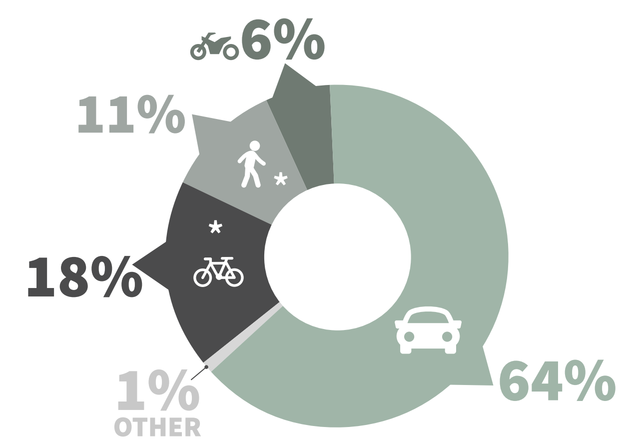
- Overall, there were 2,756 reported crashes from 2012–2016 on the study network. Of these, 219 resulted in fatalities or severe injuries ("KSI" crashes), which represents nearly eight percent of all crashes.
- Crashes involving vulnerable road users, including people walking, bicycle, and riding motorcycles, are disproportionately likely to result in severe outcomes. For instance, while pedestrian crashes represent just 11 percent of crashes, they represent 20 percent of KSI crashes. These disproportionate effects indicate a need to focus on improvements for these road users.
- The unincorporated areas of the county have the highest rates of most types of KSI crashes, with the sole exception that San Rafael has the highest rate of pedestrian KSI crashes. This may be due in part to higher rates of pedestrian exposure in San Rafael, and risk factors such as mountains and/or high-speed roads in the unincorporated areas.
- Crash patterns over time (e.g., by time of day, day of week, and month of year) generally track with expected rates of exposure. However, one notable exception is an elevated rate of solo motor vehicle crashes late at night, which is attributable in part to driving under the influence. Additionally, serious pedestrian crashes appear to peak in the winter months, when exposure is assumed to be lowest.
- Unsafe speed has the highest percentage share of crashes for total crashes (29 percent) and KSI crashes (26 percent) but is not one of the top violations for fatal crashes (5 percent).

Additional collision statistics, based on the data from 2012 to 2016, are summarized on the following pages.

CRASHES BY YEAR AND SEVERITY

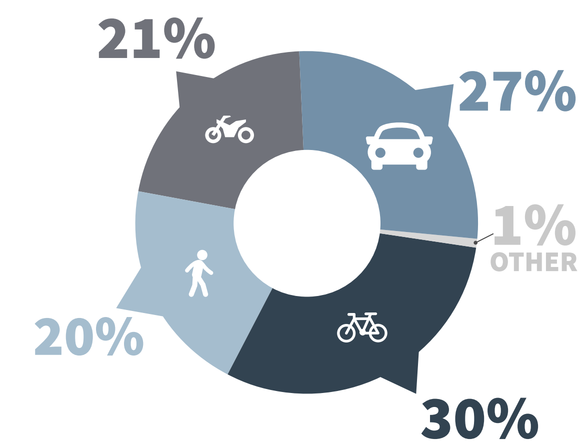


TOTAL CRASHES BY MODE

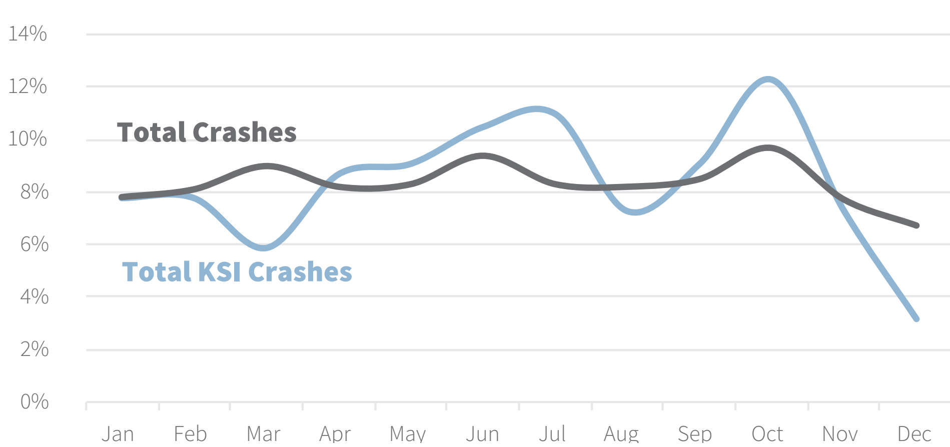


* Most collisions with pedestrians and bicycles involved an automobile

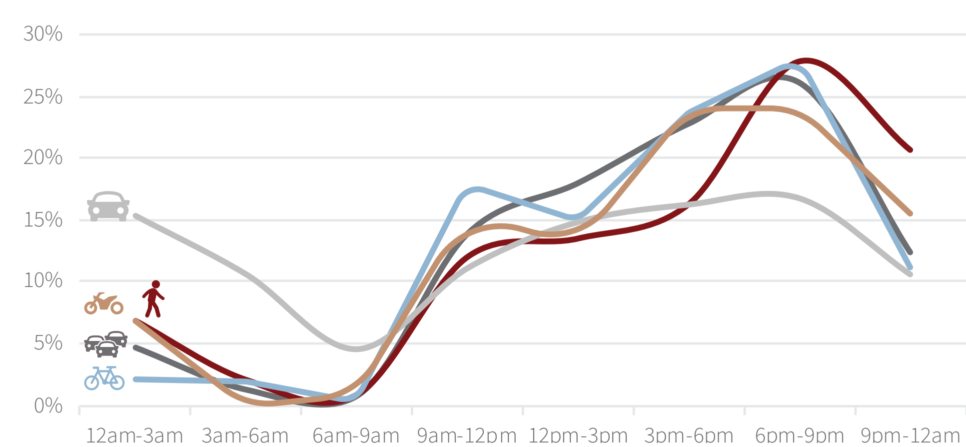
KSI CRASHES BY MODE



TOTAL CRASHES (%) BY MONTH AND SEVERITY



TIME OF CRASH ON WEEKDAYS

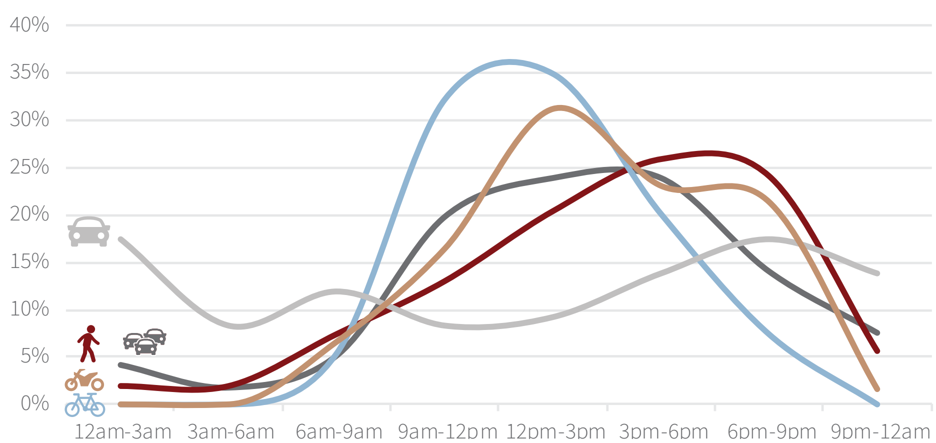


KSI = KILLED OR SEVERELY INJURED

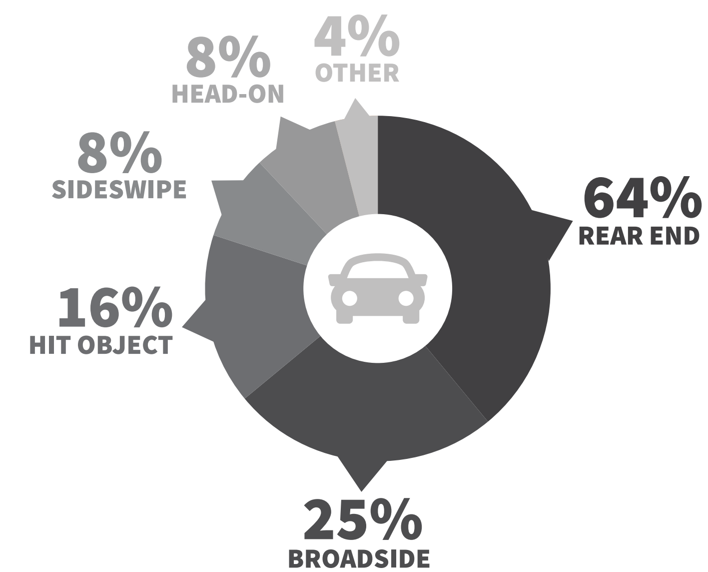
Severely Injured refers to an injury, other than a fatal injury, that includes:

- Broken or fractured bones
- Dislocated or distorted limbs
- Severe lacerations
- Skull, spinal, chest or abdominal injuries that go beyond "Other Visible Injuries"
- Unconsciousness at or when taken from the collision scene
- Severe burns

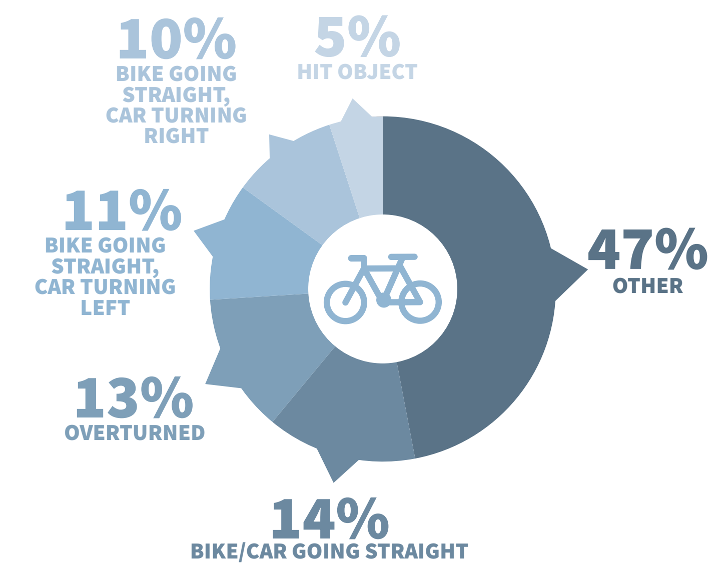
TIME OF CRASH ON WEEKENDS



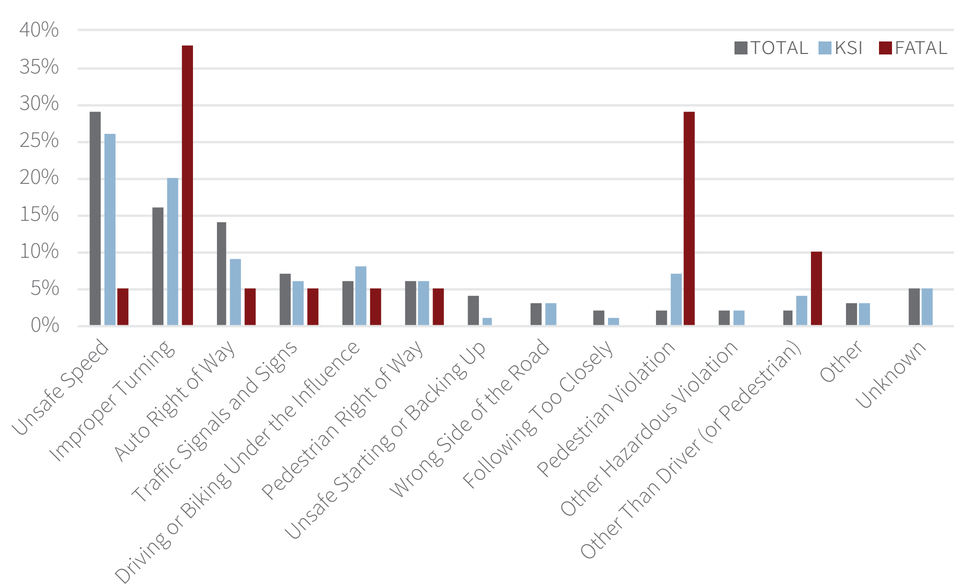
MOTOR VEHICLE CRASH TYPES



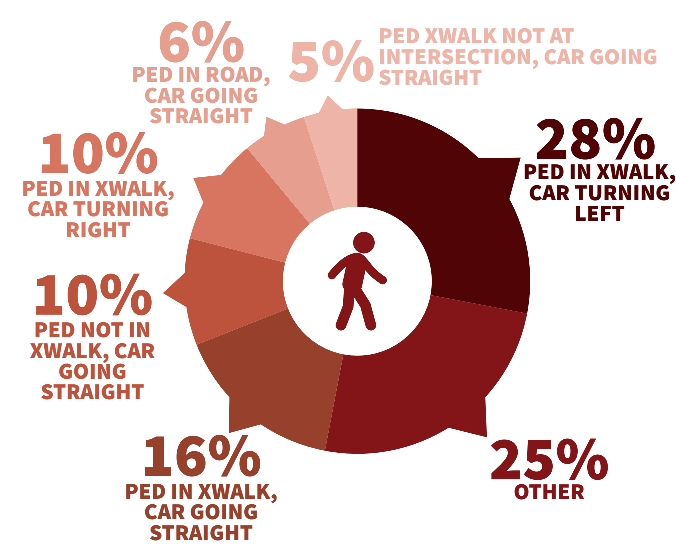
BICYCLE CRASH TYPES



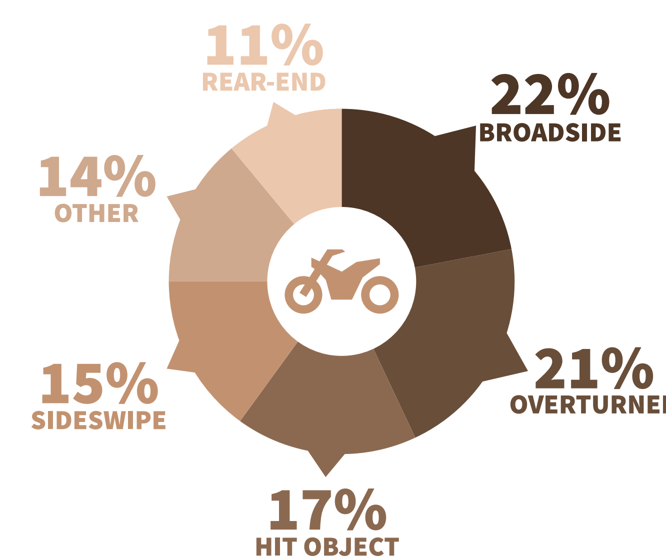
VIOLATIONS, ALL CRASHES, 2012-2016



PEDESTRIAN CRASH TYPES



MOTORCYCLE CRASH TYPES



FINDINGS BY JURISDICTION

The following is a summary of the key findings in the evaluation of collision data for individual Marin County jurisdictions:

- San Rafael had the highest number of crashes in Marin County with 953 total crashes, or 35 percent of all crashes. San Rafael also had the highest crash rates for pedestrian crashes, bicycle/vehicle, motorcycle/vehicle, and multi-vehicle crash types; all but the last of these are generally considered to be the most vulnerable roadway users. It should be noted that the crashes in San Rafael are likely due in part to higher exposure for all types of travelers.
- Unincorporated Marin County had the second highest total number of crashes with 624 total crashes, or 22 percent of total crashes.
- Nearly eight percent of all crashes in Marin County from 2012–2016 resulted in fatalities or severe injuries ("KSI" crashes). Crashes within Unincorporated Marin County had the highest probability of being a KSI crash, with 16 percent of all crashes reported as KSI, followed by Fairfax (13 percent), and Sausalito (nine percent).
- Solo-vehicle crashes were the most common crash types in Unincorporated Marin County (23 percent of KSI crashes), followed solo-bicycle (19 percent), and solo-motorcycle (19 percent).
- Over half of the pedestrian KSI crashes occurred in San Rafael (24 KSI crashes), followed by Novato with nine total pedestrian KSI crashes.
- San Rafael also had a high rate of bicycle/vehicle KSI crashes, accounting for 26 percent of the county's bicycle/vehicle KSI crashes.

PERCENT KSI AND FATAL CRASHES OF TOTAL CRASHES BY JURISDICTION

	KSI		Fatal	
Jurisdiction	Count	Percent	Count	Percent
Unincorporated	100	16%	7	1%
San Rafael	49	5%	10	1%
Novato	32	6%	4	1%
San Anselmo	9	6%	0	0%
Fairfax	9	13%	0	0%
Sausalito	8	9%	0	0%
Corte Madera	5	7%	0	0%
Mill Valley	4	3%	0	0%
Larkspur	3	3%	0	0%
Ross	0	0%	0	0%
Tiburon	0	0%	0	0%
Belvedere	0	0%	0	0%

PERCENTAGE SHARE OF KSI CRASHES BY JURISDICTION AND MODE

Jurisdiction	Total	Pedestrian/ Vehicle	Solo-Bicycle	Solo-Motorcycle	Solo-Motor Vehicle	Bicycle/ Vehicle	Motorcycle/ Vehicle	Multi-Vehicle	Other
Total Crashes (n=)	**219**	**44**	**28**	**25**	**29**	**38**	**22**	**30**	**3**
Unincorporated	**46%**	7%	71%	76%	79%	32%	55%	37%	-
San Rafael	**22%**	55%	7%	16%	-	24%	18%	17%	33%
Novato	**15%**	20%	11%	-	14%	16%	9%	27%	-
San Anselmo	**4%**	7%	4%	-	3%	5%	5%	3%	-
Sausalito	**4%**	2%	4%	-	-	8%	5%	7%	33%
Fairfax	**4%**	2%	-	-	-	11%	-	7%	33%
Corte Madera	**2%**	5%	-	4%	-	5%	-	-	-
Mill Valley	**2%**	-	-	4%	-	-	9%	3%	-
Larkspur	**1%**	2%	4%	-	3%	-	-	-	-
Ross	**-**	-	-	-	-	-	-	-	-
Tiburon	**-**	-	-	-	-	-	-	-	-
Belvedere	**-**	-	-	-	-	-	-	-	-

OTHER COLLISION FACTORS

DISTRACTED DRIVING

The National Highway Traffic Safety Administration (NHTSA) reports that 3,450 fatalities occurred nationally in 2016 due to distracted driving.

Distracted driving is any activity that diverts attention from driving, including talking or texting on the phone, eating and drinking, talking to people in the vehicle, fiddling with the stereo, entertainment or navigation system – anything that takes a driver's attention away from the task of safe driving.

Texting is the most alarming distraction. Sending or reading a text takes a motorist's eyes off the road for five seconds. At 55 mph, that's like driving the length of an entire football field with eyes closed.

Driving a vehicle while texting is six times more dangerous than driving while intoxicated.

NHTSA leads a national campaign against distracted driving that includes public service announcements to educate Americans about its dangers, providing federal investments in the locally driven strategies to address distracted driving, and partnering with the States and local police to enforce laws.

The California Office of Traffic Safety (OTS) provides the following facts about distracted driving based on surveys in 2016.

- More than 54 percent of California drivers surveyed said they had been hit or nearly hit by a driver who was talking or texting on cell phone.
- Nearly 40 percent of drivers admitted to making a mistake while talking on a cell phone.
- 7.6 percent of all drivers observed in a 2016 study displayed distracted driving as a result of electronic device use, compared to 5.4 percent in 2015.

DUI COLLISIONS

OTS reports that Marin County ranks 56 out of 58 counties in the state in the number of victims involved in collisions, (i.e., among the lowest of the state's counties) in which there were victims killed or injured where a party (driver, pedestrian, bicyclists) was classified as "had been drinking". OTS rankings by jurisdiction indicate that Fairfax ranked 12th and Sausalito ranked 19th out of 67 similar size cities in these types of collisions in 2015 (latest year for which rankings are available).

According to the DMV, under California's driving under the influence (DUI) laws, it is illegal to operate a motor vehicle with any of the following blood alcohol concentration (BAC) percentages:

- 0.08% or higher – 21 years old or older operating a regular passenger vehicle.
- 0.04% or higher – operating a commercial vehicle.
- 0.01% or higher – younger than 21 years old.

The state's DUI laws include medications, too. A person is prohibited from driving if he or she consumed illegal drugs or:

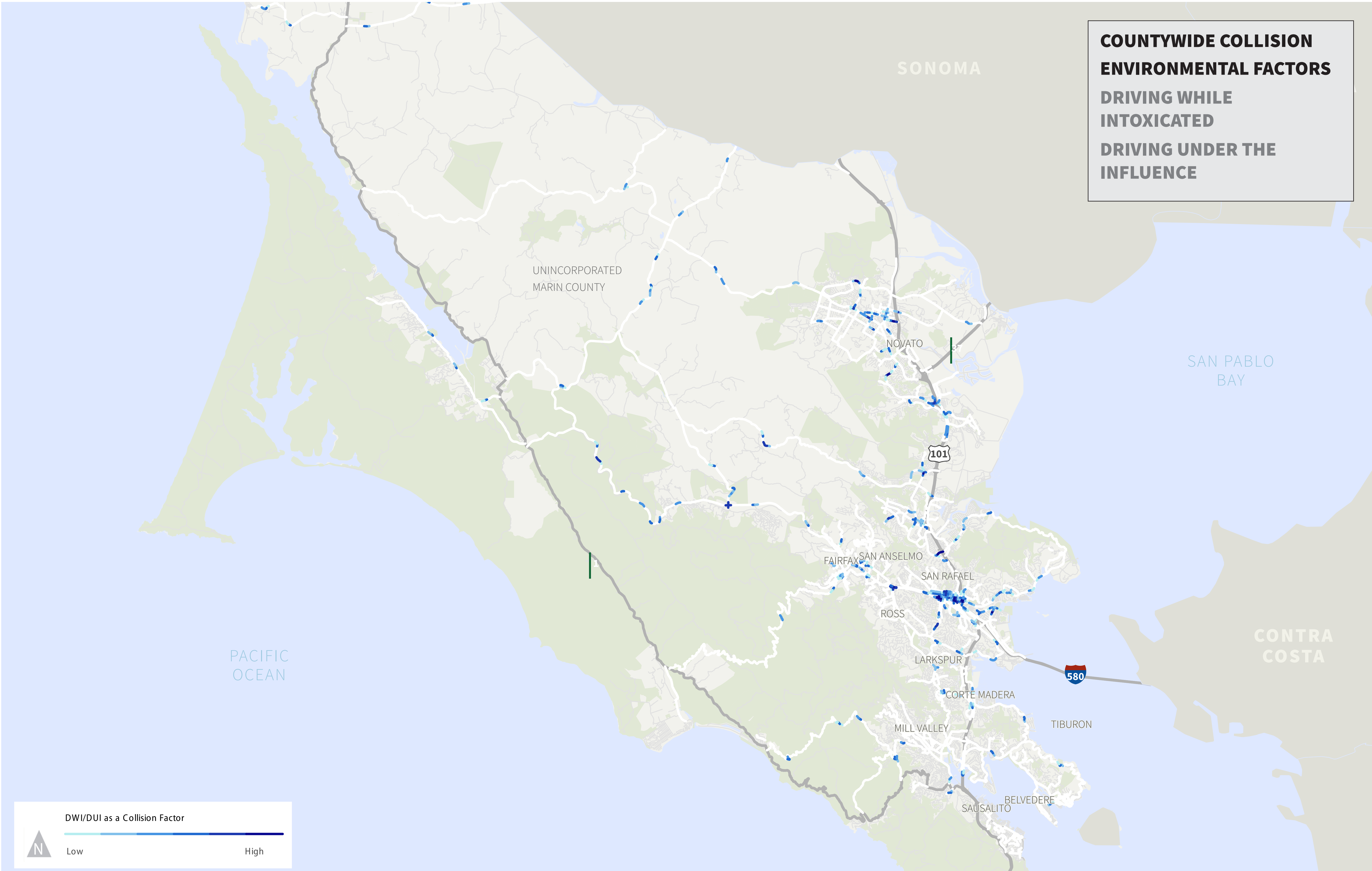
- Excessive amounts of drugs with alcohol in them (such as cough syrup).
- Prescription medication.
- Over-the-counter medication.
- The map on page 2-6 includes a figure that shows the distribution of collisions throughout Marin County in which a DUI arrest was made between 2012 and 2016. OTS does not provide rankings of DUI arrest figures by county. OTS ranking of DUI arrests by City indicate that Ross ranked fifth and Tiburon ranked sixth out of 62 similar size cities in DUI arrests in 2015.

The Centers for Disease Control and Prevention (CDC) identifies the following strategies as effective in reducing or preventing drunk driving:

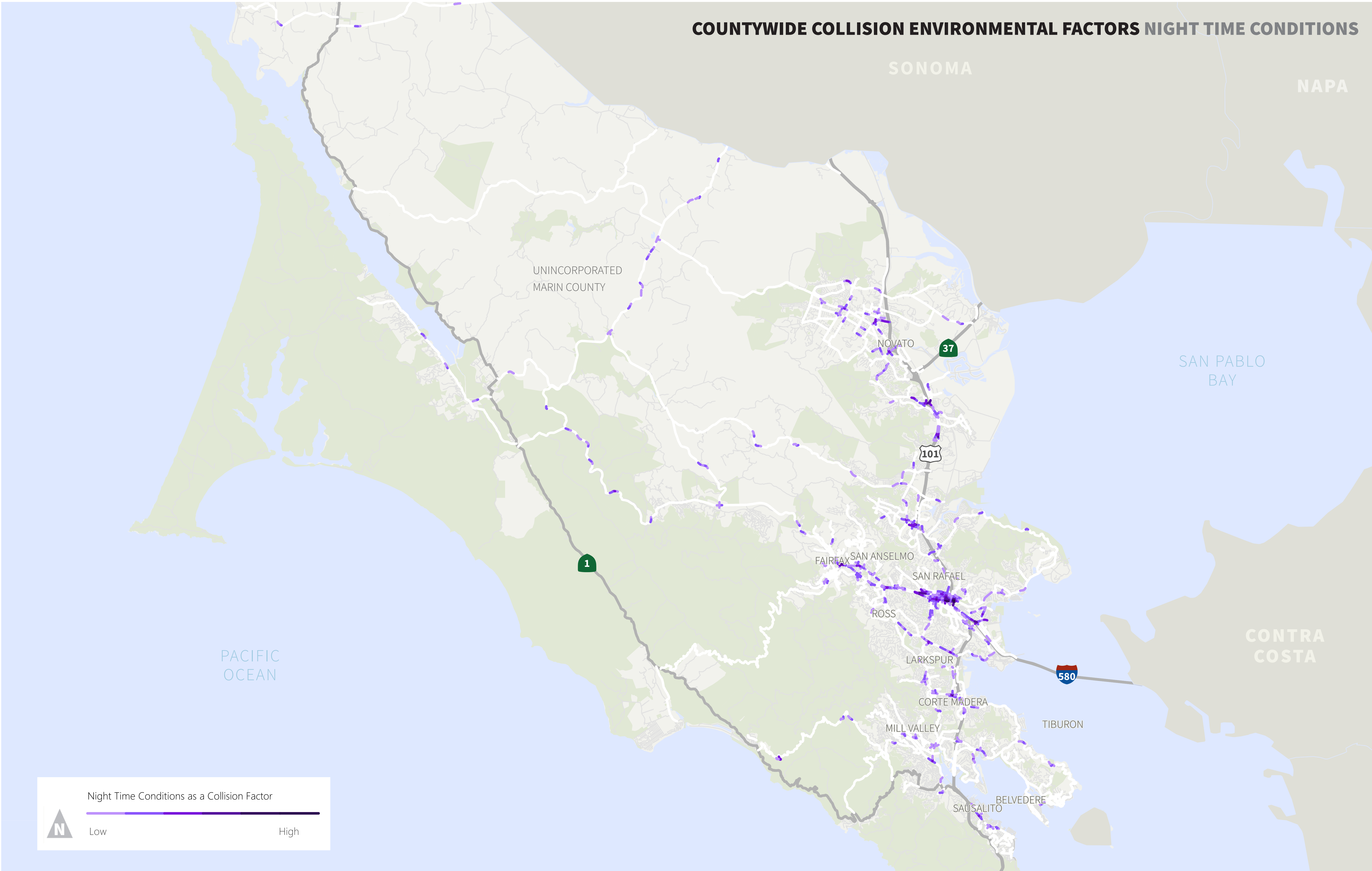
- Drunk driving laws
- Sobriety checkpoints
- Ignition interlocks
- Multi-component interventions
- Mass media campaigns
- Administrative license revocation or suspension laws
- Alcohol screening and brief interventions
- School-based instructional programs

NIGHTTIME COLLISIONS

OTS reports that Marin County ranks 55 out of 58 counties in the state (i.e., among the lowest of the state's counties) in nighttime collisions defined as collisions that occur between 9:00 pm and 2:59 am. Most cities in Marin County have low or very low frequency of nighttime collisions. OTS rankings by City indicate that Sausalito ranked fifth out of 67 similar size cities and San Rafael ranked 25th out of 105 similar size cities in these types of collisions in 2015. The map on page 2-7 shows the distribution of nighttime collisions throughout Marin County between 2012 and 2016.


COUNTYWIDE COLLISION ENVIRONMENTAL FACTORS
DRIVING WHILE INTOXICATED
DRIVING UNDER THE INFLUENCE
SONOMA
UNINCORPORATED MARIN COUNTY
NOVATO
SAN PABLO BAY
101
FAIRFAX
SAN ANSELMO
SAN RAFAEL
ROSS
LARKSPUR
580
CONTRA COSTA
CORTE MADERA
TIBURON
MILL VALLEY
BELVEDERE
SAUSALITO
PACIFIC OCEAN
DWI/DUI as a Collision Factor
Low
High
N

COUNTYWIDE COLLISION ENVIRONMENTAL FACTORS NIGHT TIME CONDITIONS



SYSTEMIC ASSESSMENT

This section describes the systemic analysis element of the project. It walks through various aspects of the methodology, including how the systemic database was created, how the models were estimated and evaluated, and how the modeling results were used to define segment and intersection rankings.

To conduct systemic analysis, databases were created summarizing the characteristics of the arterial and collector segments and intersections around the County. This process included collecting and/or inferring a wide variety of potential covariates for crashes on the road elements, and aggregating crash totals for each high-level crash type (e.g., pedestrian, solo bicycle) onto the road elements.

The directly available data sources included:

- Collisions from the Transportation Injury Mapping System, which geocodes collision data from the California Highway Patrol.
- The MarinMap Road feature class, which is derived from the Census TIGER files and has been edited to match aerial imagery. MarinMap includes the functional class of road segments.
- United States Geological Survey's National Elevation Dataset (NED), at 1/9 arc-second resolution.
- OpenStreetMap (OSM) , which is a crowdsourced GIS dataset that includes a range of road attributes.
- Population at the block-level from the 2010 Census.
- Employment data from the Metropolitan Transportation Commission (MTC).
- Average Daily Traffic (ADT) volumes collected from local agencies on a subset of road segments.
- Lighting.

Additional information was collected for the study arterial and collector roadways by the project team to supplement available data listed above:

- Updated roadway functional classification
- Number of through lanes
- Center median presence
- Radius of sharpest curve in segments
- Total number of identified curves with radii below 2,000′
- Maximum roadway slope of greatest sub-segment
- Average roadway slope
- Speed limits
- Supplemental traffic volume data
- Crowd sourced bicycle ridership data, licensed by Strava.
- Presence of protected left turn signal heads at intersections

In order to model the number of expected crashes on a particular segment or intersection, crashes were assigned to specific segments or intersections based on the following logic.

1. Buffers were generated around intersection points. The buffer sizes were selected to roughly correspond to the influence areas of the intersections. Arterial/arterial intersections were buffered by 200 feet, arterial/collector and collector/collector intersections by 150 feet, and collector/local intersections by 100 feet.
2. Crashes were assigned to intersections within whose buffers they occurred. If a crash was within the vicinity of multiple intersections, it was assigned to the closest one.
3. The remaining crashes were assigned to the nearest segment, provided that they are within 200 feet (laterally) of the segment.

At the end of this process, a set of segments and intersections with total counts of various types of crashes and important covariates were identified, including exposure information.

The objective of the systemic analysis is to identify locations on Marin's arterial and collector roads that have a high potential for collisions, based on historic crash patterns and identified predictors of crashes. The crash prediction models, or Safety Performance Functions (SPFs), that were developed for this project are Negative Binomial models fit using maximum likelihood estimation.

Separate models were estimated for each mode on segments and intersections. For the segment model, solo bicycle, solo motorcycle, and solo motor vehicle crashes were separated into their own models due to the substantially different dynamics at play in these crashes.

For each model, an optimal combination of variables was selected based on overall model fit (measured using Akaike Information Criterion, which is an estimator of the relative quality of statistical models for a given data set), significance of individual parameter estimates, and justifiability of the signs of individual terms.

Studying traffic crashes requires analysts to make a trade-off in terms of the number of years of data used. On the one hand, because crashes are relatively infrequent at any given location, using a longer time series of data makes patterns more likely to emerge. However, the longer the time period of data that is used, the more likely that conditions have changed, such as changes in traffic volumes and roadway geometries, making it difficult to identify the factors that affect crash patterns.

The Empirical Bayes method, as recommended in the Highway Safety Manual (HSM), allows an effective balance between these competing interests when considering network prioritization methods. This method has been shown to yield the best estimate of the true rate of collisions at any given location.

Models were subsequently developed for predicting crashes at Marin County intersections. Separate intersection models were developed for pedestrian crashes, bicycle crashes, motorcycle crashes, and motor vehicle crashes. Solo crashes with multi-party collisions were consolidated for the intersections because solo crashes in intersections are relatively uncommon.

Across the intersection models (except for motorcycle crashes), the presence of signals at intersections are a significant predictor of elevated crash rates. This runs counter to expected crash reduction benefits associated with signals, which again could indicate that these are serving as a proxy for more complicated and higher volume traffic environments, as those situations are more likely to result in crashes and are also the cases where signals are typically installed. Motor vehicle traffic volumes are a significant predictor of all types of crashes, as expected, and Strava Metro also serves as a significant predictor for both bicycle and motorcycle collisions at intersections.

Elevated traffic speeds serve as a predictor of all types of intersection collisions except for bicycle crashes. However, different "cutpoints" for the speed limit were most predictive for different models. For pedestrian and motorcycle collisions, a cutpoint of 25 mph was the most predictive of higher collision rates, whereas for motor vehicle intersection crashes, 40 mph was the most predictive cut point.

Three-legged intersections appear to be lower risk for pedestrian and motor vehicle collisions, which could point to lower rates of conflicting movements at these locations (i.e., fewer crossings for pedestrians, fewer conflicting turning movements for motor vehicles).

Once the best fitting functions for the various high-level crash types were determined, the formulas were applied to the data to calculate a predicted number of crashes for each intersection and segment, followed by an Empirical Bayes number (blend of the predicted and observed numbers, as described in Section 3.1.3).

The top-ranked segments and intersections, on the basis of expected number of collisions over the five-year study period according to the Empirical Bayes method, were identified as study locations for further evaluation and development of countermeasures.

STUDY SEGMENTS AND INTERSECTIONS

The majority of solo crashes involving motor vehicles, motorcycles and bicycles occurred on roadway segments away from signalized or unsignalized intersections, as shown in the following figures. Conversely, the overwhelming majority of pedestrian, bicycle-vehicle, and multi-vehicle crashes occured at intersections.

The Marin Safety Plan identifies countermeasures for study road segments and intersections that either experienced high rates of collisions over the five year study period or were identified through the systemic assessment described above. The following pages provide maps of the study corridors and intersections, as well as a collision rate chart for all jurisdiction study corridors.

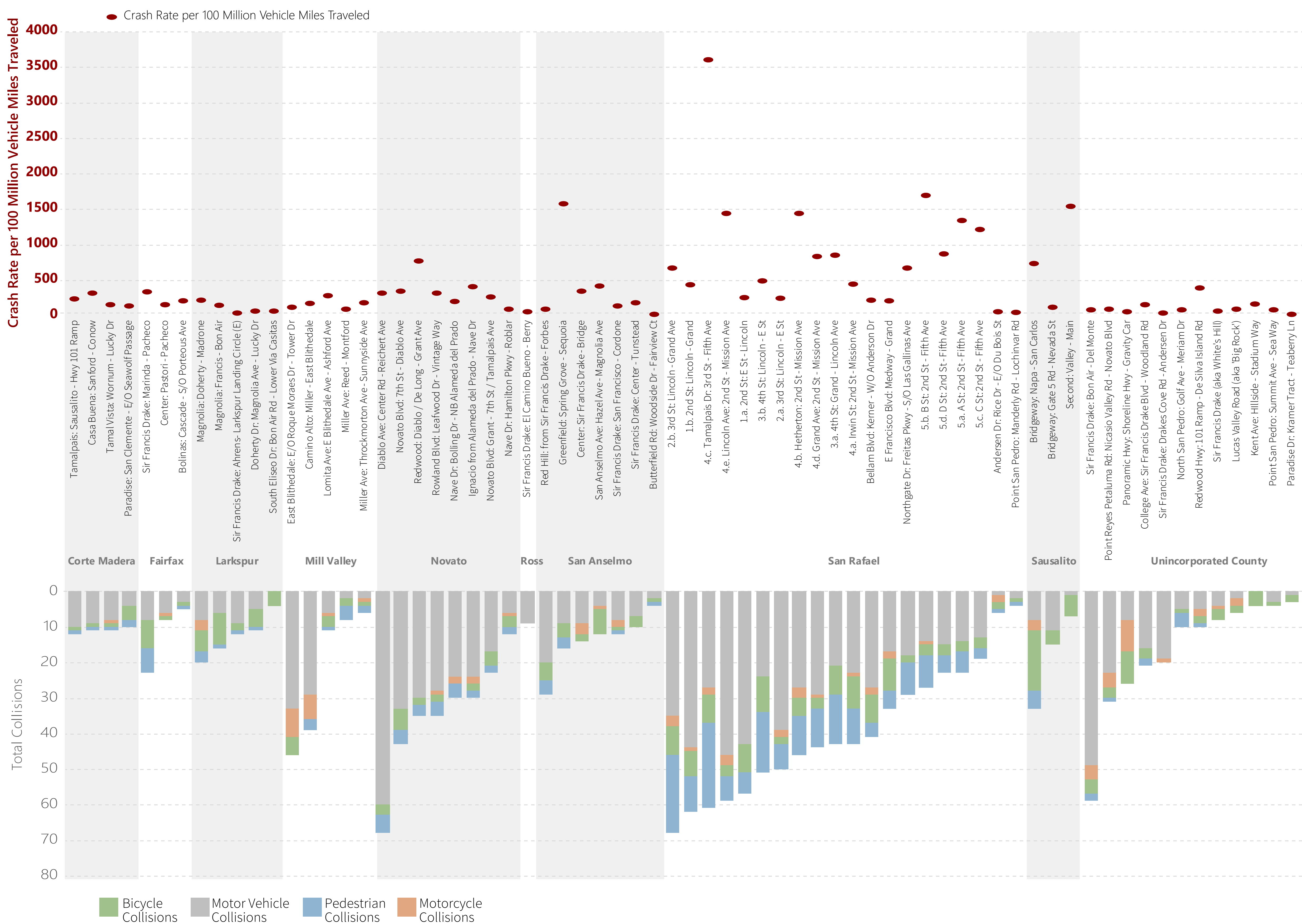
COUNTYWIDE STUDY CORRIDORS

Study corridors were identified in each jurisdiction based on a blending of a crash-based approach and a systemic approach to evaluating collision data and significant predictive factors, as described earlier in this chapter. The five years of collision data were then evaluated for each study corridor and corridor-level safety countermeasures were identified based on consultation with relevant jurisdiction staff. A complete list of the study corridors total number of collisions by mode and collision rate are listed on page 2-11. The corridor countermeasures are listed in each individual jurisdiction's chapter.

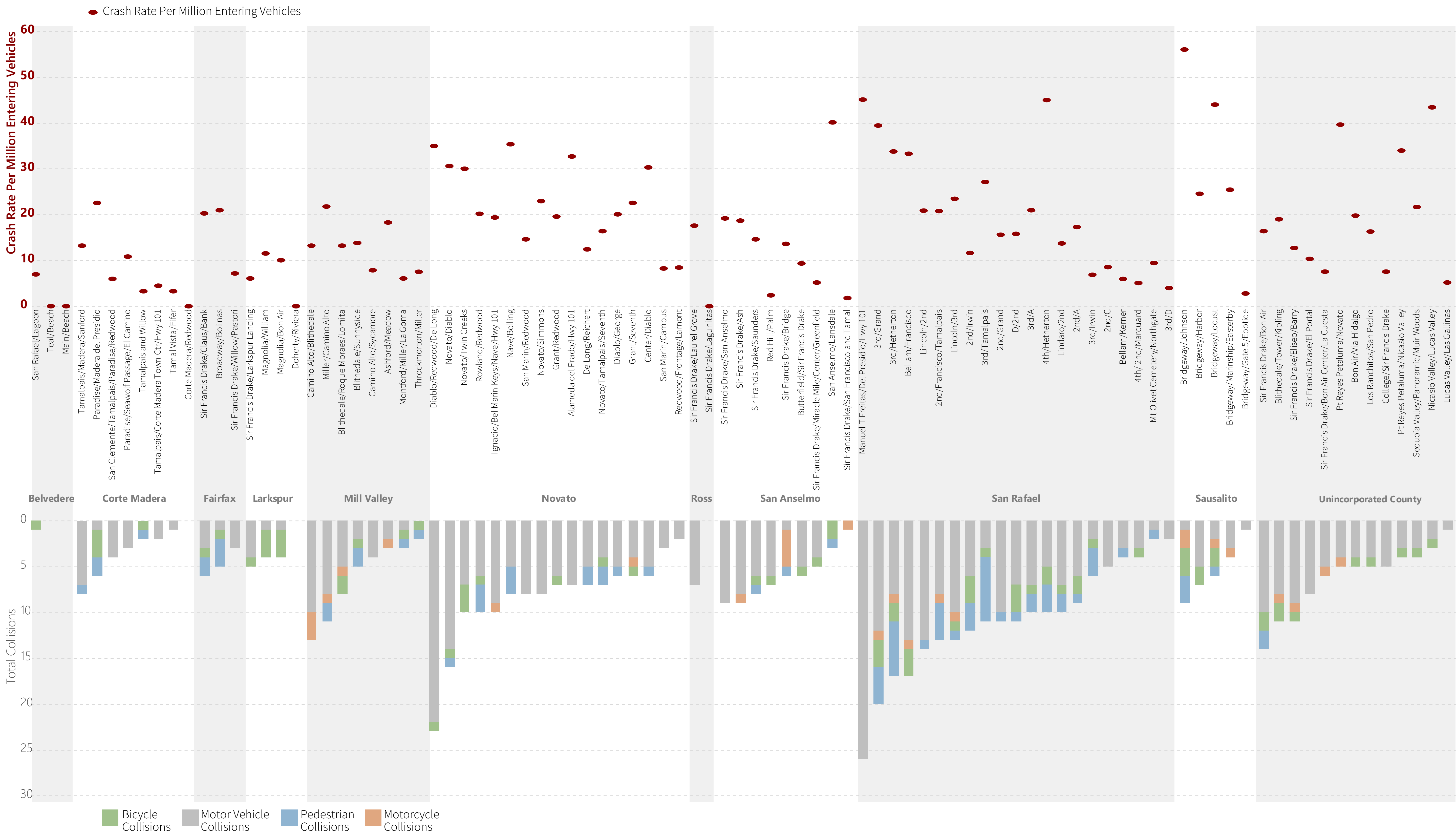
COUNTYWIDE STUDY INTERSECTIONS

Study intersections were identified in each jurisdiction based on a blending of a crash-based approach and a systemic approach to evaluating collision data and significant predictive factors, as described earlier in this chapter. The five years of collision data were then evaluated for each study intersection and intersection-level safety countermeasures were identified based on consultation with jurisdiction staff. A complete list of the study intersection's total number of collisions by mode and collision rate are listed on page 2-12.The corridor countermeasures are listed in each individual jurisdiction's chapter.

TOTAL COLLISIONS & CRASH RATE BY CORRIDOR



TOTAL COLLISIONS & CRASH RATE BY INTERSECTION



CHAPTER 3: COUNTERMEASURE TOOLKIT

INTRODUCTION

The Countermeasure Toolkit provided within the following pages summarizes the measures found in the Caltrans Local Roadway Safety Manual (CA-LRSM). The CA-LRSM is a tool intended to provide focused roadway safety information in a single document. This data uses information from the Crash Modification Factor (CMF) Clearinghouse and three other FHWA published safety manuals — Roadway Departure Safety, Intersection Safety, and Roadways Safety Information Analysis — in conjunction with its own research with the Safe Transportation Research and Education Center (SafeTREC) to develop the Caltrans Local Roadway Safety Manual (CA-LRSM).

SUMMARY OF CONTENT

The toolkit lists Highway Safety Improvements Program (HSIP) countermeasures and non-HSIP countermeasures as well as crash type, crash reduction factors (CRF), federal funding eligibility for HSIP projects and the systemic opportunity. The countermeasure list in this toolkit has been divided into four groups: signalized intersections, unsignalized intersection, roadway segments and countermeasure that do not currently apply for HSIP funding.

The information included in the countermeasure toolkit are:

- Crash Types - "All", "P & B" (Pedestrian and Bicycle), "Night", "Emergency Vehicle", or "Animal".
- CRF - Crash Reduction Factor used for HSIP calls-for-projects.
- Expected Life - 10 years or 20 years.
- Federal Funding Eligibility – the maximum federal reimbursement ratio.
- Systemic Approach Opportunity - Opportunity to Implement Using a Systemic Approach: "Very High", "High", "Medium" or "Low"

For countermeasures that are not eligible in Caltrans' local HSIP call for projects, "N/A" is placed in the above fields.

The toolkit refers to each countermeasure with an identification letter and number. The letters refer to the following:

- 'S' countermeasures apply to signalized intersections.
- 'NS' countermeasures apply to unsignalized intersections.
- 'R' countermeasures apply to roadway segments.
- 'NH' countermeasures do not qualify for HSIP funding.

The list of HSIP approved countermeasure in the following section is not an all-inclusive list and only consists of thoroughly researched countermeasures. The mix of countermeasure and CRFs included is intended to meet Caltrans' goal for a data-driven process for local agencies to follow. Where possible and appropriate, the CRF value listed in this toolkit is based on research studies that specifically established the CRF to be used for 'all' project areas, roadway types and traffic volumes. Where not all applicability factors have already been established by prior research, Caltrans worked closely with FHWA to approximate CRFs for countermeasures often utilized by local agencies.

COMPREHENSIVE APPROACH TO SAFETY

While this chapter concentrates on engineering solutions for safety, some non-HSIP countermeasures presented in the Countermeasure Toolkit are intended to encourage local jurisdictions to incorporate a compressive approach to safety. The comprehensive approach to safety incorporates all elements of the "4 Es of Safety": Engineering, Enforcement, Education and Emergency Medical Services. This approach recognizes that not all locations can be addressed solely by infrastructure improvements. Incorporating the 4 Es of Safety is often required to achieve significant safety improvements and reduce the severity and frequency of collisions throughout a jurisdiction.

Some of the common violation types that may require a comprehensive approach are speeding, failure-to-yield to pedestrians, red light running, aggressive driving, failure to wear safety belts, distracted driving, and driving while impaired. When locations are identified as having these types of violations, coordination with the appropriate law enforcement agencies is needed to arrange visible targeted enforcement to reduce the potential for future driving violations and related crashes and injuries.

To improve safety, education efforts can also be used to supplement enforcement. Additionally, education efforts can supplement enforcement to improve the efficiency of each. Education can also be employed in the short-term to address high crash locations until the recommended infrastructure project can be implemented.

S1. Add intersection lighting

Applicable at signalized intersections that have a disproportionate number of nighttime crashes and do not currently provide lighting at the intersection or at its approaches. Intersection lighting is of particular benefit to non-motorized users. Lighting not only helps them navigate the intersection, but also helps drivers see them better.

Crash Type	Night
CRF	40%
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Medium

S2. Improve signal hardware: lenses, back-plates, mounting, size, and number

Install at signalized intersections with a high frequency of right-angle and rear-end crashes occurring because drivers may be unable to see traffic signals sufficiently in advance of the intersection. Signalized intersection improvements include new LED lighting, signal back plates, retro-reflective tape outlining the back plates, or visors to increase signal visibility, larger signal heads, relocation of the signal heads, or additional signal heads.

Crash Type	All
CRF	15%
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Medium

S3. Improve signal timing (coordination, phases, red, yellow, or operation)

Install at locations that have a crash history at multiple signalized intersections along a corridor. Signalization improvements may include adding phases, lengthening clearance intervals, eliminating or restricting higher-risk movements, and coordinating signals at multiple locations.

Crash Type	All
CRF	15%
Expected Life (Years)	10
Federal Funding Eligibility	50%
Systemic Approach Opportunity	Very High

S4. Provide advanced dilemma zone detection for high speed approaches

Effective at remote areas that have a high frequency of right-angle and rear-end crashes. The Advanced Dilemma-Zone Detection system enhances safety at signalized intersections by modifying traffic control signal timing to reduce the number of drivers that may have difficulty deciding whether to stop or proceed during a yellow phase. This may reduce rear-end crashes associated with unsafe stopping and angle crashes due to illegally continuing into the intersection during the red phase.

Crash Type	All
CRF	15%
Expected Life (Years)	10
Federal Funding Eligibility	50%
Systemic Approach Opportunity	Very High

S5. Install emergency vehicle pre-emption systems

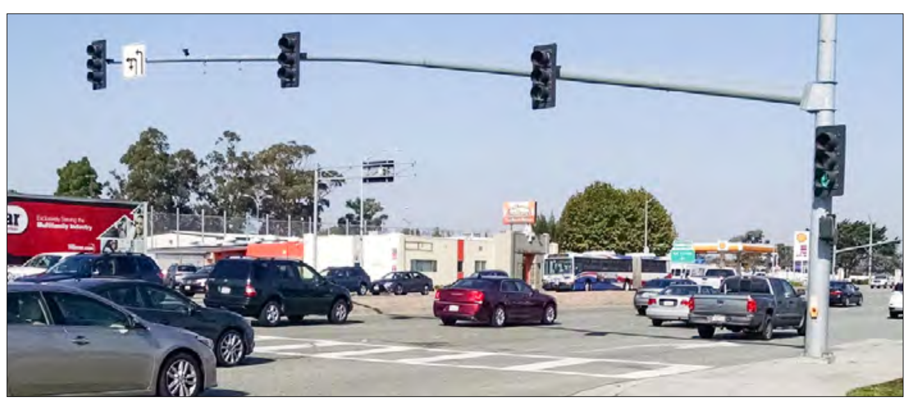
The target of this strategy is signalized intersections where normal traffic operations impede emergency vehicles and where traffic conditions create a potential for conflicts between emergency and nonemergency vehicles. These conflicts could lead to almost any type of crash, due to the potential for erratic maneuvers of vehicles moving out of the paths of emergency vehicles.

Crash Type	Emergency Vehicle
CRF	70%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	High

S6. Provide protected left turn phase (left turn lane already exists)

Applicable at signalized intersections with existing left turns pockets that currently have a permissive left-turn or no left-turn protection and have a high frequency of angle crashes involving left turning, opposing through vehicles, and non-motorized road users. A properly timed protected left-turn phase can also help reduce rear-end and sideswipe crashes between left-turning vehicles and the through vehicles as well as vehicles behind them.

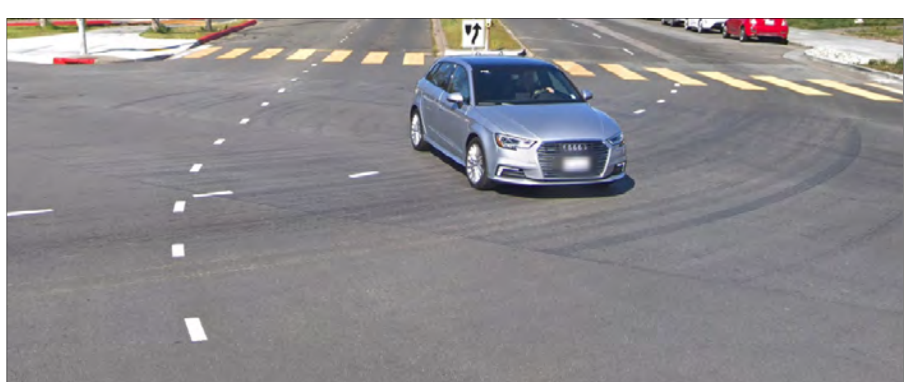
Crash Type	All
CRF	30%
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Very High



S7. Convert signal to mast arm (from pedestal-mounted)

Install at intersections that are currently controlled by pedestal mounted traffic signals (in medians and/or on outside shoulder) and that have a high frequency of right-angle and rear-end crashes occurring because drivers may be unable to see traffic signals in advance to safely negotiate the intersection. Intersections that have pedestal-mounted signals may have poor visibility and can result in vehicles not being able to stop in time for a signal change.

