Town of Moraga
Local Roadway Safety Plan

DRAFT REPORT

JULY 2022

TJKM

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EXECUTIVE SUMMARY

The Town of Moraga's Local Road Safety Plan (LRSP) is a comprehensive plan that creates a framework to systematically identify and analyze traffic safety related issues and recommend projects and countermeasures. It aims to reduce fatal and severe injury collisions through a prioritized list of improvements that can enhance safety on local roadways.

The LRSP takes a proactive approach to addressing safety needs. It is viewed as a guidance document that can be a source of information and ideas. It is also be a living document, one that is routinely reviewed and updated by Town staff and their safety partners to reflect evolving collision trends and community needs and priorities. With the LRSP as a guide, the Town will be able to ready to apply for grant funds, such as the federal Highway Safety Improvement Program (HSIP) or One Bay Area Grant (OBAG). This document summarizes an analysis of collisions that occurred in Moraga, identifies high-injury locations, and recommends countermeasures at each of these high-risk locations. It is organized into eight sections as follows:

Chapter 1 – Introduction
The Introduction describes what an LRSP is and details the study area.

Chapter 2 – Safety Partners
Involvement of safety partners is critical in the success of the LRSP. For the Town of Moraga, this included the Moraga Police Department, Moraga-Orinda Fire District, Moraga Unified School District, Acalanes Union High School District, and Moraga residents. This chapter summarizes the involvement of the stakeholders in the LRSP process.

Chapter 3 – Existing Planning Efforts
This chapter summarizes Town and regional planning documents and projects that are relevant to the LRSP. It ensures that the recommendations of the LRSP are in line with existing goals, objectives, policies, or projects.

Chapter 4 – Collision Data and Analysis
This chapter summarizes data analysis approach and presents preliminary as well as detailed collision analysis and findings in the study area. This analysis of killed and severe injury (KSI) collisions is performed by facility type (intersection and roadway segment). Collision data was obtained and analyzed for a five-year period from 2015 to 2019 from the California Highway Patrol's Statewide Integrated Traffic Records System (SWITRS) and the University of California at Berkeley SafeTREC's Transportation Injury Mapping Service (TIMS). This time period was chosen because 2020 and 2021 data were preliminary at the time of the analysis. It should be noted that in many situations for prior collisions, the safety measures are implemented post collision that may result in eliminating or reducing future collisions. For post 2019 collisions, future reviews and updates of the LRSP will capture those collisions.

Chapter 5 – Emphasis Areas

Emphasis areas are a focus of the LRSP that are identified through the various collision types and factors resulting in fatal and severe injury collisions within the Town of Moraga. The seven emphasis areas for Moraga are:

1. Improve Intersection Safety (Collisions within 250 feet of an intersection)
2. Address Hit Object Collisions
3. Address Broadside Collisions & Automobile Right-of-Way Violations
4. Improve Bicycle & Pedestrian Safety
5. Address Nighttime Collisions
6. Improve Safety Around Schools
7. Address Improper Turning Violations

Chapter 6 – Countermeasure Identification

Engineering countermeasures were selected for each of the high-risk locations and for the emphasis areas. These were based off of approved countermeasures from the Caltrans Local Roadway Safety Manual (LRSM) used in HSIP grant calls for projects. The intention is to give the Town potential countermeasures for each location that can be implemented either in future HSIP calls for projects, or using other funding sources, such as the Town's Capital Improvement Program. Non-engineering countermeasures were also selected using the 5 E's strategies, and are included with the emphasis areas.

Chapter 7 – Safety Projects

A set of five safety projects were created for high-risk intersections and roadway segments, using HSIP approved countermeasures. These safety projects are:

- Project #1: Non-Signalized Intersections (Install/Upgrade Larger Stop Signs or other Intersection Regulatory/Warning Signs, Flashing Beacon as Advance Warning
- Project #2: Pedestrian Set Aside Application
- Project #3: Signalized Intersections (Improve Signal Timing, Install Raised Pavement Markers, and Install Leading Pedestrian Interval)
- Project #4: Non-Signalized Intersections (High Friction Surface Treatments and Intersection Lighting)
- Project #5: Roadway Segments: Install/Upgrade Signs with Fluorescent Sheeting and Install Delineators/Reflectors/Object Markers

Chapter 8 – Implementation and Evaluation

The LRSP is a guidance document that is recommended to be updated every two to five years in coordination with the safety partners. The LRSP document provides engineering, education, enforcement, and emergency medical service-related countermeasures that can be implemented throughout the Town to reduce fatal and severe injury collisions. After implementing countermeasures, the performance measures for each emphasis area should be evaluated annually. The most important measure of success of the LRSP should be reducing fatal and severe injury collisions throughout the Town. If the number of fatal and severe injury collisions does not decrease over time, then the emphasis areas and countermeasures should be re-evaluated.

1. INTRODUCTION

What is an LRSP?

The Local Roadway Safety Plan (LRSP) is a localized data-driven traffic safety plan that provides opportunities to address unique roadway safety needs and reduce the number of killed and severe injury (KSI) collisions. The LRSP creates a framework to systematically identify and analyze traffic safety-related issues, and recommend safety projects and countermeasures. It facilitates the development of local agency partnerships and collaboration, resulting in the development of a prioritized list of improvements that can qualify for Highway Safety Improvement Program (HSIP) funding. The LRSP is a proactive approach to addressing safety needs and is viewed as a living document that can be constantly reviewed and revised to reflect evolving trends, and community needs and priorities.

Process

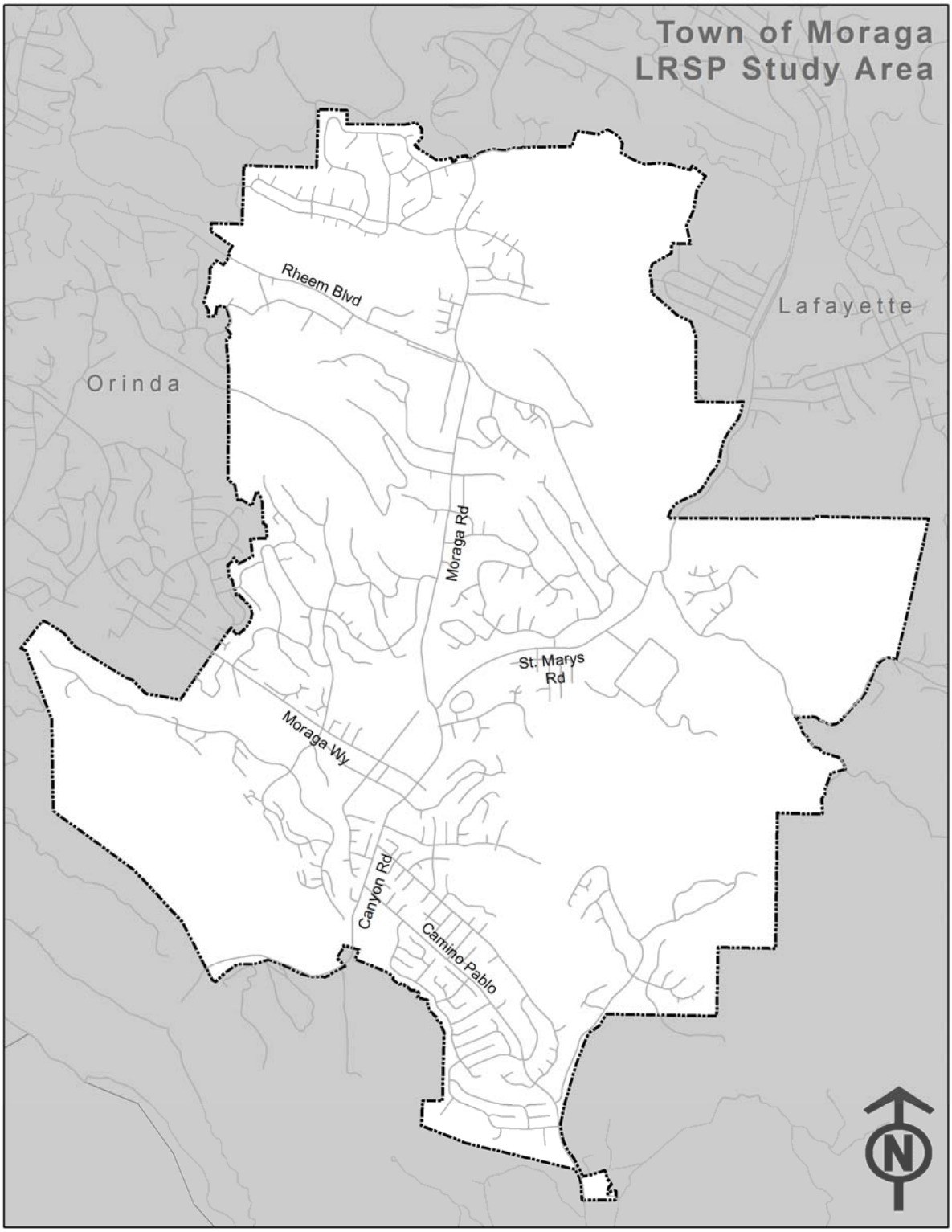
The systemic approach in preparing the LRSP involves the following steps:

- Develop plan goals and objectives
- Analyze collision data
- Meet with stakeholders/safety partners
- Determine focus areas and identify crash reduction strategies
- Prioritize countermeasures/projects
- Prepare the LRSP

Study Area

The Town of Moraga, located in Contra Costa County, California, covers a total area of 9.5 square miles and is located in the East Bay hills between Oakland and Walnut Creek. The Town's estimated population is 16,870 (US Census 2020). Moraga Way, Moraga Road, Rheem Blvd, and St. Marys Rd are main thoroughfares that connect the Town with nearby cities and State Route 24. The nearest cities include Orinda to the west, Lafayette to the north, and Oakland to the southwest. The study area is mapped in **Figure 1** below.