Crash Type	All
CRF	30%
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Medium



S8. Install raised pavement markers and striping (through intersection)

Applicable at intersections where the lane designations are not clearly visible to approaching motorists and/or intersections noted as being complex and experiencing crashes that could be attributed to a driver's unsuccessful attempt to navigate the intersection.

Crash Type	All
CRF	10%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Very High

S9. Install flashing beacons as advance warning

Applicable in advance of signalized intersections with crashes that are a result of drivers being unaware of the intersection or may be unable to see the traffic control device in time to comply.

Crash Type	All
CRF	30%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Medium

S10. Install cameras to detect red-light running

Install at signalized intersections with a high frequency of crashes attributed to drivers who intentionally disobey red signal indications. This type of automated enforcement refers to the use of photo and video camera systems connected to the signal controller. Such systems record vehicles proceeding through the intersection after the signal displays red.

Note: Not presently eligible for HSIP funding.

Crash Type	n/a
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a

S11. Improve pavement friction (High Friction Surface Treatments)

Install at signalized Intersections noted as having crashes on wet pavements or under dry conditions when the pavement friction available is significantly less than needed for the actual roadway approach speeds. This treatment is intended to target locations where skidding and failure to stop is determined to be a problem in wet or dry conditions and the target vehicle is unable to stop due to insufficient skid resistance.

Crash Type	All
CRF	40%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Medium

S12. Install raised median on approaches

Effective at intersections noted as having turning movement crashes near the intersection as a result of insufficient access control. Raised median must comply with Americans with Disabilities Act guidelines..

Crash Type	All
CRF	25%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

S13. Create directional median openings to allow (and restrict) left-turns and U-turns

Install at locations where crashes related to turning maneuvers include angle, rear-end, pedestrian, and sideswipe (involving opposing left turns) type crashes occur. If any of these crash types are an issue at an intersection, restriction or elimination of the turning maneuver may be the best way to improve the safety of the intersection.

Crash Type	All
CRF	50%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

S14. Install right-turn lane

A right-turn lane may be appropriate in situations where there are an unusually high number of rear-end collisions on a single major road approach. The need for right turn lanes should be assessed on an individual approach basis. When considering new right-turn lanes, potential impacts to non-motorized users should be considered and mitigated as appropriate.

Note: Not presently eligible for HSIP funding.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	Not eligible for federal funding
Systemic Approach Opportunity	n/a

S15. Install left-turn lane (signal has no left-turn phase – before and after)

Intersections that do not currently have a left turn lane and may be experiencing a large number of rear-end crashes as a result of traffic being stopped in the through lane. They are most effective particularly on high-volume and high-speed major-road approaches and should be considered on a single major road approach basis.

Note: Not presently eligible for HSIP funding.

Crash Type	All
CRF	44%
Expected Life (Years)	20
Federal Funding Eligibility	Not eligible for federal funding
Systemic Approach Opportunity?	n/a

S16. Install left-turn lane (signal has a left-turn phase – before and after)

Intersections that do not currently have a left turn lane and may be experiencing a large number of rear-end crashes as a result of traffic being stopped in the through lane. Many intersection safety problems can be traced to difficulties in accommodating left-turning vehicles.

Note: Not presently eligible for HSIP funding.

Crash Type	All
CRF	44%
Expected Life (Years)	20
Federal Funding Eligibility	Not eligible for federal funding
Systemic Approach Opportunity	n/a

S17. Install left-turn lane and add turn phase (signal has no left-turn lane or phase before)

Applicable at intersections that do not currently have a left turn lane or a related left-turn phase and are experiencing a large number of crashes. Many intersection safety problems can be traced to difficulties in accommodating left-turning vehicles, in particular where there is currently no accommodation for left turning traffic. A key strategy for minimizing collisions related to left-turning vehicles (angle, rear-end, sideswipe) is to provide exclusive left-turn lanes and the appropriate signal phasing, particularly on high-volume and high-speed major-road approaches.

Crash Type	All
CRF	55%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Low

S18. Convert intersection to roundabout (from signal)

Install at signalized intersections that have a significant crash problem and the only alternative is to change the nature of the intersection itself. Roundabouts can also be very effective at intersections with complex geometry and intersections with frequent left-turn movements.

Crash Type	All
CRF	Varies
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Low

S19. Install pedestrian countdown signal heads

Install at signals that have signalized pedestrian crossing with walk/don't walk indicators and where there have been pedestrian vs. vehicle crashes. Countdown signals can reassure pedestrians who are in the crosswalk when the flashing "DON'T WALK" interval appears that they still have time to finish crossing.

Crash Type	P & B
CRF	25%
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Very High

S20. Install pedestrian crossing

Install at signalized intersections with a high frequency of right-angle and rear-end crashes occurring because drivers are unable to see traffic signals sufficiently in advance to safely negotiate the intersection being approached. Signal intersection improvements include new LED lighting, signal back plates, retro-reflective tape outlining the back plates, or visors to increase signal visibility, larger signal heads, relocation of the signal heads, or additional signal heads.

Crash Type	P & B
CRF	25%
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	High

S21. Install advance stop bar before crosswalk (Bicycle Box)

Install at signalized Intersections with a marked crossing and where significant bicycle and/or pedestrians volumes are known to occur. Adding advance stop bar before the striped crosswalk has the opportunity to enhance both pedestrian and bicycle safety. Stopping cars well before the crosswalk provides a buffer between the vehicles and the crossing pedestrians. It also allows for a dedicated space for cyclists, making them more visible to drivers. This dedicated space is often referred to as a bike-box.

Crash Type	P & B
CRF	15%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Very High

S22. Modify signal phasing to implement a Leading Pedestrian Interval (LPI)

Install at signalized intersection locations noted as having high turning vehicle volumes and have had pedestrian vs. vehicle crashes. A LPI gives pedestrians the opportunity to enter an intersection about 3–7 seconds before vehicles are given a green indication.

Crash Type	P & B
CRF	60%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Very High

S23. Install pedestrian median fencing on approaches

Applicable at signalized Intersections with high pedestrian-generators nearby (e.g., transit stops) may experience a high volumes of pedestrians J-walking across the travel lanes at mid-block locations instead of walking to the intersection and waiting to cross during the walk-phase. When this safety issue cannot be mitigated with signal timing and shoulder/sidewalk treatments and a midblock crossing isn't viable, then installing a continuous pedestrian barrier in the median may be a solution.

Crash Type	P & B
CRF	35%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	High

NS1. Add intersection lighting

Install at non-signalized intersections that have a disproportionate number of night-time crashes and do not currently provide lighting at the intersection or at its approaches. Crash data should be studied to ensure that safety at the intersection could be improved by providing lighting. This strategy would be supported by a significant number of crashes that occur at night.

Crash Type	Night
CRF	40%
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Medium

NS2. Convert to all-way STOP control (from two-way or Yield control)

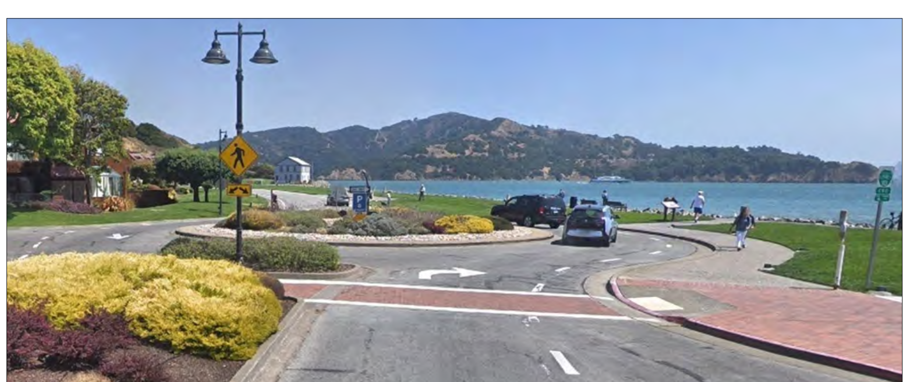
Applicable at unsignalized intersection locations that have a crash history and have no controls on the major roadway approaches. However, all-way stop sign control is suitable only at intersections with moderate and relatively balanced volume levels on the intersection approaches. Under other conditions, the use of all-way stop control may create unnecessary delays and aggressive driver behavior. CA MUTCD warrants should always be followed.

Crash Type	All
CRF	50%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	High

NS3. Install signals

Traffic signals can be used to prevent the most severe type crashes (right-angle, left-turn). Consideration to signalize an unsignalized intersection should only be given after (1) less restrictive forms of traffic control have been utilized as the installation of a traffic signal often leads to an increased frequency of crashes (rear-end) on major roadways and introduces congestion and (2) signal warrants have been met.

Crash Type	All
CRF	25%
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Low



NS4A. Convert intersection to roundabout (from all way stop)

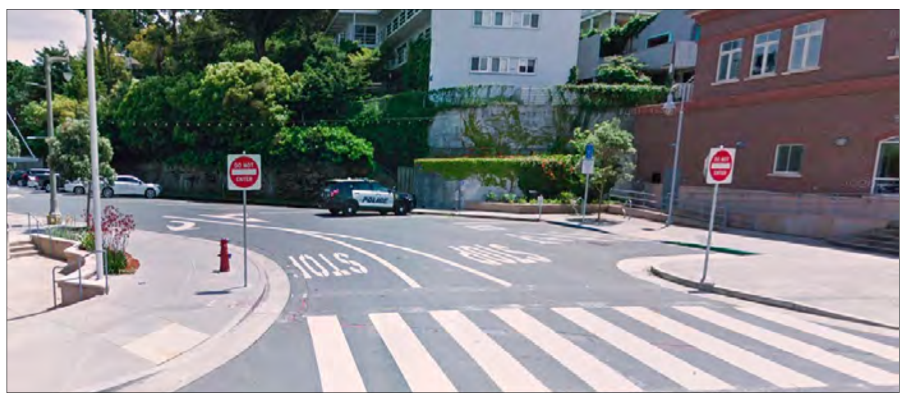
Applicable at intersections that have a high frequency of right-angle and left-turn type crashes. Whether such intersections have existing crash patterns or not, a roundabout provides an alternative to signalization. The primary target locations for roundabouts should be moderate-volume unsignalized intersections. Roundabouts may not be a viable alternative in many suburban and urban settings where right-of-way is limited.

Crash Type	All
CRF	Varies
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Low

NS4B. Convert intersection to roundabout (from stop or yield control on minor road)

Applicable at intersections that have a high frequency of right-angle and left-turn type crashes. Whether such intersections have existing crash patterns or not, a roundabout provides an alternative to signalization. The primary target locations for roundabouts should be moderate-volume unsignalized intersections, or retrofitting existing moderate volume signalized intersections. Roundabouts may not be a viable alternative in many suburban and urban settings where right-of-way is limited.

Crash Type	All
CRF	Varies
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Low



NS5. Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs

The target for this strategy should be approaches to unsignalized intersections with patterns of rear-end, right-angle, or turning collisions related to lack of driver awareness of the presence of the intersection.

Crash Type	All
CRF	15%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Very High

NS6. Upgrade intersection pavement markings

Install at unsignalized intersections that are not clearly visible to approaching motorists, particularly approaching motorists on the major road. The strategy is appropriate for intersections with patterns of rear-end, right-angle, or turning crashes related to lack of driver awareness of the presence of the intersection, also at minor road approaches where conditions allow the stop bar to be seen by an approaching driver at a significant distance from the intersection. Typical improvements include "Stop Ahead" markings and the addition of Centerlines and Stop Bars.

Crash Type	All
CRF	25%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Very High

NS7. Install flashing beacons at stop-controlled intersections

Flashing beacons can reinforce driver awareness of the non-signalized intersection control and can help mitigate patterns of right-angle crashes related to stop sign violations. Post-mounted advanced flashing beacons or overhead flashing beacons can be used at stop-controlled intersections to supplement and call driver attention to stop signs.

Crash Type	All
CRF	15%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	High

NS8. Install flashing beacons as advance warning

Install in advance of non-signalized intersections with patterns of crashes that could be related to lack of a driver's awareness of approaching intersection or controls at a downstream intersection.

Crash Type	All
CRF	30%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	High

NS9. Install transverse rumble strips on approaches

Transverse rumble strips are installed in the travel lane for the purposes of providing an auditory and tactile sensation for each motorist approaching the intersection. They can be used at any stop or yield approach intersection, often in combination with advance signing to warn of the intersection ahead. Due to the noise generated by vehicles driving over the rumble strips, care must be taken to minimize disruption to nearby residences and businesses.

Crash Type	All
CRF	n/a
Expected Life (Years)	10
Federal Funding Eligibility	90%
Systemic Approach Opportunity	n/a

NS10. Improve sight distance to intersection (clear sight triangles)

Install at unsignalized intersections with restricted sight distance and patterns of crashes related to lack of sight distance where sight distance can be improved by clearing roadside obstructions without major reconstruction of the roadway.

Crash Type	All
CRF	20%
Expected Life (Years)	10
Federal Funding Eligibility	90%
Systemic Approach Opportunity	High

NS11. Install splitter-islands on the minor road approaches

Applicable at minor road approaches to unsignalized intersections where the presence of the intersection or the stop sign is not readily visible to approaching motorists. The strategy is particularly appropriate for intersections where the speeds on the minor road are high. In creation of a splitter island allows for an additional stop sign to be placed in the median for the minor approach.

Crash Type	All
CRF	40%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

NS12. Install raised median on approaches

Install at locations where turning movements affect the safety of an intersection. This countermeasure only applies to crashes occurring on the approaches / influence area of the new raised median. All new raised medians funded with federal HSIP funding must not include the removal of the existing roadway structural section and must be doweled into the existing roadway surface.

Crash Type	All
CRF	25%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

NS13. Create directional median openings to allow (and restrict) left-turns and u-turns

Install at locations with crashes related to turning maneuvers include angle, rear-end, pedestrian, and sideswipe (involving opposing left turns) type crashes. If any of these crash types are an issue at an intersection, restriction or elimination of the turning maneuver may be the best way to improve the safety of the intersection. Because raised medians limit property access to right turns only, they should be used in conjunction with efforts to provide alternative access ways and promote driveway spacing objectives.

Crash Type	All
CRF	50%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

NS14. Install right-turn lane

Many collisions at unsignalized intersections are related to right-turn maneuvers. A key strategy for minimizing such collisions is to provide exclusive right-turn lanes, particularly on high-volume and high-speed major-road approaches. When considering new right-turn lanes, potential impacts to non-motorized users should be considered and mitigated as appropriate. When considering new right-turn lanes, potential impacts to non-motorized users should be considered and mitigated as appropriate.

Crash Type	All
CRF	20%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Low

NS15. Install left-turn lane (where no left-turn lane exists)

Many collisions at unsignalized intersections are related to left-turn maneuvers. A key strategy for minimizing such collisions is to provide exclusive left-turn lanes, particularly on high-volume and high-speed major-road approaches. When considering new left-turn lanes, potential impacts to non-motorized users should be considered and mitigated as appropriates.

Crash Type	All
CRF	35%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Low

NS16. Install raised medians / refuge islands

Applicable at intersections that have a long pedestrian crossing distance, a high number of pedestrians, or a crash history. Raised medians decrease the level of exposure for pedestrians and allow pedestrians to concentrate on (or cross) only one direction of traffic at a time.

Crash Type	P & B
CRF	45%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

NS17. Install pedestrian crossing at uncontrolled locations (new signs and markings only)

Install at non-signalized intersections without a marked crossing, where pedestrians are known to be crossing intersections that involve significant vehicular traffic. They are especially important at school crossings and intersections with right and/or left turns pockets.

Crash Type	P & B
CRF	20%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	High

NS18. Install pedestrian crossing at uncontrolled locations (with enhanced safety features)

Install at non-signalized intersections with or without a marked crossing, where pedestrians are known to be crossing intersections that involve significant vehicular traffic. At many locations, a marked crosswalk alone may not be sufficient to adequately protect non-motorized users. In these cases, rectangular rapid flashing beacons, overhead flashing beacons, curb extensions, advanced "stop" or "yield" markings, and other safety features should be added to complement the standard crossing elements.

Crash Type	P & B
CRF	35%
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Medium

NS19. Install pedestrian signal or HAWK

Intersections noted as having a history of pedestrian vs. vehicle crashes and in areas where the likelihood of a pedestrian is significant. Corridors should also be assessed to determine if there are adequate safe opportunities for non-motorists to cross and if a pedestrian signal, high-intensity activated crosswalk, or hybrid beacons are needed to provide an active warning to motorists when a pedestrian is in the crosswalk.

Crash Type	P & B
CRF	55%
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Low

NS20. Improve pavement friction (high friction surface treatments)

Install at non-signalized Intersections noted as having crashes on wet pavements or under dry conditions when the pavement friction available is significantly less than needed for the actual roadway approach speeds. This treatment is intended to target locations where skidding and failure to stop is determined to be a problem in wet or dry conditions and the target vehicle is unable to stop due to insufficient skid resistance.

Crash Type	All
CRF	40%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Medium

R1. Add segment lighting

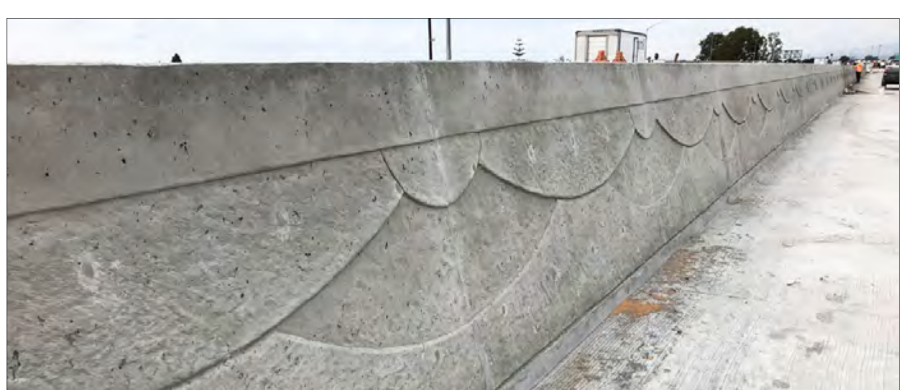
Install at locations with a noted substantial patterns of nighttime crashes. In particular, patterns of rear-end, right-angle, turning or roadway departure collisions on the roadways may indicate that night-time drivers can be unaware of the roadway characteristics.

Crash Type	Night
CRF	35%
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Medium

R2. Remove or relocate fixed objects outside of clear recovery zone

Applicable at locations or roadway segments prone to collisions with fixed objects such as utility poles, drainage structures, trees, and other fixed objects, such as the outside of a curve, end of lane drops, and in traffic islands. A clear recovery zone should be developed on every roadway, as space is available. In situations where public right-of-way is limited, steps should be taken to request assistance from property owners, as appropriate.

Crash Type	All
CRF	35%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	High



R3. Install median barrier

Applicable at areas where crash history indicates drivers are unintentionally crossing the median and the cross-overs are resulting in high severity crashes. The installation of median barriers can increase the number of property damage only collisions and non-severe injuries. The net result in safety from this countermeasure is connected more to reducing the severity of crashes not the number of crashes.

Crash Type	All
CRF	25%
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Medium

R4. Install guardrail

Guardrail is installed to reduce the severity of lane departure crashes. However, guardrail can reduce crash severity only for those conditions where striking the guardrail is less severe than going down an embankment or striking a fixed object. Guardrail should only be installed where it is clear that crash severity will be reduced, or there is a history of run-off-the-road crashes at a given location that have resulted in severe crashes.

Crash Type	All
CRF	25%
Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Approach Opportunity	High

R5. Install impact attenuators

Impact attenuators are typically used to shield rigid roadside objects such as concrete barrier ends, steel guardrail ends and bridge pillars from oncoming automobiles. Attenuators should only be installed where it is impractical for the objects to be removed.

Crash Type	All
CRF	25%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	High

R6. Flatten side slopes

Applicable at roadways experiencing frequent lane departure crashes that result in roll-over type crashes as a result of the roadway slope being so severe as to not accommodate a reasonable degree of driver correction. When there is a need to reduce the severity of lane departure crashes without installing a barrier system that could result in increased numbers of crashes.

Crash Type	All
CRF	30%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

R7. Flatten side slopes and remove guardrail

Install at locations where high number of crashes originate as a lane departure and result in collision with guardrail or a fixed object located on the side slope shielded by guardrail. The guardrail may or may not meet current standards. Even though guardrails are generally installed to reduce the severity of departure crashes, they still can result in severe crashes in some locations.

Crash Type	All
CRF	40%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

R8. Upgrade bridge railing

Open-faced railings that can present a snagging hazard, which may produce high deceleration forces leading to occupant injuries. Curbs or walkways between the driving lane and the bridge railing are another common hazard of older railing systems. Impacting vehicles may go over the railing or rollover.

Note: Not presently eligible for HSIP funding.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	Medium

R9. Install raised median

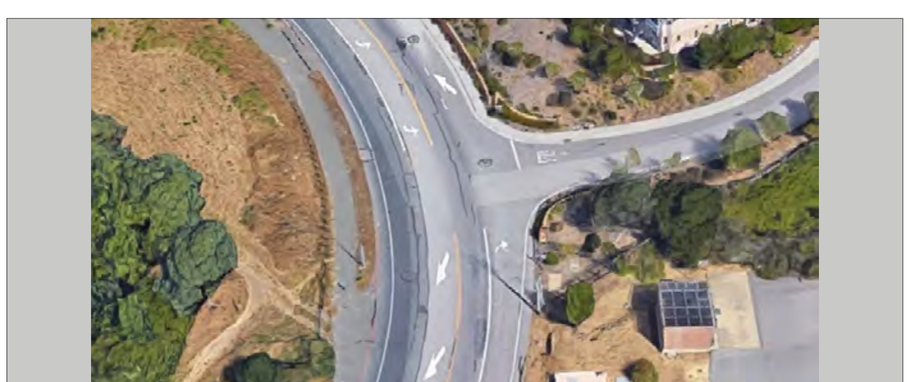
Install at locations experiencing head-on collisions that may be affected by both the number of vehicles that cross the centerline and by the speed of oncoming vehicles. Installing a raised median is a more restrictive approach in that it represents a more rigid barrier between opposing traffic.

Crash Type	All
CRF	25%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

R10. Install median (flush)

Applicable at locations experiencing head-on collisions that may be affected by both the number of vehicles that cross the centerline and by the speed of oncoming vehicles. Roadways with oversized lanes offer an opportunity to restripe the roadway to reduce the lanes to standard widths and use the extra width for the median.

Crash Type	All
CRF	15%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium



R11. Install acceleration/ deceleration lanes

Install at locations proven to have crashes that are the result of drivers not being able to turn onto a high speed roadway to accelerate until the desired roadway speed is reached and areas that do not provide the opportunity to safety decelerate to negotiate a turning movement. This countermeasure can also be used to improve the safety of merging vehicles at a lane-drop location.

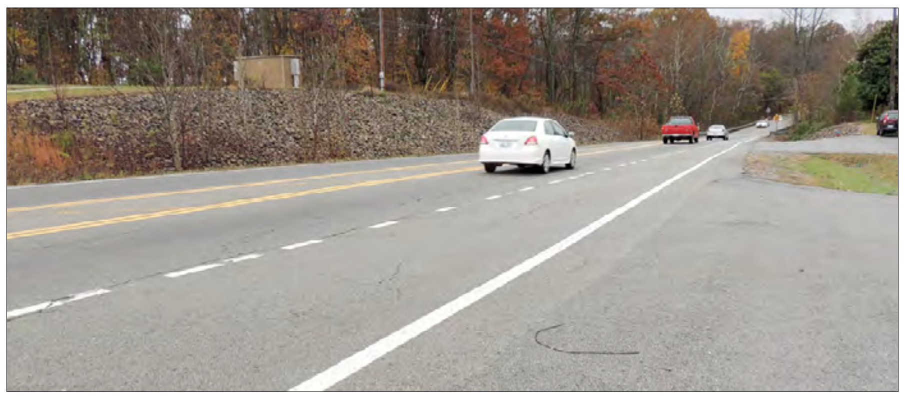
Crash Type	All
CRF	25%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Low

R12. Install climbing lane (where large difference between car and truck speed)

Applicable at areas proven to have crashes that are the result of drivers not being able to turn onto a high speed roadway to accelerate until the desired roadway speed is reached and areas that do not provide the opportunity to safety decelerate to negotiate a turning movement.

Note: Not presently eligible for HSIP funding.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	Not eligible for federal funding
Systemic Approach Opportunity	n/a



R13. Widen lane (initially less than 10 feet)

Install at horizontal curves or tangents and low speed or high speed roadways identified as having lane departure crashes, sideswipe or head-on crashes that can be attributed to an existing lane width less than 10 feet.

Crash Type	All
CRF	25%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

R14. Add two-way left-turn lane (without reducing travel lanes)

Applicable at roadways having a high frequency of drivers being rear-ended while attempting to make a left turn across oncoming traffic. Also can be effective for drivers crossing the centerline of an undivided multilane roadway inadvertently.

Crash Type	All
CRF	30%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

R15. Road Diet (reduce travel lanes from four to three and add a two-way left-turn and bike lanes)

Install at areas noted as having a higher frequency of head-on, left-turn, and rear-end crashes with traffic volumes that can be handled by only two free flowing lanes. Using this strategy in locations with traffic volumes that are too high could result in diversion of traffic to routes less safe than the original four-lane design. It may also result in congestion levels that contribute to other crashes.

Crash Type	All
CRF	30%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

R16. Widen shoulder (paved)

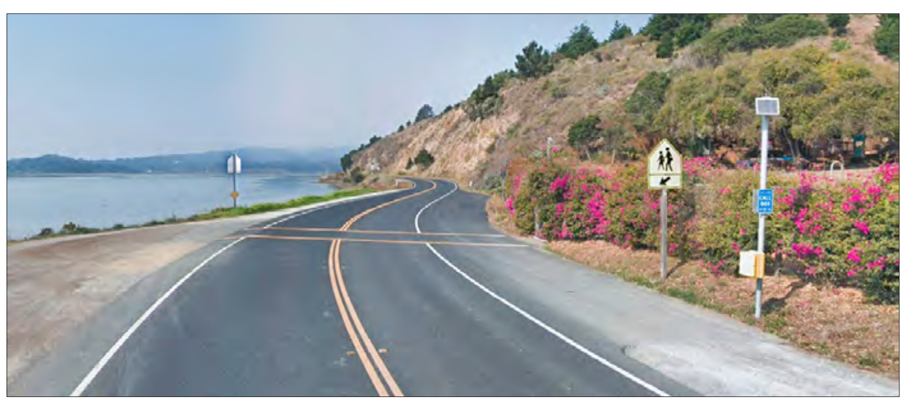
Applicable at roadways that have a frequent incidence of vehicles leaving the travel lane resulting in an unsuccessful attempt to reenter the roadway. The probability of a safe recovery is increased if an errant vehicle is provided with an increased paved area in which to initiate such a recovery.

Crash Type	All
CRF	30%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

R17. Widen shoulder (unpaved)

Consider for roadways with a frequent incidence of vehicles leaving the travel lane resulting in an unsuccessful attempt to reenter the roadway. The probability of a safe recovery is increased if an errant vehicle is provided with an area in which to initiate such a recovery. Unpaved shoulders usually have flatter cross sections and some structural integrity as compared to areas of "flatten side slopes".

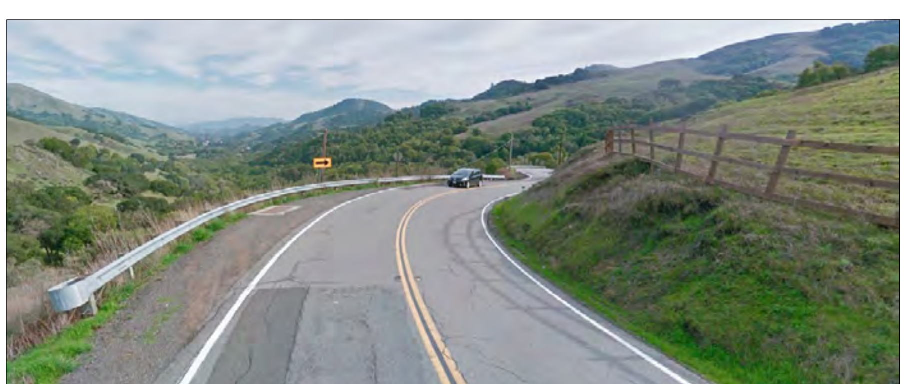
Crash Type	All
CRF	20%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium



R18. Pave existing shoulder

Install at roadways with an unpaved existing shoulder and exhibiting a frequent incidence of vehicles leaving the travel lane resulting in an unsuccessful attempt to reenter the roadway. Paving the existing shoulder provides a wider recovery area with a smooth surface that has a higher friction factor.

Crash Type	All
CRF	15%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium



R19. Improve horizontal alignment (flatten curves)

Applicable at roadways with horizontal curves that have experienced lane departure crashes as a result of a roadway segment having compound curves or a severe radius. This strategy should generally be considered only when less expensive strategies involving clearing of specific sight obstructions or modifying traffic control devices have been tried and have failed to ameliorate the crash patterns.

Crash Type	All
CRF	50%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Low

R20. Flatten crest vertical curve

The target for this strategy is usually unsignalized intersections with restricted approach sight distance due to vertical geometry and with patterns of crashes related to that lack of sight distance that cannot be ameliorated by less expensive methods. This strategy should generally be considered only when less expensive strategies involving clearing of specific sight obstructions or modifying traffic control devices have been tried and have failed to ameliorate the crash patterns.

Crash Type	All
CRF	25%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Low

R21. Improve horizontal and vertical alignments

Install at roadways that have compound issues with curves (horizontal and vertical) and are experiencing lane departure and sight distance related crashes. Curve modification reduces the likelihood of a vehicle leaving its lane, crossing the roadway centerline, and helps in providing adequate sight distance. The target for this strategy is usually unsignalized intersections with restricted sight distance. This strategy should generally be considered only when less expensive strategies involving clearing of specific sight obstructions or modifying traffic control devices have been tried and have failed to ameliorate the crash patterns.

Crash Type	All
CRF	60%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Low

R22. Improve curve superelevation

Roadways noted as having frequent lane departure crashes and inadequate or no superelevation. Safety can be enhanced when the superelevation is improved or restored along curves where the actual superelevation is less than the optimal.

Crash Type	All
CRF	45%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

R23. Convert from two-way to one-way traffic

One-way streets can offer improved signal timing and accommodate irregular-spaced signals. One-way streets can simplify crossings for pedestrians, who must look for traffic in only one direction. While studies have shown that conversion of two-way streets to one-way generally reduces pedestrian crashes and the number of conflict points, one-way streets tend to have higher speeds which can create new problems.

Crash Type	All
CRF	35%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

R24. Improve pavement friction (high friction surface treatments)

Applicable at locations with a noted amount of crashes on wet pavements or under dry conditions when the pavement friction available is significantly less than actual roadway speeds; including but not limited to curves, loop ramps, intersections, and areas with short stopping or weaving distances. This treatment is intended to target locations where skidding is determined to be a problem, in wet or dry conditions and the target vehicle is one that runs (skids) off the road or is unable to stop due to insufficient skid resistance.

Crash Type	All
CRF	40%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Medium

R25. Provide tapered edge for pavement edge drop-off

This treatment is designed to be a standard policy for any overlay project. Instead of an overlay project ending with a 90-degree asphalt or concrete face at the edge of pavement, the tapered edge provides an approximate 30-degree angle at the edge.

Note: Not presently eligible for HSIP funding.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a

R26. Install/upgrade signs with new fluorescent sheeting (regulatory or warning)

This countermeasure only applies to crashes occurring within the influence area of the new/upgraded signs. This countermeasure is not eligible unless it is done as part of a larger sign audit project, including the study of: 1) the existing signs' locations, sizes and information per MUTCD standards, 2) missing signs per MUTCD standards, and 3) sign retroreflectivity.

Crash Type	All
CRF	15%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Very High

R27. Install chevron signs on horizontal curves

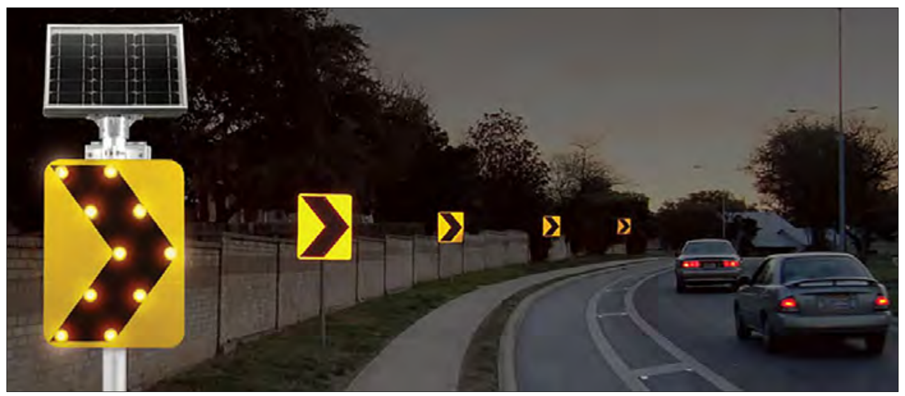
Install at roadways that have an unacceptable level of crashes on relatively sharp curves during periods of light and darkness. Ideally this type of safety countermeasure would be combined with other sign evaluations and upgrades.

Crash Type	All
CRF	40%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Very High

R28. Install curve advance warning signs

Applicable at roadways that have an unacceptable level of crashes on relatively sharp curves during periods of light and darkness. This countermeasure may also include horizontal alignment and/or advisory speed warning signs. Ideally this type of safety countermeasure would be combined with other sign evaluations and upgrades.

Crash Type	All
CRF	25%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	High



R29. Install curve advance warning signs (flashing beacon)

Install at roadways that have an unacceptable level of crashes on relatively sharp curves. Flashing beacons in conjunction with warning signs should only be used on horizontal curves that have an established severe crash history to help maintain their effectiveness.

Crash Type	All
CRF	30%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	High

R30. Install dynamic/variable speed warning signs

Install on roadways that have an unacceptable level of crashes due to excessive speeds, particularly along relatively sharp curves.

Crash Type	All
CRF	30%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	High

R31. Install delineators, reflectors and/or object markers

Applicable at roadways that have an unacceptable level of crashes on curves (relatively flat to sharp) during periods of light and darkness. Many roadways with a history of fixed object crashes can be a candidate for this treatment, as are roadways with similar fixed objects along the roadside that have yet to experience crashes.

Crash Type	All
CRF	15%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Very High

R32. Install edge-lines and centerlines

Install on roadways with a history of run-off-road right, head-on, opposite-direction-sideswipe, or run-off-road-left crashes. Install where the existing lane delineation is not sufficient to assist the motorist in understanding the existing limits of the roadway.

Crash Type	All
CRF	25%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Very High

R33. Install no-passing line

Applicable at roadways that have a high percentage of head-on crashes suggesting that many head-on crashes may relate to failed passing maneuvers. No-passing lines should be installed where drivers passing sight distance is not available due to horizontal or vertical obstructions.

Crash Type	All
CRF	45%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Very High

R34. Install centerline rumble strips/stripes

Centerline rumble strips/stripes can be used on many roadways – especially those with a history of head-on crashes. It is recommended that rumble strips/stripes be applied systematically along an entire route instead of only at spot locations. For all rumble strips/stripes, pavement condition should be sufficient to accept milled rumble strips. Care should be taken when considering installing rumble strips in locations with residential land uses or in areas with high bicycle volumes.

Crash Type	All
CRF	20%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	Very High

R35. Install edgeline rumble strips/stripes

Shoulder and edge line milled rumble strips/stripes should be used on roads with a history of roadway departure crashes. It is recommended that rumble strips/stripes be applied systematically along an entire route instead of only at spot locations. For all rumble strips/stripes, pavement condition should be sufficient to accept milled rumble strips. Special requirements may apply and care should be taken when considering installing rumble strips in locations with residential land uses or in areas with high bicycle volumes.

Crash Type	All
CRF	15%
Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Approach Opportunity	High

R36. Install bike lanes

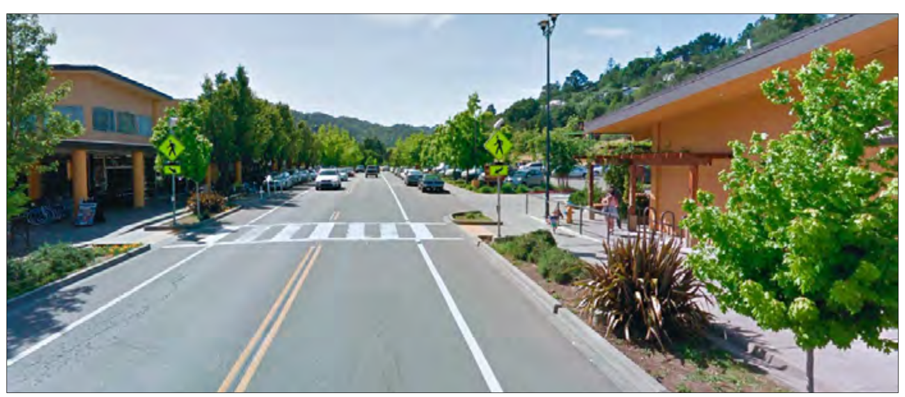
Applicable along roadway segments noted as having crashes between bicycles and vehicles or crashes that may be preventable with a buffer/shoulder. Most studies suggest that bicycle lanes may provide protection against bicycle/motor vehicle collisions. Striped bike lanes can be incorporated into a roadway when is desirable to delineate which available road space is for exclusive or preferential use by bicyclists.

Crash Type	P & B
CRF	35%
Expected Life (Years)	10
Federal Funding Eligibility	90%
Systemic Approach Opportunity	High

R37. Install sidewalk/pathway (to avoid walking along roadway)

Install at areas noted as not having adequate or no sidewalks and a history of walking along roadway pedestrian crashes. In rural areas asphalt curbs and/or separated walkways may be appropriate.

Crash Type	P & B
CRF	80%
Expected Life (Years)	10
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium



R38. Install pedestrian crossing (with enhanced safety features)

Install on roadway segments with no controlled crossing for a significant distance in high-use midblock crossing areas and/or multilane roads locations. A marked crosswalk alone may not be sufficient to adequately protect non-motorized users. In these cases, rectangular rapid flashing beacons, overhead flashing beacons, curb extensions and other safety features should be added to complement the standard crossing elements. For multi-lane roadways, advance "yield" markings can be effective in reducing the 'multiple-threat' danger to pedestrians.

Crash Type	P & B
CRF	30%
Expected Life (Years)	10
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

R39. Install raised pedestrian crossing

Applicable on lower-speed roadways, where pedestrians are known to be crossing roadways that involve significant vehicular traffic. In these cases, raised crossings can be added to complement the standard crossing elements. Special requirements may apply and extra care should be taken when considering installing raised crossings to ensure unintended safety issues are not created, such as: emergency vehicle access or truck route issues.

Crash Type	P & B
CRF	35%
Expected Life (Years)	10
Federal Funding Eligibility	90%
Systemic Approach Opportunity	High

R40. Install animal fencing

Install at locations with high percent of vehicular/animal crashes (reactive) or where there is a known high percent of animals crossing due to migratory patterns (proactive).

Crash Type	Animal
CRF	80%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Medium

R41. Install truck escape ramp

Install on roadways as identified as having a combination of heavy trucks and highway downgrades that present potentially dangerous conditions for truck drivers, other drivers on the road, and occupants of roadside property.

Note: Not presently eligible for HSIP funding.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	Low

R42. Install pedestrian median fencing on approaches

Roadway segments with high pedestrian-generators and pedestrian-destinations nearby (e.g. transit stops) may experience a high volume of pedestrians J-walking across the travel lanes at mid-block locations instead of walking to the nearest intersection or designated mid-block crossing. When this safety issue cannot be mitigated with shoulder, sidewalk and/or crossing treatments, then installing a continuous pedestrian barrier in the median may be a viable solution.

Crash Type	P & B
CRF	35%
Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Low

NH1. Refresh signage/ striping

Refresh signage and striping that has faded with age. Faded striping and signs can lead to confusion and poor night time visibility.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a

NH2. Remove slip lane

This treatment addresses pedestrian and sideswipe collisions. Slip lanes should be avoided as they allow vehicles to travel through intersections at larger speeds and allow less visibility of pedestrians waiting to cross. Removing one will result in a shorter crossing distance for pedestrians and slower speeds at the intersection.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a

NH3. Ramp metering

Ramp meters smooth the flow of traffic entering the freeway so vehicles can merge with mainline traffic with minimal disruption to traffic flow. By allowing smooth maneuvers, collisions can be avoided.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a

NH4. Back-in angle parking

Back-in angle parking provides motorists with better visibility of bicyclists, pedestrians, cars and trucks as they exit a parking space and enter moving traffic. Back-in angle parking also removes the difficulty that drivers, particularly older drivers, have when backing into moving traffic.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a

NH5. Wayfinding

This treatment can reduce pedestrian and bicycle collisions. Wayfinding can be deployed to route bicycles and pedestrians to safer facilities and avoid hazardous routes.

Crash Type	P & B
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a

NH6. Install sharrows

Sharrow markings increase the visibility of bicyclists, clarifies where bicyclists are expected to ride and reminds motorists to expect bicyclists on the road.

Crash Type	P & B
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a

NH7. Install 'Bikes May Use Full Lane' sign

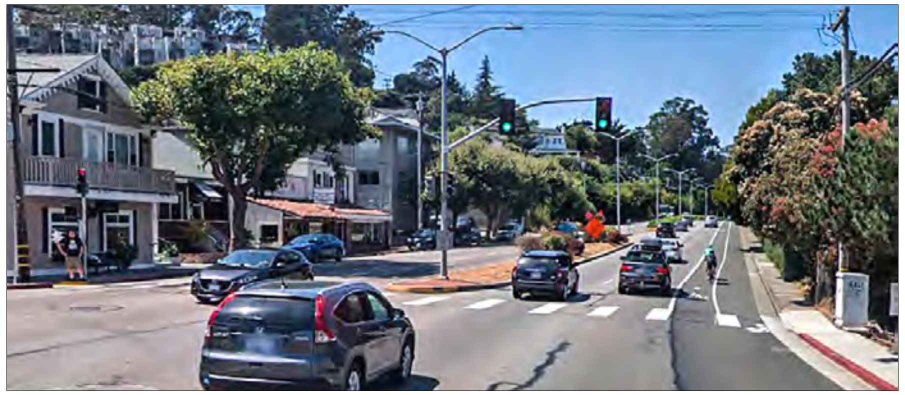
Regulatory 'Bikes May Use Full Lane' sign increases the visibility of bicyclists, clarifies where bicyclists are expected to ride and reminds motorists to expect bicyclists on the road.

Crash Type	P & B
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a

NH8. Square up intersection

Irregular angled intersections present safety hazards for all road users. Intersections less than 90 degrees reduce visibility for motorists, while intersections greater than 90 degrees allow for high-speed turns. These intersections also create unnecessarily long pedestrian crossings. Redesign intersections as close to 90 degrees as possible.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a



NH9. Reduced lane widths

Reduced lane width encourages slower speeds and frees up additional right of way for bicycle and pedestrian facilities. Residential streets may be reduced to 10 foot lanes, arterial streets may be reduced to 11 foot lanes and turn lanes may be reduced to 10 feet, as determined by individual jurisdictions.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a

NH10. Relocate parking

Parked vehicles can block sight distances. Relocate parking, or remove parking at the approaches to intersections and driveways to improve visibility.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a

NH11. No right turn on red restrictions

No right turn on red (RTOR) restrictions can benefit pedestrians with minimal impacts on traffic. They should be done in locations with substantial pedestrian volume and places where children cross. Part-time RTOR prohibitions during the busiest times of day may be sufficient to address the problem. Blank out signs can be used to reinforce turn restrictions and encourage motorist compliance.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a

NH12. Mumble strip

Mumble strips are modified rumble strips. They use noise and vibrations to alert drivers that are leaving their lane. Mumble strips generate less outside noise than rumble strips, which are less disruptive to nearby residents, through a sinusoidal wave pattern. Mumble strips should be installed on facilities where roadway departures collisions have occurred.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a

NH13. Traffic safety education programs

Education programs such as Street Smarts Marin can raise awareness, improve driving, pedestrian and bicycling behaviors. Aimed as "hot spot" locations education programs can be successful in encouraging safe traffic behavior.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a

NH14. Targeted enforcement programs

Enforcement programs be effective at reducing common violation types such as speeding, failure-to-yield, red light running, aggressive driving, failure to wear safety belts, distracted driving, and driving while impaired. They can be especially effective when combined with education.

Crash Type	All
CRF	n/a
Expected Life (Years)	n/a
Federal Funding Eligibility	n/a
Systemic Approach Opportunity	n/a

CHAPTER 4: TOWN OF CORTE MADERA

The Town of Corte Madera had an estimated population of 9,631 as of January 1, 2016, according to the California Department of Finance, representing approximately 3.7 percent of Marin County's total population. In the five year period between 2012 and 2016, Corte Madera experienced a total of 76 reported crashes on local streets. Five of those crashes involved a person that was severely injured, and of the five, there were no fatalities.

Corte Madera's share of reported crashes on local streets, as a proportion of total crashes in Marin County, during the five-year period is summarized below.

- **2.8% of all county-wide crashes**
- **2.3% of county-wide crashes in which a person was killed or severely injured (KSI)**
- **0% of all fatal county-wide crashes**

For all crashes as well as fatal and KSI crashes, Corte Madera's share of those crashes as a proportion of total crashes in Marin County was less than the town's 3.7 percent share of the total county population.

The intersection of Tamalpais Drive/ Stanford Street/ Madera Boulevard is one of Corte Madera's priority project locations. The intersection had eight reported collisions in a recent five-year period. Rear-end collisions are the most common motor vehicle collision type.

COLLISIONS 2012 TO 2016

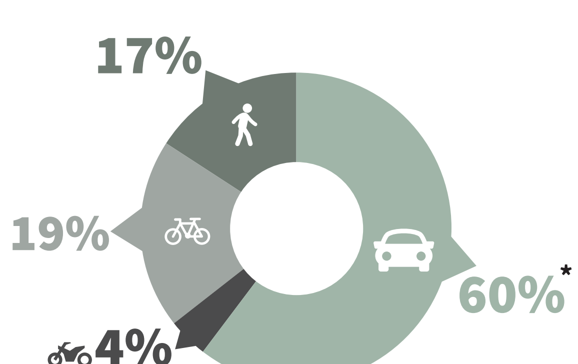
76 TOTAL COLLISIONS

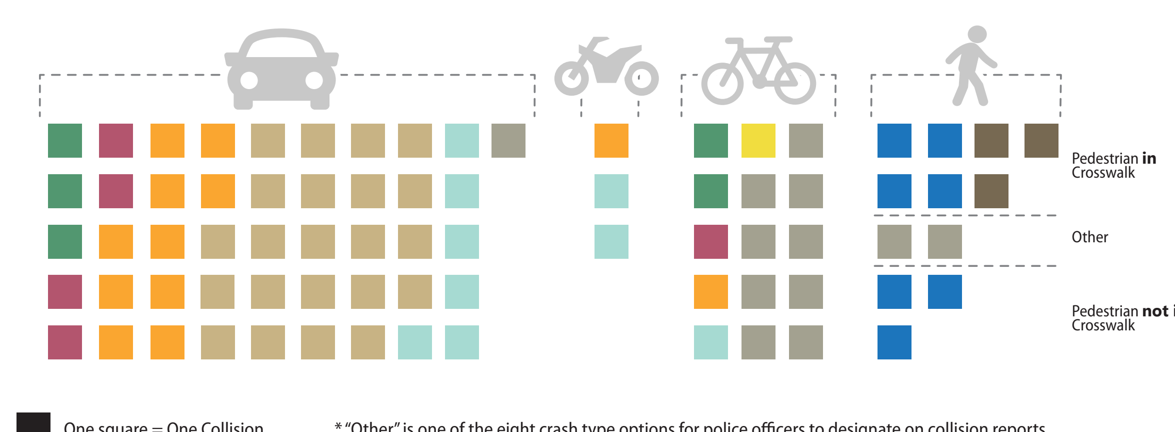
7% KILLED OR SEVERELY INJURED

[0% FATALITIES**]**

COLLISION BY MODE

COLLISION BY MODE





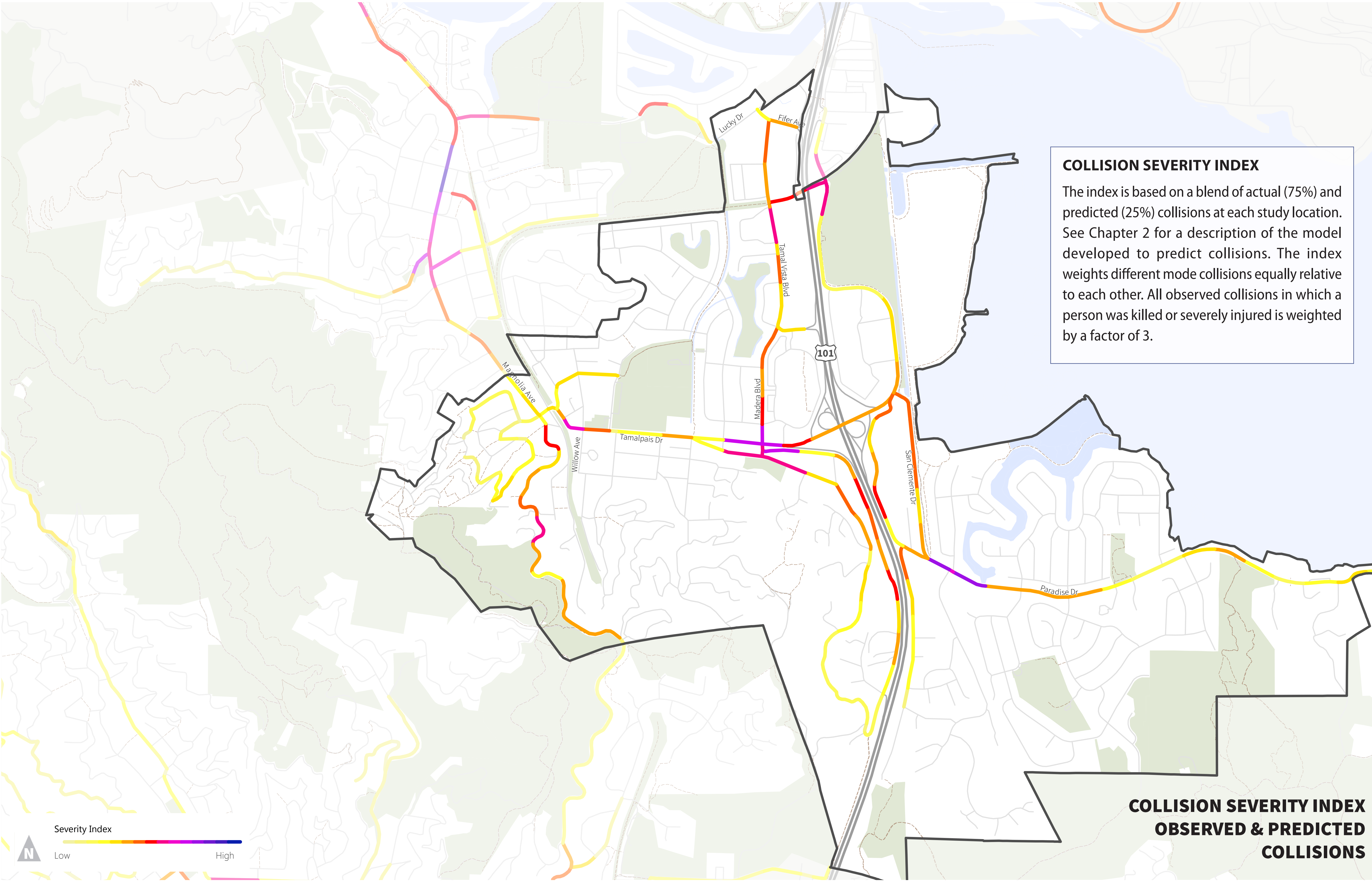
* "Other" is one of the eight crash type options for police officers to designate on collision reports. Collisions designated as "Other" are included in the auto portion of the collisions by mode chart above.