Figure 1: Study Area



According to 5-year estimates from the American Community Survey (ACS) 2019 from the U.S. Census, 57.7% of Moraga commuters get to work by driving alone, lower than both the Contra Costa County and State rate of driving commuters. The second most common method of commuting to work is public transportation at 16.1%. The different modes of transportation used by Moraga residents to commute to work are shown in **Table 1** below.

Table 1: Moraga Commute to Work Census Data

Commute to Work	Moraga	Contra Costa County	California
Drive Alone	57.7%	67.5%	73.7%
Carpool	7.2%	11.5%	10.1%
Public Transportation	16.1%	10.9%	5.1%
Walked	6.2%	1.6%	2.6%
Bicycle	0.2%	0.5%	1.0%
Work from Home	11.6%	6.6%	5.9%
Other	1.1%	1.5%	1.6%

2. SAFETY PARTNERS

Safety partners are vital to the development and implementation of an LRSP. For the Town of Moraga, these include Town staff, Moraga Police Department, Moraga-Orinda Fire Department, Moraga Unified School District, Acalanes Union High School District, and Moraga residents. These stakeholders attended two virtual stakeholder meetings, which were held on April 19, 2022, and May 23, 2022 to review project goals and findings, and to solicit feedback from the group.

Figure 2: Zoom Meeting from Stakeholder Meeting #1

This stakeholder outreach was supplemented by a project website with an interactive map tool platform that was posted to the Town's website. The interactive map was used to solicit input from Moraga residents and stakeholders outside the confines of traditional meetings.

Figure 3: Moraga LRSP Project Website

In total, 128 comments were received through the project website for Moraga. The most comments were received about Canyon Rd and Moraga Rd, and the most common concern was bicycle & pedestrian safety. The results of the interactive map are shown below in **Figure 4**, and summarized in **Figure 5**. In **Figure 4**, each dot and line represents a comment provided by a community member.

Figure 4: Interactive Map Comment Responses

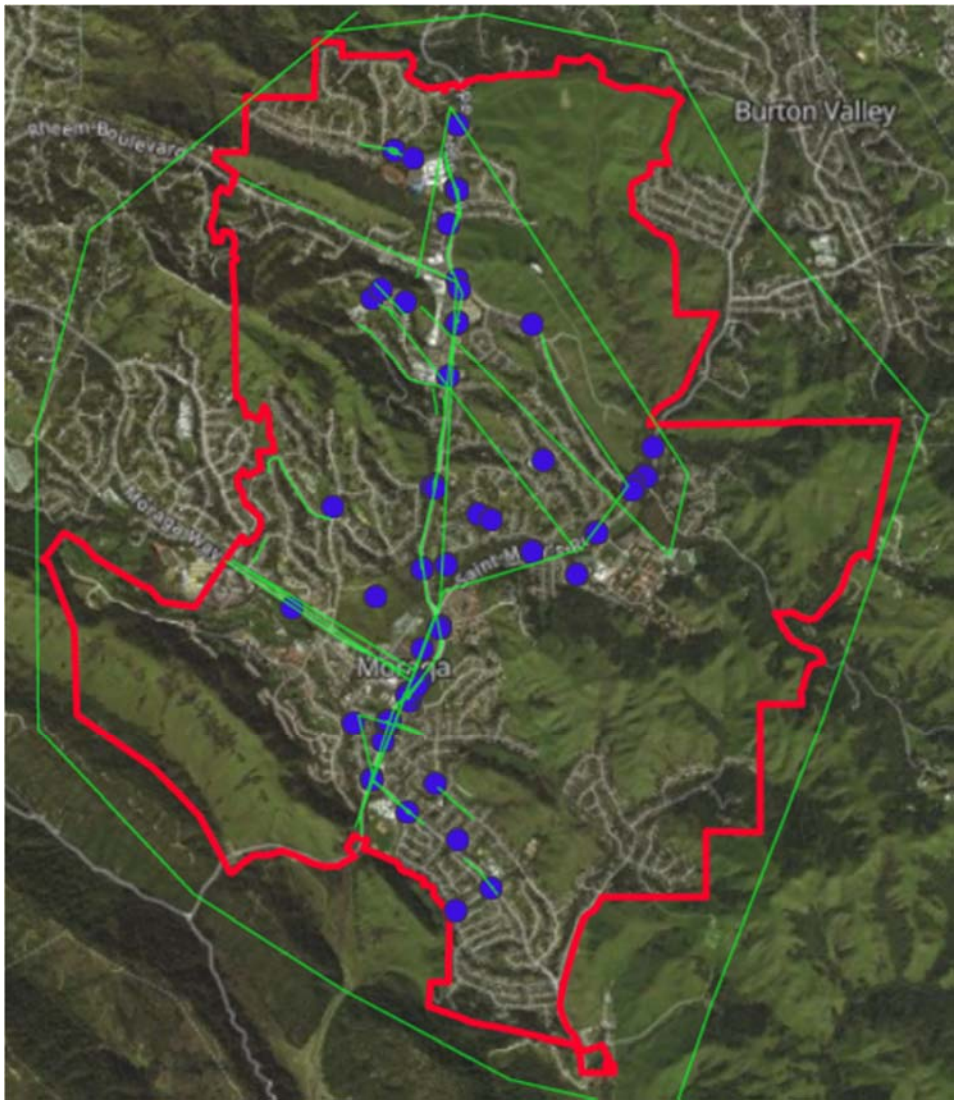
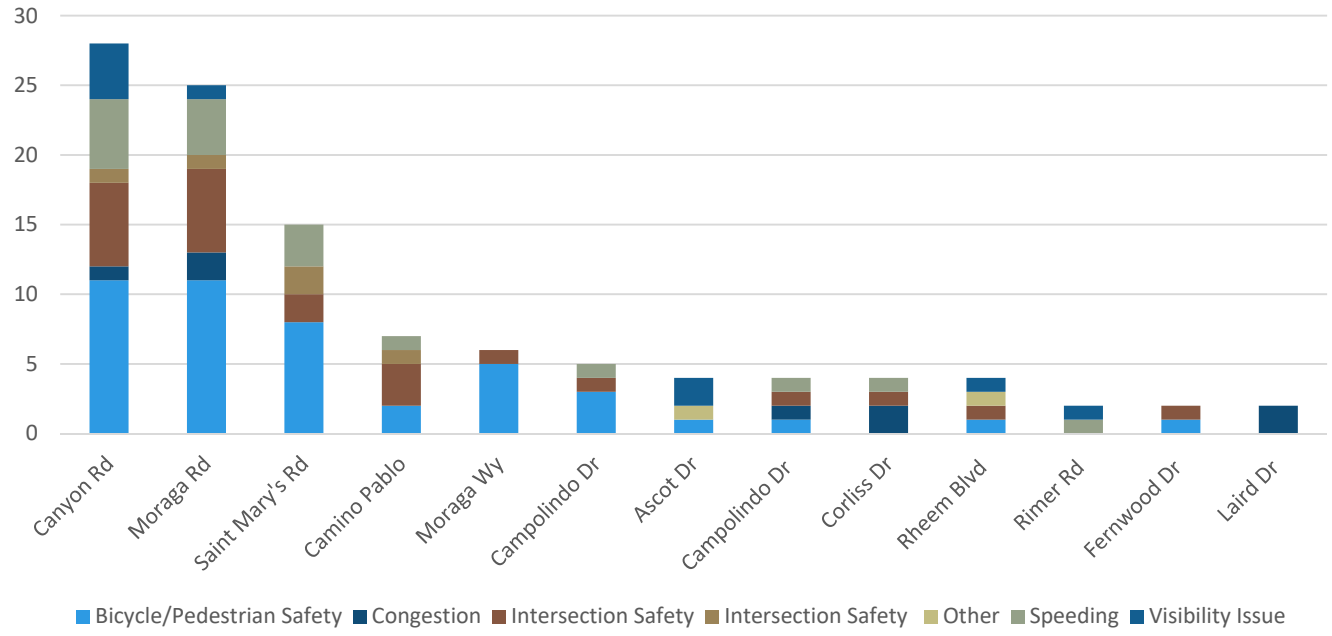


Figure 5: Public Comments on Traffic Safety by Location



Note: Corridors with less than 2 comments are not listed in this summary. Category was chosen based on the primary issue listed in the comment. Each comment was assigned to the major road if at an intersection.

3. EXISTING PLANNING EFFORTS

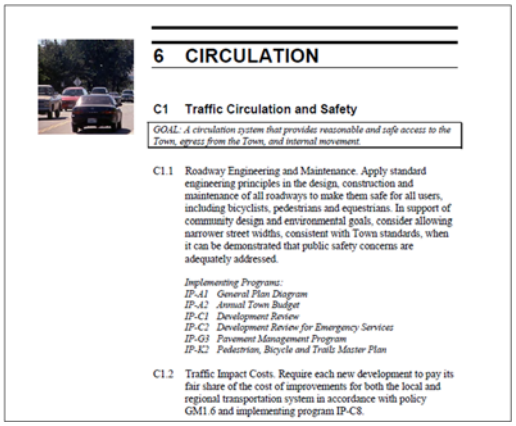
This chapter summarizes the planning documents, projects underway, and studies reviewed for the Town of Moraga Local Roadway Safety Plan (LRSP). The purpose of this memorandum is to ensure the LRSP vision, goals, and E's strategies (Education, Enforcement, Engineering, Equity, and Emergency Medical Services (EMS)) are aligned with prior planning efforts, planned transportation projects, and non-infrastructure programs for the Town. The documents reviewed are listed below:

1. Town of Moraga General Plan (2002)
2. Moraga Walk Bike Plan (2016)
3. Moraga Center Specific Plan (2010)
4. Town of Moraga Capital Improvement Program FY 2021-2022
5. Contra Costa Countywide Bike and Pedestrian Plan (2018)
6. CCTA Transportation Safety and Implementation Guide Vision Zero (2021)
7. CCTA Transportation Expenditure Plan (2020)
8. CCTA Countywide Comprehensive Transportation Plan (2017)
9. Contra Costa County Transportation Analysis Guidelines (2020)

The following sections include brief descriptions of these documents and how they inform the development of the LRSP. A more detailed list of relevant policies and projects is listed in **Appendix A**.

Town of Moraga General Plan (2002)

Moraga's General Plan is a guiding document concerning the future development of the town. The General Plan circulation element identifies safe, reliable and accessible transportation needs in Moraga through policies and standards to enhance its design and maintenance of all roadways, and to further the goal of an integrated multi-modal transportation system. These goals and policies inform the Town's Local Roadway Safety Plan to improve traffic safety/circulation, and roadway safety for active transportation users while encouraging users to choose walking, bicycling, and transit as a mode of transportation in Moraga to reduce traffic trips and improve environmental quality.



6 CIRCULATION

C1 Traffic Circulation and Safety

GOAL: A circulation system that provides reasonable and safe access to the Town, egress from the Town, and internal movement.

C1.1 Roadway Engineering and Maintenance. Apply standard engineering principles in the design, construction and maintenance of all roadways to make them safe for all users, including bicyclists, pedestrians and equestrians. In support of community design and environmental goals, consider allowing narrower street widths, consistent with Town standards, when it can be demonstrated that public safety concerns are adequately addressed.

Implementing Programs:
IP-A1 General Plan Diagram
IP-A2 Annual Town Budget
IP-C1 Development Review
IP-C2 Development Review for Emergency Services
IP-G3 Pavement Management Program
IP-K2 Pedestrian, Bicycle and Trails Master Plan

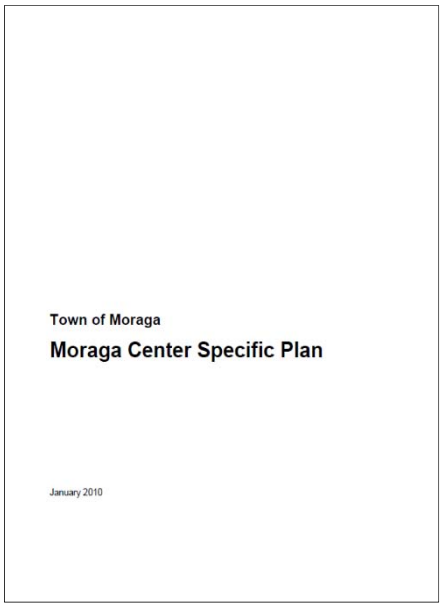
C1.2 Traffic Impact Costs. Require each new development to pay its fair share of the cost of improvements for both the local and regional transportation system in accordance with policy GM1.6 and implementing program IP-C8.

Moraga Walk | Bike Plan (2016)

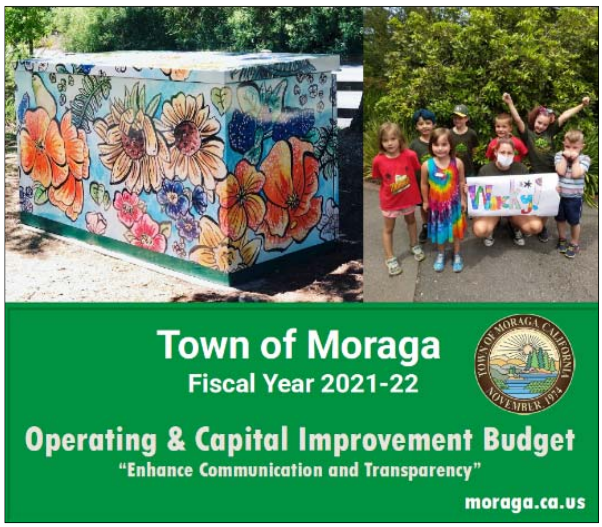
Moraga Walk Bike Plan was developed to guide the Town's decisions regarding walking and biking over the next decade. It intends to make walking and biking in Moraga safer and easier, so as to encourage more people to walk and bike for both recreation and transportation. This long-range planning document includes recommendations for both infrastructure projects and non-infrastructure actions which are designed to improve active transportation conditions for all users. The Plan identifies extensive use of on- street pedestrian and bicycle facilities and suggests various measures to elevate bicycle and pedestrian safety in Moraga neighborhoods. The improvements identified in this plan will inform the safety improvements and strategies to be recommended in the Town's Local Roadway Safety Plan.

Moraga Center Specific Plan (2010)

The purpose of the Moraga Center Specific Plan is to plan for new residential development, circulation, commercial, and residential activity in the Moraga Center area. The Plan's Circulation Element identifies the circulation system necessary to accommodate vehicular and pedestrian movements in the area. The MCSP, through policies and standards, addresses traffic access and circulation issues and integrates future transportation needs. It identifies potential solutions that encourages walking and biking in the Moraga Center area. These activities also include flexibility in parking standards and connections to residential neighborhoods. The Specific Plan will help guide growth, while embracing concepts of transit accessibility, pedestrian friendly design, high-quality development and inclusiveness. The improvements identified in this plan will inform the safety improvements and strategies to be recommended in the Town's Local Roadway Safety Plan as it pertains to roadways in the Moraga Center area.

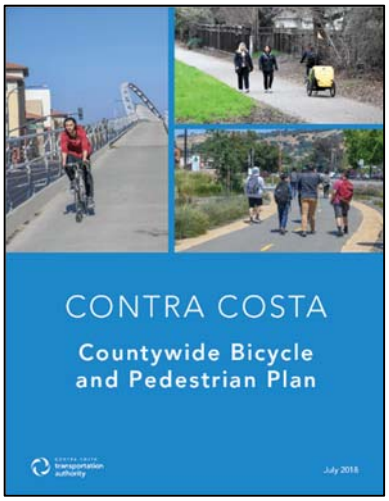


Town of Moraga Capital Improvement Program (2021-2022)



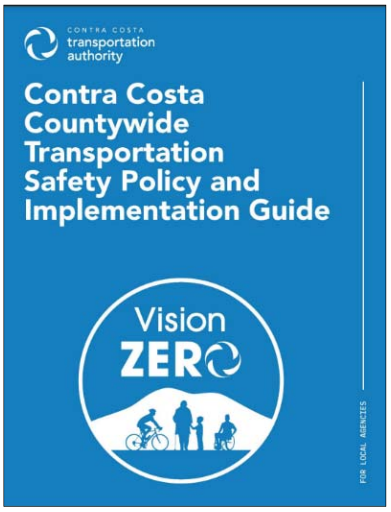
The Town of Moraga's 5-Year Capital Improvement Program (CIP) is a multi-year planning instrument for long-term fiscal sustainability and to retain Town's financial resources for the expansion of future revenues and rehabilitation or replacement of existing assets. It also identifies facility construction or improvement projects, such as park improvements, street improvements, sewer improvements, and traffic signals. The 5-year financial plan is developed by Town Staff and is adopted by the Town Council as a guide for prioritization of various projects to accomplish community goals. The CIP reflects annual goals and funding availability, prioritized capital projects, and community needs. These improvements influence Moraga's built and natural environment and help guide the trajectory of future growth or change. The improvements identified in this plan will inform the safety countermeasures and projects to be recommended in the Town's Local Roadway Safety Plan.