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

CRASH TYPES	Auto	Motorcycle	Bicycle	Pedestrian
Head-On	7%		12%	
Sideswipe	9%		7%	
Broadside	22%	33%	7%	
Rear End	47%			
Hit Object	13%	67%	7%	
Overturned			7%	
Other *	2%		60%	17%
Motorvehicle proceeding straight				58%
Motorvehicle making left turn				
Motorvehicle making right turn				25%
	100%	100%	100%	100%

TOWN OF CORTE MADERA

TOWN OF CORTE MADERA



COLLISION SEVERITY INDEX

The index is based on a blend of actual (75%) and predicted (25%) collisions at each study location. See Chapter 2 for a description of the model developed to predict collisions. The index weights different mode collisions equally relative to each other. All observed collisions in which a person was killed or severely injured is weighted by a factor of 3.

COLLISION SEVERITY INDEX OBSERVED & PREDICTED COLLISIONS

This study developed crash profiles to highlight five of the top trends among collisions in Corte Madera. The collision profiles, shown at the bottom right, are based on an analysis of crash data and related environmental factors. Every profile highlights a crash pattern the study has identified as a priority concern.

The table below shows the proportion of crash types by mode. Data to the right provides a comparison of the percentage of Corte Madera collisions vs. total collisions across all of Marin jurisdictions by mode, collision type, select age and collision violation categories.

The following pages identify safety countermeasures for study corridors and intersections. These countermeasures make up a toolkit of safety interventions the Town of Corte Madera can utilize to implement projects tailored to unique safety issues.

76 TOTAL CORTE MADERA COLLISIONS

2,756 TOTAL MARIN COLLISIONS

2012-2016

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

Auto	Motorcycle	Bicycle	Pedestrian	CRASH TYPES
7%		12%		Head-On
9%		7%		Sideswipe
22%	33%	7%		Broadside
47%				Rear End
13%	67%	7%		Hit Object
		7%		Overturned
2%		60%	17%	Other *
			58%	Motorvehicle proceeding straight
				Motorvehicle making left turn
			25%	Motorvehicle making right turn
100%	100%	100%	100%	

** "Other" is one of the eight crash type options for police officers to designate on collision reports.*

CORTE MADERA VS. MARIN COLLISIONS - RELATIVE SHARE

	AGE		VIOLATION	
	Youth	Senior	DUI	Unsafe Speed
Town of Corte Madera	**28.2%**	**28.2%**	5.6%	**36.6%**
All Marin Collisions	13.7%	21.4%	10.5%	28.2%

MODE

	Auto	Motorcycle	Bicycle	Pedestrian	Other
Town of Corte Madera	59.0%	3.8%	**19.2%**	**16.7%**	**1.3%**
All Marin Collisions	63.8%	6.4%	18.1%	11.1%	0.6%

COLLISION TYPE

	Head-on	Sideswipe	Rear-end	Broadside	Hit Object	Overturned	Vehicle/ Pedestrian	Other
Town of Corte Madera	7.0%	4.2%	**31.0%**	16.9%	9.9%	4.2%	**14.1%**	**12.7%**
All Marin Collisions	7.1%	8.7%	24.5%	20.3%	11.8%	5.6%	11.0%	10.7%

LOCAL COLLISION PROFILES

PEDESTRIAN COLLISIONS

17% (13) of all collisions in Corte Madera involved pedestrians, about 50 percent higher than the county average.

REAR-END COLLISIONS

31% (24) of all collisions in Corte Madera involved rear-end collisions, about 30 percent higher than the county average.

YOUTH COLLISIONS

28% (21) of all collisions in Corte Madera involved youth, approximately double the county average.

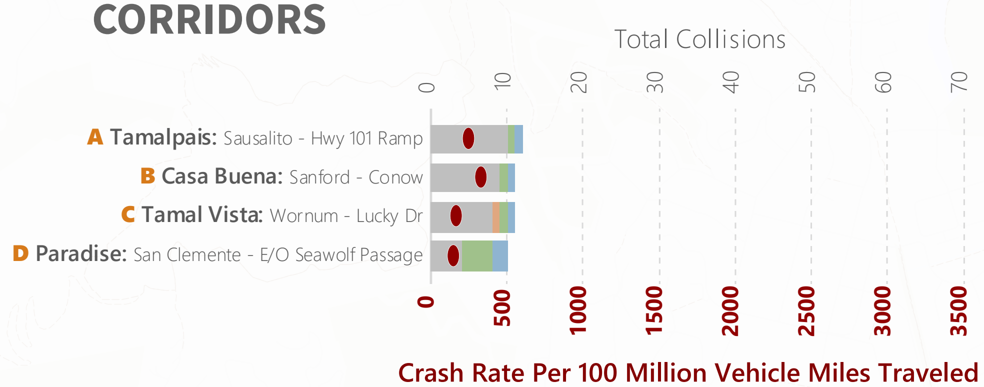
SENIOR COLLISIONS

28% (21) of all collisions in Corte Madera involved seniors, approximately one-third higher than the county average.

PEDESTRIANS IN ROAD COLLISIONS

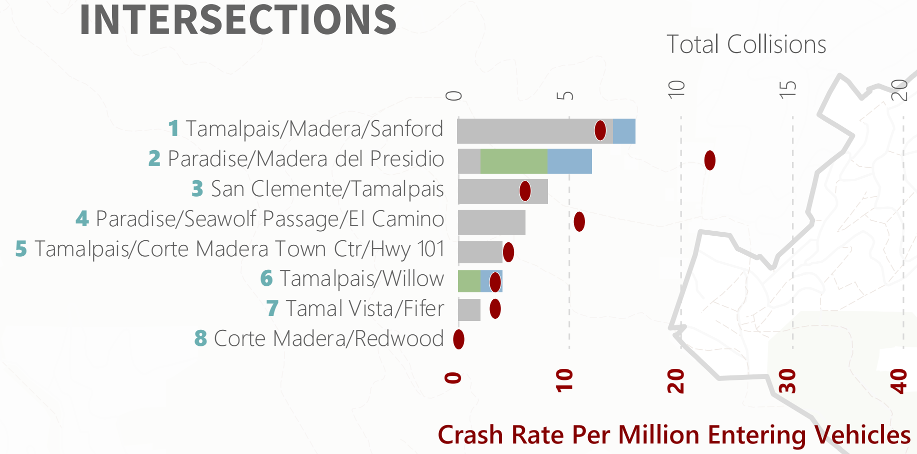
20% of all pedestrian collisions in Corte Madera involved pedestrians in the road including shoulder area, approximately two-thirds higher than the county average for pedestrian collisions.

CORRIDORS



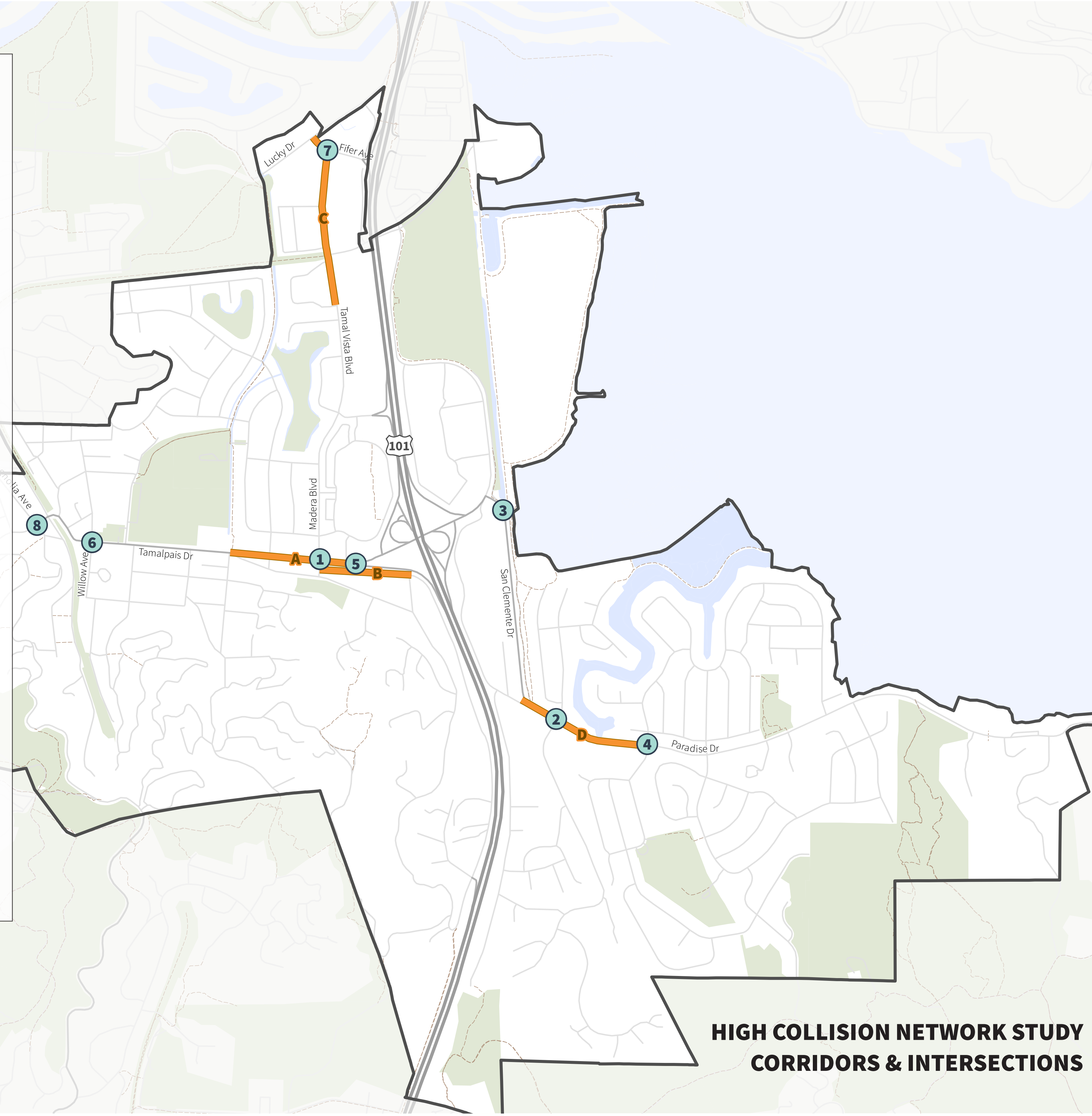
The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study corridor. The bars also illustrate, by color, a breakdown of those collisions by mode for each corridor. To normalize the collision data, the red dots in the chart show the crash rate per 100 million vehicle miles traveled for each study corridor.

INTERSECTIONS



The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study intersection. The bars also illustrate, by color, a breakdown of those collisions by mode for each intersection. To normalize the collision data, the red dots in the chart show the crash rate per million entering vehicles for each study intersection.

Motor Vehicle Collisions | Bicycle Collisions | Crash Rate | Motorcycle Collisions | Pedestrian Collisions



HIGH COLLISION NETWORK STUDY CORRIDORS & INTERSECTIONS

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

	ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
CORRIDORS	A	Tamalpais: Sausalito to S Hwy 101 Ramp	10	0	1	1	12	NS5, Install intersection warning/regulatory signs NS8, Install flashing beacons as advanced warning	NH3, Ramp metering
	B	Casa Buena: Sanford to Conow	9	0	1	1	11	R30, Install dynamic/variable speed warning signs	
	C	Tamal Vista: Wornum Dr to Lucky Dr	8	1	1	1	11	NS4, Convert intersection to roundabout R36, Install bike lanes	
	D	Paradise: San Clemente to Seawolf Passage	4	0	4	2	11	NS16, Install raised median / refuge islands R36, Install bike lanes R38, Pedestrian crossing with enhanced safety features (bulb out) S18, Convert intersection to roundabout	
INTERSECTIONS	1	Tamalpais and Madera and Sanford	7	0	0	1	8	S2, Improve signal hardware (upgrade to 12" LED modules, install pedestrian push button) S3, Improve signal timing and detection S4, Provide advanced dilemma zone detection S7, Convert signal to mast arm S18, Convert signalized intersection to roundabout (optional CM as an alternative to S2,S3, S4, S7 and S19) S19, Check for and/or install pedestrian countdown signal heads	
	2	Paradise and Madera del Presidio	1	0	3	2	6	S2, Improve signal hardware (add pedestrian push button) S17, Install left turn lane and add turn phase S19, Check for and/or install pedestrian countdown signal heads S21, Install bike box R36, Install bike lanes R38, Pedestrian crossing with enhanced safety features	NH8, Square up intersection

TOWN OF CORTE MADERA

INTERSECTIONS

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
3	San Clemente and Tamalpais	4	0	0	0	4	S2, Improve signal hardware (upgrade to 12" LED modules) S3, Improve signal timing and detection S18, Convert signalized intersection to roundabout (optional CM as an alternative to S2,S3, S19 and S20) S19, Check for and/or install pedestrian countdown signal heads S20, Pedestrian crossing with enhanced safety features (bulb out to reduce curb radii) NS16, Install raised median / refuge islands	
4	Paradise and Seawolf Passage and El Camino	3	0	0	0	3	S2, Improve signal hardware (upgrade to 12" LED modules) S3, Improve signal timing and detection S6, Provide protected left turn phase (left turn lane already exists) S7, Convert signal to mast arm S19, Check for and/or install pedestrian countdown signal heads S18, Convert signalized intersection to roundabout (optional CM as an alternative to S2,S3, S6, S7 and S19) NS16, Install raised median / refuge islands	
5	Tamalpais and Corte Madera Town Ctr and Hwy 101	2	0	0	0	2	S2, Improve signal hardware (upgrade all signal heads to 12" LED modules) S19, Check for and/or install pedestrian countdown signal heads R38, Install pedestrian crossing (with advanced safety feature, tighten up curb radii and add directional pedestrian curb ramps)	
6	Tamalpais and Willow	0	0	1	1	2	NS18, Install pedestrian crossing (with advanced safety feature, add bulb-outs)	
7	Tamal Vista and Fifer	1	0	0	0	1	S2, Improve signal hardware (upgrade to 12" LED modules) S18, Convert intersection to roundabout (Optional CM as an alternative to S2, S19 and R38) S19, Check for and/or install pedestrian countdown signal heads R38, Install pedestrian crossing (with advanced safety feature, tighten up curb radii)	
8	Corte Madera and Redwood	0	0	0	0	0	S2, Improve signal hardware (install stub pole pedestrian push button) R38, Install pedestrian crossing (with advanced safety feature, tighten up curb radii and install directional pedestrian ramps)	

PRIORITY PROJECTS

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

San Clemente Drive and Tamalpais Drive | Intersection

San Clemente Drive and Tamalpais Drive looking north

EXISTING CONDITIONS:

Tamalpais Drive and San Clemente Drive is a multi-lane arterial intersection that carries regional traffic and connects with Highway 101. It is also part of a designated bike route and connects with a segment on the Bay Trail. The intersection had four total reported collisions in five years. Rear-end collisions are the most common motor vehicle collision types.

POTENTIAL IMPROVEMENTS:

Improve Signals- Rear-end crashes may indicate clearance intervals are too short, consider adding a longer yellow phase. Other signalization improvements may include adding phases, coordinating signals at multiple locations, upgrading signal heads, and adding advanced dilemma detection zones.

Convert signalized intersection to roundabout- This is an optional alternative countermeasure. Roundabouts can be effective at reducing severe injuries at intersections with complex geometry and intersections with frequent left-turn movements.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be considered at this intersection including some of the following: stop bars, bulb outs, adding directional curb ramps, reduced curb radii and ADA/APS pedestrian push button. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Consider installing bike lanes on Tamalpais Drive where there is room. Adding dedicated bicycle facilities can lessen the chances of conflicts and collisions involving motor vehicles overtaking bicyclists. Also installing green paint through bicycle conflict zones could increase the visibility of bicyclists.

Tamalpais Drive and Corte Madera Town Center Driveway | Intersection

Tamalpais Drive and Corte Madera Town Center looking west

EXISTING CONDITIONS:

Tamalpais Drive and Corte Madera Town Center driveway is a multi-lane arterial intersection that carries regional traffic and connects with Highway 101. The intersection had two reported collisions in five years. Rear-end collisions are the most common motor vehicle collision types.

POTENTIAL IMPROVEMENTS:

Improve Signals- Rear-end crashes may indicate clearance intervals are too short, consider adding a longer yellow phase. Other signalization improvements may include adding phases, coordinating signals at multiple locations, upgrading signal heads to 12" LEDs with backplates, and adding advanced dilemma detection zones.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be considered at this intersection including some of the following: stop bars, bulb outs, directional curb ramps, reduced curb radii and ADA/APS pedestrian push button. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Consider installing bike lanes on Tamalpais Drive. Adding dedicated bicycle facilities can lessen the chances of collisions involving motor vehicles overtaking bicyclists.

Tamalpais Drive and Madera Boulevard and Sanford Street | Intersection

Tamalpais Drive and Madera Boulevard looking west

EXISTING CONDITIONS:

Tamalpais Drive and Madera Boulevard is a multi-lane arterial intersection that carries regional traffic through Corte Madera and connects with Highway 101. The intersection had eight reported collisions in five years. Rear-end collisions are the most common motor vehicle collision type.

POTENTIAL IMPROVEMENTS:

Improve signal timing- Rear-end crashes may indicate clearance intervals are too short, consider adding a longer yellow phase. Other signalization improvements may include adding phases, coordinating signals at multiple locations, upgrading signal heads to 12" LEDs with backplates, and adding advanced dilemma detection zones.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be implemented at this intersection including some of the following: stop bars, bulb outs, directional curb ramps, reduced curb radii and ADA/APS pedestrian push button. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Consider installing bike lanes on Tamalpais Drive. Adding dedicated bicycle facilities lessen the chances of collisions involving motor vehicles overtaking bicyclists.

PRIORITY PROJECTS (CONT.)

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

Tamalpais Drive and Willow Avenue | Intersection


Tamalpais Drive and Willow Avenue looking east

EXISTING CONDITIONS:

Tamalpais Drive and Willow Drive is the intersection of a regional arterial and a residential collector. Tamalpais Drive carries regional traffic through Corte Madera and connects with Highway 101. The intersection had two collisions in five years, one bicycle collision and one pedestrian collision.

POTENTIAL IMPROVEMENTS:

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be considered at this intersection including some of the following: bulb outs, RRFBs, directional curb ramps and reduced curb radii. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Consider installing continuous bike lanes on Tamalpais Drive. Adding dedicated bicycle facilities can lessens the chances of collisions involving motor vehicles overtaking bicyclists.

Tamal Vista Boulevard: Wornum to Lucky Drive | Corridor


Tamal Vista looking south

EXISTING CONDITIONS:

Tamal Vista Boulevard is a north-south two lane collector that extends from Madera Boulevard to Fifer Avenue. Tamal Vista carries local traffic and is also a designated bike route. The corridor had 11 reported collisions in five years, one bicycle collision and one pedestrian collision. Rear-end collisions are the most common motor vehicle collision type.

POTENTIAL IMPROVEMENTS:

Improve intersection- Signalization improvements may include coordinating signals at multiple locations and lengthening clearance intervals.

Convert signalized intersection to roundabout- This is an optional alternative countermeasure. Roundabouts can be effective at reducing severe injuries at intersections with complex geometry and intersections with frequent left-turn movements.

Improved Pedestrian Crossing- A number of pedestrian crossing improvements could be considered along this corridor including some of the following: advanced stop bars, directional curb ramps, median refuge islands, and reduced curb radii. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Consider installing bike lanes on Tamal Vista if feasible. Adding dedicated bicycle facilities can lessen the chances of collisions involving motor vehicles overtaking bicyclists.

Paradise Drive: San Clemente Drive to East of Seawolf Passage | Corridor


Paradise Drive looking west

EXISTING CONDITIONS:

Paradise Drive is a multi-lane arterial that carries regional traffic through Corte Madera into Tiburon. The corridor is also a designated bike route. The corridor had 11 total reported collisions in five years, one bicycle KSI collision and one pedestrian KSI collision.

POTENTIAL IMPROVEMENTS:

Improve intersection- Signalization improvements may include improving signal phasing, lengthening clearance intervals, coordinating signals at multiple locations and upgrading hardware to 12" signal heads with backplates.

Convert signalized intersection to roundabout- This is an optional alternative countermeasure. Roundabouts can be effective at reducing severe injuries at intersections with complex geometry and intersections with frequent left-turn movements.

Improved Pedestrian Crossing- A number of pedestrian crossing improvements could be considered along this corridor including some of the following: advanced stop bars, bulb outs, raised medians, directional curb ramps, pedestrian countdown heads, and refuge islands. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Consider installing bike lanes or a multi-use pathway on Paradise Drive if feasible. Adding dedicated bicycle facilities or a multi-use pathway can lessen the chances of collisions involving motor vehicles overtaking bicyclists.

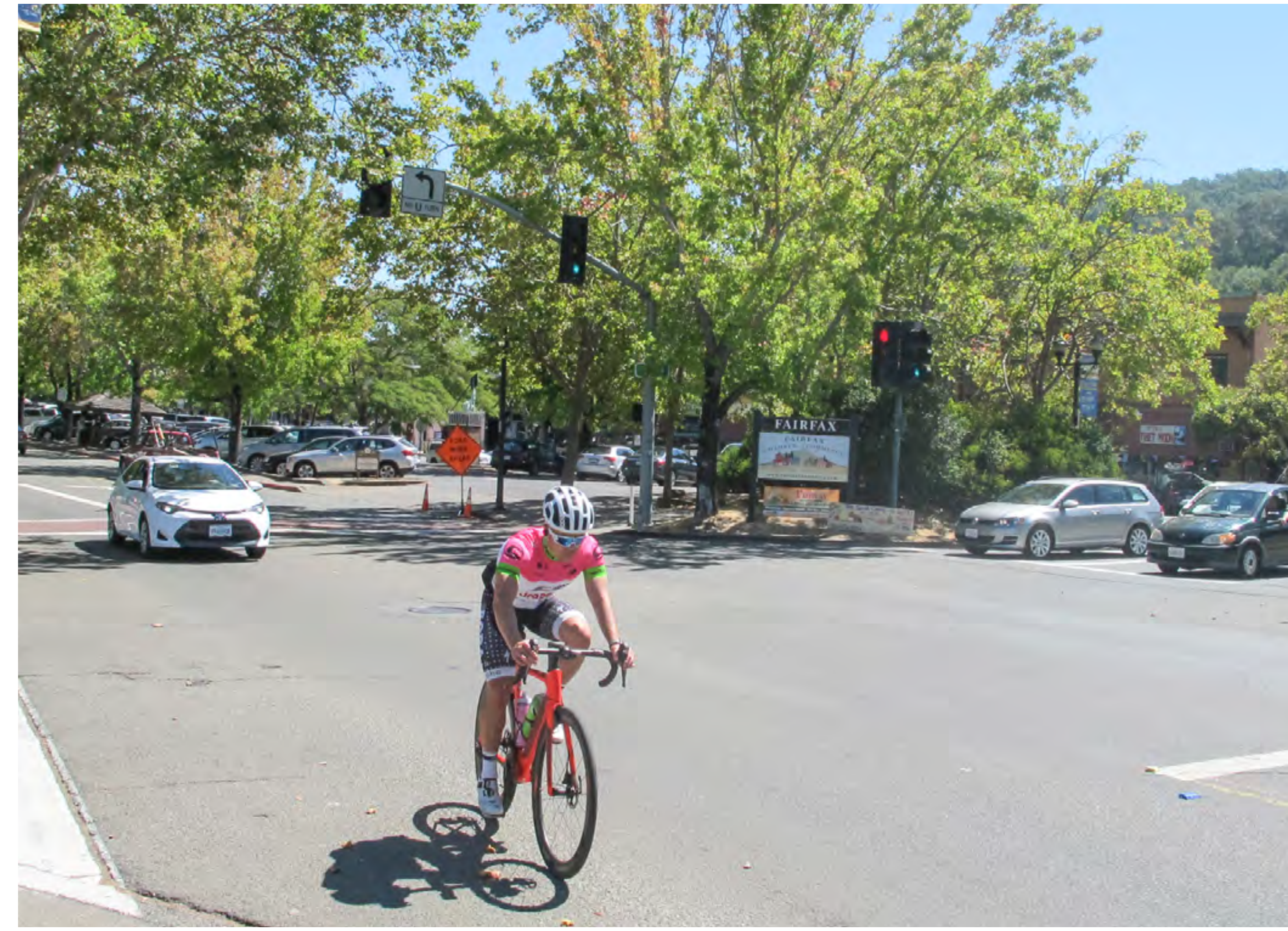
CHAPTER 5: TOWN OF FAIRFAX

The Town of Fairfax had an estimated population of 7,528 as of January 1, 2016, according to the California Department of Finance, representing approximately 2.9 percent of Marin County's total population. In the five-year period between 2012 and 2016, Fairfax experienced a total of 67 reported crashes on local streets. Nine of those crashes involved a person that was severely injured, and of the nine, there were no fatalities.

Fairfax's share of reported crashes on local streets, as a proportion of total crashes in Marin County, during the five-year period is summarized below.

- **2.4% of all county-wide crashes**
- **4.1% of county-wide crashes in which a person was killed or severely injured (KSI)**
- **0% of all fatal county-wide crashes**

For all crashes, Fairfax's share of those crashes as a proportion of total crashes in Marin County was less than the town's 2.9 percent share of the total county population. However, forcrashes involving severe injuries or fatalities, Fairfax's share of those crashes as a proportion of total crashes in Marin was higher than the town's 2.9 percent of the total county population.



The intersection of Claus Drive / Sir Francis Drake Boulevard / Bank Street is one of Fairfax's high collision network study intersections. The intersection had six reported collisions in a recent five-year period. The intersection had one bicycle collision and two pedestrian collisions.

COLLISIONS 2012 TO 2016

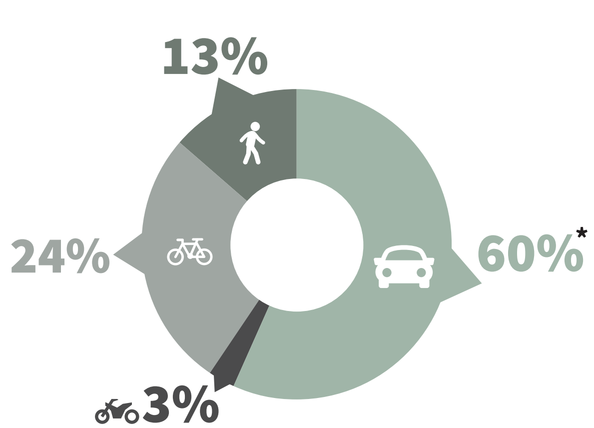
67 TOTAL COLLISIONS

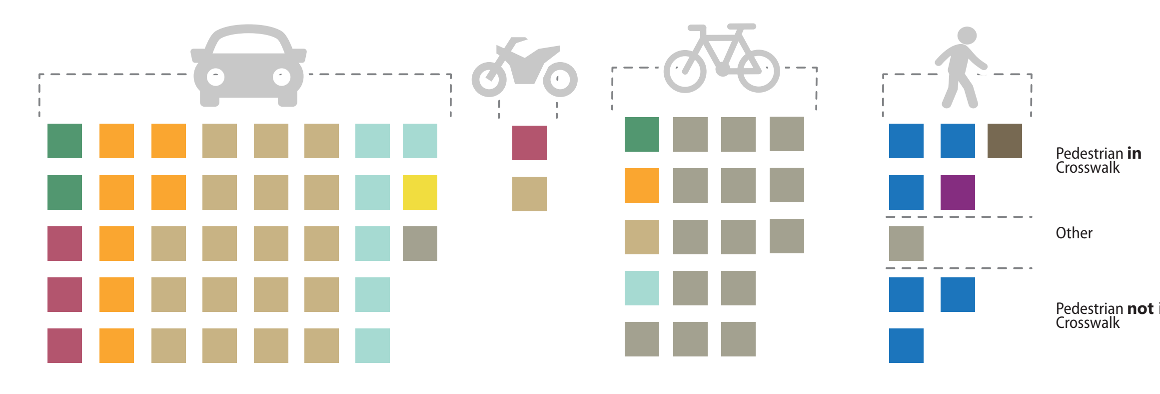
13% KILLED OR SEVERELY INJURED

[**0%** FATALITIES]

COLLISION BY MODE

COLLISION BY MODE





One square = One Collision

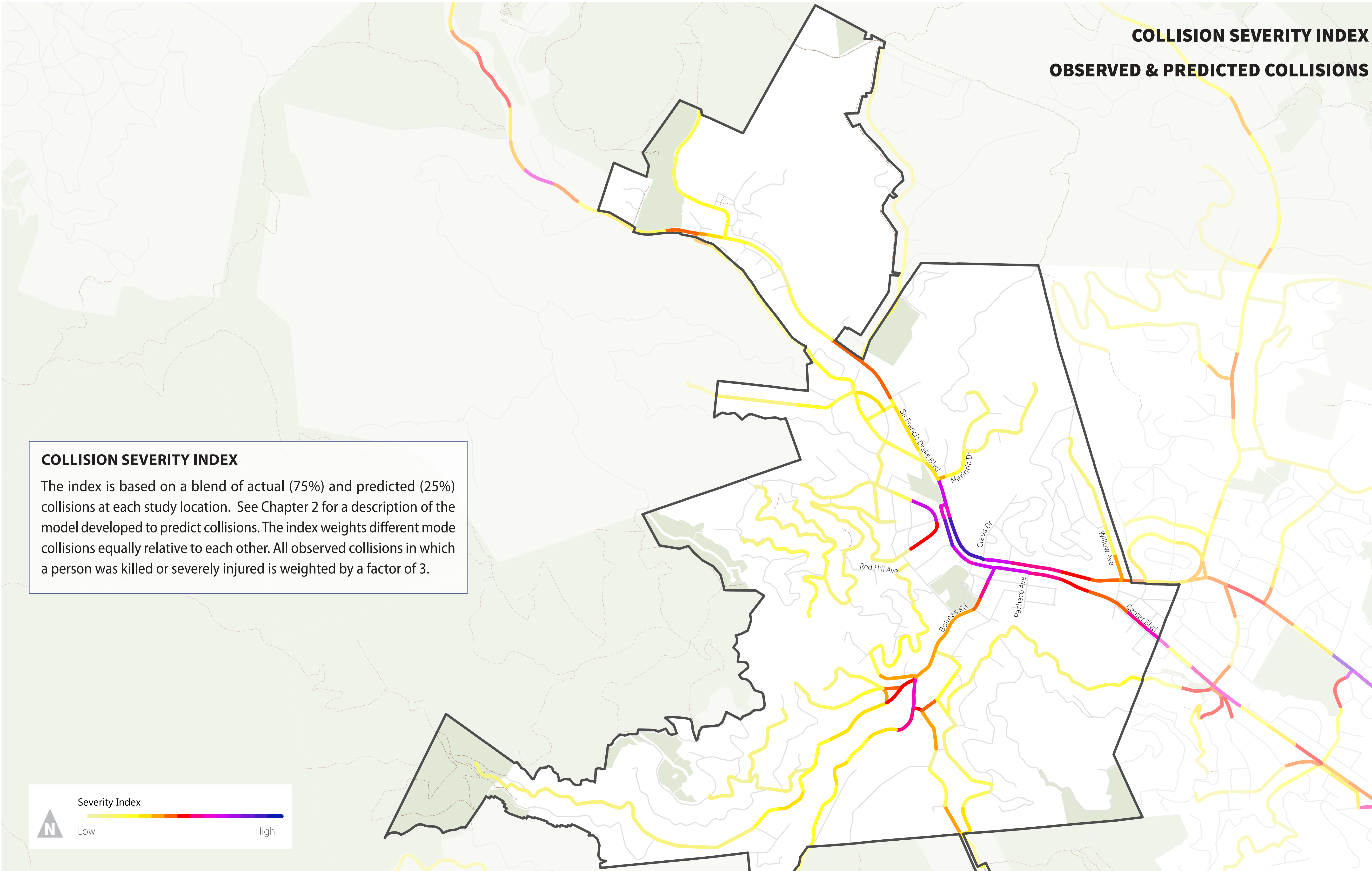
* "Other" is one of the eight crash type options for police officers to designate on collision reports. Collisions designated as "Other" are included in the auto portion of the collisions by mode chart above.

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

Auto	Motorcycle	Bicycle	Pedestrian	CRASH TYPES
5%		6%		Head-On
8%	50%			Sideswipe
18%		6%		Broadside
47%	50%	6%		Rear End
16%		6%		Hit Object
3%				Overturned
3%		76%	11%	Other *
			67%	Motorvehicle proceeding straight
			11%	Motorvehicle making left turn
			11%	Motorvehicle making right turn
100%	100%	100%	100%	

COLLISION SEVERITY INDEX

OBSERVED & PREDICTED COLLISIONS



COLLISION SEVERITY INDEX

The index is based on a blend of actual (75%) and predicted (25%) collisions at each study location. See Chapter 2 for a description of the model developed to predict collisions. The index weights different mode collisions equally relative to each other. All observed collisions in which a person was killed or severely injured is weighted by a factor of 3.

This study developed crash profiles to highlight five of the top trends among collisions in Fairfax. The collision profiles, shown at the bottom right, are based on an analysis of crash data and related environmental factors. Every profile highlights a crash pattern the study has identified as a priority concern.

The table below shows the proportion of crash types by mode. Data to the right provides a comparison of the percentage of Fairfax collisions vs. total collisions across all of Marin jurisdictions by mode, collision type, select age and collision violation categories.

The following pages identify safety countermeasures for study corridors and intersections. These countermeasures make up a toolkit of safety interventions the Town of Fairfax can utilize to implement projects tailored to unique safety issues.

67 TOTAL FAIRFAX COLLISIONS

2,756 TOTAL MARIN COLLISIONS

2012-2016

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

				CRASH TYPES
5%		6%		Head-On
8%	50%			Sideswipe
18%		6%		Broadside
47%	50%	6%		Rear End
16%		6%		Hit Object
3%				Overturned
3%		76%	11%	Other *
			67%	Motorvehicle proceeding straight
			11%	Motorvehicle making left turn
			11%	Motorvehicle making right turn
100%	100%	100%	100%	

** "Other" is one of the eight crash type options for police officers to designate on collision reports.*

FAIRFAX VS. MARIN COLLISIONS - RELATIVE SHARE

	AGE		VIOLATION	
	Youth	Senior	DUI	Unsafe Speed
Town of Fairfax	**14.5%**	17.4%	8.7%	27.5%
All Marin Collisions	13.7%	21.4%	10.5%	28.2%

	MODE				
	Auto	Motorcycle	Bicycle	Pedestrian	Other
Town of Fairfax	57.4%	2.90%	**23.5%**	**13.2%**	**2.9%**
All Marin Collisions	63.8%	6.4%	18.1%	11.1%	0.6%

	COLLISION TYPE							
	Head-on	Sideswipe	Rear-end	Broadside	Hit Object	Overturned	Vehicle/ Pedestrian	Other
Town of Fairfax	1.4%	7.2%	**29.0%**	11.6%	7.2%	1.4%	**17.4%**	**23.2%**
All Marin Collisions	7.1%	8.7%	24.5%	20.3%	11.8%	5.6%	11.0%	10.7%

LOCAL COLLISION PROFILES

BICYCLE COLLISIONS

California Office of Traffic Safety ranked Fairfax 4th of 65 similar California cities with high levels of bicycle collisions in 2014.

BICYCLE COLLISIONS

24% (16) of all collisions in Fairfax involved bicycles, about 30 percent higher than the county average.

PEDESTRIAN COLLISIONS (UNDER THE AGE OF 15)

California Office of Traffic Safety ranked Fairfax 5th of 63 similar California cities with high levels of pedestrian collisions involving children in 2013.

PEDESTRIAN COLLISIONS (OVER THE AGE OF 65)

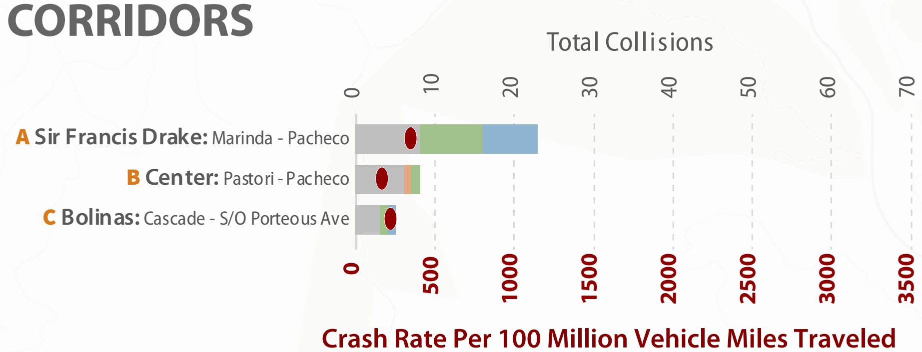
California Office of Traffic Safety ranked Fairfax 11th of 67 similar California cities with high levels of pedestrian collisions involving seniors in 2015.

PEDESTRIAN/ VEHICLE COLLISIONS

17% (11) of all collisions in Fairfax involved pedestrians and vehicles, about 60 percent higher than the county average.

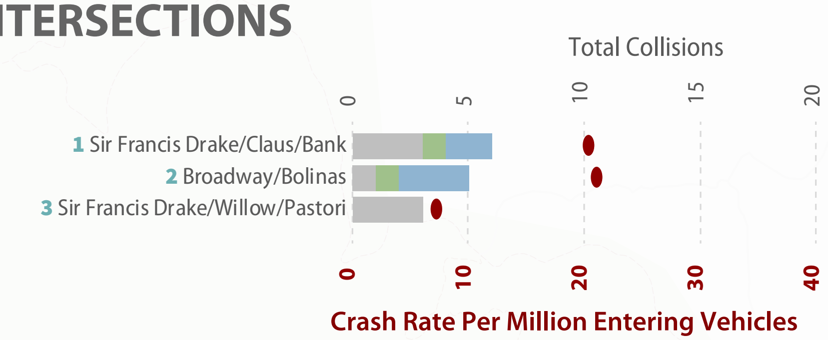
HIGH COLLISION NETWORK STUDY CORRIDORS & INTERSECTIONS

CORRIDORS



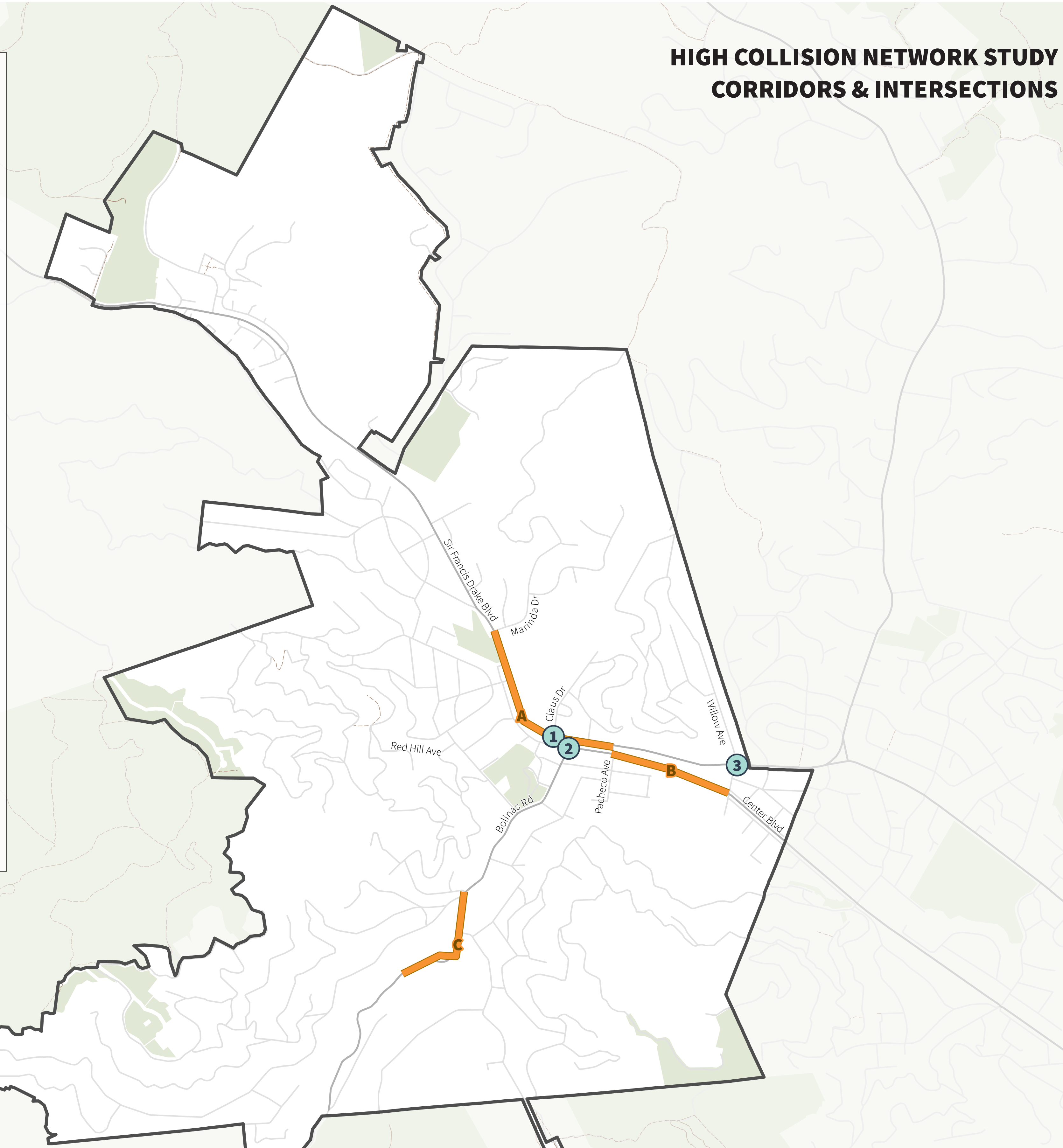
The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study corridor. The bars also illustrate, by color, a breakdown of those collisions by mode for each corridor. To normalize the collision data, the red dots in the chart show the crash rate per 100 million vehicle miles traveled for each study corridor.

INTERSECTIONS



The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study intersection. The bars also illustrate, by color, a breakdown of those collisions by mode for each intersection. To normalize the collision data, the red dots in the chart show the crash rate per million entering vehicles for each study intersection.

Motor Vehicle Collisions | Bicycle Collisions | Crash Rate
Motorcycle Collisions | Pedestrian Collisions



POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

	ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
CORRIDORS	A	Sir Francis Drake: Marinda to Pacheco	8	0	8	7	23	R38, Pedestrian crossing with enhanced safety features (ADA compliant pedestrian ramps) NS17, Install pedestrian crossing at uncontrolled locations (install high visibility crosswalks and advanced stop bars) NS18, Install pedestrian crossing at uncontrolled locations with advanced safety feature (install bulbs outs at unsignalized crossings)	NH5, Install wayfinding NH6, Install sharrows
	B	Center: Pastori to Pacheco	6	1	1	0	8		NH5, Install wayfinding
	C	Bolinas: Cascade to S/O Porteous Ave	3	0	1	1	5	R37, Install sidewalk/pathway (fill in gaps in sidewalk where applicable, check existing sidewalk for ADA compliance) R38, Pedestrian crossing with enhanced safety features (square up intersection, bulb outs, high visibility crosswalks, ADA accessible ramps)	NH7, Install 'Bikes May Use Full Lane' sign
INTERSECTIONS	1	Sir Francis Drake and Claus and Bank	3	0	1	2	6	S6, Provide protected left turn phase (left turn lane already exists) S19, Check for and/or install pedestrian countdown signal heads S20, Upgrade pedestrian crossing (install directional curb ramps, tighten curb radius) NS10, Improve sight distance to intersection (remove/trim back landscaping)	H1, Refresh signage/ striping
	2	Broadway and Bolinas	1	0	1	3	5	NS18, Install pedestrian crossing at uncontrolled location with enhanced safety features (square up intersection, add directional curb ramps, add bulb out)	
	3	Sir Francis Drake and Willow and Pastori	3	0	0	0	3	S3, Improve signal timing and detection S19, Check for and/or install pedestrian countdown signal heads S18, Convert signalized intersection to roundabout (optional CM as an alternative to S2,S3 and S19)	

PRIORITY PROJECT

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

Sir Francis Drake Boulevard: Marinda Drive to Pacheco Avenue | Corridor

Sir Francis Drake Boulevard looking south

EXISTING CONDITIONS:

Sir Francis Drake Boulevard is a regional arterial roadway that connects Fairfax to Highway 101 to the south. Sir Francis Drake Boulevard runs through downtown Fairfax and is also an important pedestrian route. The corridor had 23 reported collisions in five years, including two KSI bicycle collision and one KSI pedestrian collision. Rear-end collisions are the most common motor vehicle collision type.

POTENTIAL IMPROVEMENTS:

Improve Signals- Signalization improvements may include upgrading signals to 12" LED modules, lengthening clearance intervals and installing adaptive traffic control.

Improved Pedestrian Crossing- A number of pedestrian crossing improvements could be considered along this corridor including some of the following: advanced stop bars, directional curb ramps, median refuge islands, and reduced curb radii. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Consider adding bicycle facilities if feasible. Adding dedicated bicycle facilities can lessen the chance of conflicts and collisions involving motor vehicles overtaking bicyclists..

CHAPTER 6: CITY OF LARKSPUR

The City of Larkspur had an estimated population of 12,312 as of January 1, 2016, according to the California Department of Finance, representing approximately 4.7 percent of Marin County's total population. In the five-year period between 2012 and 2016, Larkspur experienced a total of 89 reported crashes on local streets. Three of those crashes involved a person that was severely injured, and of the three, there were no fatalities.

Larkspur's share of reported crashes on local streets, as a proportion of total crashes in Marin County, during the five year period is summarized below.

- **3.2% of all county-wide crashes**
- **1.8% of county-wide crashes in which a person was killed or severely injured (KSI)**
- **0% of all fatal county-wide crashes**

For all crashes as well as fatal and KSI crashes, Larkspur's share of those crashes as a proportion of total crashes in Marin County was less than the city's 4.7 percent share of the total county population.

The intersection of East Sir Francis Drake Boulevard and Larkspur Landing Circle (West) is within one of Larkspur's priority project corridors, which extends from East Sir Francis Drake Boulevard and Ahrens Lane to Larkspur Landing Circle (E). The corridor had 12 reported collisions in a recent five-year period. Rear-end collisions are the most common motor vehicle collision type.

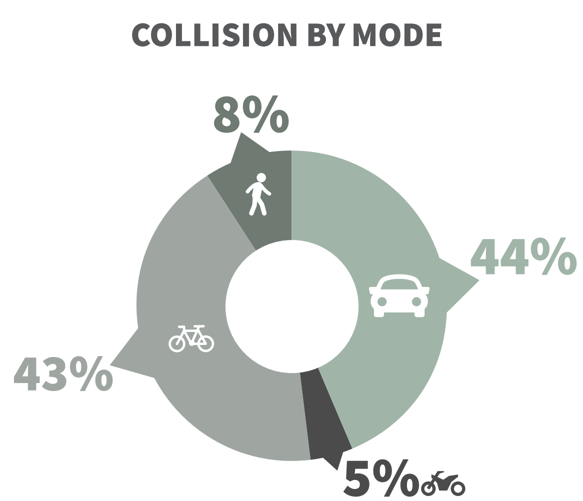
COLLISIONS 2012 TO 2016

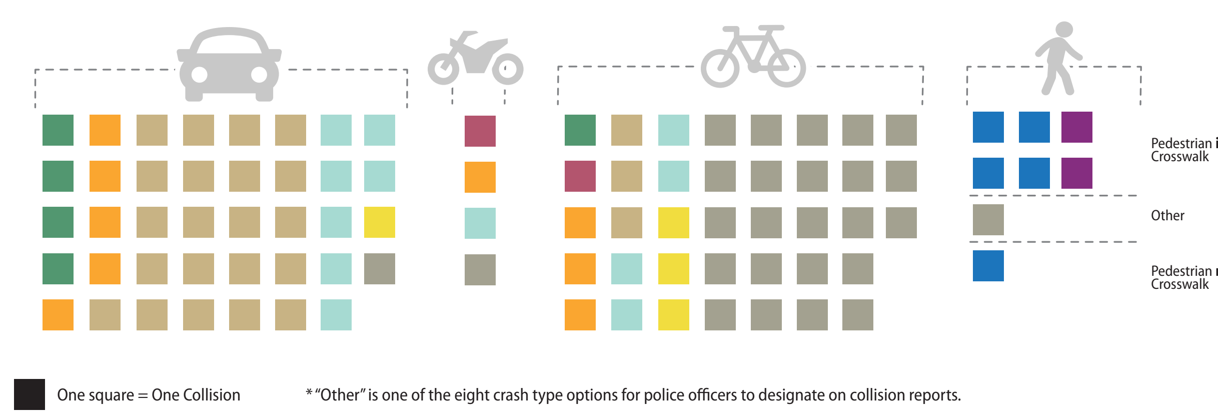
89 TOTAL COLLISIONS

4% KILLED OR SEVERELY INJURED

[0% FATALITIES**]**

COLLISION BY MODE

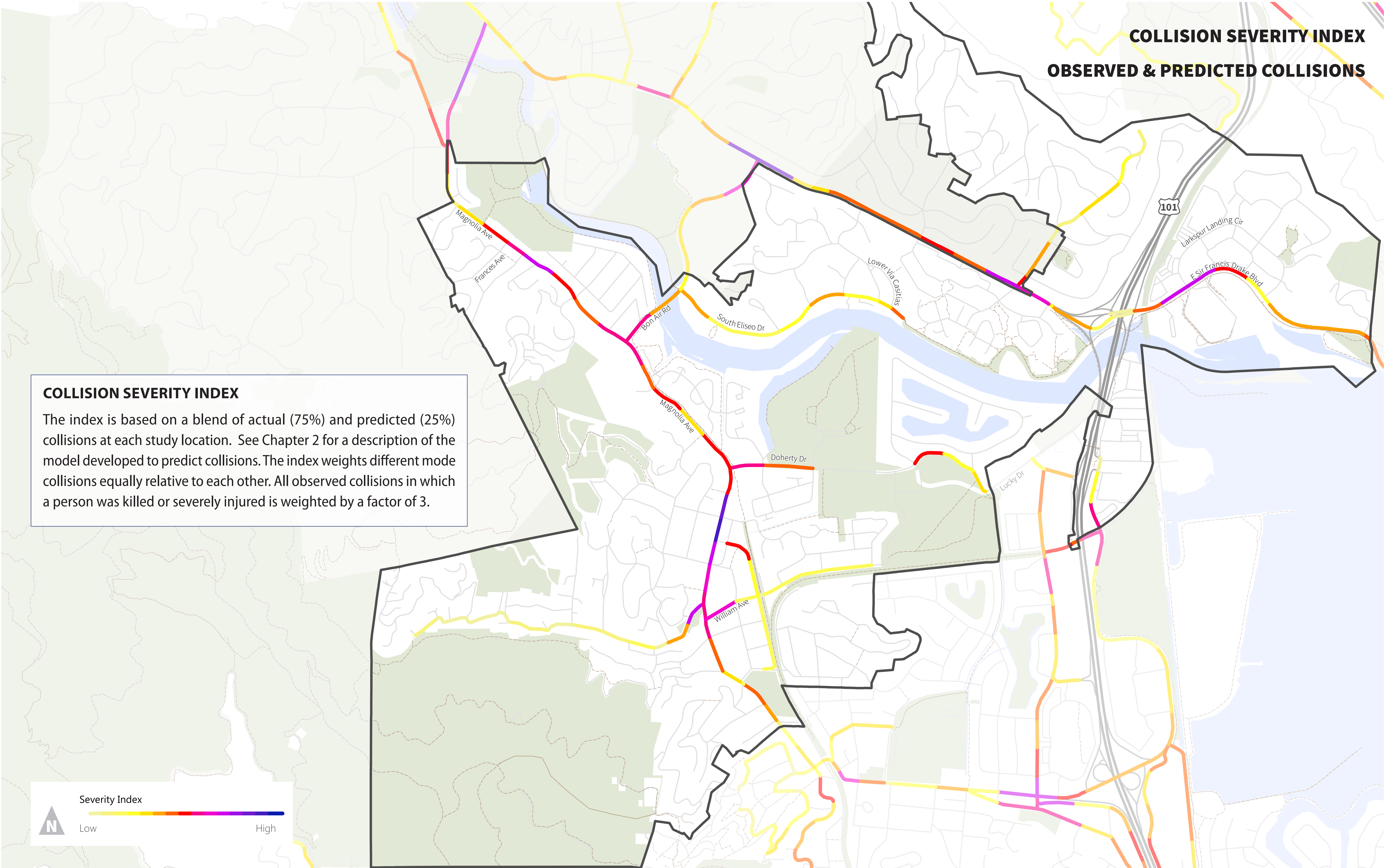




CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

CRASH TYPES	Car	Motorcycle	Bicycle	Pedestrian
Head-On	10%		3%	
Sideswipe		25%	3%	
Broadside	13%	25%	8%	
Rear End	53%		8%	
Hit Object	18%	25%	10%	
Overturned	3%		8%	
Other *	3%	25%	60%	13%
Motorvehicle proceeding straight				62%
Motorvehicle making left turn				25%
Motorvehicle making right turn				
	100%	100%	100%	100%

COLLISION SEVERITY INDEX
OBSERVED & PREDICTED COLLISIONS



COLLISION SEVERITY INDEX

The index is based on a blend of actual (75%) and predicted (25%) collisions at each study location. See Chapter 2 for a description of the model developed to predict collisions. The index weights different mode collisions equally relative to each other. All observed collisions in which a person was killed or severely injured is weighted by a factor of 3.