Contra Costa Countywide Bike and Pedestrian Plan (2018)



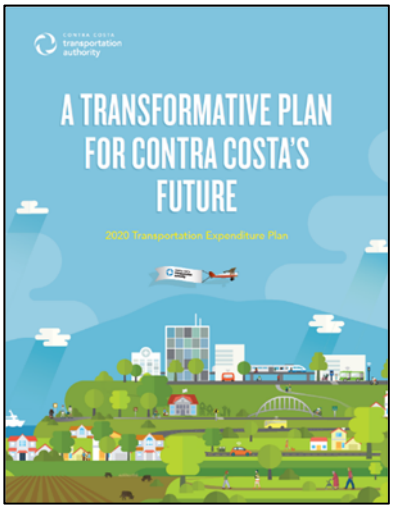
Revised in 2018, the Contra Costa Countywide Bike and Pedestrian Plan entails new policies, best practices and standards developed over the last decade as well as newly-adopted local active transportation plans. This plan highlights the need of increased interest and support for walking and bicycling. The plan also includes the pedestrian and bicycle collision density, design for pedestrian facilities, pedestrian priority area, level of traffic stress for bicycle users, and existing and proposed bicycle facilities. The improvements identified in this plan will inform the safety improvements and strategies to be recommended in the Town's Local Roadway Safety Plan.

Contra Costa Countywide Transportation Safety Policy and Implementation Guide (2021)



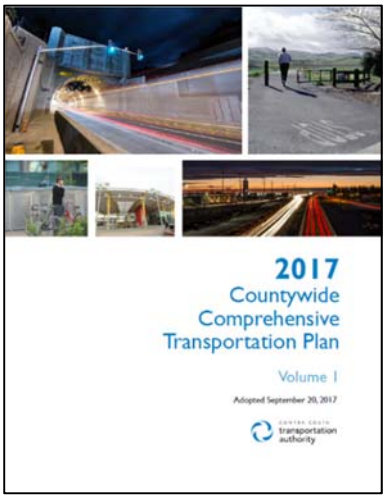
This report lays out a framework for Safety Policy and implementation in Contra Costa County. The Safe System Approach integrating multimodal equity supports the Vision Zero goal of eliminating severe injuries and fatalities. This approach is especially critical for people using non-vehicular transportation modes who lack the physical protection provided to people traveling in multi-ton vehicles, which require compliance with carefully designed and regulated manufacturing requirements. CCTA launched their Vision Zero Framework & Systemic Safety Approach effort to serve as the basis for transportation planning, policy, design, construction, and funding throughout Contra Costa County.

CCTA Transportation Expenditure Plan (TEP) (2020)



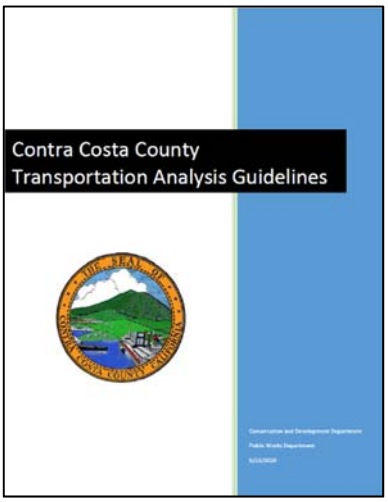
The 2020 Transportation Expenditure Plan is a carefully curated set of solutions designed to bring Contra Costa's transportation system into the future by moving more people efficiently, encouraging mode shift, and promoting shared mobility options for all. The TEP is intentionally designed to be equitable across the entire County, based on population. This plan reflects the current progress of transportation projects in Contra Costa County and the commitment to pursuing transportation policies, planning, and investments.

CCTA Countywide Comprehensive Transportation Plan (2017)



The 2017 Countywide Comprehensive Transportation Plan (CTP) provides the policy framework and steps necessary for the CCTA to achieve its vision. It includes an analysis of challenges and opportunities; a definition of the vision, goals, and strategies; and defines how the CTP will be carried out through a Long-Range Transportation Investment Program and an Implementation Program, with defined responsibilities and a schedule of activities. The CTP outlines the various strategies for addressing transportation and growth management issues within Contra Costa County.

Contra Costa County Transportation Analysis Guidelines (2020)



The Contra Costa County Transportation Analysis Guidelines (TAG) are provided to aid in the preparation of traffic analysis for project applicants and staff. The purpose of this document is to establish a uniform approach, methodology, and toolset to evaluate the impacts of land-use decisions and related transportation projects on the County's transportation system. This is a living document and is updated periodically to reflect newly acquired data and relevant policies. Capital Road Improvement and Complete Streets policies mentioned in this document will serve as a reference while developing the Town's Local Roadway Safety Plan.

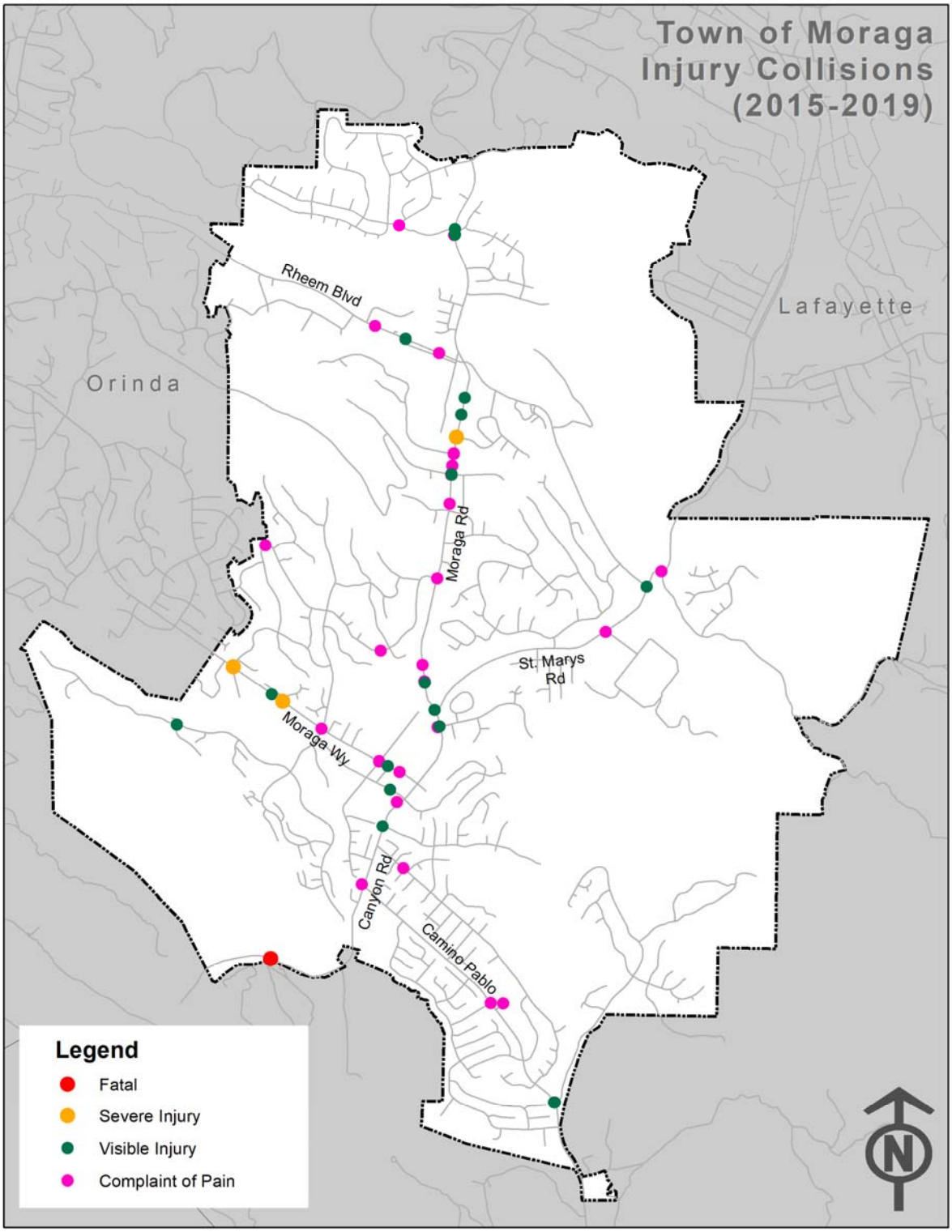
4. COLLISION DATA AND ANALYSIS

This technical memorandum summarizes the results of the analysis of collisions that have occurred in the Town of Moraga between January 1, 2015 and December 31, 2019, as part of the Local Roadway Safety Plan (LRSP). This memorandum includes the following sections:

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

The LRSP focuses on systemically identifying and analyzing traffic safety issues and recommends appropriate safety improvements. The memorandum starts with a comprehensive analysis of collisions of all severity types in the Town of Moraga and compares this with killed and severe Injury (KSI) collisions. Factors such as collision severity, type of collision, primary collision factor, lighting, weather, and time of day were analyzed. Following this, a more detailed analysis was conducted for killed and severe injury (KSI) collisions that have occurred on the Town's roadways, including analyzing collision factors together (such as comparing collision type with violation category). **Figure 6** illustrates all the injury collisions (excluding Property Damage Only (PDO) collisions) that have occurred in the Town of Moraga from 1/1/2015 to 12/31/2019.