This study developed crash profiles to highlight five of the top trends among collisions in Larkspur. The collision profiles, shown at the bottom right, are based on an analysis of crash data and related environmental factors. Every profile highlights a crash pattern the study has identified as a priority concern.

The table below shows the proportion of crash types by mode. Data to the right provides a comparison of the percentage of Larkspur collisions vs. total collisions across all of Marin jurisdictions by mode, collision type, select age and collision violation categories.

The following pages identify safety countermeasures for study corridors and intersections. These countermeasures make up a toolkit of safety interventions the City of Larkspur can utilize to implement projects tailored to unique safety issues.

89 TOTAL LARKSPUR COLLISIONS

2,756 TOTAL MARIN COLLISIONS

2012-2016

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

Auto	Motorcycle	Bicycle	Pedestrian	CRASH TYPES
10%		3%		Head-On
	25%	3%		Sideswipe
13%	25%	8%		Broadside
53%		8%		Rear End
18%	25%	10%		Hit Object
3%		8%		Overturned
3%	25%	60%	13%	Other *
			62%	Motorvehicle proceeding straight
			25%	Motorvehicle making left turn
				Motorvehicle making right turn
100%	100%	100%	100%	

** "Other" is one of the eight crash type options for police officers to designate on collision reports.*

LARKSPUR VS. MARIN COLLISIONS - RELATIVE SHARE

	AGE		VIOLATION	
	Youth	Senior	DUI	Unsafe Speed
City of Larkspur	8.3%	**34.5%**	6.0%	**35.7%**
All Marin Collisions	13.7%	21.4%	10.5%	28.2%

MODE

	Auto	Motorcycle	Bicycle	Pedestrian	Other
City of Larkspur	44.0%	4.8%	**42.9%**	**8.3%**	0.0%
All Marin Collisions	63.8%	6.4%	18.1%	11.1%	0.6%

COLLISION TYPE

	Head-on	Sideswipe	Rear-end	Broadside	Hit Object	Overturned	Vehicle/ Pedestrian	Other
City of Larkspur	6.0%	3.6%	**27.4%**	9.5%	**13.1%**	3.6%	8.3%	**27.4%**
All Marin Collisions	7.1%	8.7%	24.5%	20.3%	11.8%	5.6%	11.0%	10.7%

LOCAL COLLISION PROFILES

BICYCLE COLLISIONS

43% (38) of all collisions in Larkspur involved bicycles, about 2.5 times the county average.

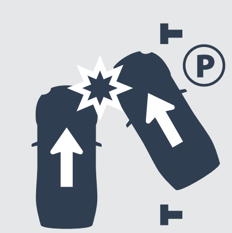
SENIOR COLLISIONS

34% (30) of all collisions in Larkspur involved seniors, approximately 60 percent higher than the county average.

SPEED RELATED COLLISIONS

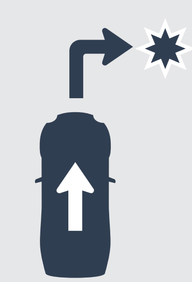
37% (33) of all collisions in Larkspur involved unsafe speed violations, about 30 percent higher than the county average.

PARKING MANEUVER COLLISIONS

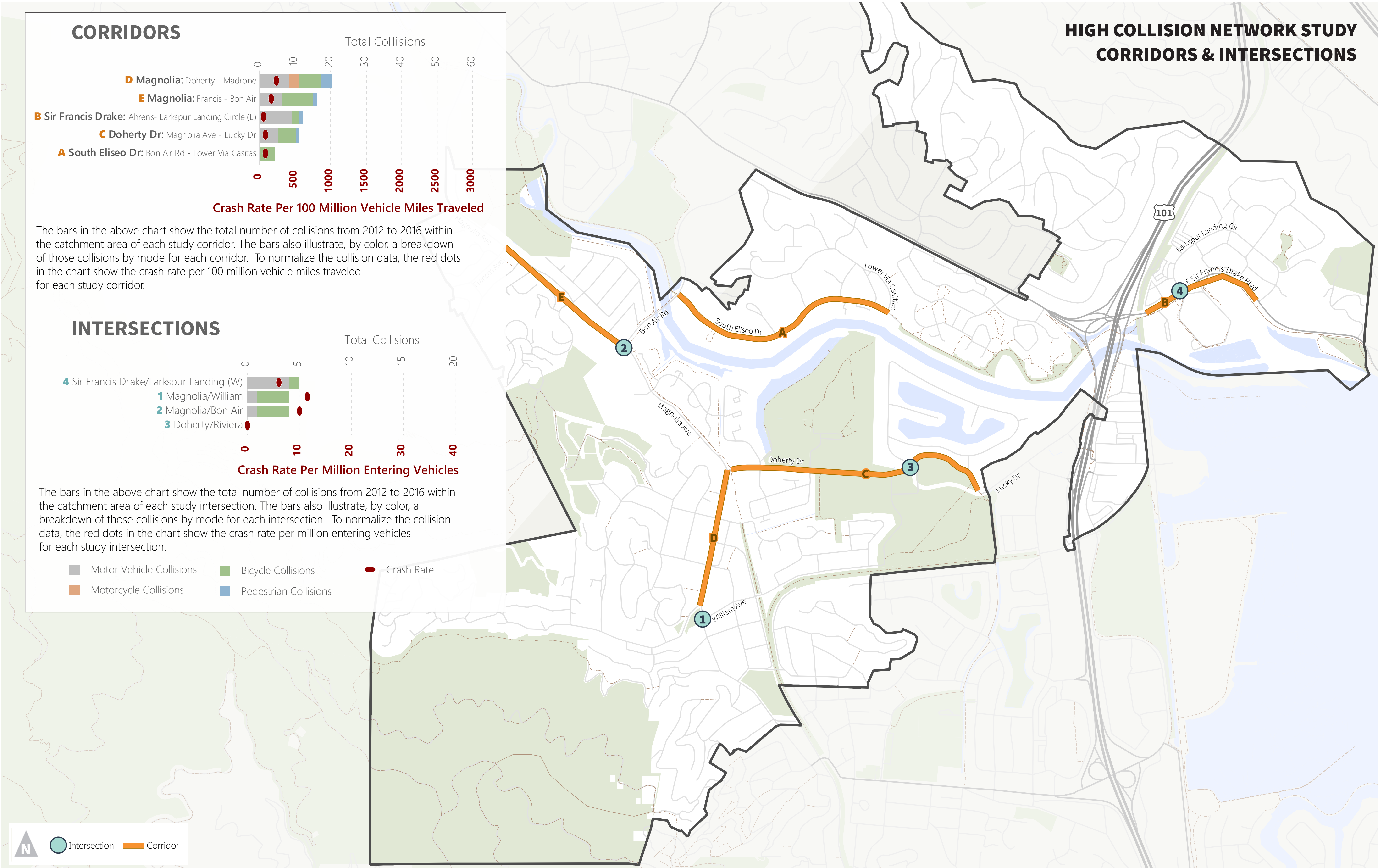


2.1% (2) of all collisions in Larkspur involved vehicles making a parking maneuver, about 10 times higher than the county average.

RIGHT TURNS COLLISIONS



5.6% (5) of all collisions in Larkspur involved vehicles making right turns, about 40 percent higher than the county average.


HIGH COLLISION NETWORK STUDY
CORRIDORS & INTERSECTIONS
CORRIDORS
Total Collisions
0 10 20 30 40 50 60
D Magnolia: Doherty - Madrone
E Magnolia: Francis - Bon Air
B Sir Francis Drake: Ahrens- Larkspur Landing Circle (E)
C Doherty Dr: Magnolia Ave - Lucky Dr
A South Eliseo Dr: Bon Air Rd - Lower Via Casitas
0 500 1000 1500 2000 2500 3000
Crash Rate Per 100 Million Vehicle Miles Traveled
The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study corridor. The bars also illustrate, by color, a breakdown of those collisions by mode for each corridor. To normalize the collision data, the red dots in the chart show the crash rate per 100 million vehicle miles traveled for each study corridor.
INTERSECTIONS
Total Collisions
0 5 10 15 20
4 Sir Francis Drake/Larkspur Landing (W)
1 Magnolia/William
2 Magnolia/Bon Air
3 Doherty/Riviera
0 10 20 30 40
Crash Rate Per Million Entering Vehicles
The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study intersection. The bars also illustrate, by color, a breakdown of those collisions by mode for each intersection. To normalize the collision data, the red dots in the chart show the crash rate per million entering vehicles for each study intersection.
Motor Vehicle Collisions
Motorcycle Collisions
Bicycle Collisions
Pedestrian Collisions
Crash Rate
101
Larkspur Landing Cir
E Sir Francis Drake Blvd
Lower Via Casitas
South Eliseo Dr
Bon Air Rd
Magnolia Ave
Doherty Dr
Lucky Dr
William Ave
Intersection
Corridor

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

	ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
CORRIDORS	A	South Eliseo Dr: Bon Air Rd to Lower Via Casitas	0	0	4	0	4	R30, Install dynamic/variable speed warning signs R38, Pedestrian crossing with enhanced safety features (Install bulb out, high visibility crossing, ADA compliant pedestrian ramps)	NH5, Install wayfinding NH14, Install raised crosswalk (at Hamilton Park)
CORRIDORS	B	East Sir Francis Drake: Ahrens to Larkspur Landing Circle (E)	9	0	2	1	12	East Sir Francis Drake Improvements project competed in Spring 2018 consisted of the following: S2, Improve signal hardware (upgrade to 12" LED modules and add backplates) S3, Improve signal timing and detection (add new signal phasing) S20, Pedestrian crossing with enhanced safety features (bulb outs, advanced stop bars, realign curve)	NH1, Refresh striping
CORRIDORS	C	Doherty Dr: Magnolia Ave to Lucky Dr	5	0	5	1	11	NS18, Install pedestrian crossing at uncontrolled locations with advanced safety feature (install RRFB or Flashing LED beacons) R36, Update existing bike lanes to buffered bike lanes (add green paint on bike lanes to delineate conflict zones at intersections)	NH9, Reduce lane widths
CORRIDORS	D	Magnolia: Doherty to Madrone	8	3	6	3	20	NS5, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs NS19, Install RRFBs R36, Install bike lanes, if feasible R38, Pedestrian crossing with enhanced safety features (bulb outs, directional curb ramps)	NH1, Refresh striping NH7, Install 'bike may use full lane' sign
CORRIDORS	E	Magnolia: Francis to Bon Air	6	0	9	1	16	S21, Install advanced stop bar before crosswalk (bike box) where applicable R36, Install bike lanes, if feasible	
INTERSECTIONS	1	Magnolia and William	1	0	3	0	4	NS17, Install stop bar NS18, Install pedestrian crossing (add missing crosswalk, bulb out)	
INTERSECTIONS	2	Magnolia and Bon Air	1	0	3	0	4	S2, Improve signal hardware (upgrade to 12" LED modules and add backplates) S19, Check for and/or install pedestrian countdown signal heads R36, Update existing bike lanes to green bike lanes through conflict zones	NH2, Remove slip lane
INTERSECTIONS	3	Doherty and Riviera (W)	0	0	0	0	0	NS4, Convert intersection to roundabout (optional CM as an alternative to NS3) NS10, Improve sight distance to intersection NS17, Pedestrian crossing (install high visibility crosswalk)	NH2, Remove slip lane
INTERSECTIONS	4	East Sir Francis Drake and Larkspur Landing (W)	4	0	1	0	5	East Sir Francis Drake Improvements project competed in Spring 2018 consisted of the following: S2, Improve signal hardware (upgrade to 12" LED modules and add backplates) S3, Improve signal timing and detection S20, Pedestrian crossing with enhanced safety features (bulb outs, advanced stop bars)	NH1, Refresh striping

CITY OF LARKSPUR

PRIORITY PROJECTS

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

East Sir Francis Drake Boulevard: Ahrens Lane to Larkspur Landing Circle (E) | Corridor

E Sir Francis Drake Boulevard and Larkspur Landing Cir looking north

EXISTING CONDITIONS:

East Sir Francis Drake Boulevard is a four-lane principal arterial roadway that connects with Highway 101 and the Larkspur Ferry Terminal. East Sir Francis Drake Boulevard is also an important bicycle and pedestrian route. The corridor had 12 reported collisions in five years, including one KSI bicycle collision. Rear-end collisions are the most common motor vehicle collision type.

POTENTIAL IMPROVEMENTS:

Improve Signals- Signalization improvements may include upgrading signals to 12" LED modules, lengthening clearance intervals and installing adaptive traffic control.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be considered along this corridor including some of the following: installing advanced stop bars, tighten curb radius, add bulb outs, directional curb ramps and pedestrian refuge islands.

Magnolia Avenue: Doherty Drive to Madrone Avenue | Corridor

Magnolia Avenue and Doherty Drive looking south

EXISTING CONDITIONS:

Magnolia Avenue is a major collector that runs through downtown Larkspur. It is a designated bike route and is an important north-south connection for transit and pedestrians. The corridor had 20 reported collisions in five years, including one KSI pedestrian collision and one KSI motor vehicle collision. Broadside collisions are the most common motor vehicle collision type.

POTENTIAL IMPROVEMENTS:

Improve Signals- Signalization improvements may include upgrading traffic signals to 12" LED with backplates.

Improve Sight Distance- Removing parking would improve sight distances at driveways and intersections.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be implemented along this corridor including some of the following: high visibility crosswalks, mid-block crossings with RRFBs, advanced stop bars, bulb outs, tighten curb radius, directional curb ramps and leading pedestrian intervals. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Magnolia Avenue: Francis Avenue to Bon Air Road (includes Magnolia and Bon Air) | Corridor

Magnolia Avenue and Dartmouth Drive south

EXISTING CONDITIONS:

Magnolia Avenue is a north-south four-lane minor arterial. It is a designated bike route and an important north-south connection for transit and pedestrians. The corridor had 16 reported collisions in five years, including one KSI bicycle collision. Rear-end collisions are the most common motor vehicle collision type.

POTENTIAL IMPROVEMENTS:

Intersection Improvements- Signalization improvements may include improving signal phasing, coordinating signals at multiple locations, lengthening clearance intervals, upgrading signals to 12" heads, adding flashing left turn arrows and adding a protected left turn phase.

Convert signalized intersection to roundabout- This is an optional alternative countermeasure. Roundabouts can be effective at reducing severe injuries at intersections with complex geometry and intersections with frequent left-turn movements.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be considered along this corridor including some of the following: advanced stop bars, bulb outs, directional curb ramps, straighten crosswalks, pedestrian refuge island, and ADA/APS pedestrian push button. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Consider installing continuous bike lanes on Magnolia Avenue. Adding dedicated bicycle facilities can lessen the chances of collisions involving motor vehicles overtaking bicyclists.

CHAPTER 7: CITY OF MILL VALLEY

The City of Mill Valley had an estimated population of 15,024 as of January 1, 2016, according to the California Department of Finance, representing approximately 5.7 percent of Marin County's total population. In the five-year period between 2012 and 2016, Mill Valley experienced a total of 133 reported crashes on local streets. Four of those crashes involved a person that was severely injured, and of the four, there were no fatalities.

Mill Valley's share of reported crashes on local streets, as a proportion of total crashes in Marin County, during the five year period is summarized below.

- **4.8% of all county-wide crashes**
- **1.4% of county-wide crashes in which a person was killed or severely injured (KSI)**
- **0% of all fatal county-wide crashes**

For all crashes as well as fatal and KSI crashes, Mill Valley's share of those crashes as a proportion of total crashes in Marin County was less than the city's 5.7 percent share of the total county population.

The intersection of East Blithedale Avenue / Roque Moraes Drive / Lomita Drive is one of Mill Valley's high collision network study intersections. The intersection had eight reported collisions in a recent five-year period. Rear-end collisions are the most common motor vehicle collision type.

COLLISIONS 2012 TO 2016

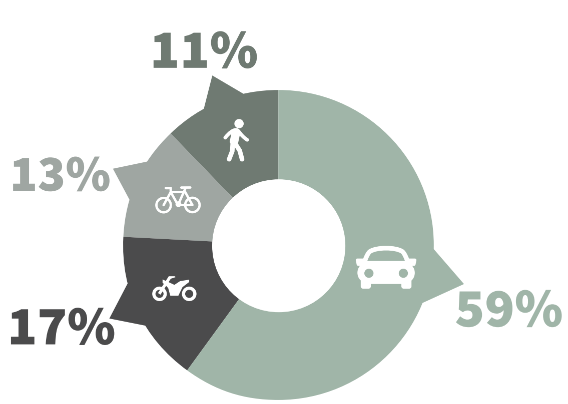
133 TOTAL COLLISIONS

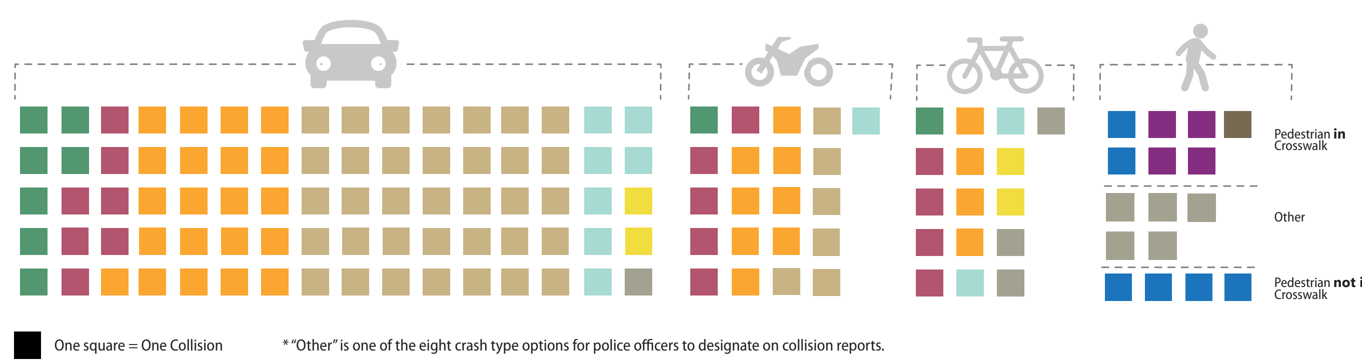
2% KILLED OR SEVERELY INJURED

[0% FATALITIES**]**

COLLISION BY MODE

COLLISION BY MODE





One square = One Collision

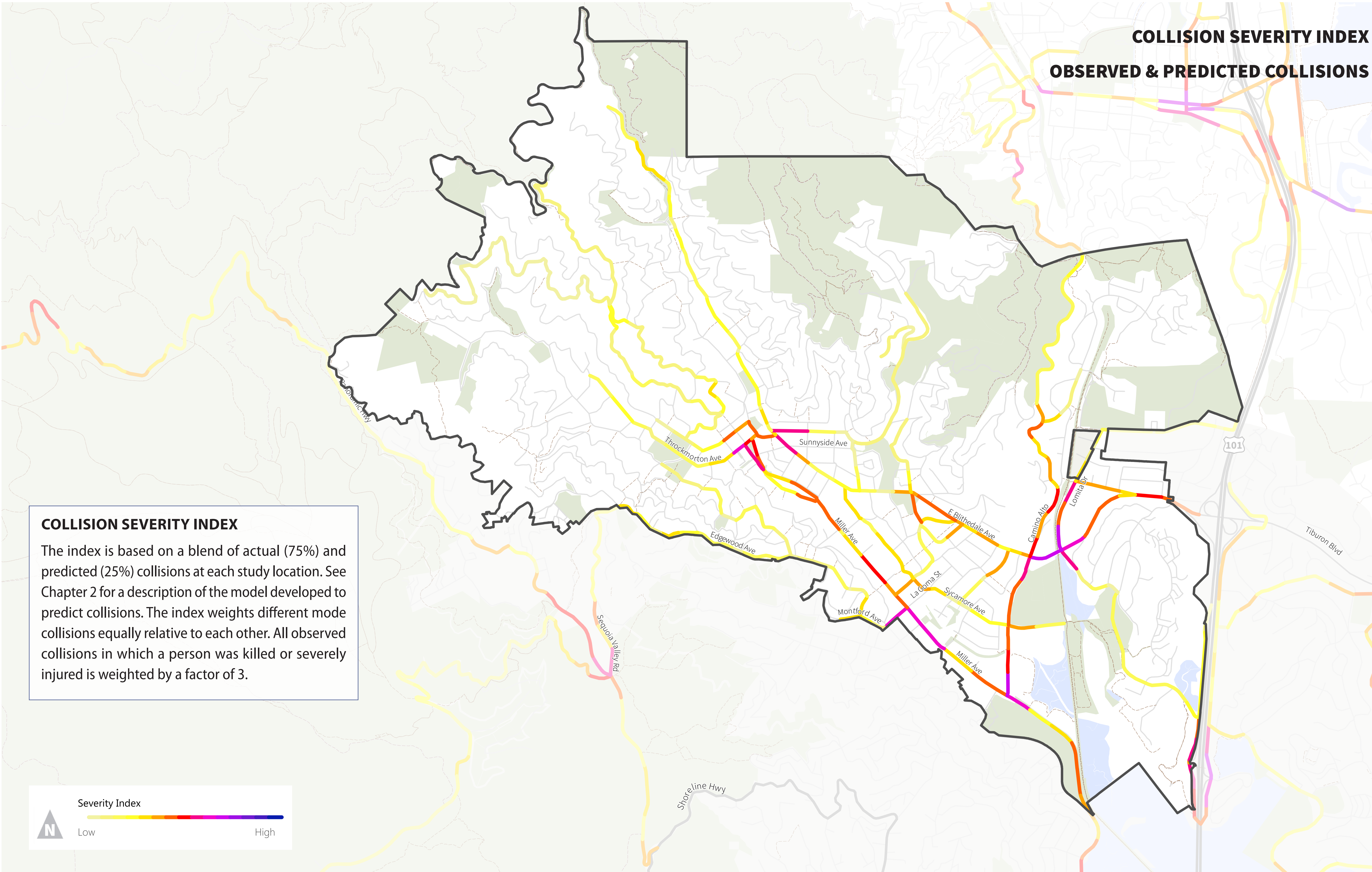
* "Other" is one of the eight crash type options for police officers to designate on collision reports.

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

CRASH TYPES				
Head-On	9%	5%	6%	
Sideswipe	9%	24%	25%	
Broadside	26%	38%	25%	
Rear End	43%	28%		
Hit Object	9%	5%	13%	
Overturned	3%		13%	
Other *	1%		18%	31%
Motorvehicle proceeding straight				38%
Motorvehicle making left turn				25%
Motorvehicle making right turn				6%
	100%	100%	100%	100%

COLLISION SEVERITY INDEX

OBSERVED & PREDICTED COLLISIONS



COLLISION SEVERITY INDEX

The index is based on a blend of actual (75%) and predicted (25%) collisions at each study location. See Chapter 2 for a description of the model developed to predict collisions. The index weights different mode collisions equally relative to each other. All observed collisions in which a person was killed or severely injured is weighted by a factor of 3.

This study developed crash profiles to highlight five of the top trends among collisions in Mill Valley. The collision profiles, shown at the bottom right, are based on an analysis of crash data and related environmental factors. Every profile highlights a crash pattern the study has identified as a priority concern.

The table below shows the proportion of crash types by mode. Data to the right provides a comparison of the percentage of Mill Valley collisions vs. total collisions across all of Marin jurisdictions by mode, collision type, select age and collision violation categories.

The following pages identify safety countermeasures for study corridors and intersections. These countermeasures make up a toolkit of safety interventions the City of Mill Valley can utilize to implement projects tailored to unique safety issues.

133 TOTAL MILL VALLEY COLLISIONS

2,756 TOTAL MARIN COLLISIONS

2012-2016

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

				CRASH TYPES
9%	5%	6%		Head-On
9%	24%	25%		Sideswipe
26%	38%	25%		Broadside
43%	28%			Rear End
9%	5%	13%		Hit Object
3%		13%		Overturned
1%		18%	31%	Other *
			38%	Motorvehicle proceeding straight
			25%	Motorvehicle making left turn
			6%	Motorvehicle making right turn
100%	100%	100%	100%	

** "Other" is one of the eight crash type options for police officers to designate on collision reports.*

MILL VALLEY VS. MARIN COLLISIONS - RELATIVE SHARE

	AGE		VIOLATION	
	Youth	Senior	DUI	Unsafe Speed
City of Mill Valley	**17.9%**	**29.1%**	0.7%	**42.5%**
All Marin Collisions	13.7%	21.4%	10.5%	28.2%

	MODE				
	Auto	Motorcycle	Bicycle	Pedestrian	Other
City of Mill Valley	58.7%	17.5%	**12.6%**	**11.2%**	0.0%
All Marin Collisions	63.8%	6.4%	18.1%	11.1%	0.6%

	COLLISION TYPE							
	Head-on	Sideswipe	Rear-end	Broadside	Hit Object	Overturned	Vehicle/ Pedestrian	Other
City of Mill Valley	6.7%	**13.4%**	**32.8%**	**22.4%**	8.2%	5.2%	9.7%	1.5%
All Marin Collisions	7.1%	8.7%	24.5%	20.3%	11.8%	5.6%	11.0%	10.7%

LOCAL COLLISION PROFILES

BICYCLE COLLISIONS (UNDER THE AGE OF 15)

California Office of Traffic Safety ranked Mill Valley 8th of 108 similar California cities with high levels of bicycle collisions involving youth in 2014.

PEDESTRIAN COLLISIONS (OVER THE AGE OF 65)

California Office of Traffic Safety ranked Mill Valley 9th of 103 similar California cities with high levels of pedestrian collisions involving seniors in 2015.

SPEED RELATED COLLISIONS

43% (57) of all collisions in Mill Valley involved unsafe speed violations, about 50 percent higher than the county average.

MOTORCYCLE COLLISIONS

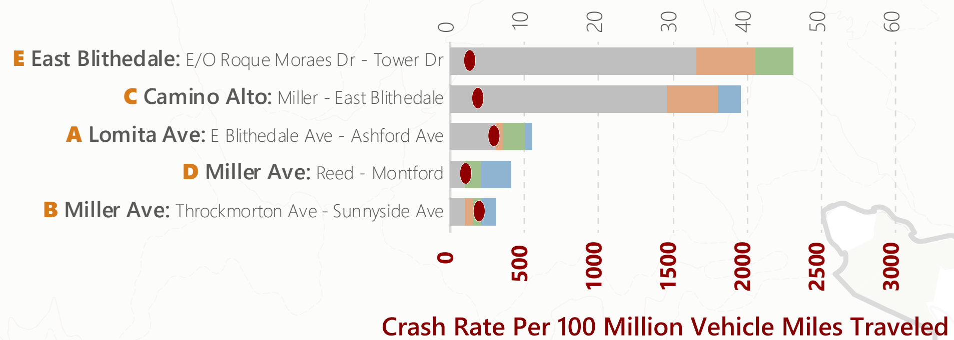
California Office of Traffic Safety ranked Mill Valley 18th of 103 similar California cities with high levels of motorcycle collisions in 2015.

MOTORCYCLE COLLISIONS

18% (24) of all collisions in Mill Valley involved motorcycles, almost 3 times higher than the county average.

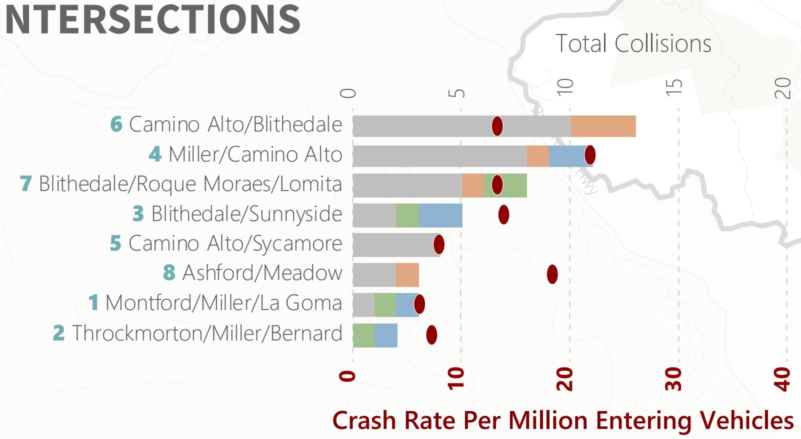
CITY OF MILL VALLEY

CORRIDORS



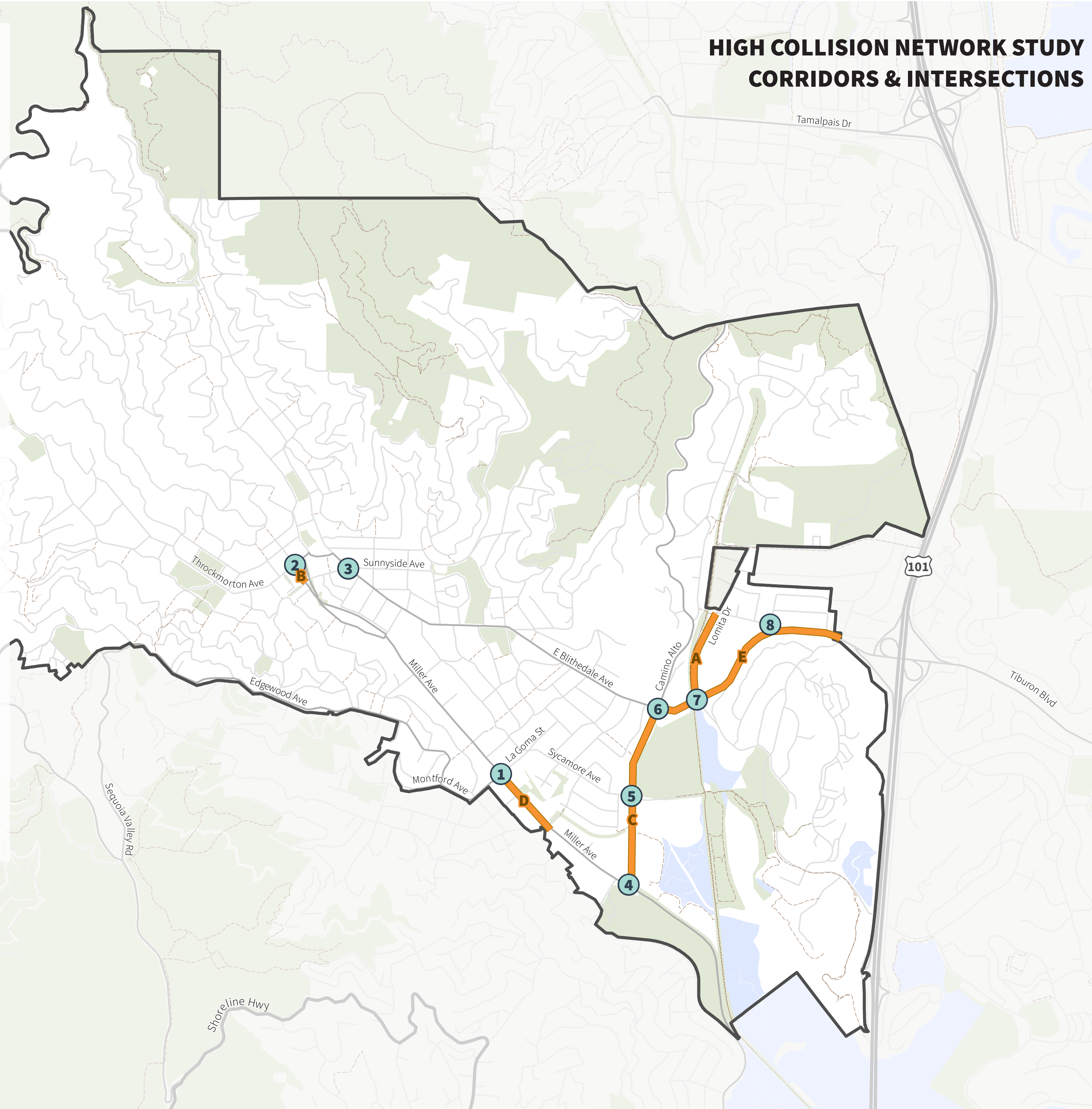
The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study corridor. The bars also illustrate, by color, a breakdown of those collisions by mode for each corridor. To normalize the collision data, the red dots in the chart show the crash rate per 100 million vehicle miles traveled for each study corridor.

INTERSECTIONS



The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study intersection. The bars also illustrate, by color, a breakdown of those collisions by mode for each intersection. To normalize the collision data, the red dots in the chart show the crash rate per million entering vehicles for each study intersection.

Motor Vehicle Collisions | Bicycle Collisions | Crash Rate | Motorcycle Collisions | Pedestrian Collisions



POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

CORRIDORS

ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
A	Lomita Ave: E Blithedale Ave to Ashford Ave	6	1	3	1	11	R32, Install edge-lines and centerlines	NH6, Install sharrows NH7, Install 'Bikes May Use Full Lane' sign NH11, Relocate parking
B	Miller Ave: Throckmorton Ave to Sunnyside Ave	2	1	1	2	6	NS17, Install pedestrian crossing improvements at uncontrolled/stop controlled locations, install bulb outs throughout) NS19, Install RRFB at mid-block crossing	NH4, Back-in angled parking (switch angled parking to back-in angled parking) NH11, Relocate parking
C	Camino Alto: Miller to East Blithedale	29	7	0	3	39	S2, Improve signal hardware (upgrade to 12" heads and add backplates) S20, Pedestrian crossing (e.g., curb extensions, directional curb ramps, high visibility crosswalks and stop bars) NS5, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs R2, Remove or relocate fixed objects outside of Clear Recovery Zone R36, Install bike lanes	
D	Miller Ave: Reed to Montford	2	0	2	4	8	Miller Ave Improvements project completed in Summer 2017 consisted of the following: R36, Install bike lanes (buffered bike lane) R38, Pedestrian crossing with enhanced safety features (bulb out, enhanced crosswalk)	
E	East Blithedale: E/O Roque Moraes Dr to Tower Dr	33	8	5	0	46	R16, Widen shoulder R36, Install bike lanes R30, Install dynamic/variable speed warning signs	

INTERSECTIONS

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
1	Montford and Miller and La Goma	1	0	1	1	3	NS3, Install signals NS4, Convert intersection to roundabout (optional CM as an alternative to NS3)	NH1, Refresh striping
2	Throckmorton and Miller and Bernard	0	0	1	1	2	R38, Pedestrian crossing with enhanced safety features (add curb extensions where feasible)	NH8, Square up Intersection (realign intersection)
3	Blithedale and Sunnyside	2	0	1	2	5	NS2, Convert to all way stop (if warranted) NS19, Install RRFB R38, Pedestrian crossing with enhanced safety features (bulb outs, square up intersection and realign intersection)	
4	Miller and Camino Alto	8	1	0	2	11	S2, Improve signal hardware S18, Convert signalized intersection to roundabout (optional CM as an alternative to S2,S3 and S19) S19, Check for and/or install pedestrian countdown signal heads	S20, Install pedestrian crossing (on leg missing a crosswalk) NH2, Modify slip lane(s)
5	Camino Alto and Sycamore	4	0	0	0	4	S2, Improve signal hardware S18, Convert signalized intersection to roundabout (optional CM as an alternative to S2, S3, S7 and S19) S19, Check for and/or install pedestrian countdown signal heads S20, Pedestrian crossing with enhanced safety features (curb extension, reduced curb radii)	NH14, Install bicycle signal
6	Camino Alto and Blithedale	10	3	0	0	13	S2, Improve signal hardware S10, Install cameras to detect red-light running S18, Convert signalized intersection to roundabout (optional CM as an alternative to S2, S3 and R38) S20, Pedestrian crossing with enhanced safety features (tighten curb radius, add directional curb ramps and install ADA accessible ramps)	
7	Blithedale and Roque Moraes and Lomita	5	1	2	0	8	S18, Convert signalized intersection to roundabout (optional CM as an alternative to S3 and S19) S19, Check for and/or install pedestrian countdown signal heads S20, Install pedestrian crossing (with advanced safety feature, add directional pedestrian ramps)	
8	Ashford and Meadow	2	1	0	0	3	NS2, Convert to all way stop (if warranted) NS5, Install/upgrade larger or other intersection warning/regulatory signs NS8, Install flashing beacons as advanced warning	

PRIORITY PROJECTS

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

Camino Alto: Miller Avenue to East Blithedale Avenue | Corridor

Camino Alto and Sycamore Avenue looking north

EXISTING CONDITIONS:

Camino Alto is a major north-south four-lane arterial roadway. The corridor had 39 total reported collisions in five years but no KSI collisions. The most common form of collision were rear-end incidents, while a significant number of broadside collisions have occurred.

POTENTIAL IMPROVEMENTS:

Improve Signals- Signalization improvements may include adding phases, lengthening clearance intervals, eliminating or restricting higher-risk movements, coordinating signals at multiple locations, upgrading signal heads to 12" LED with backplates, and adding advanced dilemma detection zones.

Pedestrian Crossing Improvements- Pedestrian crossing improvements could be considered along this corridor including some of the following: curb extensions, advanced stop bars, tighten up radii, directional curb ramps, and ADA/APS pedestrian push buttons. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Consider adding bike lanes along this corridor. Adding dedicated bicycle facilities can lessen the chances of conflicts and collisions involving motor vehicles overtaking bicyclists.

East Blithedale Avenue: East of Roque Moraes Drive to Tower Drive | Corridor

East Blithedale Avenue and Roque Moraes Drive looking east

EXISTING CONDITIONS:

East Blithedale Avenue is a four-lane arterial roadway that connects Mill Valley to the Redwood Highway and serves as an important transit route. The corridor had 46 total reported collisions in five years and no KSI collisions. The most common form of vehicle collisions were rear-end collisions, and a significant number of broadside collisions occurred as well.

POTENTIAL IMPROVEMENTS:

Improve Signals- Signalization improvements may include lengthening clearance intervals, coordinating signals at multiple locations, and adding advanced dilemma detection zones.

Roadway Improvements- Roadway improvements that could be implemented along this corridor include dynamic speed warning signs and curve advanced warning signs.

Pedestrian Crossing Improvements- Pedestrian crossing improvements could be considered along this corridor including some of the following: high visibility crosswalks, directional curb ramps, reduced curb radii, advanced stop bars and pedestrian refuge islands. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Consider adding bike lanes along this corridor. Adding dedicated bicycle facilities can lessen the chances of conflicts and collisions involving motor vehicles overtaking bicyclists.

Sunnyside Avenue and East Blithedale Avenue | Intersection

Sunnyside Avenue and E Blithedale Avenue looking east

EXISTING CONDITIONS:

Sunnyside Avenue and East Blithedale Avenue are both two-lane collectors and designated bike routes. The intersection is adjacent to downtown Mill Valley and residential neighborhood to the east. Sunnyside Avenue is an important connection for pedestrians accessing Downtown Mill Valley. The corridor had 16 total reported collisions in five years, including one KSI bicycle collision. Rear-end collisions are the most common motor vehicle collision type

POTENTIAL IMPROVEMENTS:

Intersection Improvements- Consider converting this intersection to an all-way stop sign controlled intersection. Consider realigning one or more intersection legs.

Pedestrian Crossing Improvements- Pedestrian crossing improvements could be considered at this intersection including some of the following: directional curb ramps, bulb outs and advanced stop bars. These will improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Consider installing RRFBs to help pedestrians across East Blithedale Avenue.

CHAPTER 8: CITY OF NOVATO

The City of Novato had an estimated population of 54,593 as of January 1, 2016, according to the California Department of Finance, representing approximately 20.7 percent of Marin County's total population. In the five-year period between 2012 and 2016, Novato experienced a total of 554 reported crashes on local streets. Thirty-two of those crashes involved a person that was killed or severely injured, and of the 32, four crashes involved fatalities.

Novato's share of reported crashes on local streets, as a proportion of total crashes in Marin County, during the five-year period is summarized below.

- **20.1% of all county-wide crashes**
- **14.6% of county-wide crashes in which a person was killed or severely injured (KSI)**
- **0.7% of all fatal county-wide crashes**

For all crashes as well as fatal and KSI crashes, Novato's share of those crashes as a proportion of total crashes in Marin County was less than the city's 20.7 percent share of the total county population.

The intersection of Redwood Boulevard / Diablo Avenue / De Long Ave is within one of Novato's priority project corridors, which extends from Diablo Ave and Center Road to De Long Avenue and Reichert Avenue. The corridor had 68 reported collisions in a recent five-year period. Rear-end collisions are the most common motor vehicle collision type.

COLLISIONS 2012 TO 2016

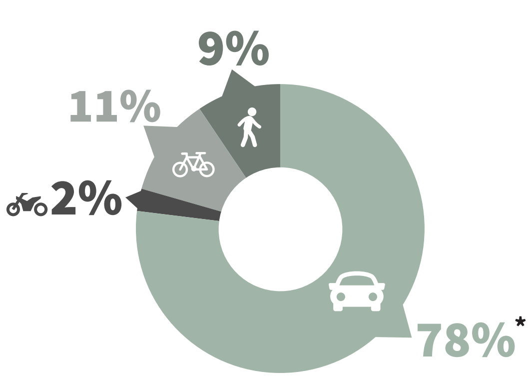
544 TOTAL COLLISIONS

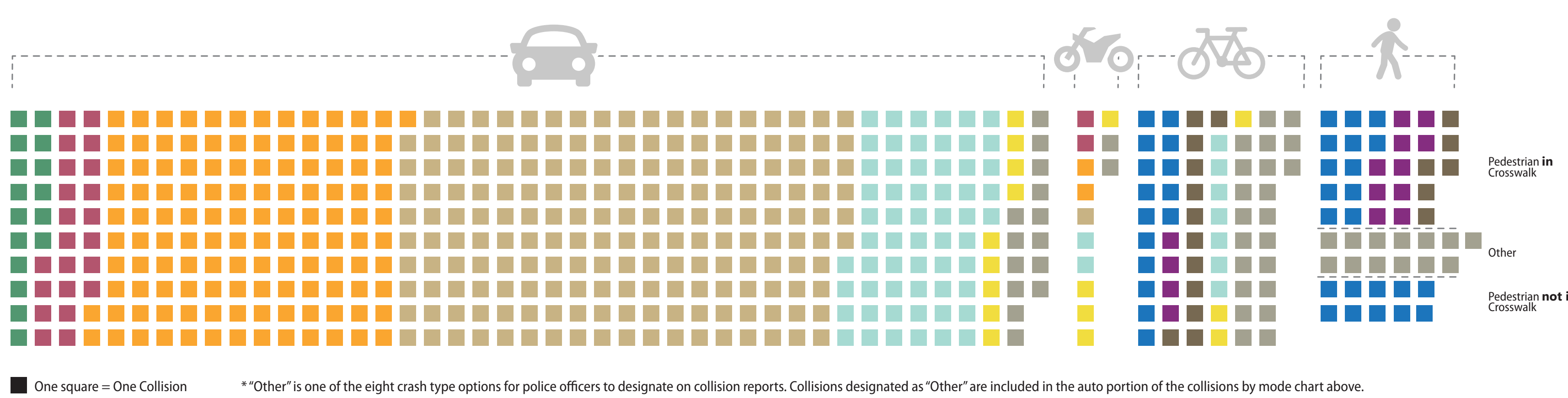
6% KILLED OR SEVERELY INJURED

[**1%** FATALITIES]

COLLISION BY MODE

COLLISION BY MODE





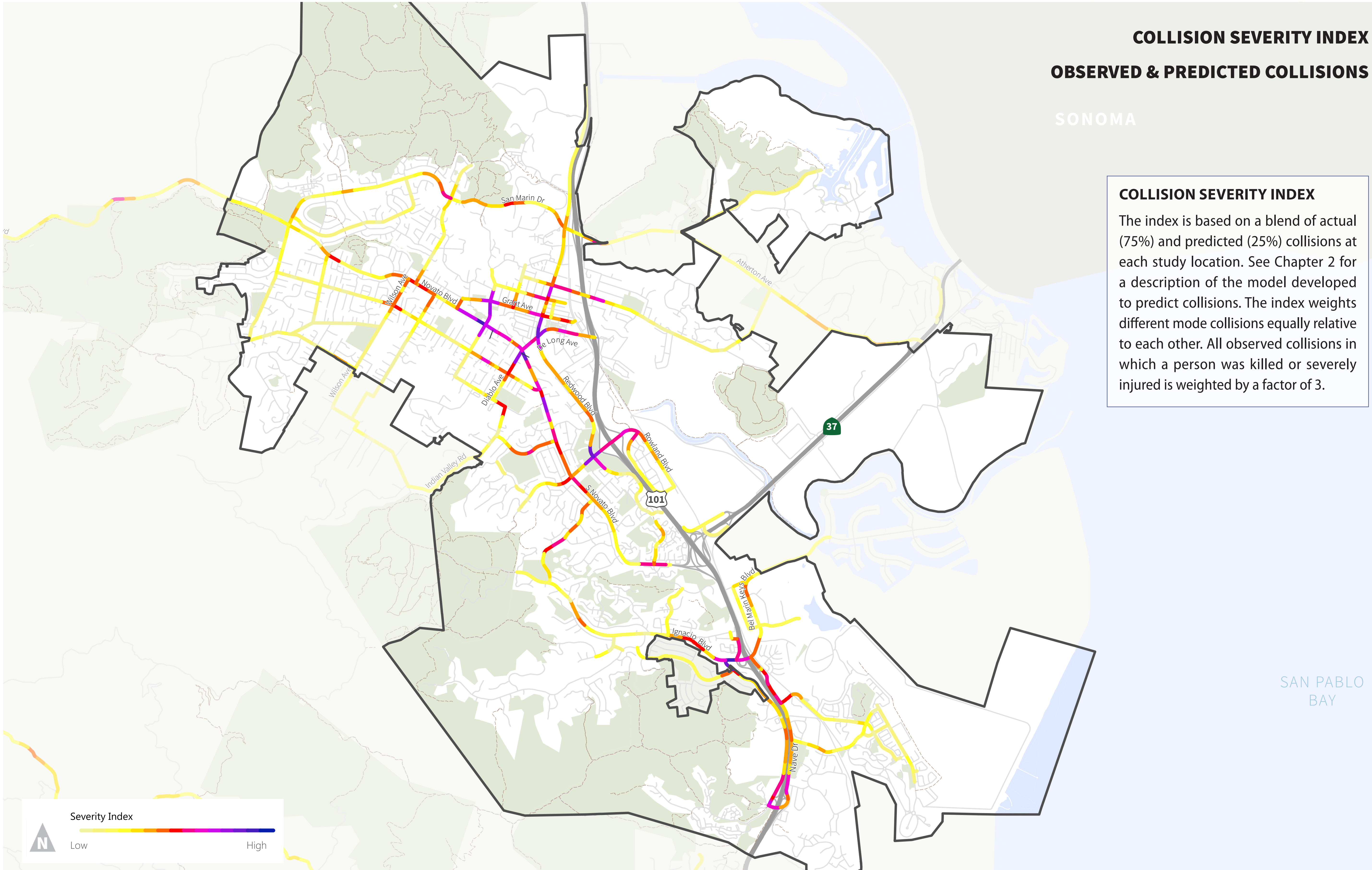
* "Other" is one of the eight crash type options for police officers to designate on collision reports. Collisions designated as "Other" are included in the auto portion of the collisions by mode chart above.

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

CRASH TYPES	Auto	Motorcycle	Bicycle	Pedestrian
Head-On	4%			
Sideswipe	5%	15%		
Broadside	29%	15%		
Rear End	43%	8%		
Hit Object	14%	15%	11%	
Overturned	2%	31%	5%	
Other *	3%	15%	35%	25%
Motorvehicle proceeding straight			24%	43%
Motorvehicle making left turn			6%	20%
Motorvehicle making right turn			19%	12%
	100%	100%	100%	100%

COLLISION SEVERITY INDEX

OBSERVED & PREDICTED COLLISIONS



COLLISION SEVERITY INDEX

The index is based on a blend of actual (75%) and predicted (25%) collisions at each study location. See Chapter 2 for a description of the model developed to predict collisions. The index weights different mode collisions equally relative to each other. All observed collisions in which a person was killed or severely injured is weighted by a factor of 3.

This study developed crash profiles to highlight five of the top trends among collisions in Novato. The collision profiles, shown at the bottom right, are based on an analysis of crash data and related environmental factors. Every profile highlights a crash pattern the study has identified as a priority concern.

The table below shows the proportion of crash types by mode. Data to the right provides a comparison of the percentage of Novato collisions vs. total collisions across all of Marin jurisdictions by mode, collision type, select age and collision violation categories.

The following pages identify safety countermeasures for study corridors and intersections. These countermeasures make up a toolkit of safety interventions the City of Novato can utilize to implement projects tailored to unique safety issues.

554 TOTAL NOVATO COLLISIONS

2,756 TOTAL MARIN COLLISIONS

2012-2016

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

				CRASH TYPES
4%				Head-On
5%	15%			Sideswipe
29%	15%			Broadside
43%	8%			Rear End
14%	15%	11%		Hit Object
2%	31%	5%		Overturned
3%	15%	35%	25%	Other *
		24%	43%	Motorvehicle proceeding straight
		6%	20%	Motorvehicle making left turn
		19%	12%	Motorvehicle making right turn
100%	100%	100%	100%	

** "Other" is one of the eight crash type options for police officers to designate on collision reports.*

NOVATO VS. MARIN COLLISIONS - RELATIVE SHARE

	AGE		VIOLATION	
	Youth	Senior	DUI	Unsafe Speed
City of Novato	**19.1%**	**23.9%**	**12.3%**	21.8%
All Marin Collisions	13.7%	21.4%	10.5%	28.2%

	MODE				
	Auto	Motorcycle	Bicycle	Pedestrian	Other
City of Novato	**77.0%**	2.3%	11.3%	9.2%	0.2%
All Marin Collisions	63.8%	6.4%	18.1%	11.1%	0.6%

	COLLISION TYPE							
	Head-on	Sideswipe	Rear-end	Broadside	Hit Object	Overturned	Vehicle/ Pedestrian	Other
City of Novato	5.5%	3.8%	**26.3%**	**26.6%**	11.6%	3.4%	10.2%	**12.3%**
All Marin Collisions	7.1%	8.7%	24.5%	20.3%	11.8%	5.6%	11.0%	10.7%

LOCAL COLLISION PROFILES

BICYCLE COLLISIONS (UNDER THE AGE OF 15)

California Office of Traffic Safety ranked Novato 17th of 105 similar California cities with high levels of bicycle collisions involving children in 2014.

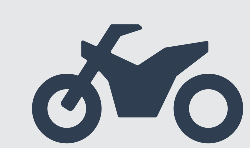
DRIVER (UNDER THE AGE OF 21) WAS DRINKING

California Office of Traffic Safety ranked Novato 25th of 105 similar California cities with high levels of DUI related collisions with drivers under the age of 21 in 2014.

PEDESTRIAN IN CROSSWALK NOT AT INTERSECTION

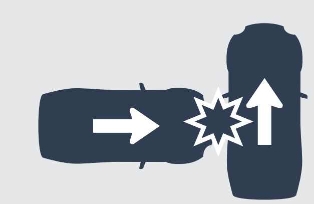
13% of all pedestrian collisions in Novato were in crosswalks not at intersections (i.e., mid-block locations), approximately 2.5 times higher than the county average for pedestrian collisions at those locations.

MOTORCYCLE COLLISIONS



California Office of Traffic Safety ranked Novato 24th of 105 similar California cities with high levels of motorcycle collisions in 2015.

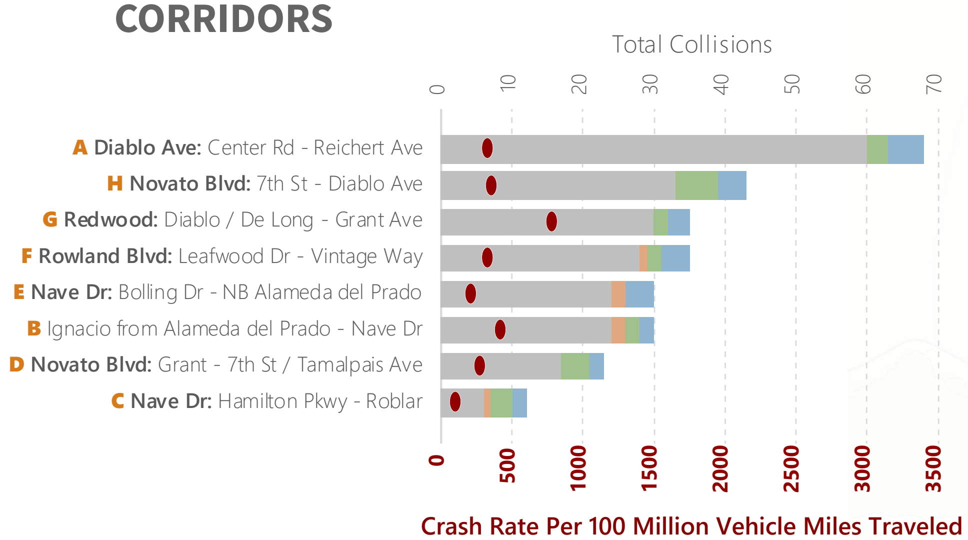
BROADSIDE COLLISIONS



27% (150) of all collisions in Novato were broadside or right angle, approximately 30% higher than the county average for broadside collisions.

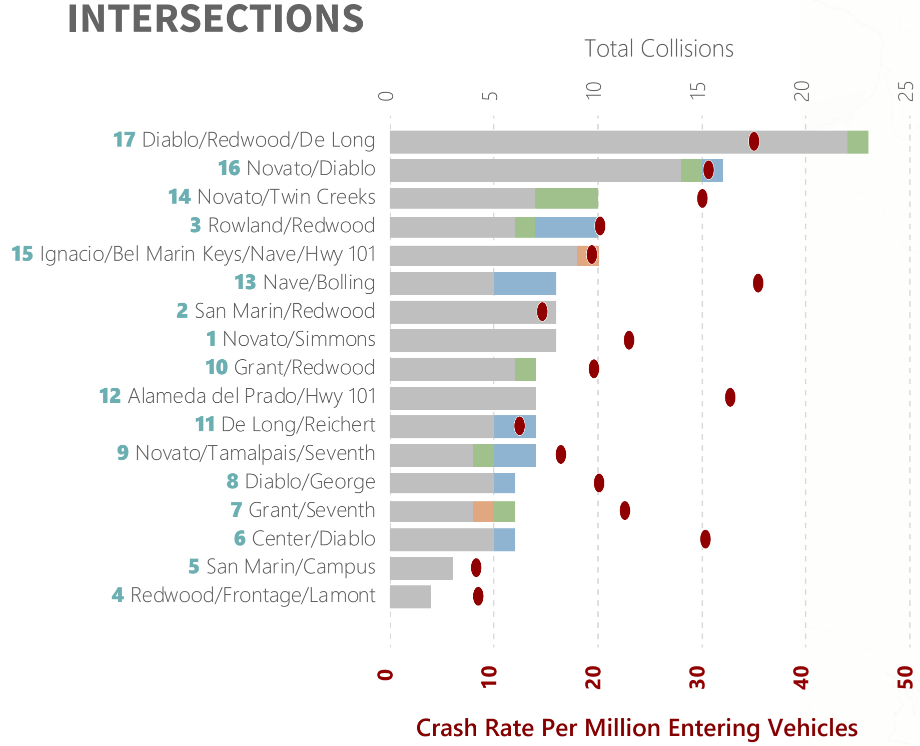
CITY OF NOVATO

CORRIDORS

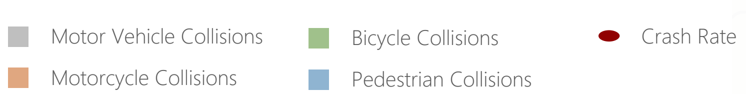


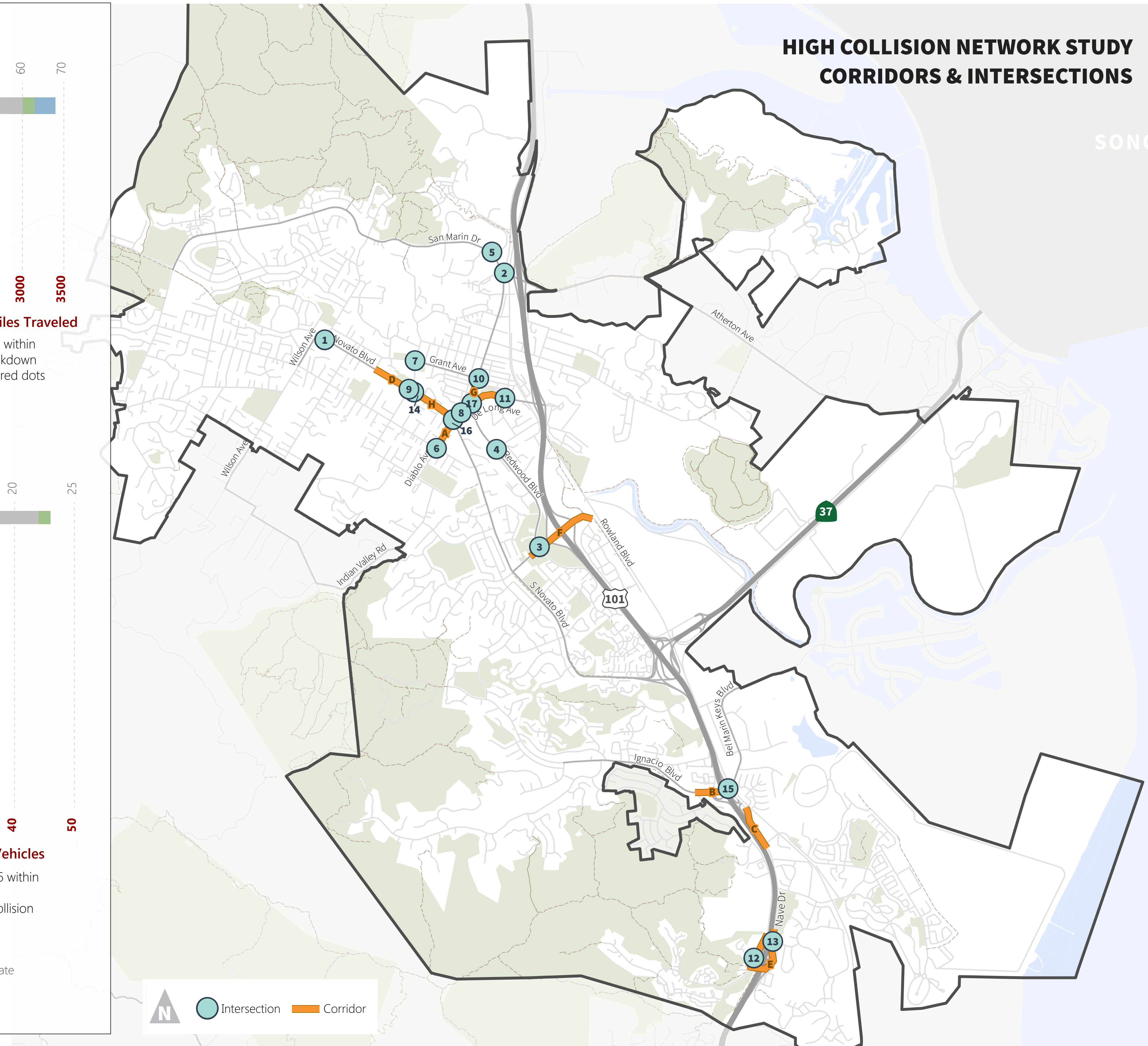
The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study corridor. The bars also illustrate, by color, a breakdown of those collisions by mode for each corridor. To normalize the collision data, the red dots in the chart show the crash rate per 100 million vehicle miles traveled for each study corridor.

INTERSECTIONS



The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study intersection. The bars also illustrate, by color, a breakdown of those collisions by mode for each intersection. To normalize the collision data, the red dots in the chart show the crash rate per million entering vehicles for each study intersection.





POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

CORRIDORS

ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
A	Diablo Ave and DeLong Ave: Center Rd to Reichert Ave	60	0	3	5	68	S20, Improve pedestrian crossing S4, Advanced dilemma detection zone S9, Install flashing beacons as advanced warning S3, Improve signal timing	NH8, Square up intersection
B	Ignacio from Alameda del Prado to Nave Dr	24	2	2	2	30	R36, Upgrade to consistent green bike lanes S3, Improve signal timing	
C	Nave Dr: Hamilton Pkwy to Roblar	6	1	3	2	12	R36, Upgrade to green bike lanes	NH5, Wayfinding NH1, Refresh striping
D	Novato Blvd: Grant to 7th St / Tamalpais Ave	17	0	4	2	23	R36, Bike lanes S21, Bike boxes S3, Improve signal timing S4, Advanced dilemma detection zone	NH1, Refresh striping at intersections
E	Nave Dr: N/O Bolling Dr continued to NB Alameda del Prado N/O 'Wildfox'	24	2	0	4	30	R28, Curve warning signs R36, Bike lane NS3, Install Signal (Nave and Alameda del Prado) S4, Advanced dilemma detection zone	NH1, Refresh striping at intersections
F	Rowland Blvd: Leafwood Dr to Vintage Way	28	1	2	4	35	S3, Improve signal timing S4, Advanced dilemma detection zone R38, Install pedestrian crossing with advanced safety features (pedestrian refuge, bulb out, tighter curb radii) S19, pedestrian countdown signal heads S9, Signal ahead warning (for Vintage and Rowland intersection before curve)	
G	Redwood: Diablo / De Long to Grant Ave	30	0	2	3	35	S21, Bike box R38, Install pedestrian crossing with advanced safety features (Add bulb outs where applicable) S3, Improve signal timing NS19, HAWK / advanced warning signage at mid-block crossing	NH8, Square up intersection
H	Novato Blvd: 7th St to Diablo Ave	33	0	6	4	43	R38, Install pedestrian crossing with advanced safety features (Add mid-block pedestrian crossing) S3, Improve signal timing R37, Install sidewalk	NH1, Refresh striping at the two signalized intersections

CITY OF NOVATO

INTERSECTIONS

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

ID	NAME	COLLISIONS: MOTOR VEHICLE	COLLISIONS: MOTORCYCLE	COLLISIONS: BICYCLE	COLLISIONS: PEDESTRIAN	COLLISIONS: TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
1	Novato and Simmons	8	0	0	0	8	S2, Improve signal hardware S3, Improve signal timing S18, Convert signalized intersection to roundabout NS6, Upgrade intersection pavement markings (high visibility crosswalk) R38, Pedestrian crossing with enhanced safety features (bulb out to reduce corner curb radii) S19, Check for and/or install pedestrian countdown signal heads	
2	San Marin and Redwood	8	0	0	0	8	S18, Convert signalized intersection to roundabout S2, Improve signal hardware S3, Improve signal timing S19, Check for and/or install pedestrian countdown signal heads	NH2, Remove slip lane(s)
3	Rowland and Redwood	6	0	1	3	10	NS6, Upgrade intersection pavement markings (high visibility crosswalk) NS16, Install raised medians / refuge islands R38, Pedestrian crossing with enhanced safety features (bulb out to reduce radii and crossing distance, increase visibility) S2, Improve signal hardware S19, Check for and/or install pedestrian countdown signal heads	
4	Redwood and Frontage and Lamont	2	0	0	0	2	S2, Improve signal hardware S7, Convert signal to mast arm S19, Check for and/or install pedestrian countdown signal heads NS6, Upgrade intersection pavement markings (high visibility crosswalk) S6, Provide protected left turn phase (on minor street approaches)	
5	San Marin and Campus	3	0	0	0	3	S2, Improve signal hardware S18, Convert signalized intersection to roundabout NS6, Upgrade intersection pavement markings (high visibility crosswalk) S19, Check for and/or install pedestrian countdown signal heads	
6	Center and Diablo	5	0	0	1	6	S18, Convert signalized intersection to roundabout NS6, Upgrade intersection pavement markings (high visibility crosswalk) NS10, Improve sight distance NS5, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs	
7	Grant and Seventh	4	1	1	0	6	S2, Improve signal hardware S3, Improve signal timing S19, Check for and/or install pedestrian countdown signal heads	NH8, Square up intersection

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

INTERSECTIONS

ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
8	Diablo and George	5	0	0	1	6	S3, Improve signal timing NS19, Install pedestrian signal or HAWK NS8, Install flashing beacons as advanced warning	
9	Novato and Tamalpais and Seventh	4	0	1	2	7	NS6, Upgrade intersection pavement markings (high visibility crosswalk) R38, Pedestrian crossing with enhanced safety features (bulb out) S2, Improve signal hardware S18, Convert signalized intersection to roundabout S19, Check for and/or install pedestrian countdown signal heads S3, Improve signal timing	
10	Grant and Redwood	6	0	1	0	7	S2, Improve signal hardware S7, Convert signal to mast arm S18, Convert signalized intersection to roundabout NS6, Upgrade intersection pavement markings (high visibility crosswalk) S19, Check for and/or install pedestrian countdown signal heads S3, Improve signal timing	
11	De Long and Reichert	5	0	0	2	7	R38, Pedestrian crossing with enhanced safety features (bulb out) NS16, Install raised median / refuge islands NS6, Upgrade intersection pavement markings (high visibility crosswalk) S2, Improve signal hardware S19, Check for and/or install pedestrian countdown signal heads	
12	Alameda del Prado and Hwy 101 (Caltrans owned/operated)	7	0	0	0	7	NS2, Convert to all-way stop NS3, Install signals S18, Convert signalized intersection to roundabout NS5, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs NS8, Install flashing beacons as advanced warning	
13	Nave and Bolling	5	0	0	3	8	NS6, Upgrade intersection pavement markings (high visibility crosswalk) R38, Pedestrian crossing with enhanced safety features (bulb out) S2, Improve signal hardware S19, Check for and/or install pedestrian countdown signal heads S18, Convert signalized intersection to roundabout	
14	Novato and Twin Creeks	7	0	3	0	10	R36, Update bike lanes to green bike lanes S3, Improve signal timing	

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

INTERSECTIONS

ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
15	Ignacio and Bel Marin Keys and Nave and Hwy 101 (Caltrans owned/operated)	9	1	0	0	10	S2, Improve signal hardware S3, Improve signal timing S18, Convert signalized intersection to roundabout S19, Check for and/or install pedestrian countdown signal heads	
16	Novato and Diablo	14	0	1	1	16	S18, Convert signalized intersection to roundabout R38, Install pedestrian crossing with enhanced safety features (bulb out to reduce intersection size) S2, Improve signal hardware S3, Improve signal timing S19, Check for and/or install pedestrian countdown signal heads S7, Convert signal to mast arm	NH2, Remove slip lane(s)
17	Diablo and Redwood and De Long	22	0	1	0	23	S18, Convert signalized intersection to roundabout R38, Install pedestrian crossing with enhanced safety features (bulb out to reduce intersection size) S2, Improve signal hardware S3, Improve signal timing S19, Check for and/or install pedestrian countdown signal heads	NH2, Remove slip lane(s) NH8, Square up intersection

PRIORITY PROJECTS

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

Diablo Avenue and DeLong Avenue: Center to Reichert Avenue (includes Diablo and Redwood and DeLong) | Corridor

DeLong Avenue looking south

EXISTING CONDITIONS:

Diablo Avenue is a multi-lane arterial that carries regional traffic through Novato and connects with Highway 101. Diablo Avenue is also an important east-west connection for bicyclists and pedestrians, and is designated as a bike route. The corridor had three KSI collisions in the past five years, and total of 68 collisions.

POTENTIAL IMPROVEMENTS:

Improve Signals- Signalization improvements may include adding phases, lengthening clearance intervals, eliminating or restricting higher-risk movements coordinating signals at multiple locations and adding advanced dilemma detection zones.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be implemented along this corridor including some of the following: squared up intersection, high visibility crosswalk, curb extensions, advanced stop bars, yield limit lines at slip lanes, reduce lane widths at pork chop islands, tighten up radii, RRFB at mid-block crossings, install a signal and ADA/APS pedestrian push button. These could improve pedestrian crossings by shorting crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Upgrading bike lanes to green bike lanes, installing green paint through conflict zones and adding bike boxes could increase the visibility of bicyclists. Reducing vehicle lane widths to 11 feet may provide additional right of way to increase substandard bike lanes and add buffered bike lanes.

Ignacio Boulevard: Alameda del Prado to Nave Drive | Corridor

Ignacio Boulevard looking west

EXISTING CONDITIONS:

Ignacio Boulevard is a multi-lane arterial that carries regional traffic through Novato and connects with Highway 101. Ignacio Boulevard is also an important east-west connection for bicyclists and pedestrians, and is designated as a bike route. The corridor had one KSI pedestrian collision in five years, and total of 30 collisions.

POTENTIAL IMPROVEMENTS:

Improve signal timing and detection- Signalization improvements may include adding phases, lengthening clearance intervals, eliminating or restricting higher-risk movements, and coordinating signals at multiple locations.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be implemented along this corridor including some of the following: high visibility crosswalks, direction curb ramps, reduced curb radii, advanced stop bars and pedestrian refuge islands. These could improve pedestrian crossings by shorting crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Upgrading bike lanes to green bike lanes, installing green paint through conflict zones and adding bike boxes could increase the visibility of bicyclists. Reducing vehicle lane widths to 11 feet may provide additional right of way to increase substandard bike lanes and add buffered bike lanes.

Rowland Boulevard and Redwood Boulevard | Intersection

Redwood Boulevard looking northwest

EXISTING CONDITIONS:

Rowland Boulevard and Redwood Boulevard a multi-lane arterial intersection that carries regional traffic through Novato and connects with Highway 101. It is also the intersection of two key bike routes. The intersection had 10 collisions in five years, including two KSI pedestrian collisions.

POTENTIAL IMPROVEMENTS:

Improve signal timing- Rear-end crashes may indicate clearance intervals are two short, consider adding a longer yellow phase.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be implemented along this corridor including some of the following: reduced curb radii, direction pedestrian ramps, pedestrian refuge islands, high visibility crosswalks, advanced stop bars and pedestrian countdown signal heads. These could improve pedestrian crossings by shorting crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Installing green paint through conflict zones and mixing zones and installing sharrow symbols through mixing zones could increase the visibility of bicyclists, clarifies where bicyclists are expected to ride and reminds motorists to expect bicyclistson the road.

PRIORITY PROJECTS (CONT.)

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

Novato Boulevard and Diablo Avenue | Intersection

Novato Boulevard and Diablo Avenue looking north

EXISTING CONDITIONS:

Diablo Avenue is a multi-lane arterial roadway that carries regional traffic through Novato and connects with Highway 101. Diablo Avenue is also an important east-west connection for bicyclists and pedestrians, and is designated as a bike route. The intersection had 16 collisions in five years. Rear-end collisions are the most common motor vehicle collision type.

POTENTIAL IMPROVEMENTS:

Improve signals- Signalization improvements may include adding phases, lengthening clearance intervals, eliminating or restricting higher-risk movements, coordinating signals at multiple locations, upgrading signal heads to 12" LED with backplates, and adding advanced dilemma detection zones.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be implemented along this corridor including some of the following: squared up intersection, high visibility crosswalk, curb extensions, advanced stop bars, yield limit lines at slip lanes, remove pork chop islands, tighten up radii, and install ADA/APS pedestrian push buttons. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Upgrading bike lanes to green bike lanes, installing green paint through conflict zones and adding bike boxes could increase the visibility of bicyclists. Reducing vehicle lane widths to 11 feet may provide additional right of way to increase substandard bike lanes and add buffered bike lanes.

Nave Drive and Bolling Drive | Intersection

Nave Drive and Bolling Drive looking west

EXISTING CONDITIONS:

Nave Drive is a two lane arterial roadway that parallels Highway 101. Nave Drive is also a designated bike route. The intersection had eight collisions in five years. Including one KSI pedestrian collisions. Rear-end collisions are the most common motor vehicle collision type.

POTENTIAL IMPROVEMENTS:

Improve signal timing and detection- Signalization improvements may include adding phases, lengthening clearanceintervals, eliminating or restricting higher-risk movements, and coordinating signals at multiple locations.

Improved Pedestrian Crossing- A number of pedestrian crossing improvements could be implemented at this intersection including some of the following: high visibility crosswalks, direction curb ramps, reduced curb radii and advanced stop bars. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Upgrading bike lanes to green bike lanes, installing green paint through conflict zones and adding bike boxes could increase the visibility of bicyclists.

CHAPTER 9: TOWN OF ROSS

The Town of Ross had an estimated population of 2,538 as of January 1, 2016, according to the California Department of Finance, representing approximately one percent of Marin County's total population. In the five-year period between 2012 and 2016, Ross experienced a total of 14 reported crashes on local streets. None of those crashes involved a person that was killed or severely injured.

Ross's share of reported crashes on local streets, as a proportion of total crashes in Marin County, during the five-year period is summarized below.

- **0.5% of all county-wide crashes**
- **0% of county-wide crashes in which a person was killed or severely injured (KSI)**
- **0% of all fatal county-wide crashes**

For all crashes as well as fatal and KSI crashes, Ross's share of those crashes as a proportion of total crashes in Marin County was less than the town's one percent share of the total county population.

The intersection of Sir Francis Drake Boulevard and Laurel Grove Avenue is Ross' high priority project location. The intersection had seven reported collisions in a recent five-year period. Rear-end collisions are the most common motor vehicle collision type.

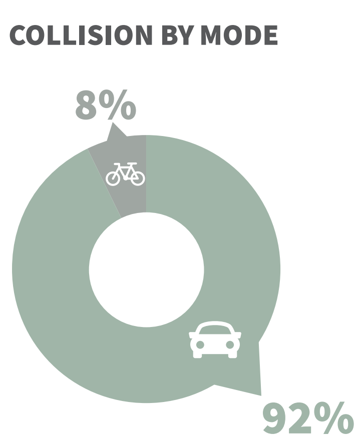
COLLISIONS 2012 TO 2016

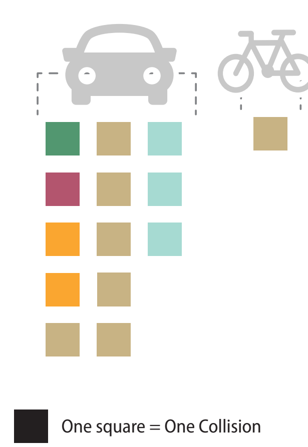
14 TOTAL COLLISIONS

0% KILLED OR SEVERELY INJURED

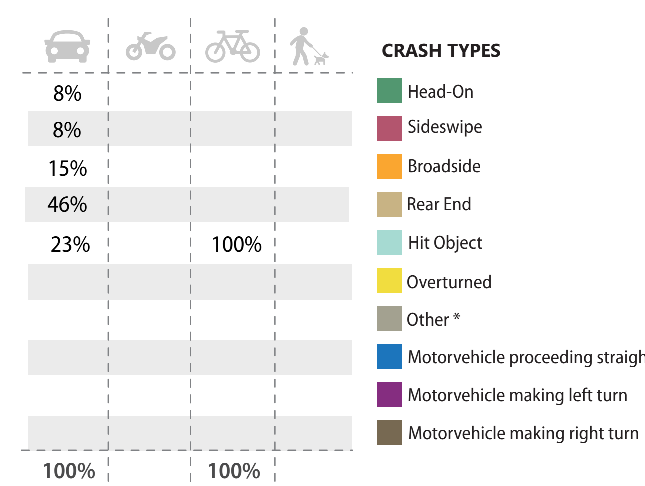
[**0%** FATALITIES]

COLLISION BY MODE





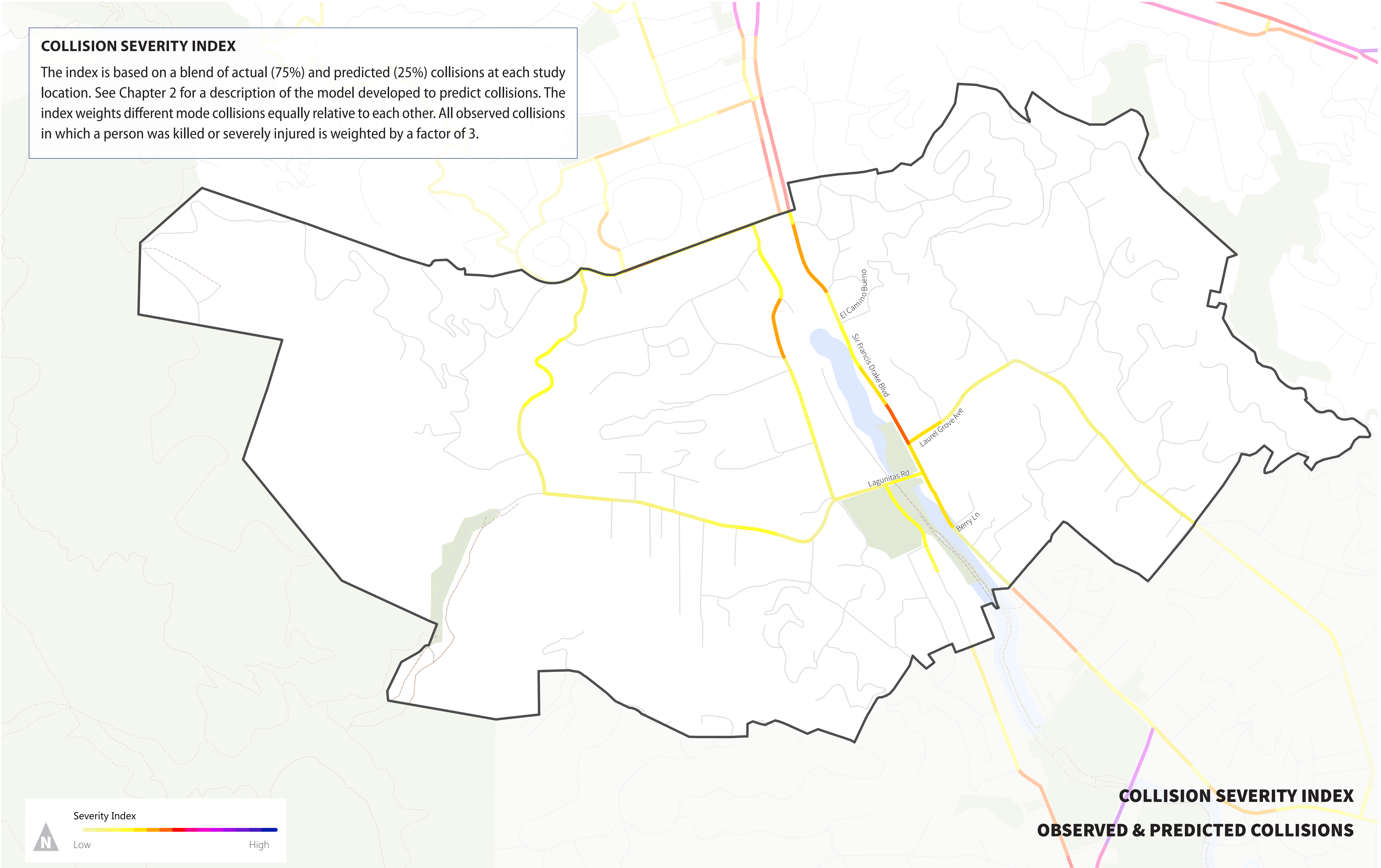
CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS



* "Other" is one of the eight crash type options for police officers to designate on collision reports.

COLLISION SEVERITY INDEX

The index is based on a blend of actual (75%) and predicted (25%) collisions at each study location. See Chapter 2 for a description of the model developed to predict collisions. The index weights different mode collisions equally relative to each other. All observed collisions in which a person was killed or severely injured is weighted by a factor of 3.



COLLISION SEVERITY INDEX

OBSERVED & PREDICTED COLLISIONS

This study developed crash profiles to highlight four of the top trends among collisions in Ross. The collision profiles, shown at the bottom right, are based on an analysis of crash data and related environmental factors. Every profile highlights a crash pattern the study has identified as a priority concern.

The table below shows the proportion of crash types by mode. Data to the right provides a comparison of the percentage of Ross collisions vs. total collisions across all of Marin jurisdictions by mode, collision type, select age and collision violation categories.

The following pages identify safety countermeasures for study corridors and intersections. These countermeasures make up a toolkit of safety interventions the Town of Ross can utilize to implement projects tailored to unique safety issues.

14 TOTAL ROSS COLLISIONS

2,756 TOTAL MARIN COLLISIONS

2012-2016

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

				CRASH TYPES
8%				Head-On
8%				Sideswipe
15%				Broadside
46%				Rear End
23%		100%		Hit Object
				Overturned
				Other *
				Motorvehicle proceeding straight
				Motorvehicle making left turn
				Motorvehicle making right turn
100%		100%		

"Other" is one of the eight crash type options for police officers to designate on collision reports.

ROSS VS. MARIN COLLISIONS - RELATIVE SHARE

	AGE		VIOLATION	
	Youth	Senior	DUI	Unsafe Speed
Town of Ross	**16.7%**	**44.4%**	**11.1%**	**44.4%**
All Marin Collisions	13.7%	21.4%	10.5%	28.2%

	MODE				
	Auto	Motorcycle	Bicycle	Pedestrian	Other
Town of Ross	**92.3%**	0.0%	7.7%	0.0%	0.0%
All Marin Collisions	63.8%	6.4%	18.1%	11.1%	0.6%

	COLLISION TYPE							
	Head-on	Sideswipe	Rear-end	Broadside	Hit Object	Overturned	Vehicle/ Pedestrian	Other
Town of Ross	5.6%	5.6%	**38.9%**	16.7%	**27.8%**	0.0%	5.6%	0.0%
All Marin Collisions	7.1%	8.7%	24.5%	20.3%	11.8%	5.6%	11.0%	10.7%

LOCAL COLLISION PROFILES

BICYCLE COLLISIONS (UNDER THE AGE OF 15)

California Office of Traffic Safety ranked Ross 3rd of 67 similar California cities with high levels of bicycle collisions involving children in 2015.

DRIVER (UNDER THE AGE OF 21) AFTER DRINKING

California Office of Traffic Safety ranked Ross 12th of 67 similar California cities with high levels of DUI related collisions with drivers under the age of 21 in 2015.

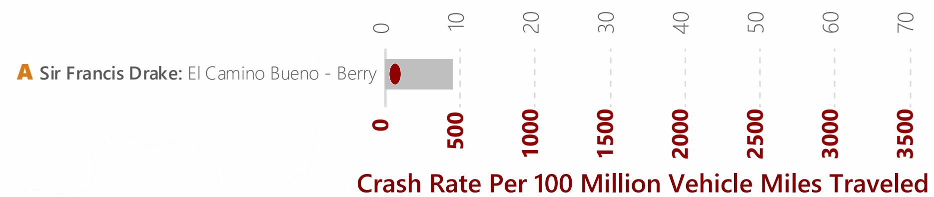
SENIOR COLLISIONS

44% (6) of all collisions in Ross involved seniors, more than double the county average.

SPEED RELATED-COLLISIONS

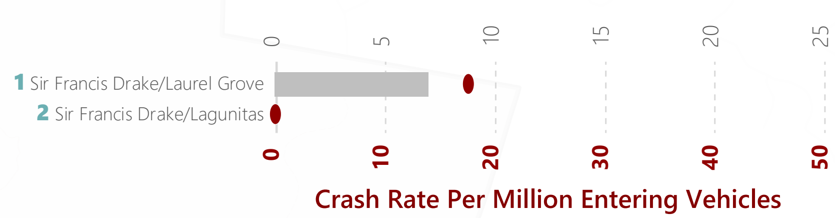
44% (6) of all collisions in Ross involved unsafe speed violations, more than 50 percent higher than the county average.

CORRIDORS



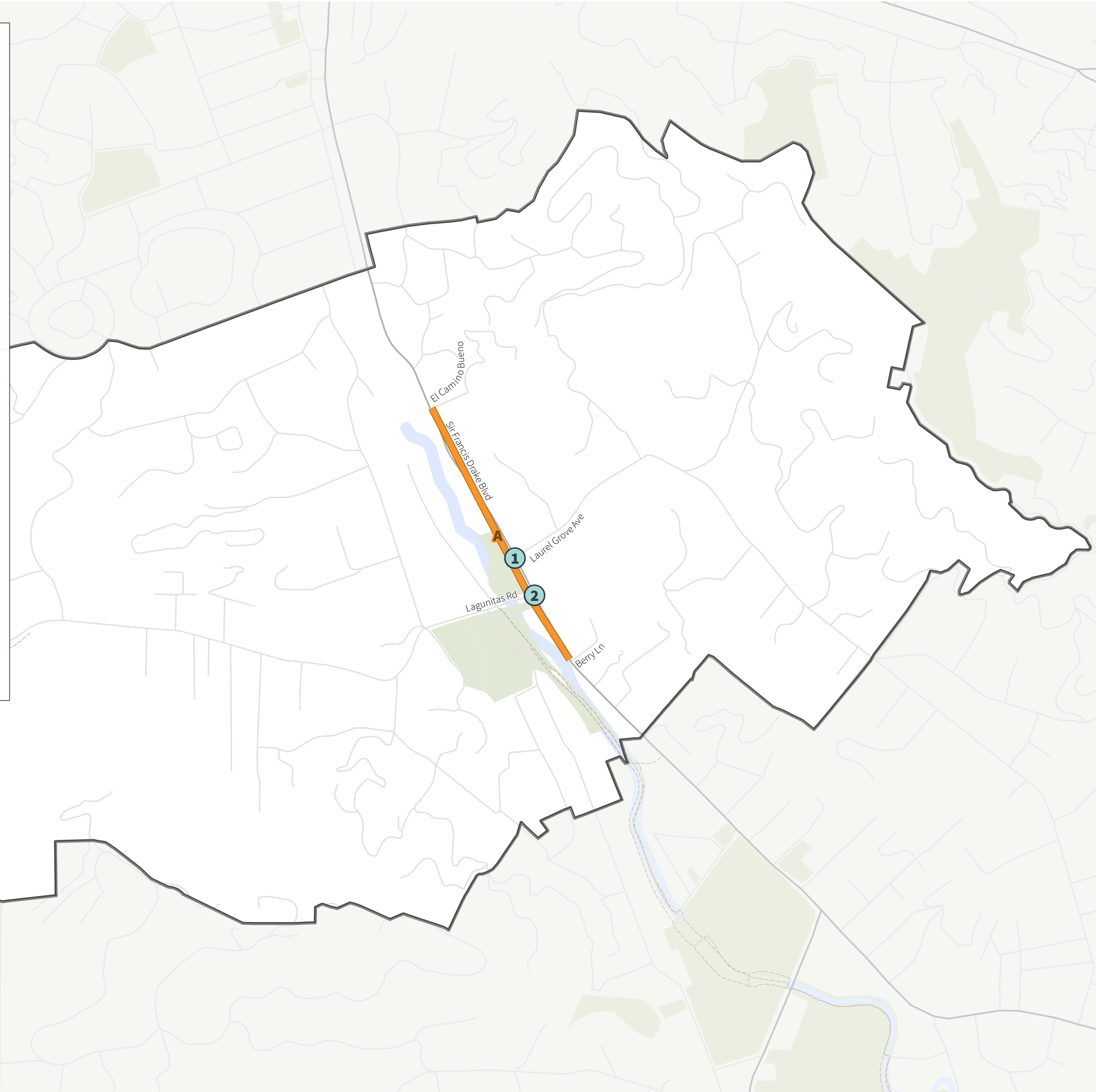
The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study corridor. The bars also illustrate, by color, a breakdown of those collisions by mode for each corridor. To normalize the collision data, the red dots in the chart show the crash rate per 100 million vehicle miles traveled for each study corridor.

INTERSECTIONS



The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study intersection. The bars also illustrate, by color, a breakdown of those collisions by mode for each intersection. To normalize the collision data, the red dots in the chart show the crash rate per million entering vehicles for each study intersection.

Motor Vehicle Collisions
Motorcycle Collisions
Bicycle Collisions
Pedestrian Collisions
Crash Rate



POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

	ID	NAME	COLLISIONS: MOTOR VEHICLE	COLLISIONS: MOTORCYCLE	COLLISIONS: BICYCLE	COLLISIONS: PEDESTRIAN	COLLISIONS: TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
CORRIDORS	A	Sir Francis Drake Blvd: El Camino Bueno to Berry	9	0	0	0	9	S3, Improve signal timing and detection S4, Install advanced dilemma detection zone R30, Install dynamic/variable speed warning signs R38, Install pedestrian crossing (directional ADA pedestrian ramps, high visibility crosswalk and bulb outs)	NH1, Refresh signage/striping
INTERSECTIONS	1	Sir Francis Drake Blvd and Laurel Grove Ave	7	0	0	0	7	S3, Improve signal timing and detection S19, Install pedestrian countdown signal heads S20, Install pedestrian crossing (high visibility crosswalk, push buttons)	
INTERSECTIONS	2	Sir Francis Drake Blvd and Lagunitas Rd	0	0	0	0	0	S2, Improve signal hardware S3, Improve signal timing and detection	NH2, Remove slip lane(s)

PRIORITY PROJECT

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

Sir Francis Drake Boulevard and Laurel Grove Avenue | Intersection

Sir Francis Drake Boulevard and Laurel Grove Avenue looking east

EXISTING CONDITIONS:

Sir Francis Drake Boulevard is a four-lane principal arterial roadway that intersects with Laurel Grove Avenue, at two-lane major collector. The intersection had seven total reported collisions in five years and no KSI collisions. The most common form of motor vehicle collisions were rear-end collisions at four incidents in five years.

POTENTIAL IMPROVEMENTS:

Improve Signals- Rear-end crashes may indicate clearance intervals are too short, consider adding a longer yellow phase. Other signalization improvements may include adding phases, eliminating or restricting higher-risk movements, coordinating signals at multiple locations, and adding advanced dilemma detection zones.

Pedestrian Crossing Improvements- This intersection does not have a designated pedestrian crossing across Sir Francis Drake Blvd. Consider adding a pedestrian crossing and implement some of the following: high visibility crosswalks, directional curb ramps, reduced curb radii and adding pedestrian countdown heads. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

CHAPTER 10: TOWN OF SAN ANSELMO

The Town of San Anselmo had an estimated population of 13,017 as of January 1, 2016, according to the California Department of Finance, representing approximately 4.9 percent of Marin County's total population. In the five-year period between 2012 and 2016, San Anselmo experienced a total of 142 reported crashes on local streets. Nine of those crashes involved a person that was severely injured, and of the nine, there were no fatalities.

San Anselmo's share of reported crashes on local streets, as a proportion of total crashes in Marin County, during the five-year period is summarized below.

- **5.2% of all county-wide crashes**
- **3.7% of county-wide crashes in which a person was killed or severely injured (KSI)**
- **0% of all fatal county-wide crashes**

For all crashes, San Anselmo's share of those crashes as a proportion of total crashes in Marin County was greater than the town's 4.9 percent share of the total county population. However, for crashes involving severe injuries or fatalities, San Anselmo's share of those crashes as a proportion of total crashes in Marin was less than the town's 4.9 percent of the total county population.

The corridor of Red Hill Road from Sir Francis Drake Boulevard to Forbes Avenue is one of San Anselmo's high priority project locations. The corridor had 29 reported collisions in a recent five-year period. Rear-end collisions are the most common motor vehicle collision type.

COLLISIONS 2012 TO 2016

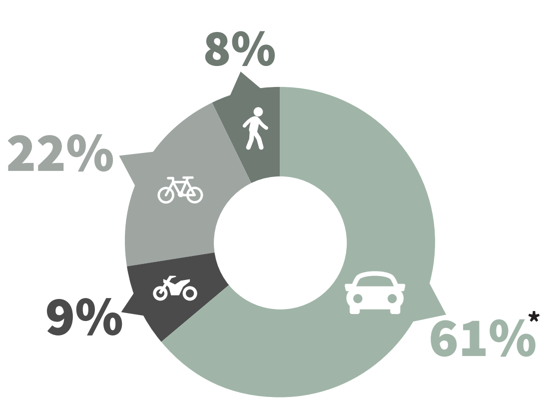
142 TOTAL COLLISIONS

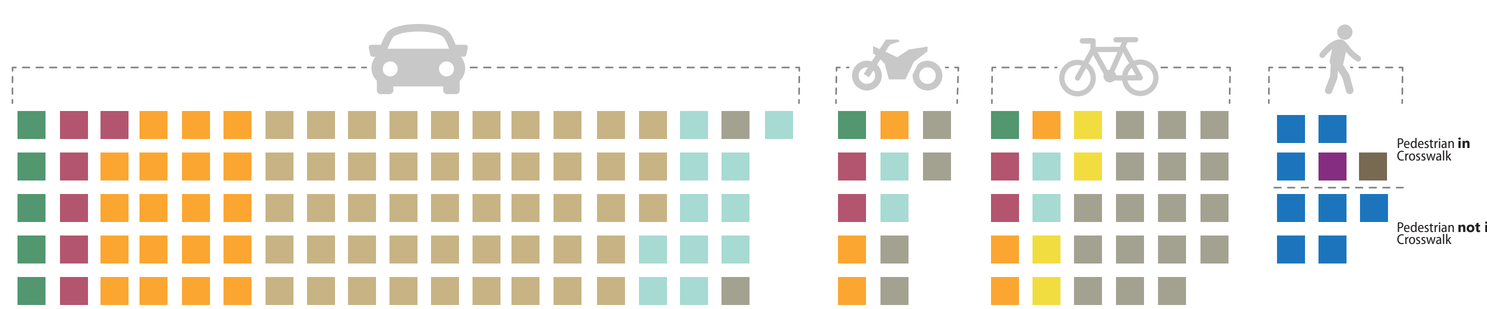
6% KILLED OR SEVERELY INJURED

[**0%** FATALITIES]

COLLISION BY MODE

COLLISION BY MODE





One square = One Collision

* "Other" is one of the eight crash type options for police officers to designate on collision reports. Collisions designated as "Other" are included in the auto portion of the collisions by mode chart above.

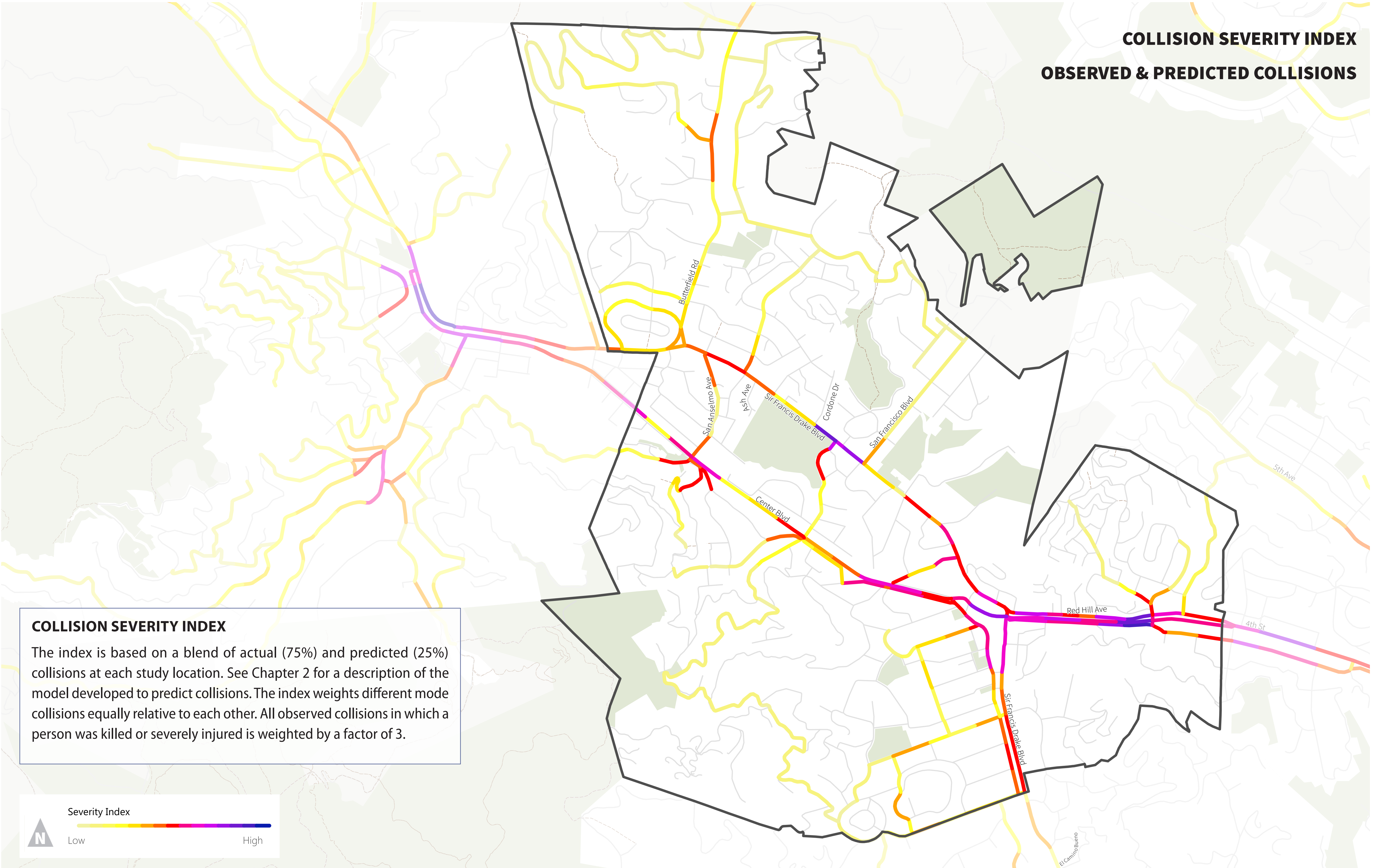
CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

				CRASH TYPES
5%		3%		Head-On
7%	8%	7%		Sideswipe
21%	8%	10%		Broadside
53%	25%			Rear End
12%	8%	7%		Hit Object
	8%	14%		Overturned
2%	43%	59%		Other *
			80%	Motorvehicle proceeding straight
			10%	Motorvehicle making left turn
			10%	Motorvehicle making right turn

TOWN OF SAN ANSELMO

COLLISION SEVERITY INDEX

OBSERVED & PREDICTED COLLISIONS



COLLISION SEVERITY INDEX

The index is based on a blend of actual (75%) and predicted (25%) collisions at each study location. See Chapter 2 for a description of the model developed to predict collisions. The index weights different mode collisions equally relative to each other. All observed collisions in which a person was killed or severely injured is weighted by a factor of 3.

This study developed crash profiles to highlight five of the top trends among collisions in San Anselmo. The collision profiles, shown at the bottom right, are based on an analysis of crash data and related environmental factors. Every profile highlights a crash pattern the study has identified as a priority concern.

The table below shows the proportion of crash types by mode. Data to the right provides a comparison of the percentage of San Anselmo collisions vs. total collisions across all of Marin jurisdictions by mode, collision type, select age and collision violation categories.

The following pages identify safety countermeasures for study corridors and intersections. These countermeasures make up a toolkit of safety interventions the Town of San Anselmo can utilize to implement projects tailored to unique safety issues.

142 TOTAL SAN ANSELMO COLLISIONS

2,756 TOTAL MARIN COLLISIONS

2012-2016

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

				CRASH TYPES
5%	8%	3%		Head-On
7%	8%	7%		Sideswipe
21%	25%	10%		Broadside
53%	8%			Rear End
12%	8%	7%		Hit Object
		14%		Overturned
2%	43%	59%		Other *
			80%	Motorvehicle proceeding straight
			10%	Motorvehicle making left turn
			10%	Motorvehicle making right turn
100%	100%	100%	100%	

** "Other" is one of the eight crash type options for police officers to designate on collision reports.*

SAN ANSELMO VS. MARIN COLLISIONS - RELATIVE SHARE

	AGE		VIOLATION	
	Youth	Senior	DUI	Unsafe Speed
Town of San Anselmo	12.5%	15.4%	10.3%	**34.6%**
All Marin Collisions	13.7%	21.4%	10.5%	28.2%

	MODE				
	Auto	Motorcycle	Bicycle	Pedestrian	Other
Town of San Anselmo	60.2%	**9.0%**	**21.8%**	8.3%	**0.8%**
All Marin Collisions	63.8%	6.4%	18.1%	11.1%	0.6%

	COLLISION TYPE							
	Head-on	Sideswipe	Rear-end	Broadside	Hit Object	Overturned	Vehicle/ Pedestrian	Other
Town of San Anselmo	5.9%	6.6%	**33.1%**	16.2%	10.3%	3.7%	7.4%	**16.2%**
All Marin Collisions	7.1%	8.7%	24.5%	20.3%	11.8%	5.6%	11.0%	10.7%

LOCAL COLLISION PROFILES

PEDESTRIANS CROSSING NOT IN A CROSSWALK

40% (5) of all pedestrian collisions in San Anselmo involved pedestrians crossing not in a crosswalk, almost three times higher than the county average for pedestrian collisions.

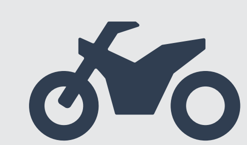
REAR-END COLLISIONS

33% (47) of all collisions in San Anselmo involved rear-end collisions, almost 40 percent higher than the county average.

SPEED RELATED COLLISIONS

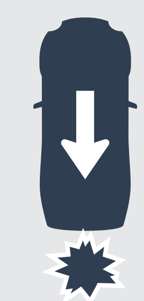
35% (50) of all collisions in San Anselmo involved unsafe speed violations, about 20 percent higher than the county average.

MOTORCYCLE COLLISIONS



9% (13) of all collisions in San Anselmo involved motorcycles, almost 50 percent higher than the county average.

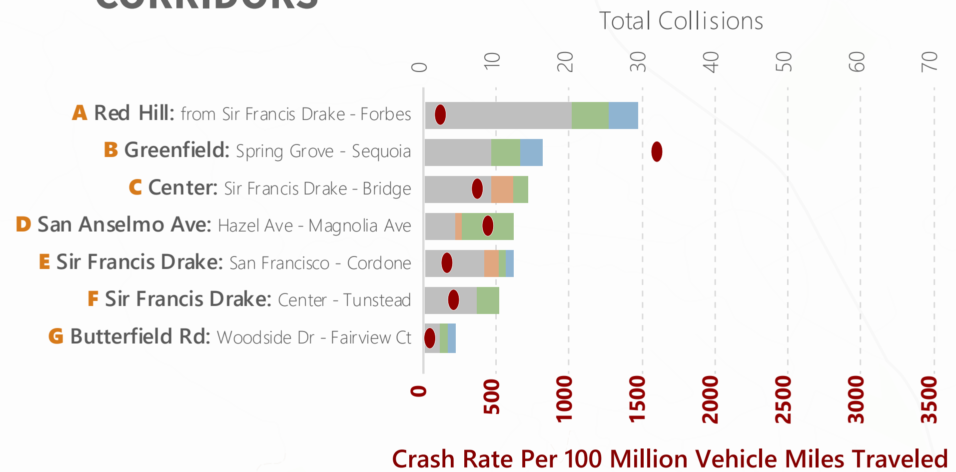
BACKING UP COLLISIONS



1.9% (3) of all collisions in San Anselmo involved vehicles backing up, more than twice the county average.

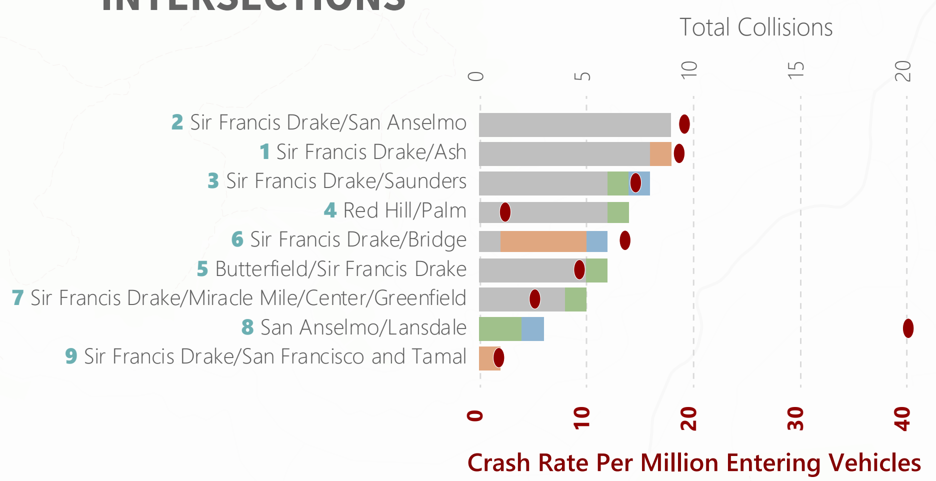
TOWN OF SAN ANSELMO

CORRIDORS



The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study corridor. The bars also illustrate, by color, a breakdown of those collisions by mode for each corridor. To normalize the collision data, the red dots in the chart show the crash rate per 100 million vehicle miles traveled for each study corridor.