Figure 6: Injury Collisions in the Town of Moraga (2015-2019)



Data Collection

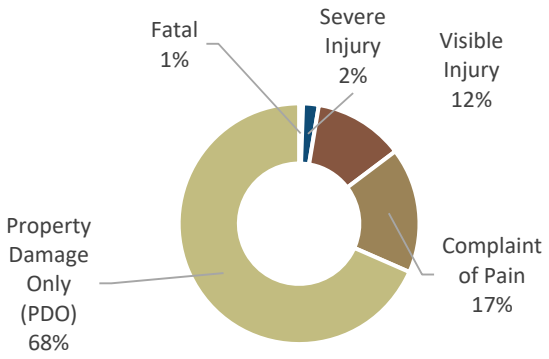
Collision data helps to understand different factors that might be leading to collisions and influencing collision patterns in a given area. For the purpose of this analysis, five-years of jurisdiction-wide collision data (2015 to 2019) was retrieved from Transportation Injury Mapping System (TIMS) and Statewide Integrated Traffic Records System (SWITRS). The collision data was analyzed and plotted in ArcMap to identify high-injury intersections and roadways segments.

Collision Data Analysis Results

Collision Analysis by Severity

There were a total of 190 collisions reported on Moraga roads from 2015 to 2019. Out of these, 130 collisions (68%) led to Property Damage Only (PDO), 32 collisions (17%) led to a complaint of pain injury, and 23 collisions (12%) led to visible injury. There were 5 KSI (killed and severe injury) collisions, of which 4 collisions (2%) led to a severe injury and 1 collision (1%) led to a fatality. **Figure 7** illustrates the classification of all collisions based on severity.

Figure 7: Collisions by Severity (2015-2019)



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

The collision data was separated by facility type, i.e. based on collisions occurring on intersections and roadway segments. For the purposes of the analysis and in accordance with HSIP guidelines, a collision was designated to have occurred at an intersection if it occurred within 250 feet of it. The reported collisions categorized by facility type and collision severity are presented in **Table 2**.

Table 2: Collision by Severity and Facility Type

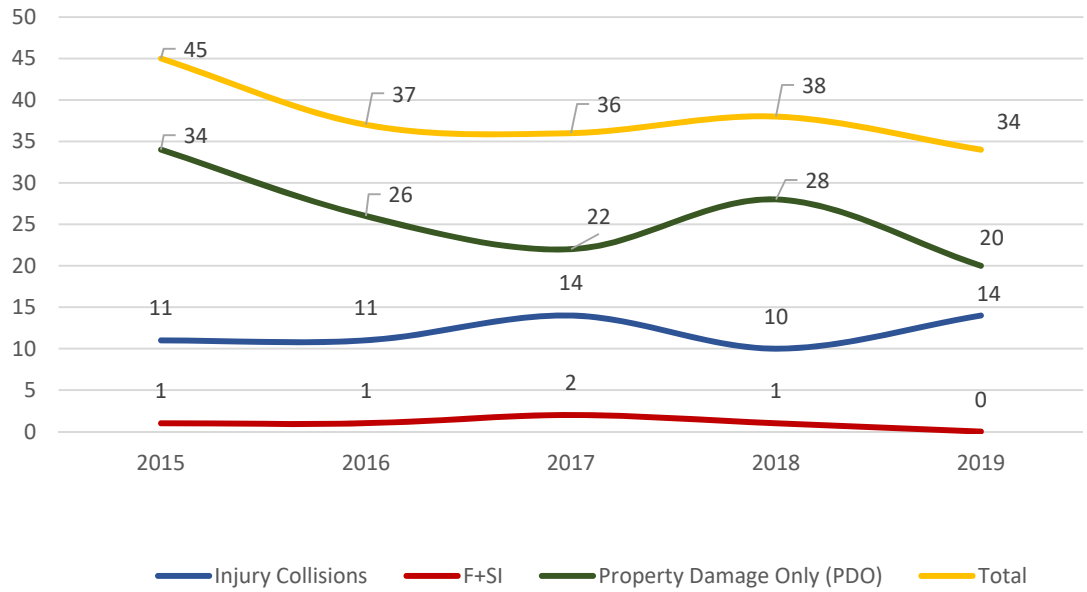
Collision Severity	Roadway Segment	Intersection	Total
Fatal	1	0	1
Severe Injury	1	3	4
Visible Injury	4	19	23
Complaint of Pain	7	25	32
Property Damage Only (PDO)	12	118	130
Total	**25**	**165**	**190**

Preliminary Analysis

Yearly Trend

The number of reported collisions of all severity has overall decreased between 2015 and 2019. While Property Damage Only (PDO) collisions are decreasing, the number of injury collisions has overall increased. The year with the highest total number of collisions was 2015 (45 collisions), while the year with the lowest total number of collisions was 2019 (34 collisions). A total of 5 Killed and Severe Injury (KSI) collisions occurred in the Town of Moraga during the study period, with the most occurring in 2017 (2 KSI collisions). **Figure 8** illustrates the five-year collision trend for all collisions, injury collisions, PDO collisions, and KSI collisions.

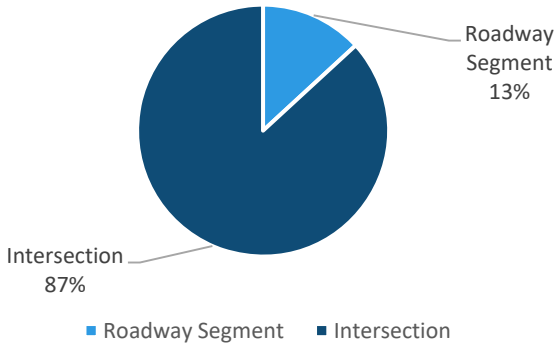
Figure 8: Five Year Collision Trend



Roadway Segment vs. Intersection

When evaluating the locations of collisions, most collisions occurred at intersections and not along roadway segments. In the Town of Moraga, 87% of all collisions (165 collisions) occurred at intersections whereas 13% (25 collisions) occurred on roadway segments. This classification by facility type can be observed **Figure 9**.

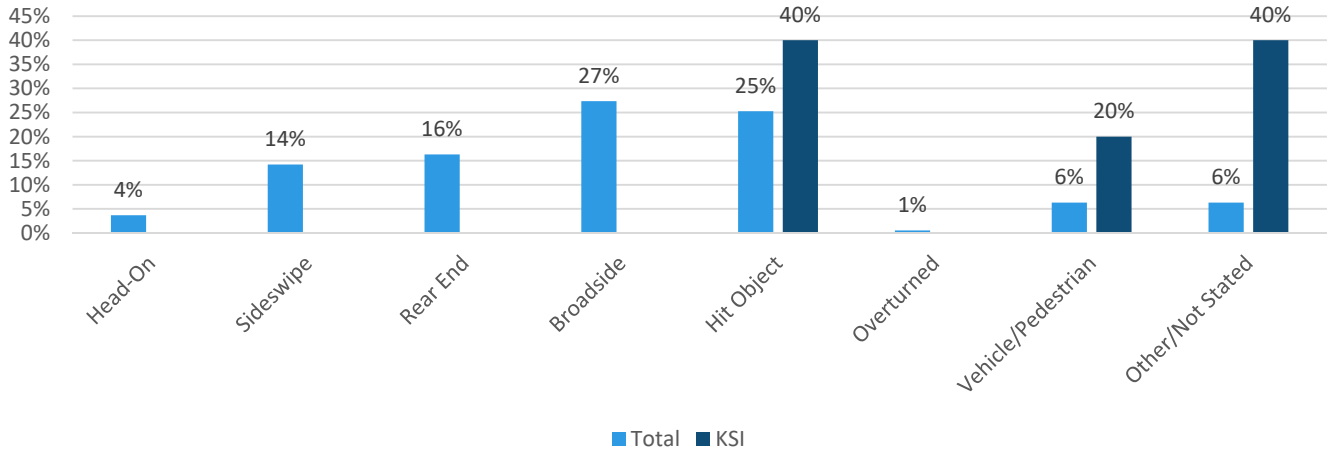
Figure 9. Intersection vs Roadway Collisions - All



Collision Type

This category refers to the type of collision that occurred (whether the vehicle crashed into a pedestrian, fixed object, at an angle, etc.) It's important to examine this to see what trends are occurring and subsequently what strategies may address them. The most commonly occurring collision types were broadside collisions (27%) and hit object collisions (25%). For KSI collisions, where the most commonly occurring collision type was hit object collisions (40%). This was followed by collisions listed as "Other/Not Stated" (40%) and vehicle and pedestrian collisions (20%). **Figure 10** illustrates the collision type for all collisions as well as KSI collisions.