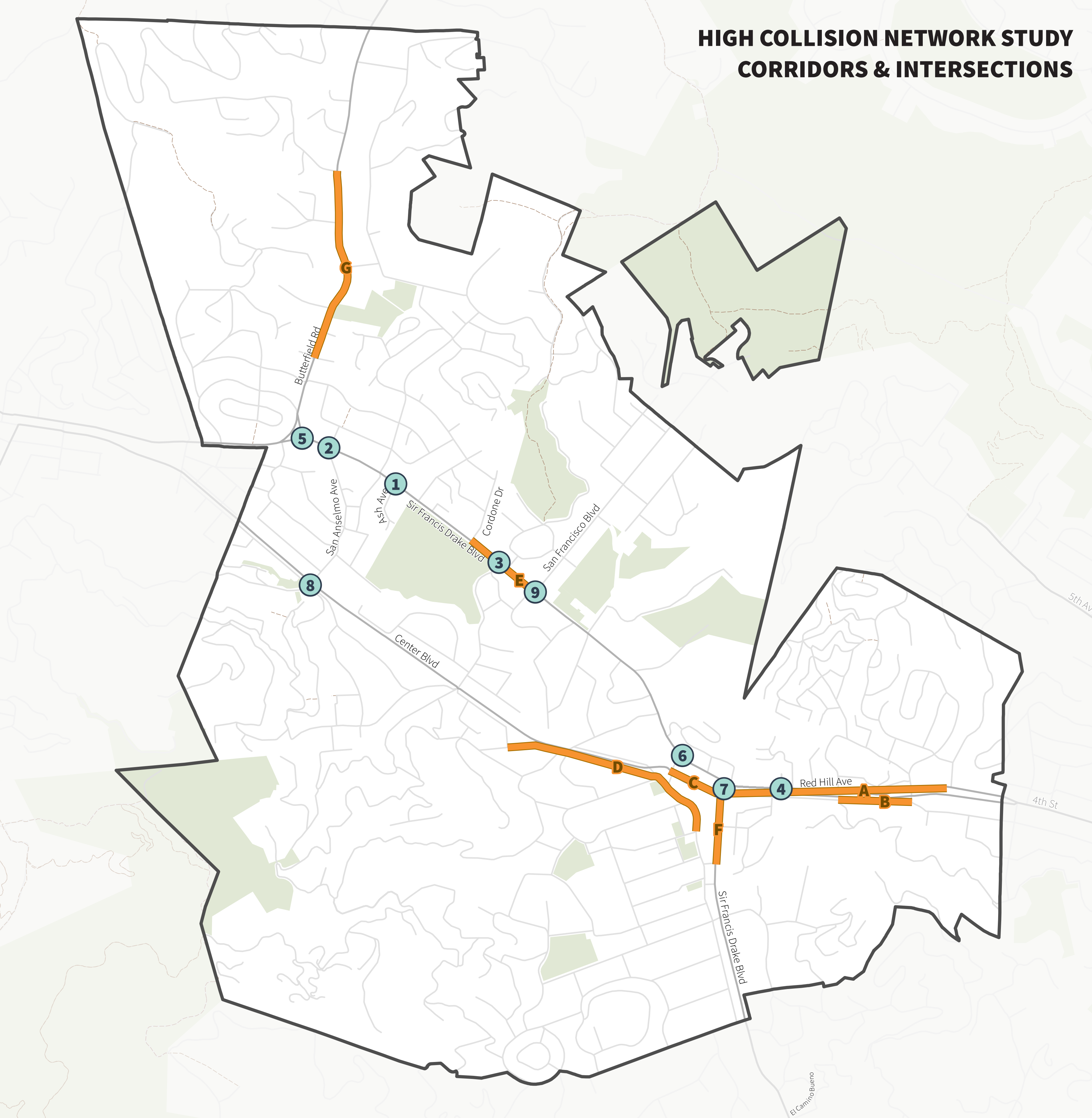
INTERSECTIONS



The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study intersection. The bars also illustrate, by color, a breakdown of those collisions by mode for each intersection. To normalize the collision data, the red dots in the chart show the crash rate per million entering vehicles for each study intersection.

Motor Vehicle Collisions
Bicycle Collisions
Crash Rate
Motorcycle Collisions
Pedestrian Collisions

HIGH COLLISION NETWORK STUDY CORRIDORS & INTERSECTIONS



POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

TOWN OF SAN ANSELMO

CORRIDORS

ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
A	Red Hill: from Sir Francis Drake to Forbes	20	0	5	4	29	S2, Improve signal hardware S3, Improve signal timing and detection S18, Convert signalized intersection to roundabout (optional CM as an alternative to S2, S3 and S19) S19, Check for and/or install pedestrian countdown signal heads R38, Pedestrian crossing with enhanced safety features (bulb out) R32, Install edge-lines and centerlines R9, Install raised median	
B	Greenfield: Spring Grove to Sequoia	9	0	4	3	16	R32, Install edge-lines and centerlines S20, Install pedestrian crossing NS6, Upgrade intersection pavement markings (high visibility crosswalk)	NH5, Install wayfinding (bike route/ bike boulevard wayfinding) NH11, Raised intersection
C	Center: Sir Francis Drake to Bridge	9	3	2	0	14	NS18, Install pedestrian crossing at uncontrolled locations with advanced safety feature (install RRFB or Flashing LED beacons) R32, Install centerlines	
D	San Anselmo Ave: Hazel Ave to Magnolia Ave	4	1	7	0	13	NS17, Install pedestrian crossing at uncontrolled locations	NH6, Install sharrows NH7, Install 'Bikes May Use Full Lane' sign
E	Sir Francis Drake: San Francisco to Cordone	8	2	1	1	12	R32, Install edge-lines and centerlines NS10, Improve sight distance (at T intersections)	
F	Sir Francis Drake: Center to Tunstead	7	0	3	0	10	R32, Install edge-lines and centerlines	
G	Butterfield Rd: Woodside Dr to Fairview Ct	2	0	1	1	4	NS18, Install pedestrian crossing at uncontrolled locations with advanced safety feature (install Flashing LED beacons)	NH1, Refresh signage/striping

TOWN OF SAN ANSELMO

INTERSECTIONS

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
1	Sir Francis Drake and Ash	8	1	0	0	9	NS16, Install raised medians / refuge island NS19, Install pedestrian signal or HAWK	
2	Sir Francis Drake and San Anselmo	9	0	0	0	9	NS10, Trim vegetation and pull stop bar up for side street sight distance	
3	Sir Francis Drake and Saunders	6	0	1	1	8	NS6, Improve pavement markings NS19, Upgrade to newest standard of flashing beacons; consider upgrading to HAWK	
4	Red Hill and Palm	6	0	1	0	7	S18, Convert signalized intersection to roundabout (at The Hub) R38, Pedestrian crossing with enhanced safety features (bulb out, push back stop bar)	
5	Butterfield and Sir Francis Drake	5	0	1	0	6	S2, Improve signal hardware S3, Improve signal timing and detection S18, Convert signalized intersection to roundabout to reduce collision severity and improve congestion downstream of intersection, downstream has high rates of rear ends (optional CM as an alternative to S2,S3 and S19) S19, Check for and/or install pedestrian countdown signal heads	NH1, Refresh striping
6	Sir Francis Drake and Bridge	1	4	0	1	6	NS6, Upgrade intersection pavement markings (high visibility crosswalk with stopbar)	
7	Sir Francis Drake and Miracle Mile and Center and Greenfield	4	0	1	0	5	S2, Improve signal hardware (check for and upgrade to 12" LED modules) S3, Improve signal timing and detection S7, Convert signal to mast arm S18, Convert signalized intersection to roundabout (optional CM as an alternative to S2, S3, S7 and S19) S19, Check for and/or install pedestrian countdown signal heads	
8	San Anselmo and Lansdale	0	0	2	1	3	NS4, Convert intersection to roundabout (optional CM as an alternative to NS17, NS18 and R38) NS17, Install pedestrian crossing at uncontrolled locations (add high visibility crosswalk) NS18, Install pedestrian crossing at uncontrolled locations with advanced safety feature (install RRFB or Flashing LED beacons) R38, Pedestrian crossing with enhanced safety features (add curb extensions)	
9	Sir Francis Drake and San Francisco and Tamal	0	1	0	0	1	R38, Pedestrian crossing with enhanced safety features (bulb out)	

PRIORITY PROJECTS

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

Red Hill Avenue: Sir Francis Drake Boulevard to Forbes Avenue | Corridor

Red Hill and Sir Francis Drake Boulevard looking north

EXISTING CONDITIONS:

Red Hill Avenue is a multi-lane arterial roadway that carries regional traffic from point east to San Anselmo. The corridor had 29 reported collisions in five years, including one KSI motor vehicle collision. Rear-end collisions are the most common motor vehicle collision type.

POTENTIAL IMPROVEMENTS:

Improve Signals- Rear-end crashes may indicate clearance intervals are two short, consider adding a longer yellow phase. Signalization improvements may also include adding phases, eliminating or restricting higher-risk movements, upgrading signal hardware to 12" LED heads with backplates, and coordinating signals at multiple locations.

Convert signalized intersection to round about- This is an optional alternative counter-measure. Roundabouts can be effective at reducing severe injuries at intersections with complex geometry and intersections with frequent left-turn movements. (Recommended at Sir Francis Drake Boulevard and Red Hill Avenue intersection).

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be considered along this corridor including some of the following: high visibility crosswalks, direction curb ramps, removing pork chop islands, reduced curb radii, advanced stop bars, pedestrian refuge islands and designate mid block crossings with a HAWK, pedestrian signal or RRFB. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Greenfield Avenue: Spring Grove Avenue to Sequoia Drive | Corridor

Greenfeild Avenue and Spring Grove Avenue looking east

EXISTING CONDITIONS:

Greenfield Avenue is a two-lane local road that parallels Red Hill Avenue. Greenfield Avenue is also a designated bike route. The corridor had 16 total reported collisions in five years and no KSI collisions. Four collisions were bicycle collisions and three collisions were pedestrian collisions. Rear-end collisions are the most common motor vehicle collision type.

POTENTIAL IMPROVEMENTS:

Roadway Improvements- Roadway improvements may include adding edge-lines to visually narrow the roadway particularly at times where on-street parking occupancy is low or replacing angled parking with back-in angled parking, which would increase visibility.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be considered along this corridor including some of the following: high visibility crosswalks, removing pork chop island, direction curb ramps, additional curb ramps where they are missing, advanced stop bars and speed tables. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Installing way-finding throughout the corridor and leading to the corridor may direct bicyclists to use this route as an alternative to parallel Red Hill Avenue Installing sharrows can increase the visibility of bicyclists and clarify where bicyclists are expected to ride.

CHAPTER 11: CITY OF SAN RAFAEL

The City of San Rafael had an estimated population of 60,551 as of January 1, 2016, according to the California Department of Finance, representing approximately 23 percent of Marin County's total population. In the five year period between 2012 and 2016, San Rafael experienced a total of 953 reported crashes on local streets. Forty-nine of those crashes involved a person that was severely injured and ten crashes involved fatalities.

San Rafael's share of reported crashes on local streets, as a proportion of total crashes in Marin County, during the five-year period is summarized below.

- **34.6% of all county-wide crashes**
- **23.3% of county-wide crashes in which a person was killed or severely injured (KSI)**
- **0.9% of all fatal county-wide crashes**

For all crashes, San Rafael's share of those crashes as a proportion of total crashes in Marin County was higher than the city's 23 percent share of the total county population. However, for crashes involving severe injuries or fatalities, San Rafael's share of those crashes as a proportion of total crashes in Marin was similar to the city's 23 percent of the total county population.

The intersection of Third Street / Grand Avenue is within one of San Rafael's priority project corridor, which extends along Third Street from Grand Avenue to Lincoln Avenue. The corridor had 68 reported collisions within a recent five-year period. The corridor had 22 pedestrian collisions.

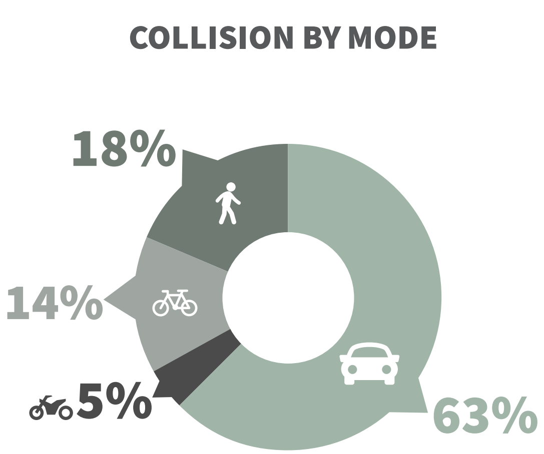
COLLISIONS 2012 TO 2016

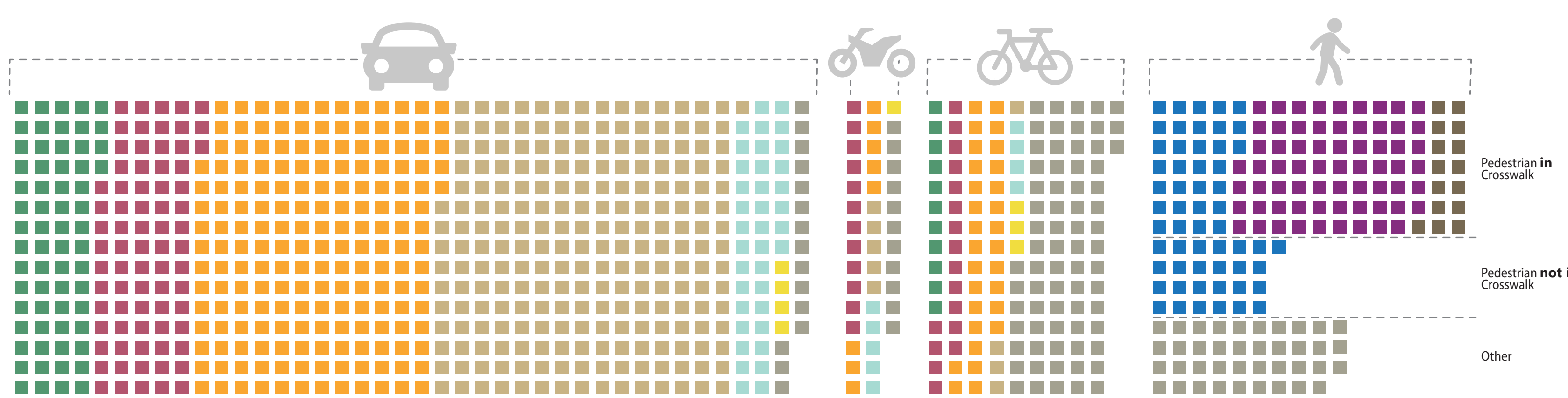
953 TOTAL COLLISIONS

5% KILLED OR SEVERELY INJURED

[**1%** FATALITIES]

COLLISION BY MODE





One square = One Collision

* "Other" is one of the eight crash type options for police officers to designate on collision reports.

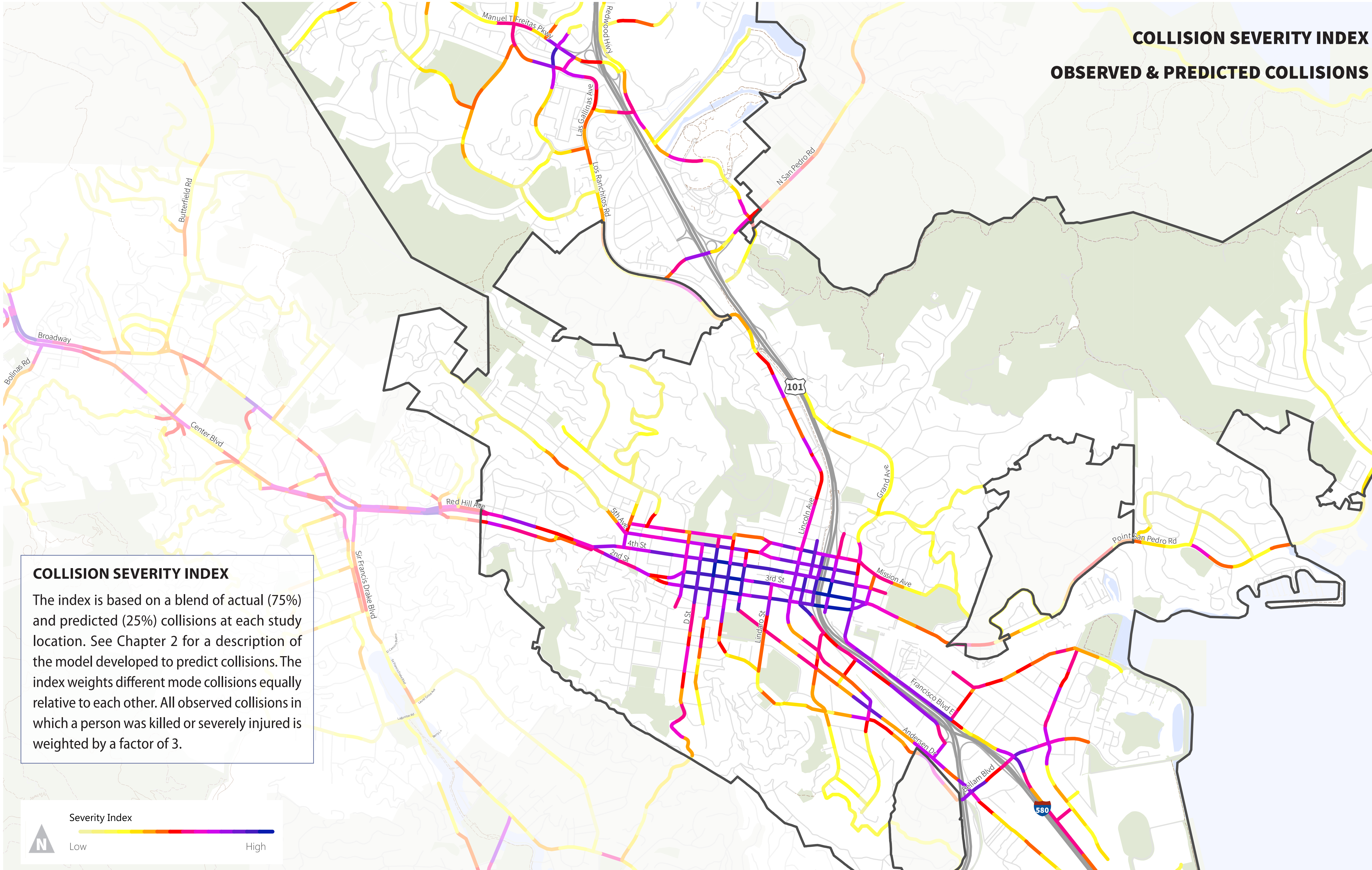
CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

CRASH TYPES	Auto	Motorcycle	Bicycle	Pedestrian
Head-On	11%		8%	
Sideswipe	12%	29%	12%	
Broadside	30%	19%	21%	
Rear End	37%	12%	3%	
Hit Object	6%	12%	3%	
Overturned	1%	2%	2%	
Other *	3%	26%	49%	21%
Motorvehicle proceeding straig			2%	32%
Motorvehicle making left turn				38%
Motorvehicle making right turr				9%
	100%	100%	100%	100%

CITY OF SAN RAFAEL

COLLISION SEVERITY INDEX

OBSERVED & PREDICTED COLLISIONS



COLLISION SEVERITY INDEX

The index is based on a blend of actual (75%) and predicted (25%) collisions at each study location. See Chapter 2 for a description of the model developed to predict collisions. The index weights different mode collisions equally relative to each other. All observed collisions in which a person was killed or severely injured is weighted by a factor of 3.

This study developed crash profiles to highlight five of the top trends among collisions in San Rafael. The collision profiles, shown at the bottom right, are based on an analysis of crash data and related environmental factors. Every profile highlights a crash pattern the study has identified as a priority concern. The table below shows the proportion of crash types by mode. Data to the right provides a comparison of the percentage of San Rafael collisions vs. total collisions across all of Marin jurisdictions by mode, collision type, select age and collision violation categories.

The following pages identify safety countermeasures for study corridors and intersections. These countermeasures make up a toolkit of safety interventions the City of San Rafael can utilize to implement projects tailored to unique safety issues.

953 TOTAL SAN RAFAEL COLLISIONS

2,756 TOTAL MARIN COLLISIONS

2012-2016

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

				CRASH TYPES
11%		8%		Head-On
12%	29%	12%		Sideswipe
30%	19%	21%		Broadside
37%	12%	3%		Rear End
6%	12%	3%		Hit Object
1%	2%	2%		Overturned
3%	26%	49%	21%	Other *
		2%	32%	Motorvehicle proceeding straight
			38%	Motorvehicle making left turn
			9%	Motorvehicle making right turn
100%	100%	100%	100%	

** "Other" is one of the eight crash type options for police officers to designate on collision reports.*

SAN RAFAEL VS. MARIN COLLISIONS - RELATIVE SHARE

	AGE		VIOLATION	
	Youth	Senior	DUI	Unsafe Speed
City of San Rafael	12.4%	19.7%	10.0%	22.8%
All Marin Collisions	13.7%	21.4%	10.5%	28.2%

MODE

	Auto	Motorcycle	Bicycle	Pedestrian	Other
City of San Rafael	63.0%	4.6%	14.1%	**18.0%**	0.3%
All Marin Collisions	63.8%	6.4%	18.1%	11.1%	0.6%

COLLISION TYPE

	Head-on	Sideswipe	Rear-end	Broadside	Hit Object	Overturned	Vehicle/ Pedestrian	Other
City of San Rafael	**9.3%**	**11.0%**	22.8%	**24.7%**	4.8%	1.0%	**16.7%**	9.5%
All Marin Collisions	7.1%	8.7%	24.5%	20.3%	11.8%	5.6%	11.0%	10.7%

LOCAL COLLISION PROFILES

PEDESTRIAN COLLISIONS (OVER THE AGE OF 65))

California Office of Traffic Safety ranked San Rafael 6th of 105 similar California cities with high levels of pedestrian collisions involving seniors in 2015.

DRIVER (UNDER THE AGE OF 21) WAS DRINKING

California Office of Traffic Safety ranked San Rafael 7th of 105 similar California cities with high levels of DUI related collisions with drivers under the age of 21 in 2015.

SPEED RELATED COLLISIONS

California Office of Traffic Safety ranked San Rafael 10th of 105 similar California cities with high levels of speed related collisions in 2015.

PEDESTRIAN COLLISIONS

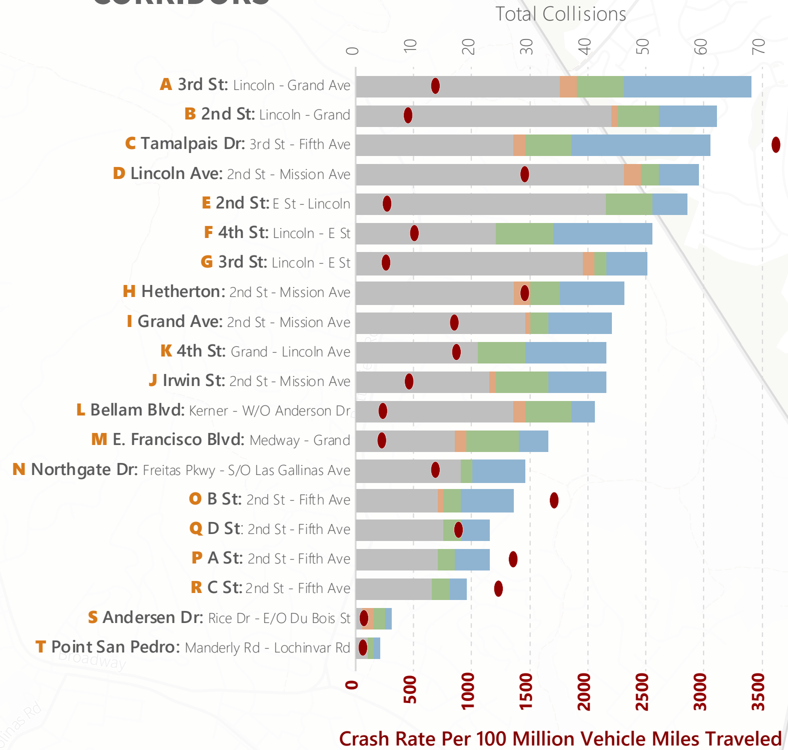
California Office of Traffic Safety ranked San Rafael 2nd of 105 similar California cities with high levels of pedestrian collisions in 2015. 18% of all collisions in San Rafael involved pedestrians, about 70 percent higher than the county average.

HEAD-ON COLLISIONS

9% of all collisions in San Rafael involved head-on collisions, about 30 percent higher than the county average.

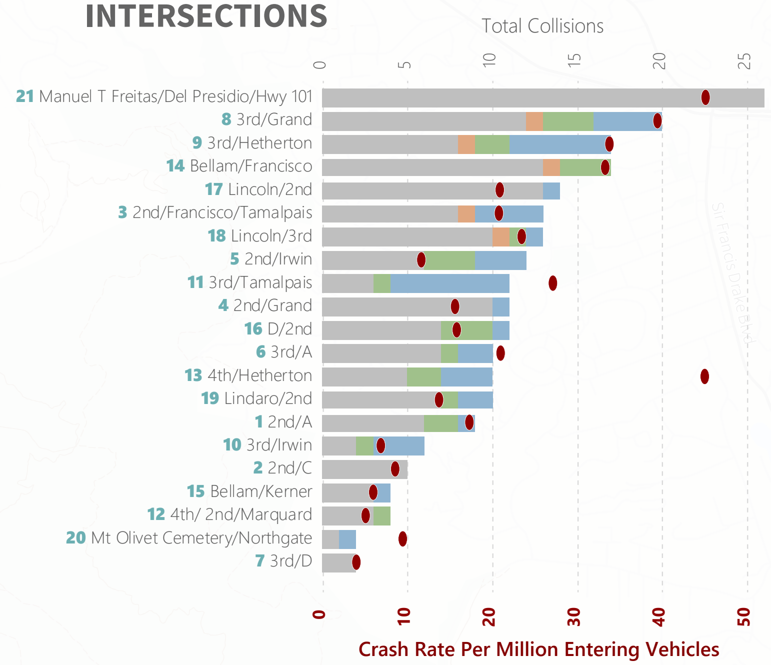
CITY OF SAN RAFAEL

CORRIDORS



The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study corridor. The bars also illustrate, by color, a breakdown of those collisions by mode for each corridor. To normalize the collision data, the red dots in the chart show the crash rate per 100 million vehicle miles traveled for each study corridor.

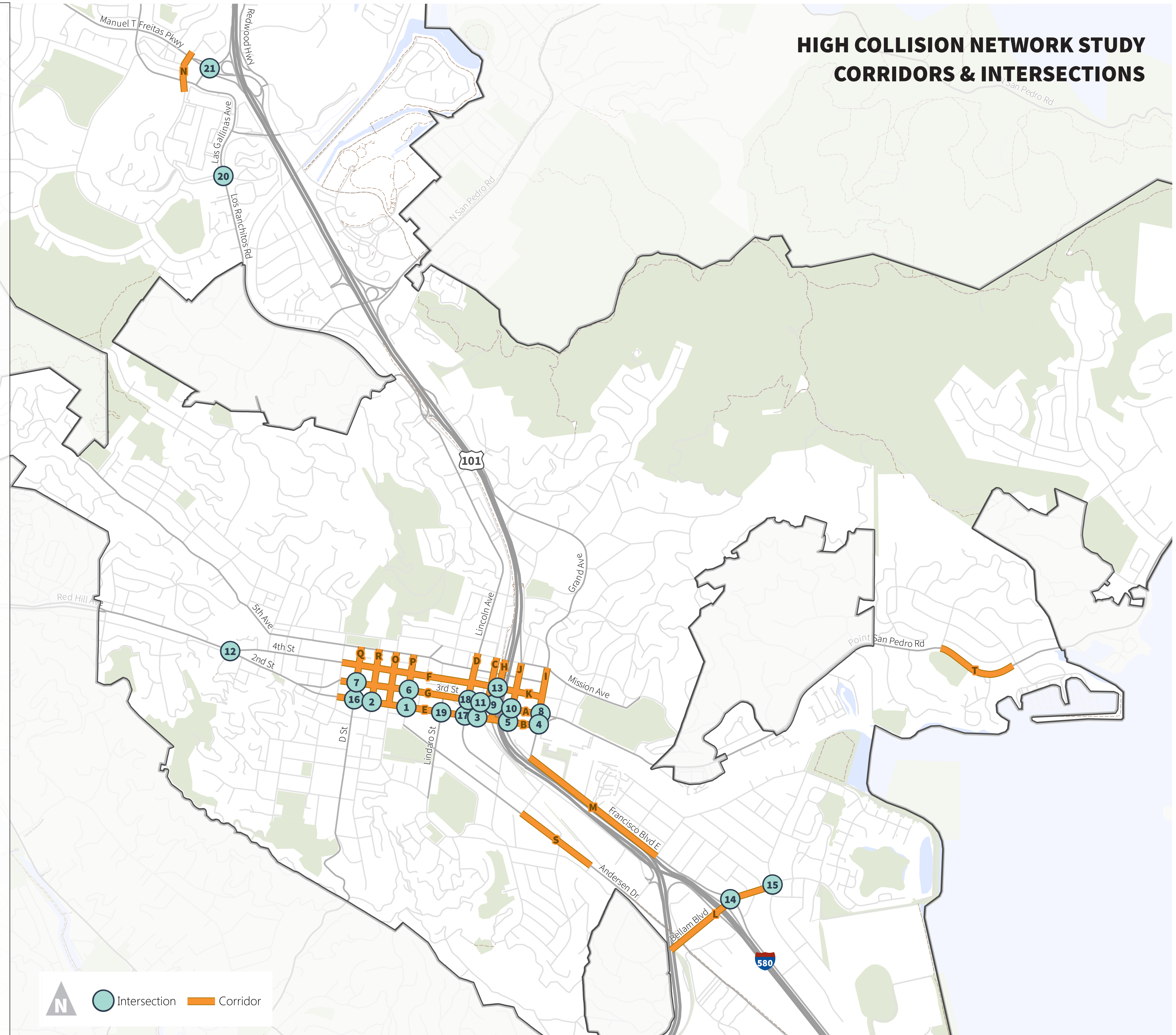
INTERSECTIONS



The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study intersection. The bars also illustrate, by color, a breakdown of those collisions by mode for each intersection. To normalize the collision data, the red dots in the chart show the crash rate per million entering vehicles for each study intersection.

Motor Vehicle Collisions
Motorcycle Collisions
Bicycle Collisions
Pedestrian Collisions
Crash Rate

HIGH COLLISION NETWORK STUDY CORRIDORS & INTERSECTIONS



POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

CITY OF SAN RAFAEL

CORRIDORS

ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE		NON-HSIP COUNTERMEASURE
A	3rd St: Lincoln to Grand Avenue	35	3	8	22	68	S17, Install left turn lane and add turn phase S21, Install advance stop bar before crosswalk (Bicycle Box) NS6, Upgrade intersection pavement markings (high visibility crosswalk)	NS17, Install pedestrian crossing (midblock) R38, Pedestrian crossing with enhanced safety features (bulb out where applicable)	
B	2nd St: Lincoln to Grand	44	1	7	10	62	S17, Install left turn lane and add turn phase S21, Install advance stop bar before crosswalk (Bicycle Box)	NS6, Upgrade intersection pavement markings (high visibility crosswalk) NS17, Install pedestrian crossing (midblock)	
C	Tamalpais Dr: 3rd St to Fifth Avenue	27	2	8	24	61	R36, Install bike lanes		NH1, Refresh signage/striping
D	Lincoln Avenue: 2nd St to Mission Avenue	46	3	3	7	59	S4, Provide Advanced Dilemma Zone Detection S6, Provide protected left turn phase, if warranted	S21, Install advanced stop bar before crosswalk (bike box)	
E	2nd St: E St to Lincoln	43	0	8	6	57	S6, Provide protected left turn phase, if warranted S21, Install advance stop bar before crosswalk (Bicycle Box)	NS6, Upgrade intersection pavement markings (high visibility crosswalk) NS17, Install pedestrian crossing (midblock) R36, Install bike lanes	
F	4th St: Lincoln to E St	24	0	10	17	51	S2, Improve signal hardware S6, Provide protected left turn phase, if warranted	S21, Install advanced stop bar before crosswalk (bike box) NS17, Install pedestrian crossing (midblock) R36, Install bike lanes	NH5, Install wayfinding
G	3rd St: Lincoln to E St	39	2	2	7	50	S6, Provide protected left turn phase, if warranted	NS17, Install pedestrian crossing (midblock)	
H	Hetherton: 2nd St to Mission Avenue	27	3	5	11	46	S6, Provide protected left turn phase, if warranted NS6, Upgrade intersection pavement marking (upgrade to high visibility)	NS17, Install pedestrian crossing (midblock)	
I	Grand Avenue: 2nd St to Mission Avenue	29	1	3	11	44	S4, Provide Advanced Dilemma Zone Detection S6, Provide protected left turn phase, if warranted	NS6, Upgrade intersection pavement marking (upgrade to high visibility) NS17, Install pedestrian crossing (midblock) R38, Pedestrian crossing with enhanced safety features (bulb out)	
J	Irwin St: 2nd St to Mission Avenue	23	1	9	10	43	S6, Provide protected left turn phase, if warranted S21, Install advanced stop bar before crosswalk (bike box) (optional)	NS17, Install pedestrian crossing (midblock) R38, Pedestrian crossing with enhanced safety features (bulb out)	

CITY OF SAN RAFAEL

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

CORRIDORS

ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE		NON-HSIP COUNTERMEASURE
K	4th St: Grand to Lincoln Avenue	21	0	8	14	43	S6, Provide protected left turn phase, if warranted S21, Install advanced stop bar before crosswalk (bike box)	NS17, Install pedestrian crossing (midblock) R36, Install bike lanes R38, Pedestrian crossing with enhanced safety features (bulb out)	NH5, Install wayfinding
L	Bellam Blvd: Kerner to W/O Ander-son Dr	27	2	8	4	41	S3, Improve signal timing and detection S4, Provide Advanced Dilemma Zone Detection S21, Install advanced stop bar before crosswalk (bike box)	R36, Install bike lanes R38, Pedestrian crossing with enhanced safety features (bulb out or pedestrian refuge island)	
M	E Francisco Blvd: Medway to Grand	17	2	9	5	33	S3, Improve signal timing and detection NS3, Install signals or NS2, Convert to all-way STOP control		NH1, Refresh signage/striping
N	Northgate Dr: Freitas Pkwy to S/O Las Gallinas Avenue	18	0	2	9	29	S3, Improve signal timing and detection S4, Provide Advanced Dilemma Zone Detection S6, Provide protected left turn phase (at Las Gallinas), if warranted	S7, Convert signal to mast arm R36, Install bike lanes	
O	B St: 2nd St to Fifth Avenue	14	1	3	9	27	S6, Provide protected left turn phase, if warranted S19, Install pedestrian countdown signal heads	NS6, Upgrade intersection pavement markings (to high visibility) NS17, Install pedestrian crossing at uncontrolled location (new signs and markings only) R36, Install bike lanes (install sharrows if bike lanes are infeasible)	
P	A St: 2nd St to Fifth Avenue	14	0	3	6	23	S6, Provide protected left turn phase, if warranted	NS17, Install pedestrian crossing (midblock) R36, Install bike lanes (install sharrows if bike lanes are infeasible)	NH5, Install wayfinding (wayfinding for bikes with directions to bike routes and major destinations)
Q	D St: 2nd St to Fifth Avenue	15	0	3	5	23	S6, Provide protected left turn phase, if warranted	NS17, Install pedestrian crossing at uncontrolled location (new signs and markings only)	NH1, Refresh signage/ striping (refresh sharrow markings) NH7, Install 'Bikes May Use Full Lane' sign
R	C St: 2nd St to Fifth Avenue	13	0	3	3	19	S6, Provide protected left turn phase, if warranted		NH1, Refresh signage/ striping (refresh sharrow markings) NH7, Install 'Bikes May Use Full Lane' sign
S	Andersen Dr: Rice Dr to E/O Du Bois St	1	2	2	1	6	S19, Install pedestrian countdown signal heads S21, Install advanced stop bar before crosswalk (bike box)	R36, Install bike lanes (Consistent bike lanes / more frequent striping)	NH8, Square up intersection
T	Point San Pedro: Manderly Rd to Lochinvar Rd	2	0	1	1	4	NS19, Install pedestrian signal or HAWK (and high visibility cross-walks at San Pedro Elementary School)	R30, Install dynamic/variable speed warning sign R36, Install bike lanes	

CITY OF SAN RAFAEL

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

INTERSECTIONS

ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE		NON-HSIP COUNTERMEASURE
1	2nd and A	6	0	2	1	9	S2, Improve signal hardware S7, Convert signal to mast arm	S19, Check for and/or install pedestrian countdown signal heads S21, Install bike box NS6, Upgrade intersection pavement markings (high visibility crosswalk) R36, Install bike lanes	
2	2nd and C	5	0	0	0	5	S2, Improve signal hardware	S7, Convert signal to mast arm S19, Check for and/or install pedestrian countdown signal heads NS6, Upgrade intersection pavement markings (high visibility crosswalk)	
3	2nd and Francisco and Tamalpais	8	1	0	4	13	S2, Improve signal hardware	S19, Check for and/or install pedestrian countdown signal heads	
4	2nd and Grand	10	0	0	1	11	2nd and Grand Improvements project completed in Fall 2017		
5	2nd and Irwin	6	0	3	3	12	S2, Improve signal hardware S3, Improve signal timing and detection	S20, Install pedestrian crossing (relocate crosswalk to reduce potentail conflicts)	
6	3rd and A	7	0	1	2	10	S2, Improve signal hardware S7, Convert signal to mast arm	S17, Install left-turn lane and add turn phase S19, Check for and/or install pedestrian countdown signal heads NS6, Upgrade intersection pavement markings (high visibility crosswalk) R38, Pedestrian crossing with enhanced safety features (bulb out)	
7	3rd and D	2	0	0	0	2	S2, Improve signal hardware S7, Convert signal to mast arm	S19, Check for and/or install pedestrian countdown signal heads NS6, Upgrade intersection pavement markings (high visibility crosswalk)	
8	3rd and Grand	12	1	3	4	20	S2, Improve signal hardware S6, Provide protected left turn phase	S7, Convert signal to mast arm S19, Check for and/or install pedestrian countdown signal heads NS6, Upgrade intersection pavement markings (high visibility crosswalk)	

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

INTERSECTIONS

ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE		NON-HSIP COUNTERMEASURE
9	3rd and Hetherton	8	1	2	6	17	S2, Improve signal hardware (install pedestrian push button) S3, Improve signal timing and detection S19, Check for and/or install pedestrian countdown signal heads	NS20, Improve sight distance to intersection (shadows from trees and overpass) R38, Pedestrian crossing with enhanced safety features (install bulb outs, square up intersection)	
10	3rd and Irwin	2	0	1	3	6	S2, Improve signal hardware S17, Install left-turn and add turn phase (signal has no left turn lane or phase before)	S19, Install pedestrian countdown signal head NS6, Upgrade intersection pavement markings (high visibility crosswalk) R38, Pedestrian crossing with enhanced safety features (bulb out)	
11	3rd and Tamalpais	3	0	1	7	11	S2, Improve signal hardware	S17, Install left-turn and add turn phase (signal has no left turn lane or phase before) S19, Check for and/or install pedestrian countdown signal heads NS6, Upgrade intersection pavement markings (high visibility crosswalk)	
12	4th and 2nd and Marquard	3	0	1	0	4	S2, Improve signal hardware	NS6, Upgrade intersection pavement markings (high visibility crosswalk)	
13	4th and Hetherton	5	0	2	3	10	S2, Improve signal hardware S17, Install left-turn lane and add turn phase	S19, Check for and/or install pedestrian countdown signal heads NS6, Upgrade intersection pavement markings (high visibility crosswalk) R36, Install bike lanes R38, Pedestrian crossing with enhanced safety features (install bulb outs)	
14	Bellam and Francisco	13	1	3	0	17	S3, Improve signal timing and detection S2, Improve signal hardware	NS6, Upgrade intersection pavement markings (high visibility crosswalk) R38, Pedestrian crossing with enhanced safety features (tighten curb radius and square intersection)	NH2, Remove slip lane(s)
15	Bellam and Kerner	3	0	0	1	4	S2, Improve signal hardware S3, Improve signal timing and detection	S19, Check for and/or install pedestrian countdown signal heads R38, Pedestrian crossing with enhanced safety features (bulb out and high visibility crosswalk)	

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

INTERSECTIONS

ID	NAME	COLLISIONS: MOTOR VEHICLE	COLLISIONS: MOTORCYCLE	COLLISIONS: BICYCLE	COLLISIONS: PEDESTRIAN	COLLISIONS: TOTAL	POTENTIAL HSIP COUNTERMEASURE		NON-HSIP COUNTERMEASURE
16	D and 2nd	7	0	3	1	11	S2, Improve signal hardware S4, Provide advanced dilemma zone detection S19, Check for and/or install pedestrian countdown signal heads	S21, Install bike box NS6, Upgrade intersection pavement markings (high visibility crosswalk) R36, Install bike lanes R38, Pedestrian crossing with enhanced safety features (bulb out)	
17	Lincoln and 2nd	13	0	0	1	14	S2, Improve signal hardware	S19, Install pedestrian countdown signal heads NS6,Upgrade intersection pavement markings (high visibility crosswalk)	
18	Lincoln and 3rd	10	1	1	1	13	S2, Improve signal hardware	S7, Convert signal to mast arm	
19	Lindaro and 2nd	7	0	1	2	10	S17, Install left-turn lane and add turn phase NS6, Upgrade intersection pavement markings (high visibility crosswalk) R38, Pedestrian crossing with enhanced safety features (bulb out)	S2, Improve signal hardware S19, Check for and/or install pedestrian countdown signal heads	
20	Los Ranchitos and Las Gallinas and Mt Olivet Cemetery and Northgate	1	0	0	1	2	S2, Improve signal hardware S18, Convert signalized intersection to roundabout (optional CM as an alternative to S2, S3 and S19)	S19, Check for and/or install pedestrian countdown signal heads NS6, Upgrade intersection pavement markings (high visibility crosswalk) R38, Install pedestrian crossing with enhanced safety features (bulb out)	
21	Manuel T Freitas and Del Presidio and Hwy 101	26	0	0	0	26	S2, Improve signal hardware S3, Improve signal timing and detection	S19, Check for and/or install pedestrian countdown signal heads R38, Pedestrian crossing with enhanced safety features (square up intersection)	NH2, Remove slip lane(s)

PRIORITY PROJECTS

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

3rd Street: Lincoln Avenue to Grand Avenue | Corridor

3rd Street and Tamalpais Avenue looking east

EXISTING CONDITIONS:

3rd Street is a three lane one-way street that runs through downtown San Rafael. 3rd Street is directly adjacent to the San Rafael SMART train station, the San Rafael Transit Center and connects with Highway 101. It is an important east-west connection for transit and pedestrians. The corridor had 68 reported collisions in five years, including two KSI pedestrian collisions and one KSI bicycle collision. Twenty-two of the reported collisions were bicycle collisions and eight were pedestrian collisions.

POTENTIAL IMPROVEMENTS:

Improve Signals- Signalization improvements may include coordinating signals at multiple locations, lengthening clearance intervals, adding protected left turn phases, adding dedicated left turn lanes and upgrading hardware to 12" signal heads with backplates.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be implemented along this corridor including some of the following: high visibility crosswalks, advanced stop bars, bulb outs, adding directional curb ramps, pedestrian countdown signal heads and ADA/APS pedestrian push button. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- While there is no room for bicycle facilities on this corridor potential provision of a bicycle facility on an adjacent corridor if and where feasible could improve bicycle connectivity through downtown.

2nd Street: Lincoln Avenue to Grand Avenue | Corridor

2nd Street and Tamalpais Avenue looking west

EXISTING CONDITIONS:

2nd Street is a four-lane one-way street that runs through downtown San Rafael. The corridor had 62 reported collisions in five years, including two KSI pedestrian collisions. 10 of the reported collisions were pedestrian collisions and seven were bicycle collisions. Broadside and rear-end collisions are the most common motor vehicle collision types. Twenty-three of the reported collision's main violation was a motorist disregarding traffic signals.

POTENTIAL IMPROVEMENTS:

Improve Signals- Signalization improvements may include adding a protected left turn phases, improving signal phasing, lengthening clearance intervals, coordinating signals at multiple locations, adding dedicated left turn lanes and upgrading hardware to 12" signal heads with backplates.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be implemented along this corridor including some of the following: high visibility crosswalks, advanced stop bars, bulb outs, pedestrian countdown signal heads, adding directional curb ramps and ADA/APS pedestrian push button. These will improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Installing bike lanes if feasible, could improve bicycle connectivity through downtown as well as provide a key bicycle connection to a regional transit center.

4th Street: Lincoln Avenue to E Street | Corridor

4th Street and C Street looking west

EXISTING CONDITIONS:

4th Street is a two-lane arterial street that runs through downtown San Rafael. It is a designated bike route and a pedestrian route between major downtown destinations. The corridor had 51 reported collisions in five years, including five KSI pedestrian collisions. Broadside and rear-end collisions are the most common motor vehicle collision types. Thirteen of the reported collision's main violation was a motorist failing to yield to a pedestrian and 11 were traveling too fast for the conditions.

POTENTIAL IMPROVEMENTS:

Improve Signals- Signalization improvements may include improving signal phasing, coordinating signals at multiple locations, lengthening clearance intervals, upgrading signals to 12" heads, adding backplates, adding flashing left turn arrows and adding a protected left turn phase.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be implemented along this corridor including some of the following: high visibility crosswalks, advanced stop bars, bulb outs, adding directional curb ramps, adding wayfinding signs, pedestrian countdown signal heads and ADA/APS pedestrian push button. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Installing bicycle boxes and green backed sharrows could also increase the visibility of bicyclists and clarify where bicyclists are expected to ride.

PRIORITY PROJECTS

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

4th Street: Grand Avenue to Lincoln Avenue | Corridor

4th Street and Tamalpais Avenue looking west

EXISTING CONDITIONS:

4th Street is a two-lane arterial roadway that runs through downtown San Rafael. The corridor had 43 reported collisions in five years, including one KSI pedestrian collision and two KSI bicycle collisions. Fourteen of the reported collisions were pedestrian collisions and eight were bicycle collisions. Twelve of the reported collision's main violation was a motorist failing to yield to a pedestrian, eight were traveling too fast for the conditions and seven disregarded traffic signals

POTENTIAL IMPROVEMENTS:

Improve Signals- Signalization improvements may include improving signal phasing, coordinating signals at multiple locations, adding dedicated left turn lanes and upgrading hardware to 12" signal heads with backplates.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be implemented along this corridor including some of the following: high visibility crosswalks, mid-block crossings, advanced stop bars, bulb outs, adding directional curb ramps, wayfinding, pedestrian countdown signal heads and ADA/APS pedestrian push button. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Installing bike lanes could improve bicycle connectivity through downtown as well as provide a key low stress bicycle connection. This would however likely require parking removal. Bicycle boxes and green backed sharrows could also increase the visibility of bicyclists and clarify where bicyclists are expected to ride.

Manuel T Freitas Parkway and Del Presidio Boulevard | Intersection

Manuel T Freitas Parkway and Del Presidio Boulevard looking west

EXISTING CONDITIONS:

Manuel Freitas Parkway is a multi-lane arterial that carries regional traffic through San Rafael and connects with Highway 101. The intersection had 26 reported collisions in five years, including one motor vehicle KSI collision. Broadside and rear-end collisions are the most common motor vehicle collision types. Six of the reported collision's main violation was a motorist failing to obey signal or sign, six failed to yield to a driver turning and five were traveling too fast for the conditions.

POTENTIAL IMPROVEMENTS:

Improve Signals- Signalization improvements may include upgrading signal hardware, lengthening clearance intervals, eliminating or restricting higher-risk movements, coordinating signals at multiple locations and upgrading hardware to 12" signal heads with backplates.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be implemented along this corridor including some of the following: high visibility crosswalks, directional curb ramps, reduced curb radii, pedestrian countdown signal heads, and removing pork chop islands. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

CHAPTER 12: CITY OF SAUSALITO

The City of Sausalito had an estimated population of 7,227 as of January 1, 2016, according to the California Department of Finance, representing approximately 2.7 percent of Marin County's total population. In the five-year period between 2012 and 2016, Sausalito experienced a total of 94 reported crashes on local streets. Eight of those crashes involved a person that was severely injured, and of the eight, there were no fatalities.

Sausalito's share of reported crashes on local streets, as a proportion of total crashes in Marin County, during the five-year period is summarized below.

- **3.4% of all county-wide crashes**
- **3.7% of county-wide crashes in which a person was killed or severely injured (KSI)**
- **0% of all fatal county-wide crashes**

For all crashes, as well as fatal and KSI crashes, Sausalito's share of those crashes as a proportion of total crashes in Marin County was higher than the city's 2.7 percent share of the total county population.

The corridor of Bridgeway from Napa Street to San Carlos Avenue is one of Sausalito's priority project locations. The corridor had 34 reported collisions in a recent five-year period. The intersection had 17 bicycle collisions and five pedestrian collisions.

COLLISIONS 2012 TO 2016

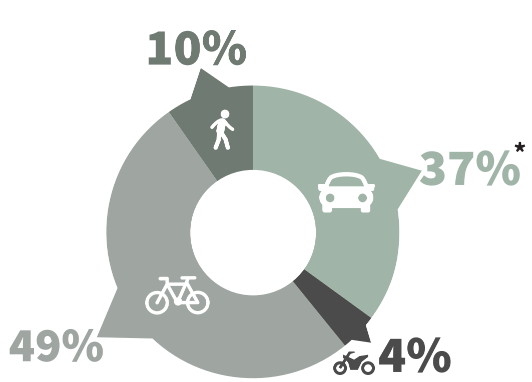
94 TOTAL COLLISIONS

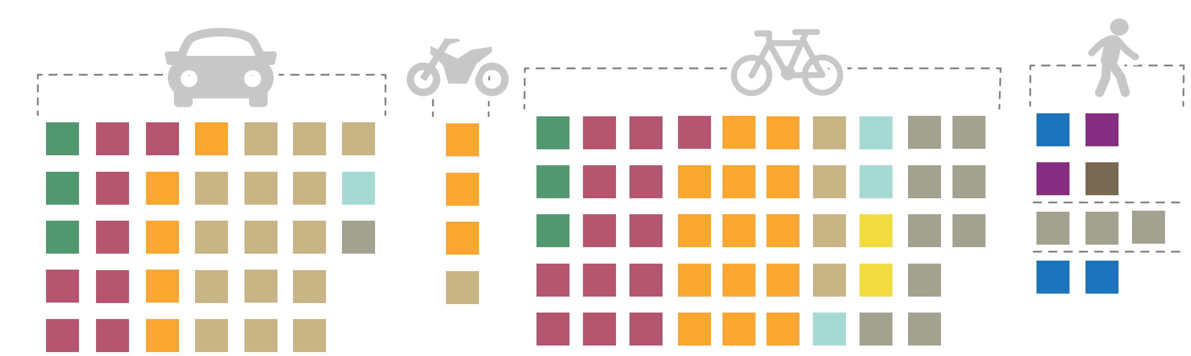
9% KILLED OR SEVERELY INJURED

[0% FATALITIES**]**

COLLISION BY MODE

COLLISION BY MODE





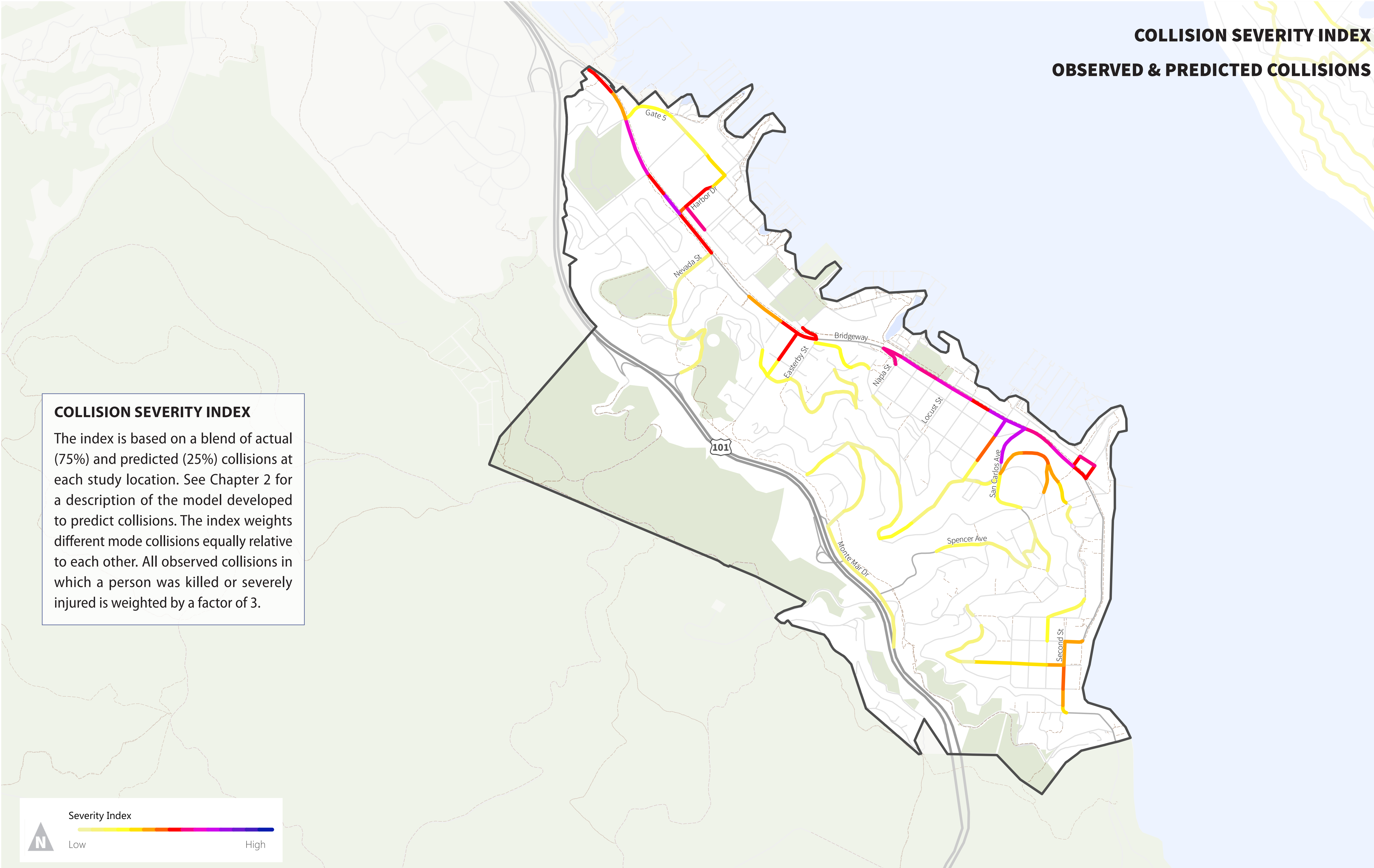
One square = One Collision

* "Other" is one of the eight crash type options for police officers to designate on collision reports. Collisions designated as "Other" are included in the auto portion of the collisions by mode chart above.

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

CRASH TYPES	Auto	Motorcycle	Bicycle	Pedestrian
Head-On	9%		6%	
Sideswipe	24%		27%	
Broadside	15%	75%	30%	
Rear End	46%	25%	8%	
Hit Object	3%		6%	
Overturned			4%	
Other *	3%		19%	33%
Motorvehicle proceeding straight				33%
Motorvehicle making left turn				23%
Motorvehicle making right turn				11%
	100%	100%	100%	100%

COLLISION SEVERITY INDEX
OBSERVED & PREDICTED COLLISIONS



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The table below shows the proportion of crash types by mode. Data to the right provides a comparison of the percentage of Sausalito collisions vs. total collisions across all of Marin jurisdictions by mode, collision type, select age and collision violation categories.

The following pages identify safety countermeasures for study corridors and intersections. These countermeasures make up a toolkit of safety interventions the City of Sausalito can utilize to implement projects tailored to unique safety issues.

94 TOTAL SAUSALITO COLLISIONS

2,756 TOTAL MARIN COLLISIONS

2012-2016

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

Auto	Motorcycle	Bicycle	Pedestrian	CRASH TYPES
9%		6%		Head-On
24%		27%		Sideswipe
15%	75%	30%		Broadside
46%	25%	8%		Rear End
3%		6%		Hit Object
		4%		Overturned
3%		19%	33%	Other *
			33%	Motorvehicle proceeding straight
			23%	Motorvehicle making left turn
			11%	Motorvehicle making right turn
100%	100%	100%	100%	

** "Other" is one of the eight crash type options for police officers to designate on collision reports.*

SAUSALITO VS. MARIN COLLISIONS - RELATIVE SHARE

	AGE		VIOLATION	
	Youth	Senior	DUI	Unsafe Speed
City of Sausalito	9.6%	**22.3%**	6.4%	27.7%
All Marin Collisions	13.7%	21.4%	10.5%	28.2%

MODE	Auto	Motorcycle	Bicycle	Pedestrian	Other
City of Sausalito	34.8%	4.3%	**48.9%**	**9.8%**	**2.2%**
All Marin Collisions	63.8%	6.4%	18.1%	11.1%	0.6%

COLLISION TYPE	Head-on	Sideswipe	Rear-end	Broadside	Hit Object	Overturned	Vehicle/ Pedestrian	Other
City of Sausalito	6.4%	**22.3%**	23.4%	20.2%	6.4%	1.1%	10.6%	9.6%
All Marin Collisions	7.1%	8.7%	24.5%	20.3%	11.8%	5.6%	11.0%	10.7%

LOCAL COLLISION PROFILES

SPEED-RELATED COLLISIONS

California Office of Traffic Safety ranked Sausalito 5th of 67 similar California cities with high levels of pedestrian collisions in 2015.

BICYCLE COLLISIONS

California Office of Traffic Safety ranked Sausalito 1st of 67 similar California cities with high levels of bicycle collisions in 2015.

BICYCLE COLLISIONS

49% (46) of all collisions in Sausalito involved bicycles, more than 2.5 times the county average.

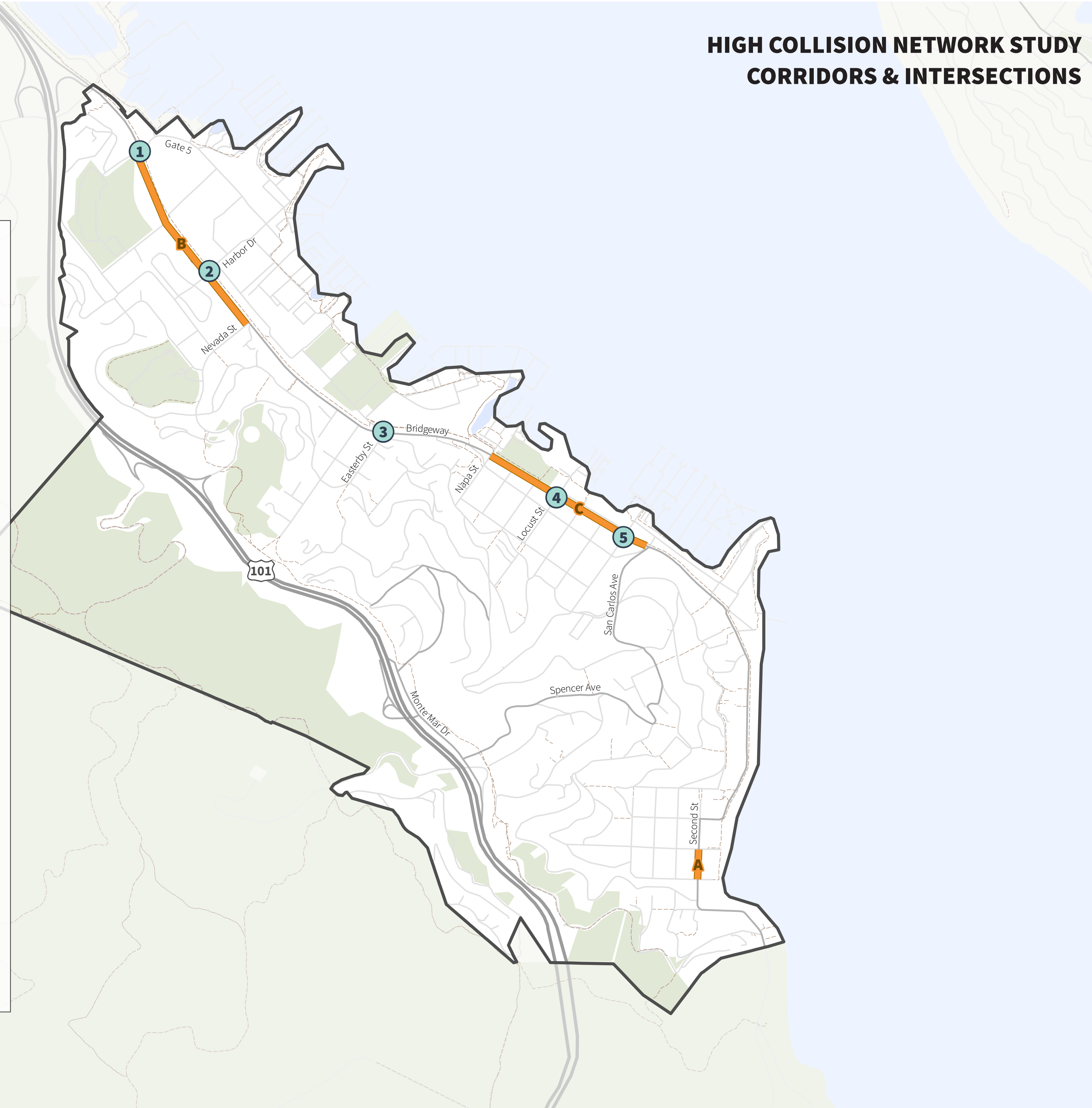
PEDESTRIAN COLLISIONS

California Office of Traffic Safety ranked Sausalito 5th of 67 similar California cities with high levels of pedestrian collisions in 2015.

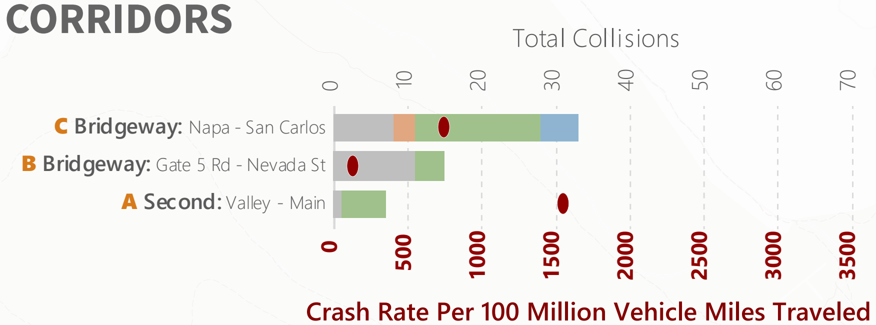
SIDE SWIPE COLLISIONS

22% (20) of all collisions in Sausalito involved side swipe collisions, more than 2.5 times the county average.

CITY OF SAUSALITO

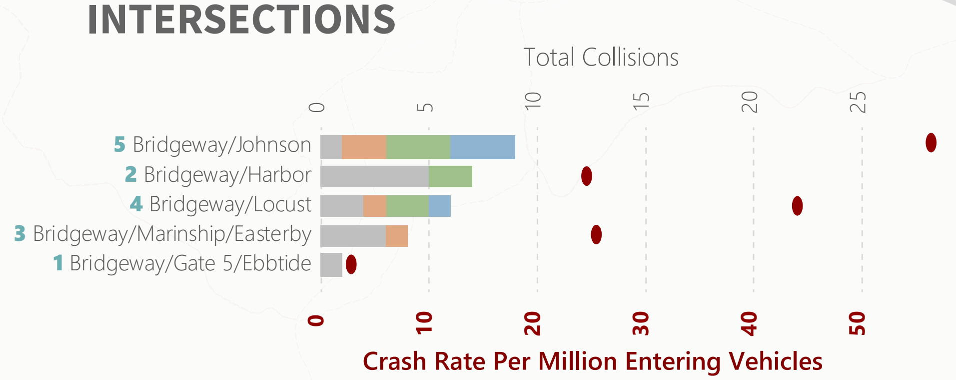


CORRIDORS



The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study corridor. The bars also illustrate, by color, a breakdown of those collisions by mode for each corridor. To normalize the collision data, the red dots in the chart show the crash rate per 100 million vehicle miles traveled for each study corridor.

INTERSECTIONS



The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study intersection. The bars also illustrate, by color, a breakdown of those collisions by mode for each intersection. To normalize the collision data, the red dots in the chart show the crash rate per million entering vehicles for each study intersection.

Motor Vehicle Collisions
Motorcycle Collisions
Bicycle Collisions
Pedestrian Collisions
Crash Rate

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

	ID	NAME	MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
			COLLISIONS						
CORRIDORS	A	Second: Valley to Main	1	0	6	0	7	NS18, Upgrade pedestrian crossing (install ADA compliant curb ramps and high visibility pedestrian crosswalk signage)	NH1, Refresh signage/striping (refresh bike lane striping, install higher frequency of sharrow striping) NH5, Install wayfinding (for tourists) NH6, Install sharrows NH7, Install 'Bikes May Use Full Lane' sign
	B	Bridgeway: Gate 5 Road to Nevada Street	11	0	4	0	15	S3, Improve signal timing and detection R36, Update existing bike lanes to green bike lanes at conflict areas	NH1, Refresh striping (refresh bicycle striping) NH11, Install no right on red restrictions NH9, Reduce lane widths
	C	Bridgeway: Napa to San Carlos	8	3	17	5	34	S2, Improve signal hardware S3, Improve signal timing and detection R38, Install pedestrian crossing with enhanced safety features (yield teeth, advanced signage, bulb outs, high visibility crosswalk)	NH1, Refresh signage/striping (refresh centerline restriping, refresh bike lane striping)
INTERSECTIONS	1	Bridgeway and Gate 5 and Ebbtide	1	0	0	0	1	S2, Improve signal hardware S3, Improve signal timing and detection S19, Check for and/or install pedestrian countdown signal heads NS6, Upgrade intersection pavement markings (high visibility crosswalk) S20, Pedestrian crossing with enhanced safety features (bulb out, high visibility crosswalk)	NH2, Remove slip lane
	2	Bridgeway and Harbor	5	0	2	0	7	S2, Improve signal hardware S3, Improve signal timing and detection S19, Check for and/or install pedestrian countdown signal heads R38, Pedestrian crossing with enhanced safety features (bulb out)	NH11, Install no right on red restrictions
	3	Bridgeway and Marinship and Easterby	3	1	0	0	4	S2, Improve signal hardware S3, Improve signal timing and detection (replace controller) S19, Check for and/or install pedestrian countdown signal heads	NH11, Install no right on red restrictions
	4	Bridgeway and Locust	2	1	2	1	6	R38, Pedestrian crossing with enhanced safety features (bulb outs)	
	5	Bridgeway and Johnson	1	2	3	3	9	S2, Improve signal hardware S19, Check for and/or install pedestrian countdown signal heads NS6, Upgrade intersection pavement markings (high visibility crosswalk) R38, Pedestrian crossing with enhanced safety features (bulb out)	

PRIORITY PROJECTS

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

Bridgeway: Napa Avenue to San Carlos Avenue | Corridor

Bridgeway and Johnson Street looking southwest

EXISTING CONDITIONS:

In this segment Bridgeway is a two-lane principal arterial roadway. It is a designated bike route and is an important north-south connection for transit and pedestrians. The corridor had 34 total reported collisions in five years, including 16 bicycle collisions. Bicycles proceeding straight and motor vehicle turning right are the most common bicycle collision type.

POTENTIAL IMPROVEMENTS:

Improve Signals- Signalization improvements may include improving signal phasing, coordinating signals at multiple locations, upgrading signals to 12" heads, prohibiting right turns on red and adding video detection.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be implemented along this corridor including some of the following: adding high visibility crosswalks, curb extensions, center pedestrian refuge island, leading pedestrian intervals, advanced stop bars, yield lines and pedestrian orientated street lighting. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Consider upgrading bike lanes (e.g., by providing wider bicycle lanes and narrow traffic lanes, by creating green transition zones) and installing bike lane where there are gaps. While the corridor is constrained for space along this segment, bicycle collisions may indicate greater separation of bicycles and motor vehicles may be needed. Installing green paint through conflict zones and adding 'right turn yield to bikes' sign can increase the visibility of bicyclists.

Bridgeway: Gate 5 Road to Nevada Street (includes Brideway and Marinship/Easterby) | Corridor

Bridgeway and Coloma Street looking north

EXISTING CONDITIONS:

In this segment Bridgeway is a major four-lane principal arterial roadway. It is a designated bike route and is an important north-south connection for transit and pedestrians. The corridor had 15 total reported collisions in five years, including one motor vehicle KSI collision. Rear-end collisions are the most common motor vehicle collision type.

POTENTIAL IMPROVEMENTS:

Improve Signals- Signalization improvements may include improving signal phasing, coordinating signals at multiple locations, extending left turn pockets, upgrading signals to 12" heads, prohibiting right turns on red and adding video detection. Replace controllers to allow operational and safety improvment.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be implemented along this corridor including some of the following: high visibility crosswalks, blank-out signs to reinforce a no right on red turn restriction, advanced stop bars, bulb outs, tighten curb radius, directional curb ramps and leading pedestrian intervals. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence. In addition, off-system pathway improvements should be considered.

Bicycle Facility Improvements- Installing green paint through conflict zones can increase the visibility of bicyclists. Bicycle signals at key locations should be considered, e.g., Princess, Nevada and Spring. Provision for a wider bike lane by narrowing traffic lanes should be considered.

CHAPTER 13: TOWN OF TIBURON / CITY OF BELVEDERE

The following pages (13-1 to 13-4) address the collision history on local streets (i.e., excluding collisions on State Route 131/ Tiburon Boulevard) in both the Town of Tiburon and the City of Belvedere.

On pages 13-5 to 13-6, a focused assessment of collisions on State Route 131 (also known as Tiburon Boulevard) is presented to supplement the information in the plan, since a high proportion of collisions in the Town of Tiburon occur on State Route 131.

The Town of Tiburon had an estimated population of 9,644 as of January 1, 2016, according to the California Department of Finace, representing approximately 3.6 percent of Marin County's total population. In the five-year period between 2012 and 2016, Tiburon experienced a total of five reported crashes on local streets. None of the five crashes involved a person that was killed or severely injured.

Tiburon's share of reported crashes on local streets, as a proportion of total crashes in Marin County, during the five-year period is summarized below.

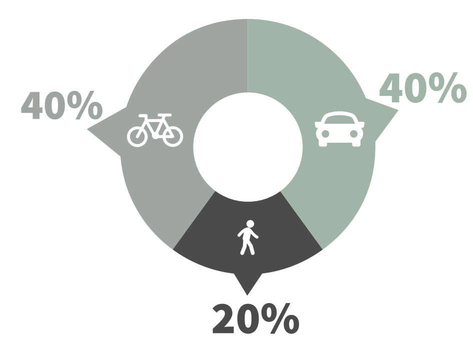
- **0.3% of all county-wide crashes**
- **0% of county-wide crashes in which a person was killed or severely injured (KSI)**
- **0% of all fatal county-wide crashes**

For all crashes as well as fatal and KSI crashes, Tiburon's share of those crashes as a proportion of total crashes in Marin County is less than the town's 3.4 percent share of the total county population.

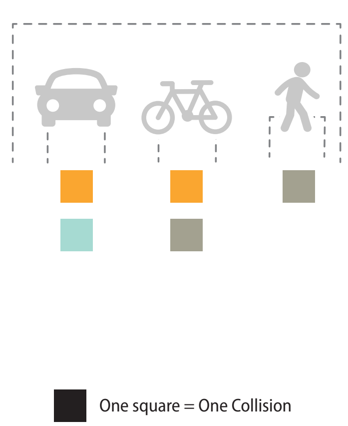
TIBURON COLLISIONS 2012 TO 2016

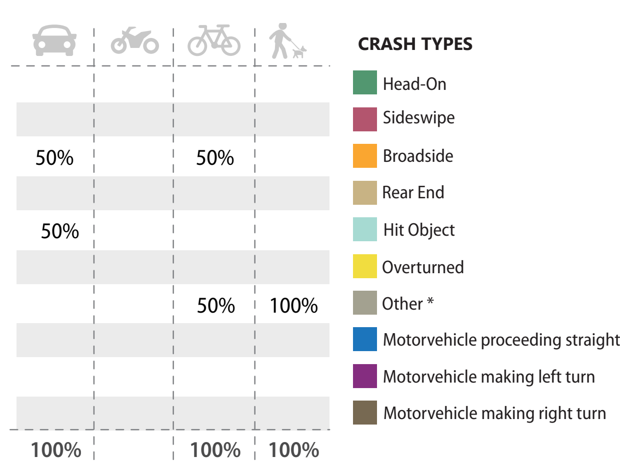
5 TOTAL COLLISIONS

0% KILLED OR SEVERELY INJURED [**0%** FATALITIES]



COLLISION BY MODE





CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

** "Other" is one of the eight crash type options for police officers to designate on collision reports.*

The City of Belvedere had an estimated population of 2,129 as of January 1, 2016, according to the California Department of Finace, representing approximately 0.8 percent of Marin County's total population. In the five-year period between 2012 and 2016, Belvedere experienced a total of three reported crashes on local streets. None of the three crashes involved a person that was killed or severely injured.

Belvedere's share of reported crashes on local streets, as a proportion of total crashes in Marin County, during the five-year period is summarized below.

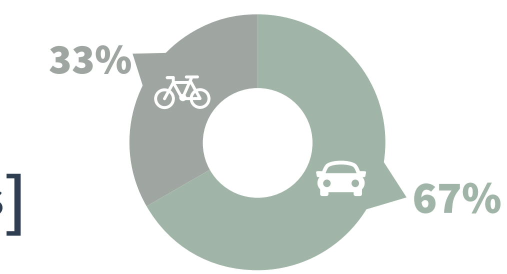
- **0.1% of all county-wide crashes**
- **0% of county-wide crashes in which a person was killed or severely injured (KSI)**
- **0% of all fatal county-wide crashes**

For all crashes as well as fatal and KSI crashes, Belvedere's share of those crashes as a proportion of total crashes in Marin County is less than the city's 0.8 percent share of the total county population.

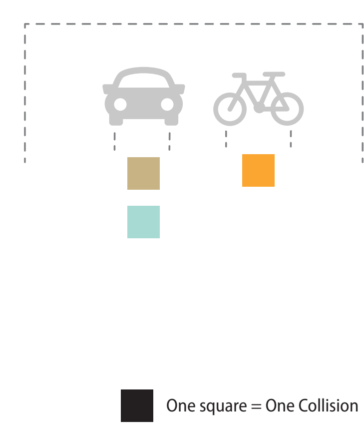
BELVEDERE COLLISIONS 2012 TO 2016

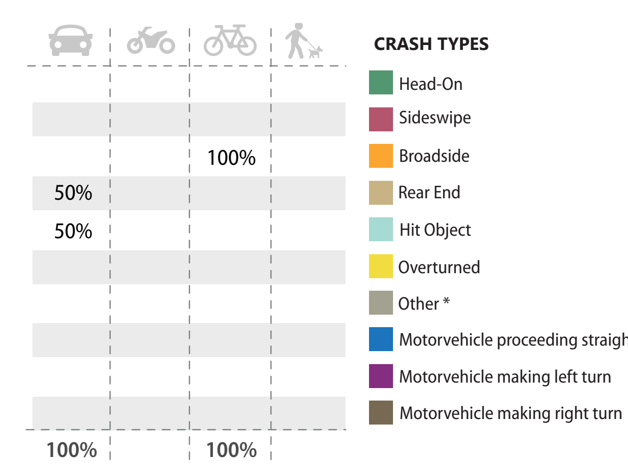
3 TOTAL COLLISIONS

0% KILLED OR SEVERELY INJURED [**0%** FATALITIES]



COLLISION BY MODE

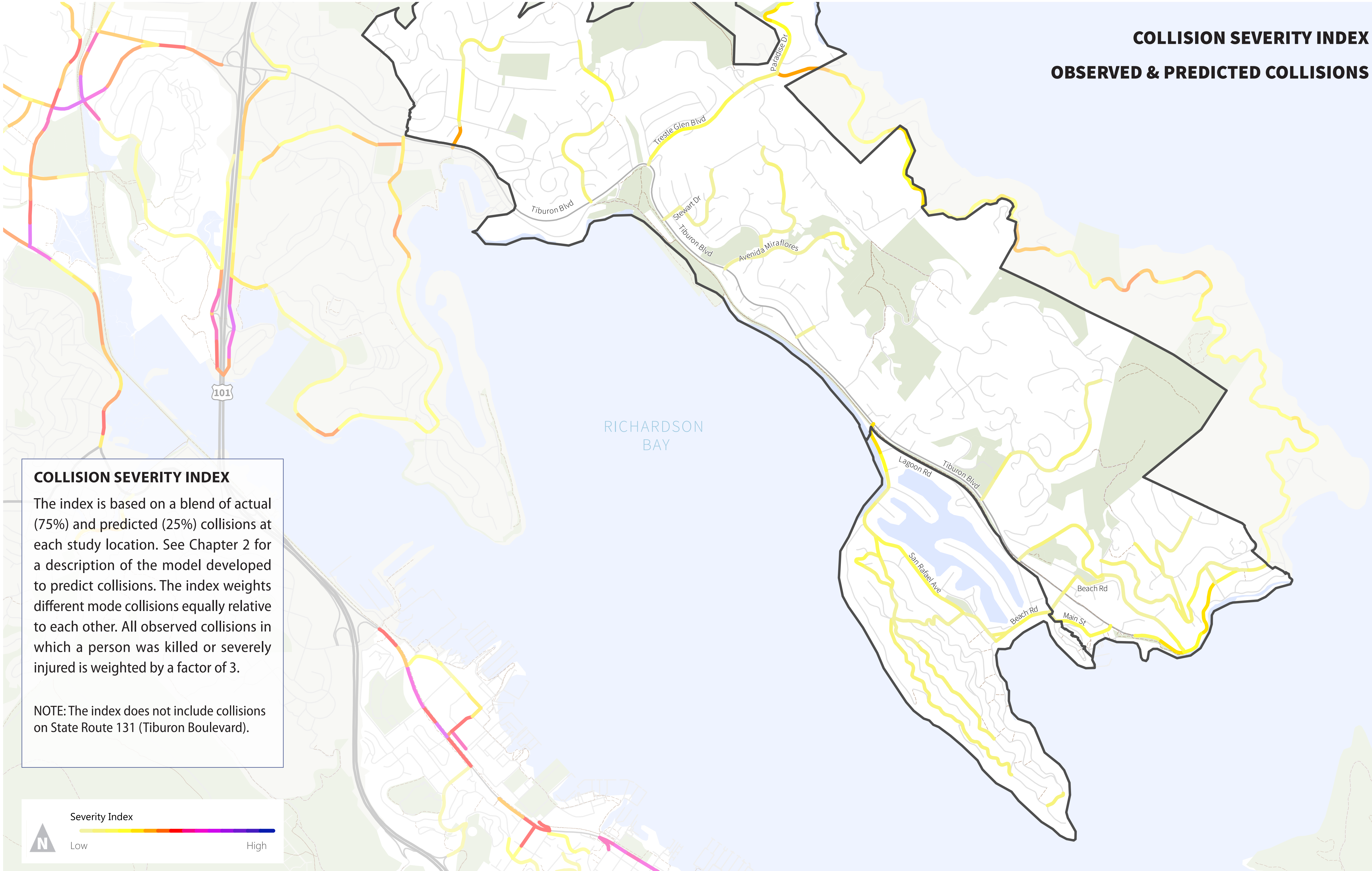




CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

COLLISION SEVERITY INDEX

OBSERVED & PREDICTED COLLISIONS



COLLISION SEVERITY INDEX

The index is based on a blend of actual (75%) and predicted (25%) collisions at each study location. See Chapter 2 for a description of the model developed to predict collisions. The index weights different mode collisions equally relative to each other. All observed collisions in which a person was killed or severely injured is weighted by a factor of 3.

NOTE: The index does not include collisions on State Route 131 (Tiburon Boulevard).

The four collision profiles, shown at the bottom right, are based on an analysis of Tiburon crash data and related environmental factors. Every profile highlights a crash pattern the study has identified as a priority concern.

The table below shows the proportion of crash types by mode. Data to the right provides a comparison of the percentage of Tiburon collisions vs. total collisions across all of Marin jurisdictions by mode, collision type, select age and collision violation categories.

The following pages identify safety countermeasures for study corridors and intersections. These countermeasures make up a toolkit of safety interventions the Town can utilize to implement projects tailored to unique safety issues.

5 TOTAL TIBURON COLLISIONS

2,756 TOTAL MARIN COLLISIONS

2012-2016

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

				CRASH TYPES
				Head-On
				Sideswipe
50%		50%		Broadside
				Rear End
50%				Hit Object
				Overturned
		50%	100%	Other *
				Motorvehicle proceeding straight
				Motorvehicle making left turn
				Motorvehicle making right turn
100%		100%	100%	

** "Other" is one of the eight crash type options for police officers to designate on collision reports.*

TIBURON VS. MARIN COLLISIONS - RELATIVE SHARE

	AGE		VIOLATION	
	Youth	Senior	DUI	Unsafe Speed
Town of Tiburon	**20.0%**	20.0%	0.0%	0.0%
All Marin Collisions	13.7%	21.4%	10.5%	28.2%

	MODE				
	Auto	Motorcycle	Bicycle	Pedestrian	Other
Town of Tiburon	40.0%	0.0%	**40.0%**	**20.0%**	0.0%
All Marin Collisions	63.8%	6.4%	18.1%	11.1%	0.6%

	COLLISION TYPE							
	Head-on	Sideswipe	Rear-end	Broadside	Hit Object	Overturned	Vehicle/ Pedestrian	Other
Town of Tiburon	0.0%	0.0%	0.0%	**40.0%**	**20.0%**	0.0%	0.0%	**40.0%**
All Marin Collisions	7.1%	8.7%	24.5%	20.3%	11.8%	5.6%	11.0%	10.7%

LOCAL COLLISION PROFILES

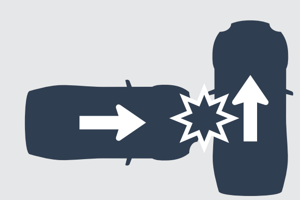
BICYCLE COLLISIONS (UNDER THE AGE OF 15

California Office of Traffic Safety ranked Tiburon 19th of 75 similar California cities with high levels of bicycle collisions involving children in 2012.

BICYCLE COLLISIONS

2 of 5 collisions in Tiburon involved bicycles, more than twice the county average.

BROADSIDE COLLISIONS



2 of 5 collisions in Tiburon involved broadside collisions, double the county average.

HIT OBJECT COLLISIONS

1 of 5 collisions in Tiburon involved hitting fixed objects, double the county average.

The four collision profiles, shown at the bottom right, are based on an analysis of Belvedere crash data and related environmental factors. Every profile highlights a crash pattern the study has identified as a priority concern.

The table below shows the proportion of crash types by mode. Data to the right provides a comparison of the percentage of Belvedere collisions vs. total collisions across all of Marin jurisdictions by mode, collision type, select age and collision violation categories.

The following pages identify safety countermeasures for study corridors and intersections. These countermeasures make up a toolkit of safety interventions the City can utilize to implement projects tailored to unique safety issues.

3 TOTAL BELVEDERE COLLISIONS

2,756 TOTAL MARIN COLLISIONS

2012-2016

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

				CRASH TYPES
				Head-On
				Sideswipe
		100%		Broadside
50%				Rear End
50%				Hit Object
				Overturned
				Other *
				Motorvehicle proceeding straight
				Motorvehicle making left turn
				Motorvehicle making right turn
100%		100%		

** "Other" is one of the eight crash type options for police officers to designate on collision reports.*

BELVEDERE VS. MARIN COLLISIONS - RELATIVE SHARE

	AGE		VIOLATION	
	Youth	Senior	DUI	Unsafe Speed
City of Belvedere	**33.3%**	0.0%	**33.3%**	0.0%
All Marin Collisions	13.7%	21.4%	10.5%	28.2%

MODE

	Auto	Motorcycle	Bicycle	Pedestrian	Other
City of Belvedere	**66.7%**	0.0%	**33.3%**	0.0%	0.0%
All Marin Collisions	63.8%	6.4%	18.1%	11.1%	0.6%

COLLISION TYPE

	Head-on	Sideswipe	Rear-end	Broadside	Hit Object	Overturned	Vehicle/ Pedestrian	Other
City of Belvedere	0.0%	0.0%	**33.3%**	**33.3%**	**33.3%**	0.0%	0.0%	0.0%
All Marin Collisions	7.1%	8.7%	24.5%	20.3%	11.8%	5.6%	11.0%	10.7%

LOCAL COLLISION PROFILES

BICYCLE COLLISIONS

1 of 3 collisions in Belvedere involved bicycles, almost double the county average.

DUI

1 of 3 collisions in Belvedere involved persons that were driving under the influence, more than double the county average.

YOUTH COLLISIONS

1 of 3 collisions in Belvedere involved youth, approximately double the county average.

HIT OBJECT COLLISIONS

1 of 3 collisions in Belvedere involved hitting fixed objects, more than double the county average.

TIBURON BOULEVARD (STATE ROUTE 131)

This Marin Travel Safety Plan addresses collisions and countermeasures on local streets throughout Marin County, as the objective is to provide a plan for local agencies to implement safety measures over the coming years. The Travel Safety Plan does not address conditions on state highways in Marin County, as improvements on those facilities would be funded and implemented by Caltrans. As such, collisions on Tiburon Boulevard (also State Route 131) are not included in previous sections presented in this plan.

The following subsection presents a focused assessment of collisions on Tiburon Boulevard to supplement the information in the plan, since a high proportion of collisions in the Town of Tiburon occur on Tiburon Boulevard. Over the five-year period between 2012 and 2016, Tiburon Boulevard experienced a total of 32 collisions that involved an injury or fatality based on the UC Berkeley/PATH TIMS database that is derived from the SWITRS accident report database. Screening of TIMS crash records found some collisions to be missing. Supplemental records provided by the City of Tiburon were added to the database.

The corridor of Tiburon Boulevard (State Route 131) is one of Tiburon's priority project locations. Unsafe speed collisions are the most common motor vehicle collision type.

COLLISIONS 2012 TO 2016

32 TOTAL COLLISIONS

3% KILLED OR SEVERELY INJURED

3% FATALITIES

PRIMARY COLLISION FACTOR

- 18 Unsafe Speed
- 4 Improper Turning
- 3 Unsafe Starting or Backing
- 3 Auto Right-of-way
- 2 Pedestrian Collisions
- 1 Wrong Side of Road
- 1 Other Improper Driving

TRAVEL MODES

7 VEHICLE/ MOTORCYCLE COLLISIONS

2 VEHICLE/ BICYCLE COLLISIONS

2 VEHICLE/ PEDESTRIAN COLLISIONS

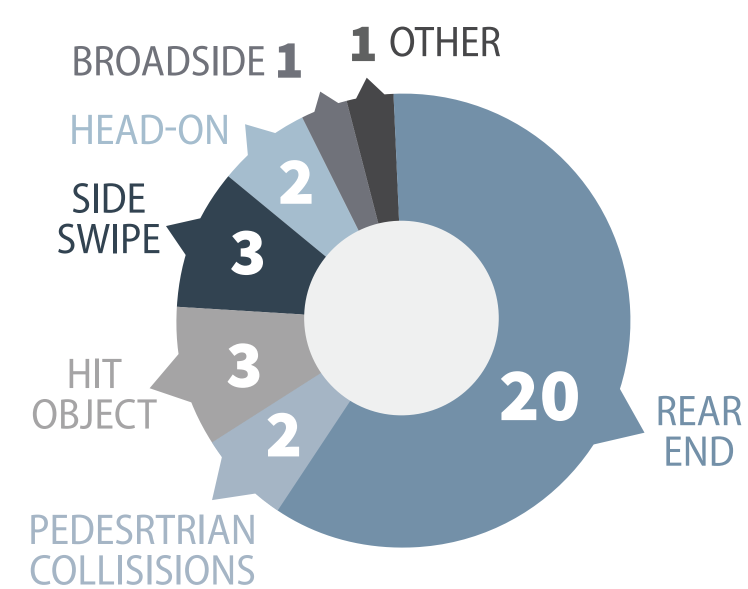
CONDITIONS

28 COLLISIONS OCCURRED DURING DAYLIGHT

4 COLLISIONS OCCURRED DURING NIGHT

0 COLLISIONS OCCURRED ON WET PAVEMENT

COLLISION TYPES



SUMMARY OF FATAL OR INJURED COLLISIONS ON TIBURON BOULEVARD

The following is a summary of the key characteristics of the 32 collisions that involved an injury or fatality on Tiburon Boulevard between 2012 and 2016. Most of the collisions on Tiburon Boulevard were rear-end (63%) and most were caused by autos traveling at an unsafe speed (56%). Two collisions involved bicycles and there were two collisions involving pedestrians. Alcohol was involved in one collision.

The five collisions at Stewart Drive were all rear-end collisions that occurred as a result of unsafe auto speeds. Three involved vehicles traveling eastbound and two involved vehicles traveling westbound. One of the collisions involved an auto and a motorcycle, with the motorcycle being at fault.

The three collisions at Reed Ranch Road involved two rear-end collisions and a left turn collision. The rear-end collisions both involved eastbound vehicles, and were both due to unsafe speeds. The third collision involved an auto making a southbound left turn and an auto traveling in the westbound direction.

The three collisions at San Rafael Avenue included one collision with a bicyclist and one with a motorcycle. The bicycle was traveling eastbound on Tiburon Boulevard, and was hit by an eastbound auto that was turning right onto San Rafael Avenue, with the auto driver at fault. The motorcycle was traveling eastbound and was struck by a westbound auto turning left onto San Rafael Avenue, with the auto driver at fault. The third collision was a rear-end involving two eastbound vehicles and was due to unsafe speed.

The three collisions at Rock Hill Road involved two rear-end collisions and a sideswipe collision. One of the rear-end collisions involved a westbound auto and motorcyclist, and was due to unsafe speed. The other two collisions involved eastbound vehicles. The eastbound rear-end collision was due to unsafe speed and the sideswipe collision was due to a right-of-way violation.

The three collisions at Beach Road involved two rear-end and a left turn collision. Both rear-end collisions, one of which involved eastbound vehicles and the other westbound vehicles, occurred due to unsafe speed. The left turn collision involved a northbound vehicle making a left turn and a westbound vehicle proceeding straight.

The two collisions at Cecilia Way both involved a motorcycle and an auto. The collisions were both rear-end collisions that occurred as a result of unsafe speeds. In both cases, the motorcycle was at fault.

The two collisions at Avenida Mira Flores included a fatal collision and a second collision about 160 feet west of the intersection. The fatal collision was a solo crash where a westbound auto ran off the road and hit a fixed object. The other collision involved a westbound vehicle that also ran off the road and hit a fixed object due to unsafe speed.

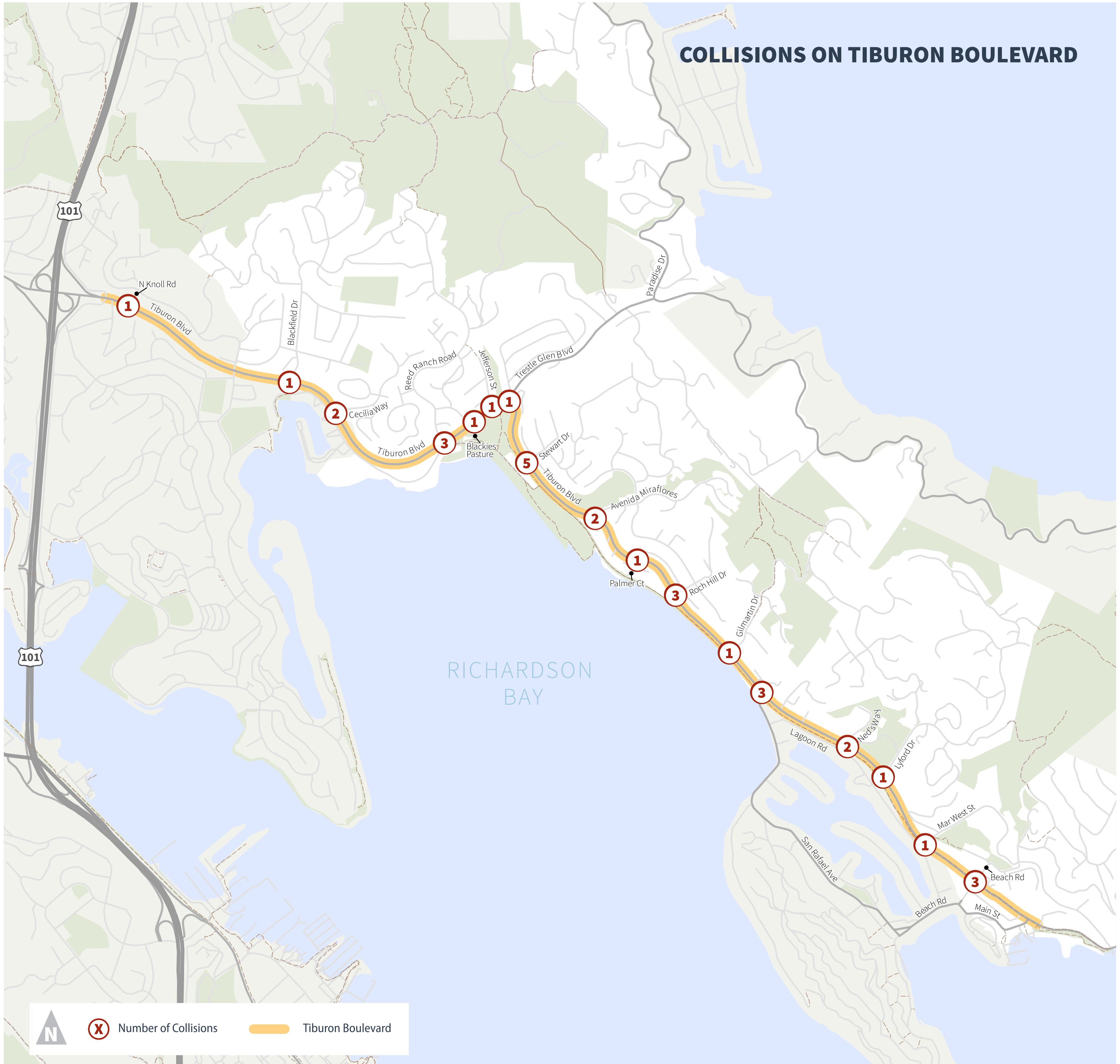
The two collisions at Ned's Way involved pedestrians in the crosswalk at the north leg of the intersection at night. Both collisions resulted in injuries and the driver was found to be at fault.

The one collision at Jefferson Drive was the second of two collisions on the corridor involving a bicycle (e.g., the other occurred at San Rafael Avenue and is described above). The cyclist was traveling in the eastbound direction on Tiburon Boulevard, but on the wrong side of the road. The crash occurred between the cyclist and an auto making a southbound right turn from Jefferson Drive onto westbound Tiburon Boulevard.

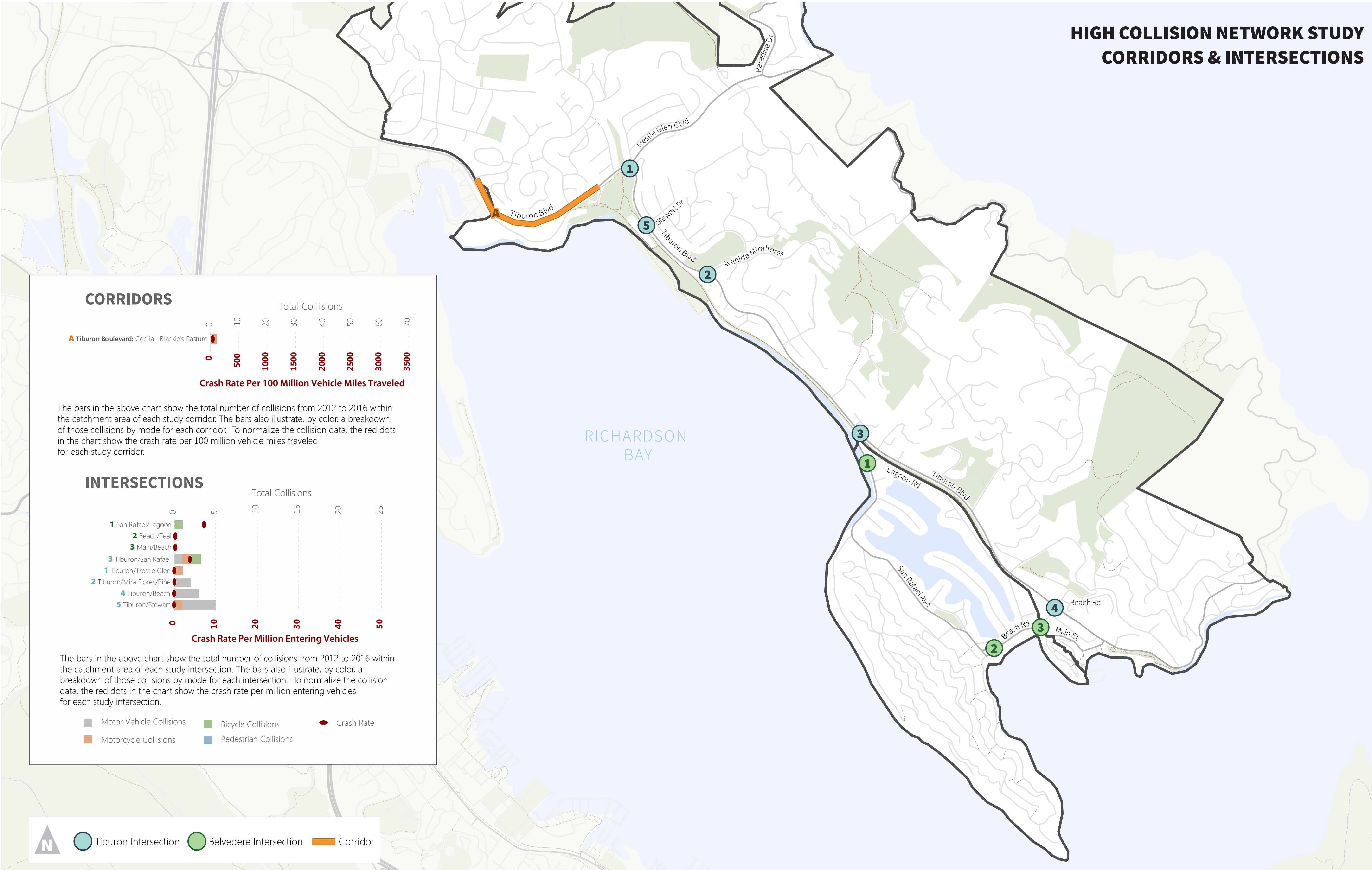
The one collision at Trestle Glen Boulevard involved a rear-end collision between a westbound motorcycle and auto with the auto driver at fault. The one collision at Lyford Drive also involved a rear-end collision between a westbound motorcycle and auto with the auto driver at fault.

The single collision at Blackie's Pasture involved a collision of an eastbound auto and a northbound auto from the side street making a right turn. The single collision at Mar West Street involved a single eastbound auto that ran off the road and hit a fixed object.

The single collisions at the following intersections involved rear-end collisions due to unsafe speed: North Knoll Road, Blackfield Drive, Palmer Court, and Gilmartin Drive.



TOWN OF TIBURON / CITY OF BELVEDERE


HIGH COLLISION NETWORK STUDY
CORRIDORS & INTERSECTIONS
RICHARDSON BAY
Tiburon Blvd
Trestle Glen Blvd
Paradise Dr
Stewart Dr
Avenida Miraflores
Lagoon Rd
San Rafael Ave
Beach Rd
Main St
CORRIDORS
Total Collisions
A Tiburon Boulevard: Cecilia - Blackie's Pasture
Crash Rate Per 100 Million Vehicle Miles Traveled
The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study corridor. The bars also illustrate, by color, a breakdown of those collisions by mode for each corridor. To normalize the collision data, the red dots in the chart show the crash rate per 100 million vehicle miles traveled for each study corridor.
INTERSECTIONS
Total Collisions
1 San Rafael/Lagoon
2 Beach/Teal
3 Main/Beach
3 Tiburon/San Rafael
1 Tiburon/Trestle Glen
2 Tiburon/Mira Flores/Pine
4 Tiburon/Beach
5 Tiburon/Stewart
Crash Rate Per Million Entering Vehicles
The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study intersection. The bars also illustrate, by color, a breakdown of those collisions by mode for each intersection. To normalize the collision data, the red dots in the chart show the crash rate per million entering vehicles for each study intersection.
Motor Vehicle Collisions
Motorcycle Collisions
Bicycle Collisions
Pedestrian Collisions
Crash Rate
N
Tiburon Intersection
Belvedere Intersection
Corridor

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

BELVEDERE

	ID	NAME	COLLISIONS: MOTOR VEHICLE	COLLISIONS: MOTORCYCLE	COLLISIONS: BICYCLE	COLLISIONS: PEDESTRIAN	COLLISIONS: TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
INTERSECTIONS	1	San Rafael and Lagoon	0	0	1	0	1	NS16, Install intersection pavement markings (high visibility crosswalk)	NH6, Install sharrows
INTERSECTIONS	2	Beach Rd and Teal Rd	0	0	0	0	0	NS16, Install intersection pavement markings (high visibility crosswalk) NS18, Install pedestrian crossing (with advanced safety feature: install bulb outs, install directional ADA pedestrian ramps)	
INTERSECTIONS	3	Main and Beach	0	0	0	0	0	NS8, Install flashing beacon as advanced warning NS16, Upgrade intersection pavement markings (high visibility crosswalk) NS18, Install pedestrian crossing (with advanced safety feature: install bulb outs, install directional ADA pedestrian ramps)	NH6, Install sharrows

TIBURON

	ID	NAME	COLLISIONS: MOTOR VEHICLE	COLLISIONS: MOTORCYCLE	COLLISIONS: BICYCLE	COLLISIONS: PEDESTRIAN	COLLISIONS: TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURES
CORRIDOR	A	Tiburon Blvd: Cecilia Way to Blackies Pasture	4	2	0	0	6	R36, Install bike lanes R37, Install sidewalk/ pathway where there is right-of-way S20, Upgrade intersection pavement markings (high visibility crosswalk), install ADA pedestrian curb ramp and tighten curb radii S20, Consider installing a pedestrian signal or HAWK	NH2, Remove slip lane(s)
INTERSECTIONS	1	Tiburon Blvd and Trestle Glen Blvd	0	1	0	0	1	S2, Improve signal hardware S3, Improve signal timing and detection S18, Convert signalized intersection to roundabout (optional CM as an alternative to S2,S3 and S19) S19, Check for and/or install pedestrian countdown signal heads S20, Upgrade intersection pavement markings (high visibility crosswalk)	
INTERSECTIONS	2	Tiburon Blvd and Avenida Miraflores and Pine	2	0	0	0	2	S3, Improve signal timing and detection S18, Convert signalized intersection to roundabout (optional CM as an alternative to S3)	NH2, Remove slip lane(s)
INTERSECTIONS	3	Tiburon Blvd and San Rafael Avenue	1	1	1	0	3	NS6, Upgrade intersection pavement markings (high visibility crosswalk) R36, Install bike lanes	
INTERSECTIONS	4	Tiburon Blvd and Beach Rd	3	0	0	0	3	S2, Improve signal hardware S6, Provide protected left turn phase S18, Convert signalized intersection to roundabout (optional CM as an alternative to S2, S6 and S19) S19, Check for and/or install pedestrian countdown signal heads	
INTERSECTIONS	5	Tiburon Blvd and Stewart Dr	4	1	0	0	5	NS6, Upgrade intersection pavement markings NS8, Install flashing beacon as advanced warning NS16, Consider installing raised median/ refuge island NS19, Install a pedestrian signal or HAWK or an RRFB	

PRIORITY PROJECTS

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

TIBURON

Tiburon Boulevard: Cecilia Way to Blackies Pasture | Corridor

Tiburon Boulevard looking north

EXISTING CONDITIONS:

In this segment Tiburon Boulevard is a four-lane arterial that runs along the waterfront through Tiburon. Tiburon Boulevard is one of only two ways in and out of Tiburon and connects with Highway 101. The corridor had six total reported collisions in five years, including one bicycle collision.

POTENTIAL IMPROVEMENTS:

Pedestrian Crossing Improvements- A number of pedestrian improvements could be implemented along this corridor including some of the following: adding high visibility crosswalks, installing ADA curb ramps where applicable, installing sidewalks where there is room and removing slip lanes. Consider installing RRFBs or HAWKs to facilitate pedestrian crossings. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Consider installing bike lanes on Tiburon Boulevard. Adding dedicated bicycle facilities can lessen the chances of collisions involving motor vehicles overtaking bicyclists.