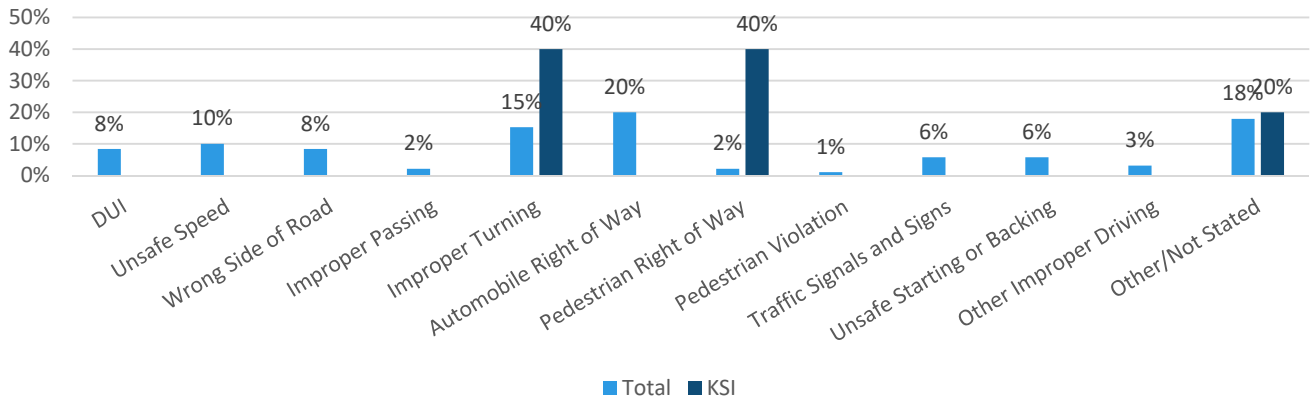
Figure 10. Collision Type - All Collisions vs KSI Collisions



Primary Collision Factor

Primary collision factor refers to the violation that the party at fault in the collision committed that caused the collision. It's distinguished from collision type in that it focuses more on the cause of the collision rather than the type. For collisions of all severity, the most common violation categories (besides other/not stated) were observed to be automobile right of way (20%), and improper turning (15%). The most common primary violation categories for KSI collisions were improper turning (40%) and pedestrian right of way (40%). **Figure 11** illustrates the violation category for all collisions and KSI collisions.

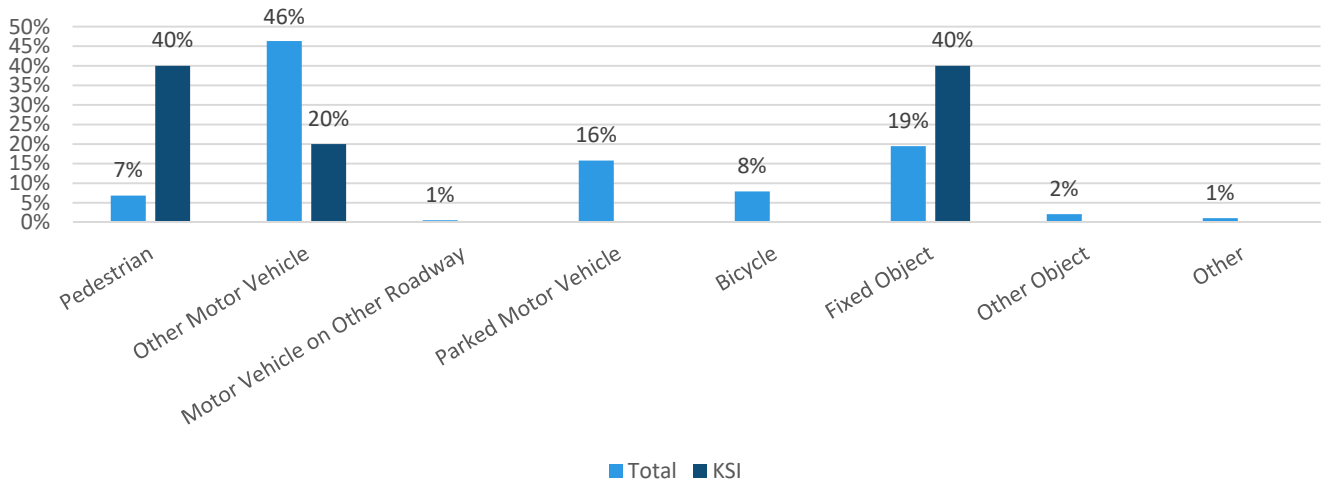
Figure 11. Violation Categories: All Collisions vs KSI



Motor Vehicle Involved With

Motor Vehicle Involved With (MVIW) refers to what the vehicle collided with in the collision. The category can give insight into trends with collisions that are not with other motor vehicles, such as bicycle, pedestrian, or fixed object crashes. For collisions of all severity, 46% of the collisions occurred by motor vehicles colliding with other vehicles. This was followed by fixed object (19%) and parked motor vehicle (16%). For KSI collisions, 40% of the collisions occurred by motor vehicles colliding with pedestrians, 40% involved a fixed object and 20% involved another motor vehicle. **Figure 12** illustrates the motor vehicle involved with category for all collisions as well as KSI collisions.

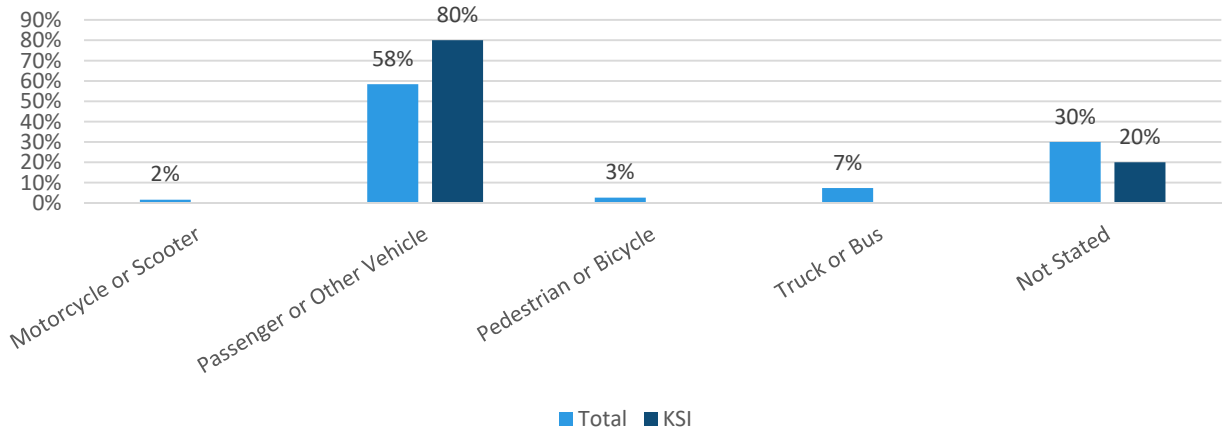
Figure 12: Motor Vehicle Involved With: All Collisions vs KSI Collisions



Modes

In addition to motor vehicle involved with, modes include a more detailed breakdown of the mode at fault in the accident. This gives an indication if the collision was caused by a passenger motor vehicle or some other mode, such as a truck, bus, pedestrian, or bicyclist. It can give an insight if collisions are being caused by other modes and if countermeasures to address them are needed. For collisions of all severity, the majority were caused by passenger or other vehicles (58%), similar to KSI collisions where 80% were caused by passenger or other vehicles. **Figure 13** illustrates the percentage for all collisions as well as KSI collisions by mode.