Tiburon Boulevard and Stewart Drive | Intersection

Tiburon Boulevard and Stewart Drive looking north

EXISTING CONDITIONS:

Near Stewart Drive, Tiburon Boulevard is a two-lane arterial that runs along the waterfront through Tiburon. Tiburon Boulevard is one of only two ways in and out of Tiburon and connects with Highway 101. The intersection of Tiburon Boulevard and Stewart Drive has a pedestrian beacon. This intersection had five reported collisions in five years.

POTENTIAL IMPROVEMENTS:

Pedestrian Crossing Improvements- A number of pedestrian improvements could be implemented at this intersection including some of the following: upgrade pedestrian signal to an RRFB, install yield limit lines, install a flashing beacon as advanced warning and add pavement markings. These could improve pedestrian crossings by emphasising pedestrian's presence.

BELVEDERE

San Rafael Avenue and Lagoon Road | Intersection

San Rafael Avenue and Lagoon Road looking south

EXISTING CONDITIONS:

San Rafael Avenue is a two-lane arterial that runs along the waterfront through Belvedere. San Rafael Avenue is one of only two access roads into Belvedere Island. The corridor had one reported collision in five years, which was a bicycle collision.

POTENTIAL IMPROVEMENTS:

Pedestrian Crossing Improvements- Consider installing high visibility crosswalks at the intersection. This could improve pedestrian crossings by emphasizing pedestrian's presence.

Bicycle Facility Improvements- Consider installing sharrow markings along San Rafael Avenue. Sharrow markings can increase the visibility of bicyclists and clarify where bicyclists are expected to ride.

CHAPTER 14: UNINCORPORATED MARIN COUNTY

Unincorporated Marin County had an estimated population of 69,016 as of January 1, 2016, according to the California Department of Finance, representing approximately 26.2 percent of Marin County's total population. In the five-year period between 2012 and 2016, Unincorporated Marin County experienced a total of 624 reported crashes on local streets. One hundred of those crashes involved a person that was killed or severely injured, and of the 100, seven crashes involved fatalities.

Unincorporated Marin County's share of reported crashes on local streets, as a proportion of total crashes in Marin County, during the five-year period is summarized below.

- **22.6% of all county-wide crashes**
- **45.2% of county-wide crashes in which a person was killed or severely injured (KSI)**
- **1.3% of all fatal county-wide crashes**

For all crashes, Unincorporated Marin County's share of those crashes as a proportion of total crashes in Marin County was less than the jurisdiction's 26.2 percent share of the total county population. However, for crashes involving severe injuries or fatalities, Unincorporated Marin County's share of those crashes as a proportion of total crashes in Marin was greater than the jurisdiction's 26 percent of the total county population.

Panoramic Highway between Shoreline Highway and Gravity Car Road is one of unincorporated County's priority project locations. The corridor had 26 total reported collisions in a recent five-year period. Overturn incidents are the most common motorcycle collision type and hit objects are the most common motor vehicle collision type.

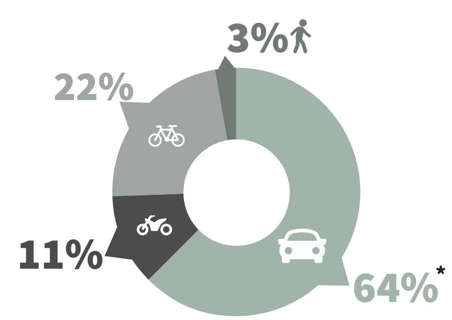
COLLISIONS 2012 TO 2016

624 TOTAL COLLISIONS

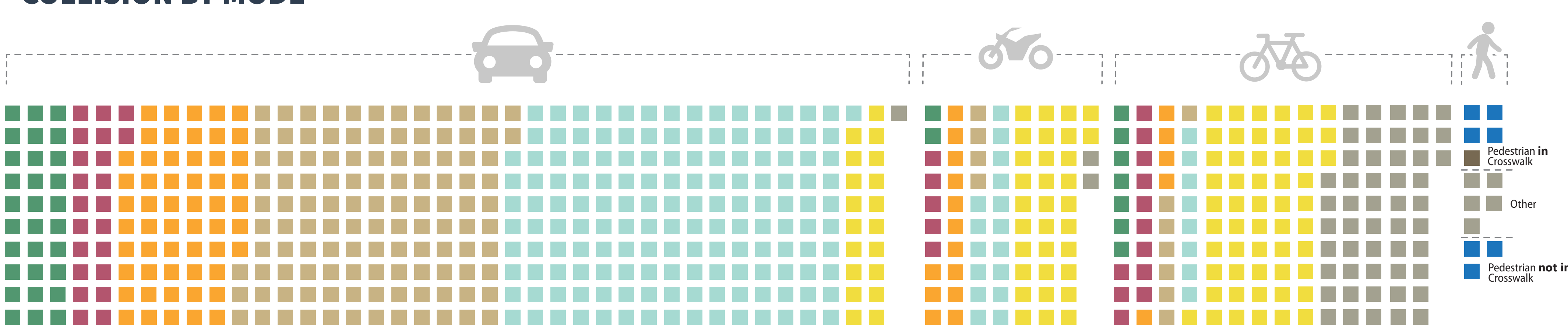
16% KILLED OR SEVERELY INJURED

[1% FATALITIES**]**

COLLISION BY MODE



COLLISION BY MODE



One square = One Collision

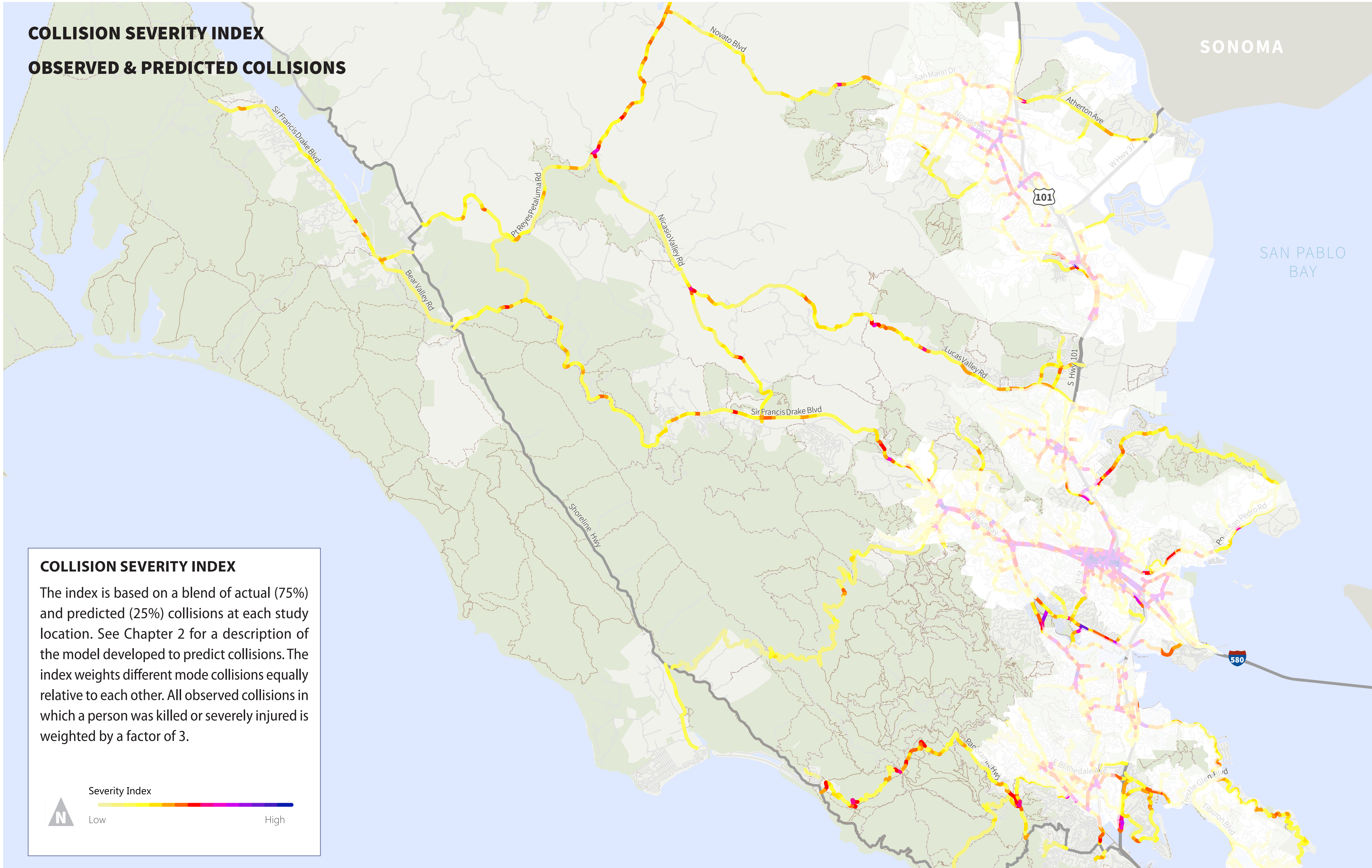
* "Other" is one of the eight crash type options for police officers to designate on collision reports. Collisions designated as "Other" are included in the auto portion of the collisions by mode chart above.

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

CRASH TYPES	Auto	Motorcycle	Bicycle	Pedestrian
Head-On	8%	3%	5%	
Sideswipe	6%	7%	8%	
Broadside	14%	18%	3%	
Rear End	29%	5%		
Hit Object	38%	22%	6%	
Overturned	5%	43%	38%	
Other *		3%	34%	38%
Motorvehicle proceeding straight			1%	54%
Motorvehicle making left turn				
Motorvehicle making right turn				8%
	100%	100%	100%	100%

COLLISION SEVERITY INDEX

OBSERVED & PREDICTED COLLISIONS



COLLISION SEVERITY INDEX

The index is based on a blend of actual (75%) and predicted (25%) collisions at each study location. See Chapter 2 for a description of the model developed to predict collisions. The index weights different mode collisions equally relative to each other. All observed collisions in which a person was killed or severely injured is weighted by a factor of 3.

This study developed crash profiles to highlight five of the top trends among collisions in Unincorporated Marin County. The collision profiles, shown at the bottom right, are based on an analysis of crash data and related environmental factors. Every profile highlights a crash pattern the study has identified as a priority concern.

The table below shows the proportion of crash types by mode. Data to the right provides a comparison of the percentage of Unincorporated Marin County collisions vs. total collisions across all of Marin jurisdictions by mode, collision type, select age and collision violation categories.

The following pages identify safety countermeasures for study corridors and intersections. These countermeasures make up a toolkit of safety interventions the Unincorporated Marin County can utilize to implement projects tailored to unique safety issues.

624 TOTAL COUNTY COLLISIONS

2,756 TOTAL MARIN COLLISIONS

2012-2016

CRASH TYPES BY MODE: RATIOS OF ALL COLLISIONS

Auto	Motorcycle	Bicycle	Pedestrian	CRASH TYPES
8%	3%	5%		Head-On
6%	7%	8%		Sideswipe
14%	18%	3%		Broadside
29%	5%	5%		Rear End
38%	22%	6%		Hit Object
5%	43%	38%		Overturned
	3%	34%	38%	Other *
		1%	54%	Motorvehicle proceeding straight
				Motorvehicle making left turn
			8%	Motorvehicle making right turn
100%	100%	100%	100%	

** "Other" is one of the eight crash type options for police officers to designate on collision reports.*

UNINCORPORATED COUNTY VS. MARIN COLLISIONS - RELATIVE SHARE

	AGE		VIOLATION	
	Youth	Senior	DUI	Unsafe Speed
Unincorporated Marin	11.9%	19.7%	**14.9%**	**33.6%**
All Marin Collisions	13.7%	21.4%	10.5%	28.2%

	MODE				
	Auto	Motorcycle	Bicycle	Pedestrian	Other
Unincorporated Marin	63.1%	**11.2%**	**22.2%**	2.4%	**1.0%**
All Marin Collisions	63.8%	6.4%	18.1%	11.1%	0.6%

	COLLISION TYPE							
	Head-on	Sideswipe	Rear-end	Broadside	Hit Object	Overturned	Vehicle/ Pedestrian	Other
Unincorporated Marin	5.7%	6.2%	21.2%	13.0%	**25.4%**	**16.9%**	2.8%	8.8%
All Marin Collisions	7.1%	8.7%	24.5%	20.3%	11.8%	5.6%	11.0%	10.7%

LOCAL COLLISION PROFILES

BICYCLE COLLISIONS

California Office of Traffic Safety ranked Unincorporated Marin County 2nd of 58 California counties with high levels of bicycle collisions in 2015.

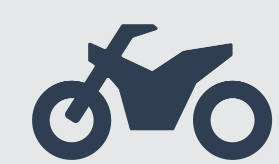
PEDESTRIAN COLLISIONS (OVER THE AGE OF 65)

California Office of Traffic Safety ranked Unincorpo-rated Marin County 3rd of 58 California counties with high levels of pedestrian collisions involving seniors in 2015.

SPEED RELATED COLLISIONS

California Office of Traffic Safety ranked Unincorporated Marin County 1st of 58 California counties with high levels of speed related collisions in 2014.

MOTORCYCLE COLLISIONS

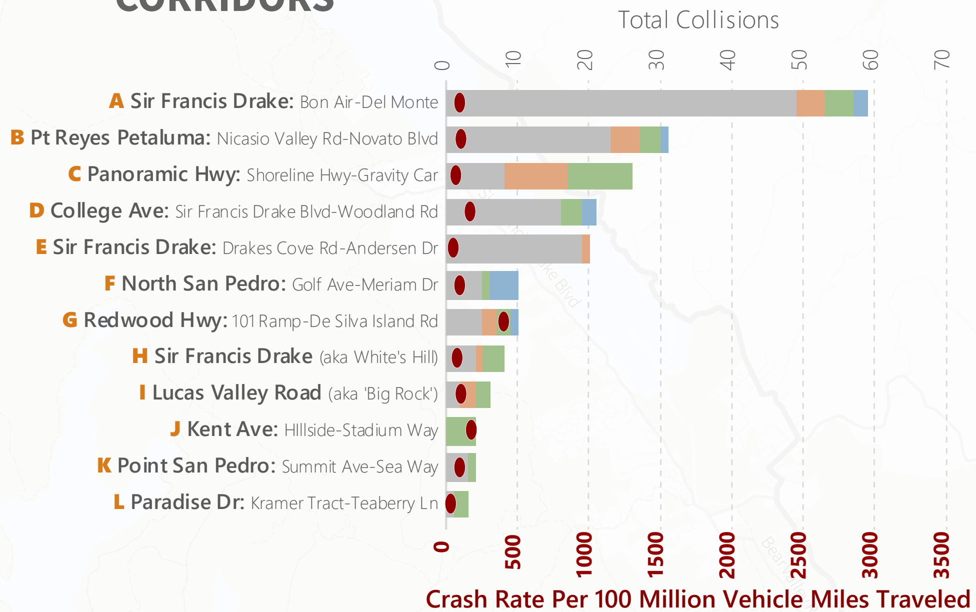


11% (69) of all collisions in Unincorporated Marin County involved motorcycles, almost double the county average.

HIT OBJECT COLLISIONS

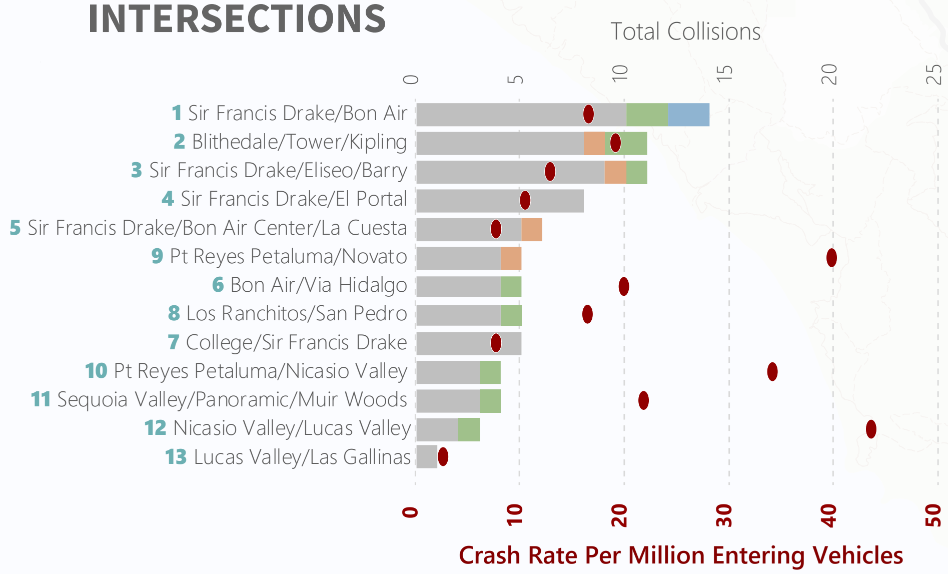
25% (156) of all collisions in Unincorporated Marin County involved hitting fixed objects, more than double the county average.

CORRIDORS



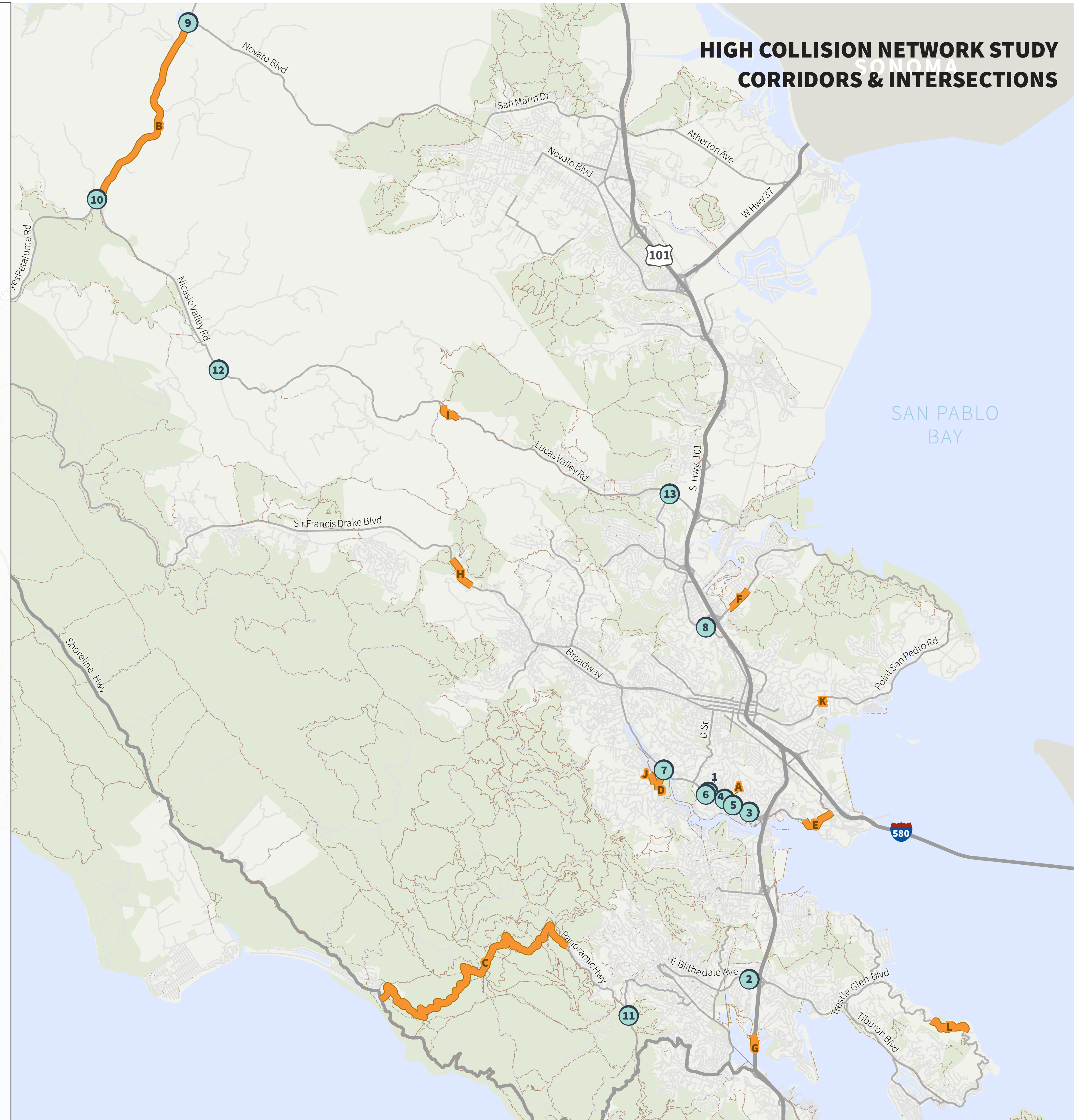
The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study corridor. The bars also illustrate, by color, a breakdown of those collisions by mode for each corridor. To normalize the collision data, the red dots in the chart show the crash rate per 100 million vehicle miles traveled for each study corridor.

INTERSECTIONS



The bars in the above chart show the total number of collisions from 2012 to 2016 within the catchment area of each study intersection. The bars also illustrate, by color, a breakdown of those collisions by mode for each intersection. To normalize the collision data, the red dots in the chart show the crash rate per million entering vehicles for each study intersection.

Motor Vehicle Collisions
Motorcycle Collisions
Bicycle Collisions
Pedestrian Collisions
Crash Rate



POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

CORRIDORS

ID	NAME	COLLISIONS: MOTOR VEHICLE	COLLISIONS: MOTORCYCLE	COLLISIONS: BICYCLE	COLLISIONS: PEDESTRIAN	COLLISIONS: TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURE
A	Sir Francis Drake: Bon Air to Del Monte	49	4	4	2	59	S3, Improve signal timing and detection S4, Advanced dilemma zone detection	
B	Point Reyes Petaluma Rd: Nicasio Valley Rd to Novato Blvd	23	4	3	1	32	R4, Install guardrail R16, Widen shoulder (paved) R27, Install chevron signs on horizontal curves	
C	Panoramic Hwy: Shoreline Hwy to Gravity Car	8	9	9	0	26	R4, Install guardrail R27, Install chevron signs on horizontal curves R28, Install curve advanced warning sign R30, Install dynamic/variable speed warning sign (on down hill sections)	NH7, Install 'Bikes May Use Full Lane' sign
D	College Avenue: Sir Francis Drake Blvd to Woodland Rd	16	0	3	2	21	NS4, Convert signal to roundabout (at Woodland Rd and College Ave) R36, Install bike lanes (upgrade to green bike lanes and / or more frequent bike lane markings) R38, Install pedestrian crossing with enhanced safety features (bulb outs)	
E	Sir Francis Drake: Drakes Cove Rd to Andersen Dr	19	1	0	0	20	S3, Improve signal timing and detection	
F	North San Pedro: Golf Avenue to Meriam Dr	5	0	1	4	10	R38, Install pedestrian crossing with enhanced safety features (add bulb outs, midblock crossing and tighten up curb radii) NS13, Create directional median openings to allow and restrict left turns NS18, Install pedestrian crossing at uncontrolled locations with advanced safety feature (install RRFB or Flashing LED beacons midblock crossing)	NH7, Install 'Bikes May Use Full Lane' sign
G	Redwood Hwy: 101 Ramp to De Silva Island Rd	5	2	2	1	10	S3, Improve signal timing and detection S20, Install pedestrian crossing (install high visibility crosswalks, curb extensions where applicable and advanced stop bars) R4, Install guardrail R36, Install bike lanes (install green paint through intersection to delineate conflict zones)	
H	Sir Francis Drake (aka White's Hill)	4	1	3	0	8	R30, Install dynamic/variable speed warning signs R36, Install bike lanes(green or buffered bike lanes)	NH7, Install 'Bikes May Use Full Lane' sign

UNINCORPORATED MARIN COUNTY

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

	ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURE
CORRIDORS	I	Lucas Valley Road (aka 'Big Rock')	2	2	2	0	6	R4, Install guardrail (where applicable) R16, Widen shoulder R30, Install dynamic/variable speed warning signs (for downhill sections)	NH7, Install 'Bikes May Use Full Lane' sign (for downhill segment)
CORRIDORS	J	Kent Avenue: HIllside to Stadium Way	0	0	4	0	4	R36, Install bike lanes	NH5, Install wayfinding (install bicycle route signs and designate corridor as a bike route)
CORRIDORS	K	Paradise Dr: Kramer Tract to Teaberry Lane	1	0	2	0	4	R4, Install guardrail R16, Widen shoulder R27, Install chevron signs on horizontal curves	NH7, Install 'Bikes May Use Full Lane' sign
CORRIDORS	L	Point San Pedro: Summit Avenue to Sea Way	3	0	1	0	4	NS18, Install pedestrian crossing at uncontrolled locations with advanced safety feature (install RRFB or Flashing LED beacons)	NH7, Install 'Bikes May Use Full Lane' sign
INTERSECTIONS	1	Sir Francis Drake and Bon Air	10	0	2	2	14	S2, Improve signal hardware S3, Improve signal timing and detection S19, Check for and/or install pedestrian countdown signal heads S20, Pedestrian crossing with enhanced safety features (ADA curb ramps, tighten curb radii) NS6, Upgrade intersection pavement markings (high visibility crosswalk) NH2, Remove slip lane(s) NH8, Square up intersection	
INTERSECTIONS	2	Blithedale and Tower and Kipling	8	1	2	0	11	S3, Improve signal timing and detection S20, Install pedestrian crossing (with advanced safety feature: such as curb extensions & directional ADA pedestrian ramps)	
INTERSECTIONS	3	Sir Francis Drake and Eliseo and Barry	9	1	1	0	11	S2, Improve signal hardware S3, Improve signal timing and detection (to help reduce congestion) S19, Check for and/or install pedestrian countdown signal heads S20, Pedestrian crossing with enhanced safety features NS6, Upgrade intersection pavement markings (high visibility crosswalk) NS16, Install raised median / refuge island	NH2, Remove slip lane(s) NH8, Square up intersection

UNINCORPORATED MARIN COUNTY

POTENTIAL COUNTERMEASURES FOR HIGH COLLISIONS NETWORK STUDY CORRIDORS AND INTERSECTIONS

INTERSECTIONS

ID	NAME	COLLISIONS: MOTOR VEHICLE	MOTORCYCLE	BICYCLE	PEDESTRIAN	TOTAL	POTENTIAL HSIP COUNTERMEASURE	NON-HSIP COUNTERMEASURE
4	Sir Francis Drake and El Portal	8	0	0	0	8	S2, Improve signal hardware S3, Improve signal timing and detection S19, Check for and/or install pedestrian countdown signal heads	NH2, Remove slip lane(s) NH8, Square up intersection
5	Sir Francis Drake and Bon Air Center and La Cuesta	5	1	0	0	6	S2, Improve signal hardware S3, Improve signal timing and detection NS16, Install raised median / refuge islands NS6, Upgrade intersection pavement markings (high visibility crosswalk) S19, Check for and/or install pedestrian countdown signal head	NH2, Remove slip lane(s)
6	Bon Air and Via Hidalgo	4	0	1	0	5	R38, Pedestrian crossing with enhanced safety features (tighten curb radii)	
7	College and Sir Francis Drake	5	0	0	0	5	S3, Improve signal timing and detection R38, Pedestrian crossing with enhanced safety features (tighten curb radii and add directional pedestrian ramps)	
8	Los Ranchitos and San Pedro	4	0	1	0	5	S2, Improve signal hardware S3, Improve signal timing and detection S19, Check for and/or install pedestrian countdown signal heads S20, Pedestrian crossing (square up intersection)	NH2, Remove slip lane(s)
9	Pt Reyes Petaluma and Novato	4	1	0	0	5	R2, Remove or relocate fixed objects	
10	Pt Reyes Petaluma and Nicasio Valley	3	0	1	0	4	NS4, Convert intersection to roundabout (optional CM as an alternative to NS15 and NS11) NS15, Install left turn lane (where no left turn lane exists) NS11, Install splinter island on the minor road approaches	
11	Sequoia Valley and Panoramic and Muir Woods	3	0	1	0	4	NS10, Improve sight distance NS2, Convert to all way stop	
12	Nicasio Valley and Lucas Valley	2	0	1	0	3	NS4, Convert intersection to roundabout (optional CM as an alternative to NS5) NS5, Install upgrade larger or additional stop signs or other intersection warning/regulatory signs	
13	Lucas Valley and Las Gallinas	1	0	0	0	1	S3, Improve signal timing and detection S18, Convert signalized intersection to roundabout (optional CM as an alternative to S3)	

PRIORITY PROJECTS

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

Panoramic Highway: Shoreline Highway to Gravity Car | Corridor

Panoramic Highway looking west

EXISTING CONDITIONS:

Panoramic Highway is a two-lane arterial and a popular bicyclist and motorcyclist route. The corridor had 26 total reported collisions in five years, including five KSI bicycle collisions, four KSI motorcycle collisions, and four KSI motor vehicle collisions. Overturn incidents are the most common motorcycle collision type and hit objects are the most common motor vehicle collision type.

POTENTIAL IMPROVEMENTS:

Road Improvements- Roadway improvements may include widening the shoulder and installing designated turn outs where feasible, installing curve advanced warning signs, guard rails and dynamic variable speed warning signs

Bicycle Facility Improvements- Installing a wider shoulder, where feasible, could give cyclists and motorists more room to maneuver. Installing "Bikes may use full lane" signs clarifies where bicyclists are expected to ride and reminds motorists to expect bicyclists on the road. Other signage to alert motorists to bicyclist presence could also be beneficial.

College Avenue: Sir Francis Drake Boulevard to Woodland Road | Corridor

College Avenue from Sir Francis Drake Boulevard, looking west

EXISTING CONDITIONS:

College Avenue is a two-lane arterial that services the College of Marin and AE Kent Middle School. The corridor had 21 total reported collisions in five years, including one KSI pedestrian collision. Rear-end incidents are the most common motor vehicle collision.

POTENTIAL IMPROVEMENTS:

Improve Intersection- The intersection of Woodland Road and College Avenue may benefit from installation of a traffic signal or roundabout. Signalization would require a warrant study to determine if this countermeasure is appropriate

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be considered along this corridor including some of the following: high visibility crosswalks, RRFBs, pedestrian signals or HAWKs, advanced stop bars, bulb outs, tightening curb radius, directional curb ramps and leading pedestrian intervals. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence

Bicycle Facility Improvements- Upgrading bike lanes to green bike lanes, installing green paint through conflict zones and adding bike boxes could increase the visibility of bicyclists.

North San Pedro Road: Golf Avenue to Meriam Dr | Corridor

North San Pedro looking east

EXISTING CONDITIONS:

North San Pedro Road is two-lane arterial road with a median lane that connects to Highway 101. Major destinations along this road are Venetia Valley School and the Marin County Civic Center. North San Pedro Road is also a designated bicycle route. The corridor had 10 total reported collisions in five years, including two KSI pedestrian collisions. Rear-end incidents are the most common motor vehicle collision type.

POTENTIAL IMPROVEMENTS:

Roadway Improvements- Consider installing a two-way left turn lane where applicable.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be considered along this corridor including some of the following: high visibility crosswalks, RRFBs, advanced stop bars, bulb outs, tightening curb radius and directional curb ramps. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Installing "Bikes may use full lane" signs clarifies where bicyclists are expected to ride and reminds motorists to expect bicyclists on the road.

PRIORITY PROJECTS

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

Redwood Highway Frontage Road: 101 Ramp to De Silva Island Road | Corridor

101 Ramp to De Silva Island Drive looking east

EXISTING CONDITIONS:

Redwood Highway Frontage Road is a two-lane arterial that runs parallel and east of Highway 101. The Redwood Highway Frontage passes under the highway and intersects with the 101 Ramp and De Silva Island Road intersection. Redwood Highway Frontage Road is a designated bike route. The corridor had 10 total reported collisions in five years, including two KSI motorcycle collisions.

POTENTIAL IMPROVEMENTS:

Improve signals- Signalization improvements may include adding left turn phases, lengthening clearance intervals, eliminating or restricting higher-risk movements, and coordinating signals at multiple locations.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be considered along this corridor including some of the following: high visibility crosswalks, directional curb ramps, reducing curb radii and advanced stop bars. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Installing a wider shoulder, where feasible, could give cyclists and motorists more room to maneuver. Installing "Bikes May Use Full Lane" signs clarifies where bicyclists are expected to ride and reminds motorists to expect bicyclists on the road.

Paradise Drive: Kramer Tract to Teaberry Lane | Corridor

San Marin Drive looking northwest

EXISTING CONDITIONS:

Paradise Drive is a two-lane arterial that runs along the Bay in Marin County. Paradise Drive is also a designated bicycle route. The corridor had four total reported collisions in five years, with one KSI bicycle collision.

POTENTIAL IMPROVEMENTS:

Roadway Improvements- Roadway improvements may include widening the shoulder and installing designated turn outs where feasible, and installation of curve advanced warning signs and guard rails.

Bicycle Facility Improvements- Installing a wider shoulder, where feasible, could give cyclists and motorists more room to maneuver. Installing "Bikes May Use Full Lane" signs clarifies where bicyclists are expected to ride and reminds motorists to expect bicyclists on the road.

Point Reyes Petaluma Road: Nicasio Valley Road to Novato Boulevard | Corridor

Point Reyes Petaluma Road looking north

EXISTING CONDITIONS:

Point Reyes Petaluma Road is a two-lane arterial connecting Point Reyes Station to Petaluma and a designated bike route. The corridor had 32 total reported collisions in five years, with one KSI bicycle collision, two KSI motorcycle collisions, and four KSI motor vehicle collisions. The most common type of motor vehicle collisions were rear-end collisions and collisions with fixed objects.

POTENTIAL IMPROVEMENTS:

Road Improvements- Roadway improvements could include widening the shoulder and installing guard rails where applicable.

Bicycle Facility Improvements- Installing a wider shoulder, where feasible, could give cyclists and motorists more room to maneuver. Installing "Bikes May Use Full Lane" signs clarifies where bicyclists are expected to ride and reminds motorists to expect bicyclists on the road.

PRIORITY PROJECTS

Safety improvements identified for the following study locations were identified as priority projects based on an evaluation of collision data and consultation with jurisdiction staff.

Point Reyes Petaluma Road and Novato Boulevard | Intersection

Point Reyes Petaluma Road and Novato looking north

EXISTING CONDITIONS:

Point Reyes Petaluma Road is a regional arterial that carries north-south traffic through unincorporated Marin County. Both Novato Boulevard and Point Reyes Petaluma Road are two-lane rural roads that are designated bike routes. The intersection had five reported collisions in five years, including one motor vehicle KSI collision. The most common type of motor vehicle collisions are rear-end collisions and collisions with fixed objects.

POTENTIAL IMPROVEMENTS:

Improve Intersection- Intersection improvements may include installing a left turn lane where applicable and installing splinter islands on the minor road approaches.

Convert signalized intersection to roundabout- This is an optional alternative countermeasure. Roundabouts can be effective at reducing severe injuries at intersections.

Bicycle Facility Improvements- Installing a wider shoulder, where feasible, could give cyclists and motorists more room to maneuver. Installing "Bikes may use full lane" signs clarifies where bicyclists are expected to ride and reminds motorists to expect bicyclists on the road.

Point Reyes Petaluma Road and Nicasio Valley Road | Intersection

Point Reyes Petaluma Road looking south

EXISTING CONDITIONS:

Point Reyes Petaluma Road is a regional arterial that carries north-south traffic through unincorporated Marin County. Both Nicasio Valley Road and Point Reyes Petaluma Road are two-lane rural roads that are designated bike routes. The intersection had four reported collisions in five years, including one bicycle KSI collision.

POTENTIAL IMPROVEMENTS:

Intersection Improvements- Intersection improvements may include installing a left turn lane where applicable and installing splinter islands on the minor road approach.

Convert signalized intersection to roundabout- This is an optional alternative countermeasure. Roundabouts can be effective at reducing severe injuries at intersections.

East Blithedale Avenue and Tower Drive and Kipling Drive | Intersection

101 Ramp to De Silva Island Drive looking east

EXISTING CONDITIONS:

The intersection of East Blithedale Avenue, Tower Drive and Kipling Drive is a multi-lane arterial intersection that carries regional traffic through Highway 101 to destinations west. Blithedale and Tower are designated bicycle routes. The intersection had 11 total reported collisions in five years, with three broadside incidents and five rear-end incidents.

POTENTIAL IMPROVEMENTS:

Improve signals- Signalization improvements may include upgrading signal hardware, lengthening clearance intervals, eliminating or restricting higher-risk movements, coordinating signals at multiple locations and upgrading hardware to 12" signal heads with backplates.

Pedestrian Crossing Improvements- A number of pedestrian crossing improvements could be considered at this intersection including some of the following: high visibility crosswalks, directional curb ramps, pedestrian countdown heads, reduced curb radii, and removing pork chop islands. These could improve pedestrian crossings by shortening crossing distances and emphasize pedestrian's presence.

Bicycle Facility Improvements- Installing "Bikes may use full lane" signs clarifies where bicyclists are expected to ride and reminds motorists to expect bicyclists on the road.

CHAPTER 15: HIGHWAY SAFETY IMPROVEMENT PROGRAM

HIGHWAY SAFETY IMPROVEMENT PROGRAM

This section presents a description of the Highway Safety Improvement Program (HSIP) and the grants that were prepared for HSIP Cycle 9 as part of the Marin County Travel Safety Plan.

The HSIP is one of the core federal-aid programs in the federal surface transportation act – Fixing America's Surface Transportation Act – which was signed into law on December 4, 2015. The purpose of the HSIP program is to achieve a significant reduction in traffic fatalities and serious injuries on all public roads, including non-State-owned public roads and roads on tribal land, by funding the implementation of proven countermeasures prioritized through a systemic safety analysis.

The Systemic Safety Analysis Report Program (SSARP), established and funded by the State of California in 2016, exchanges federal-local HSIP funds for State Highway Account funds to provide grants to smaller jurisdictions for the preparation of Systemic Safety Analysis reports that can compete for HSIP funding.

HSIP GRANT APPLICATION SELECTION PROCESS

After the completion of the comprehensive data analysis described in the preceding chapters, a number of potential projects were considered for HSIP grant applications. Three projects were ultimately selected by the project's Technical Advisory Committee based on the selection criteria described below.

There are two main types of HSIP applications: 1) common benefit-cost ratio (BCR) applications, which require benefit cost ratio calculations, and 2) set aside funding applications, which do not require a BCR calculation but must use a preselected countermeasure. All three of the grant applications submitted for HSIP Cycle 9 funding applied to the BCR type of application as they did not fit into one of the set aside funding categories used for this cycle.

For common BCR applications, there are two types of projects: systemic projects or spot locations. Systemic projects can be selected by identifying countermeasures to be applied at multiple locations throughout a jurisdiction (city, town, or countywide) with a mix of high collision locations and potential collision locations. Spot locations can be identified by finding high collision locations that can be remedied by effective and low-cost countermeasures.

In general, selecting locations with the highest number of crashes first and then identifying projects for those locations is the preferred method in identifying potential safety projects. Conversely, identifying the project and then justifying the project with crashes is not recommended, as this method is unlikely to produce a high cost benefit ratio. It is the goal of the Marin County Travel Safety Plan that the high collision networks identified in this plan can assist local jurisdictions for future HSIP funding and for other funding opportunities.

Other considerations for application selection included:

- Feasibility of approving and constructing the project in a timely manner (safety projects that are controversial can have issues remaining on budget and schedule)
- Construction costs being large enough to justify the staff time and resources needed to complete the federal and state process and requirements. Projects should have a construction cost between $1 and $10 million (the maximum federal reimbursement amount).
- Projects with a high cost benefit ratio. The minimum BCR for HSIP Cycle 9 was 3.5, but a cost-benefit ratio higher than that is preferred. The applications selected through this study aimed for a BCR of 8 or higher.
- Projects that were recommended through other planning and outreach processes.
- The majority of applications that were rejected in previous HSIP cycles were due to the misuse of countermeasures and using collisions not in the countermeasure influence area. Projects selected made sure that the countermeasures selected directly related to the crash types used.

HSIP CYCLE 9 GRANT APPLICATION PROJECTS

The projects selected for potential HSIP Cycle 9 funding were identified as San Rafael's Third Street corridor project, Novato's De Long Avenue/Diablo Avenue corridor project, and a Countywide traffic signal enhancements project.

San Rafael's Third Street project would focus on all of Third Street's signalized intersections between Grand Avenue and Lindaro Street, with the exception of Hetherton Street which received previous HSIP funding for safety improvements. Improvements would be implemented at each of the five intersections, including the provision of high-visibility crosswalks and advanced stop bars, pedestrian countdown signals, larger vehicle signals, and the addition of mast arms at three locations.

The corridor has the highest occurrence of collisions of all identified corridors in Marin County, and the most amount of pedestrian-involved collisions per mile in San Rafael. The potential project's benefit-cost ratio was estimated at 9.4.

Novato's De Long Avenue/Diablo Avenue project, extending between Novato Boulevard and Reichert Avenue, would install a number of countermeasures including improved pedestrian crosswalks throughout the corridor, advanced dilemma zone detection at two key intersections, and providing advance flashing beacon upstream of Redwood Boulevard. Other safety-related improvements would include provision of rectangular flashing beacons and narrowed lane widths.

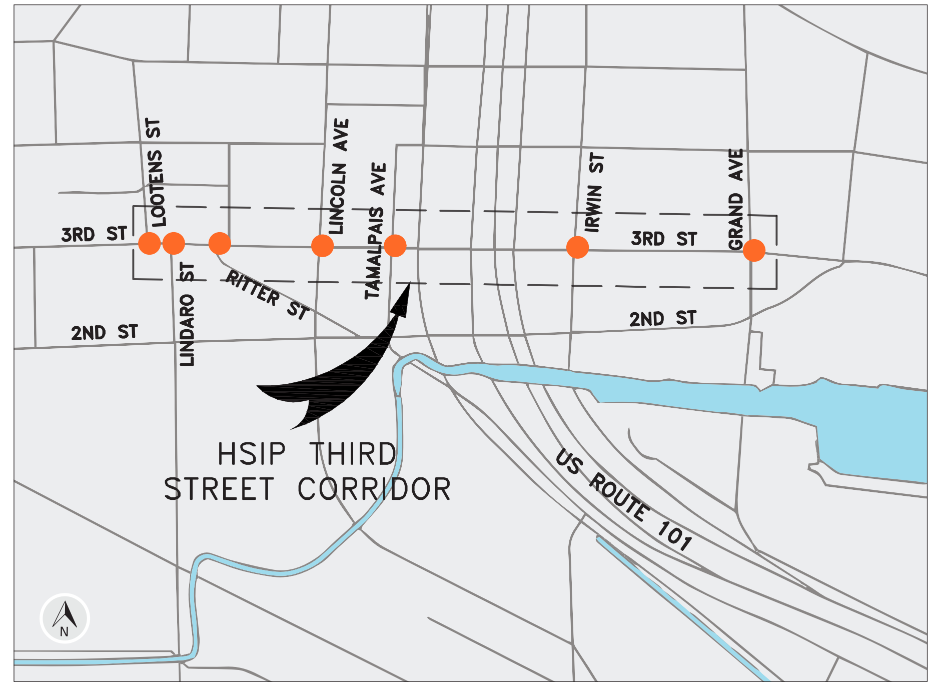
Based on the safety analysis conducted as part of this report, the segment of De Long Avenue and Diablo Avenue has the second highest occurrence of collisions of all identified corridors in Marin County. The potential project's benefit-cost ratio was estimated to be 8.5.

The Countywide traffic signal enhancement project would provide upgrades to 51 intersections throughout incorporated cities and towns and in Unincorporated Marin County. A list of the intersections included in the grant is located on page 15-3. The locations were selected based on collision histories.

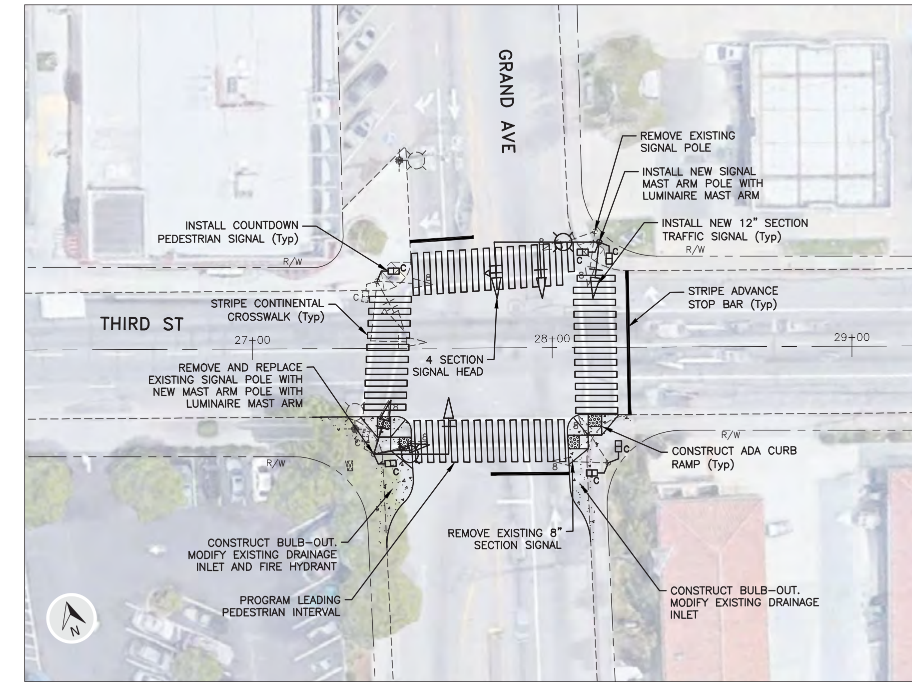
Systemic countermeasures proposed include improving traffic signal hardware (including signal heads and mounting hardware), installing pedestrian countdown signal heads, and adding advanced dilemma detection zones. Many of the countermeasures were selected due to the level of rear-end vehicle collisions and pedestrian right-of-way violations reported at the intersections.

This systemic HSIP grant application's estimated benefit-cost ratio was estimated to be 15.7.

San Rafael's Third Street Project

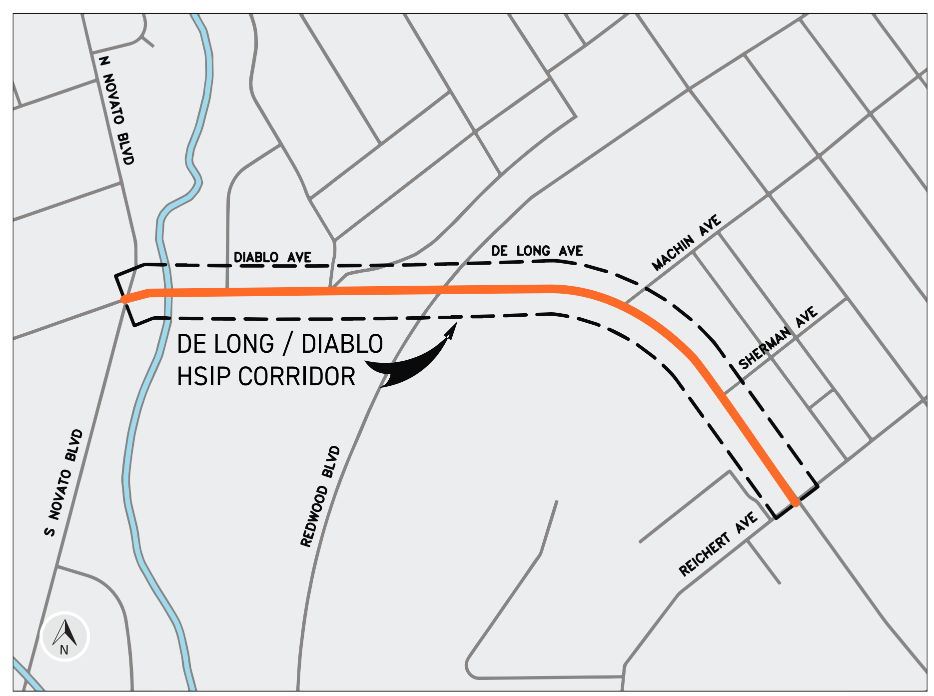


Project Limits



Sample Improvement

Novato's De Long Avenue/Diablo Avenue Project



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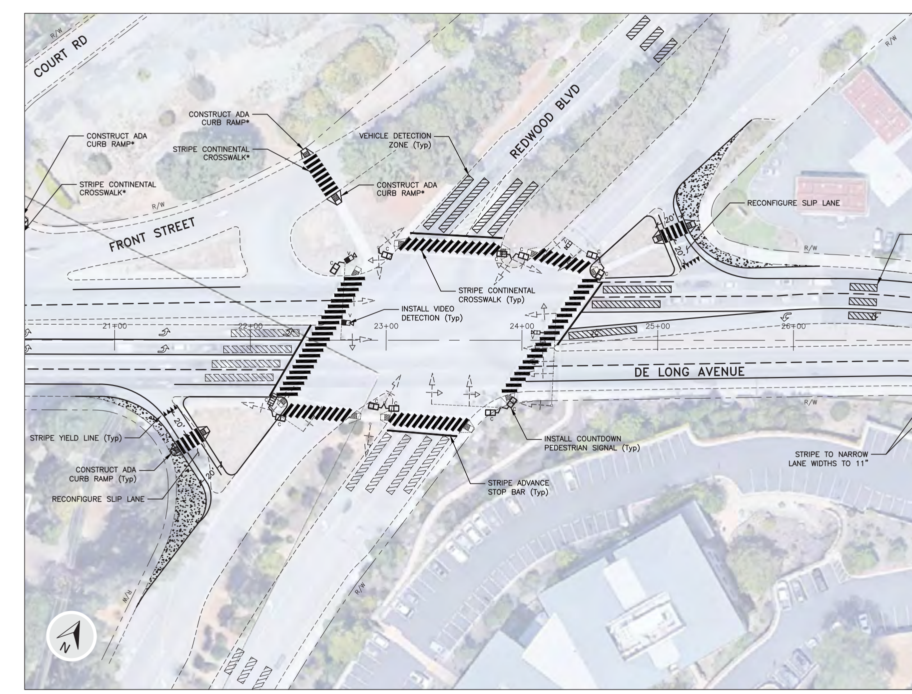

Sample Improvement

Countywide Traffic Signal Enhancement Project:

Project Intersection	Jurisdiction	Intersection Location
1	Corte Madera	Tamalpais and Corte Madera Town Ctr
2	Corte Madera	San Clemente and Tamalpais and Redwood
3	Corte Madera	Paradise and Seawolf Passage and El Camino
4	Corte Madera	Tamalpais and Madera and Sanford
5	Corte Madera	Tamal Vista and Fifer
6	Fairfax	Sir Francis Drake and Claus and Bank
7	Fairfax	Sir Francis Drake and Willow and Pastori
8	Mill Valley	Camino Alto and Blithedale
9	Mill Valley	Miller and Camino Alto
10	Mill Valley	Blithedale and Roque Moraes and Lomita
11	Novato	Diablo and Redwood and De Long
12	Novato	De Long and Reichert
13	Novato	Grant and Redwood
14	Novato	Grant and Seventh
15	Novato	Ignacio and Bel Marin Keys and Nave and Hwy 101
16	Novato	Nave and Bolling
17	Novato	Novato and Diablo
18	Novato	Novato and Tamalpais and Seventh
19	Novato	Redwood and Frontage and Lamont
20	Novato	San Marin and E Campus
21	Novato	Novato and Simmons
22	Novato	Rowland and Redwood
23	Novato	San Marin and Redwood
24	San Anselmo	Sir Francis Drake and Butterfield
25	San Anselmo	Sir Francis Drake and Miracle Mile and Center and Greenfield
26	San Anselmo	Sir Francis Drake and San Francisco and Tamal

Project Intersection	Jurisdiction	Intersection Location
27	San Rafael	2nd and A
28	San Rafael	2nd and C
29	San Rafael	2nd and Francisco and Tamalpais
30	San Rafael	2nd and Irwin
31	San Rafael	3rd and A
32	San Rafael	3rd and D
33	San Rafael	3rd and Grand
34	San Rafael	3rd and Hetherton
35	San Rafael	3rd and Irwin
36	San Rafael	3rd and Tamalpais
37	San Rafael	4th and 2nd and Marquard
38	San Rafael	Bellam and Francisco
39	San Rafael	Bellam and Kerner
40	San Rafael	Lincoln and 2nd
41	San Rafael	Lincoln and 3rd
42	Sausalito	Bridgeway and Johnson
43	Sausalito	Bridgeway and Gate 5 and Ebbtide
44	Sausalito	Bridgeway and Harbor
45	Sausalito	Bridgeway and Marinship and Easterby
46	County of Marin	Sir Francis Drake and College
47	County of Marin	Los Ranchitos and San Pedro
48	Ross	Lagunitas and Sir Francis Drake
49	Ross	Laurel Grove and Sir Francis Drake
50	Larkspur	Magnolia and Doherty
51	Larkspur	Magnolia and Ward

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