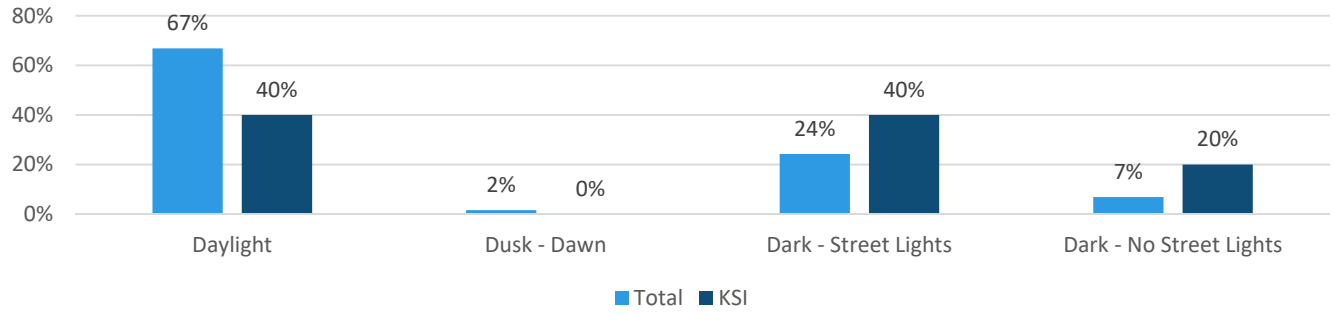
Figure 13: Modes: All Collisions vs KSI Collisions



Lighting

This category shows what the lighting conditions were at the time of the collision, such as during the day time or at night with or without street lights. It can give an indication if lighting was a factor in the collisions. For collisions of all severity, 67% of collisions occurred in daylight, while 24% of collisions occurred in the dark on streets with streetlights. For KSI collisions, a higher percentage of crashes occurred in nighttime conditions, with 40% of collisions having occurred in daylight and 40% of collisions occurred in the dark on streets with street lights (followed by another 20% occurring in the dark on streets without street lights). **Figure 14** illustrates the lighting condition for all collisions and KSI collisions.

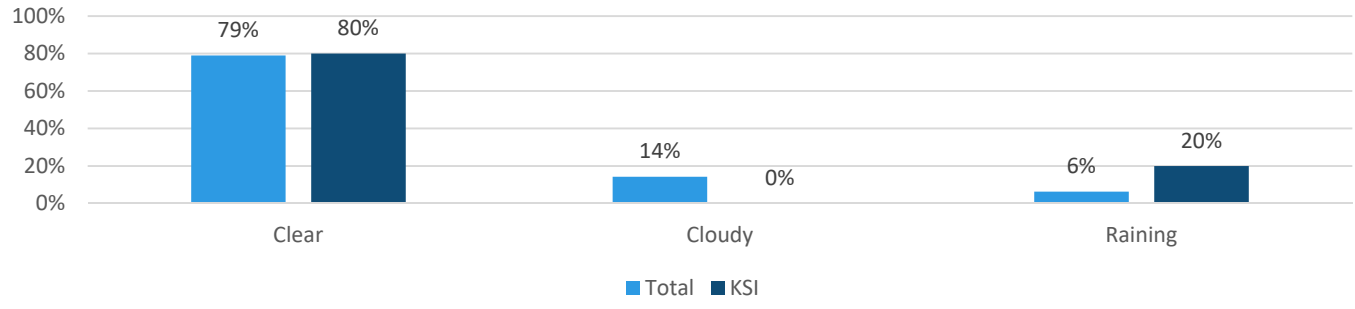
Figure 14: Lighting Conditions: All Collisions vs KSI Collisions



Weather

This category shows the weather conditions at the time of the collision, to examine if it may have been a contributing factor. For all collisions, the vast majority occurred during clear weather conditions (79%). For KSI collisions similar trends have been observed, where 80% of the collisions occurred during clear weather conditions. **Figure 15** illustrates the percent distribution of weather conditions during occurrence of collisions of all severity as well as KSI collisions.

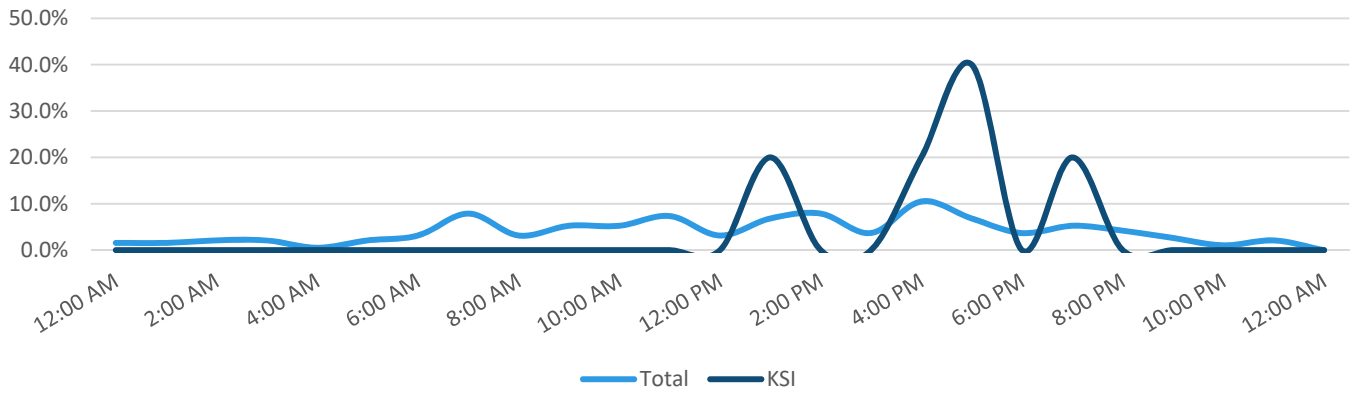
Figure 15: Weather Conditions: All Collisions vs KSI Collisions



Time of the Day

Time of day shows the collisions broken down by the hour of the collision, to see if there are patterns of collisions at certain times of the day. For collisions of all severity, the hour with the most number of collisions was between 4:00 p.m. to 5:00 p.m. (10.5%) while the hour with the fewest number of collisions was between 4:00 a.m. to 5:00 a.m. (0.5%). For KSI collisions, maximum number of collisions occurred between 5:00 p.m. to 6:00 p.m. (40%). The three peaks of KSI collisions below could potentially be due to increased traffic volumes during those times. **Figure 16** illustrates the percentage of collisions occurring during each hour of the day for all collisions as well as KSI collisions.

Figure 16: Time of the Day: All Collisions vs KSI



Killed and Severe Injury Collisions

This section describes a detailed collision analysis performed for KSI collisions occurring at roadway segments and intersections in the Town of Moraga. Of the total 5 KSI collisions that occurred during the study period, 2 collisions (40%) occurred on roadway segments and 3 collisions (60%) occurred at intersections. It's important to note that 87% of all collisions occurred at intersections, while only 60% of KSI collisions did. This distribution is illustrated in **Figure 17.**

Figure 18 maps the KSI collisions that occurred the Town of Moraga during the study period.

Figure 17: Intersection vs. Roadway Segment Collisions – KSI Collisions

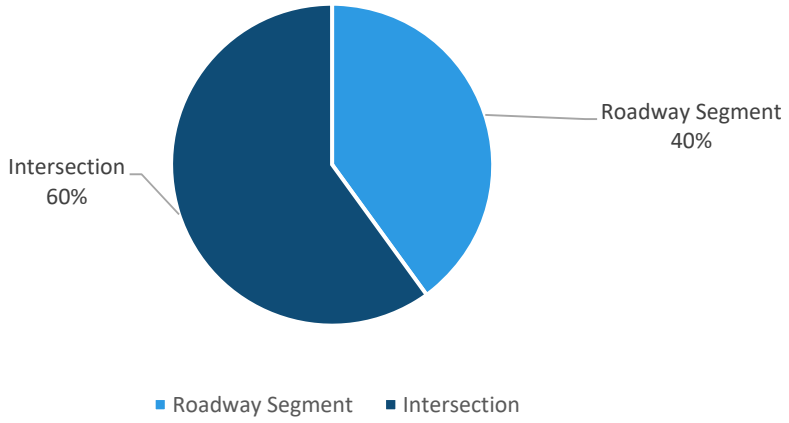
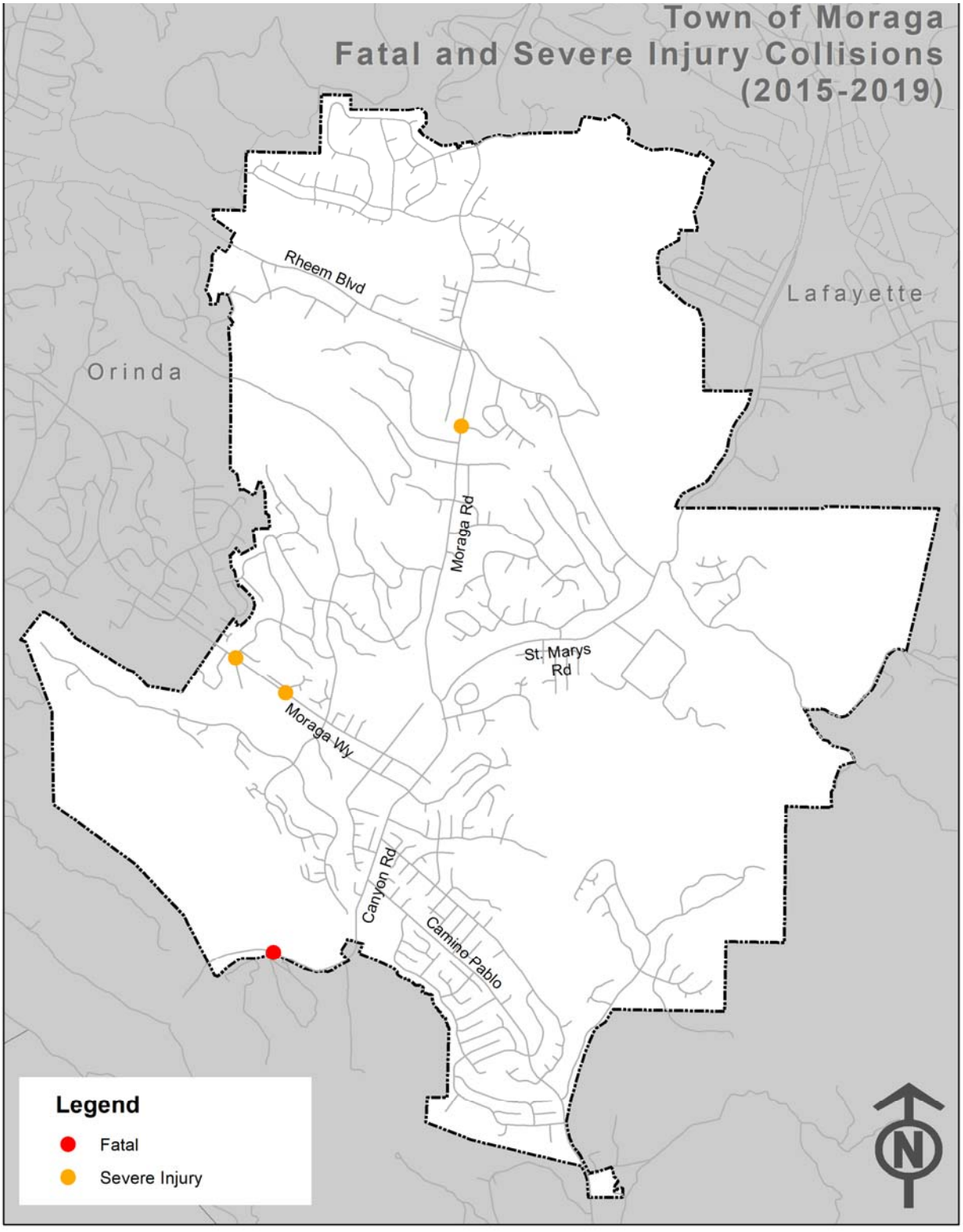


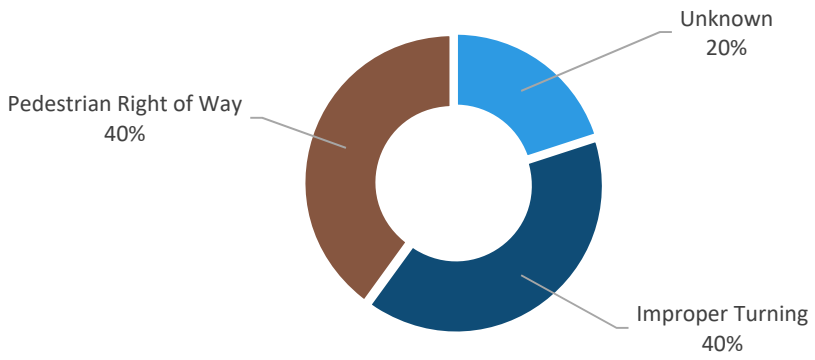
Figure 18: Fatal and Severe Injury Collisions (2015 - 2019)



VIOLATION CATEGORY

For KSI collisions, pedestrian right of way (40%) and improper turning (40%) was observed to be the two major violation categories. **Figure 19** shows violation categories for KSI collisions.

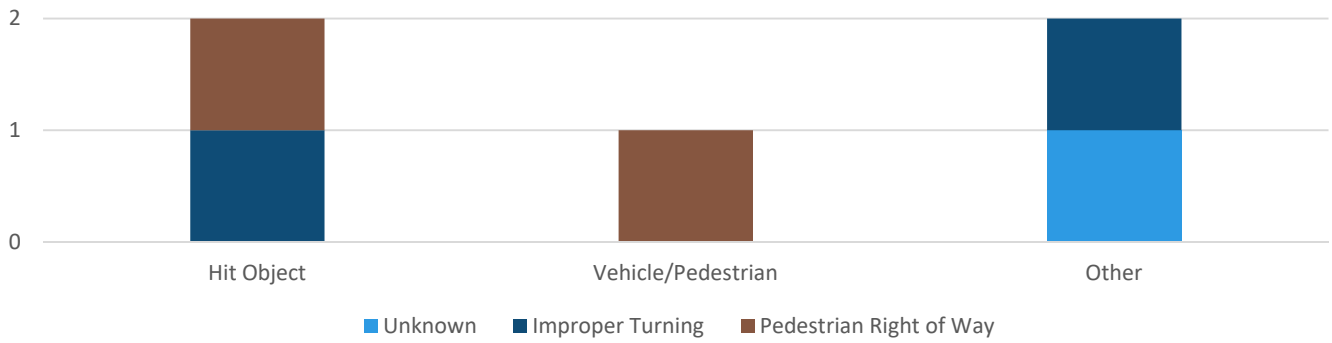
Figure 19. KSI Collisions: Violation Category



VIOLATION CATEGORY BY COLLISION TYPE

For all KSI collisions, the most common collision types were vehicle/pedestrian collisions and hit object collisions that occurred due to improper turning and pedestrian right of way violations. **Figure 20** shows the type of collisions as well as the violation category for KSI collisions.

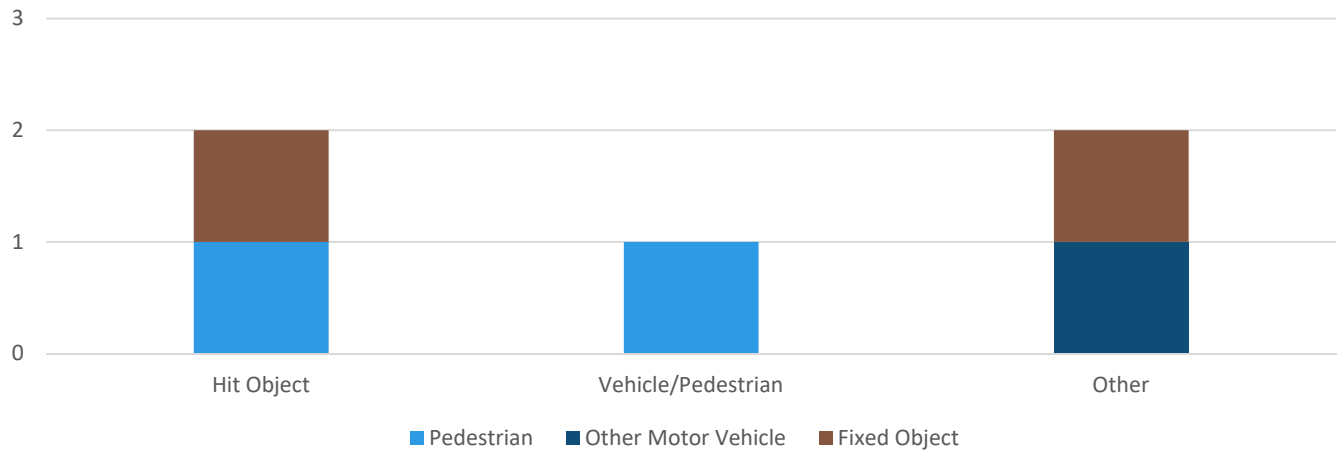
Figure 20: KSI Collision Type and Violation Category (2015-2019)



MOTOR VEHICLE INVOLVED WITH (MVIW) BY COLLISION TYPE

For KSI collisions, the two hit object collisions involved a pedestrian and a fixed object. Other MVIW categories included pedestrians, and other motor vehicles. **Figure 21** shows the type of collisions as well as the motor vehicle involved with for KSI collisions.

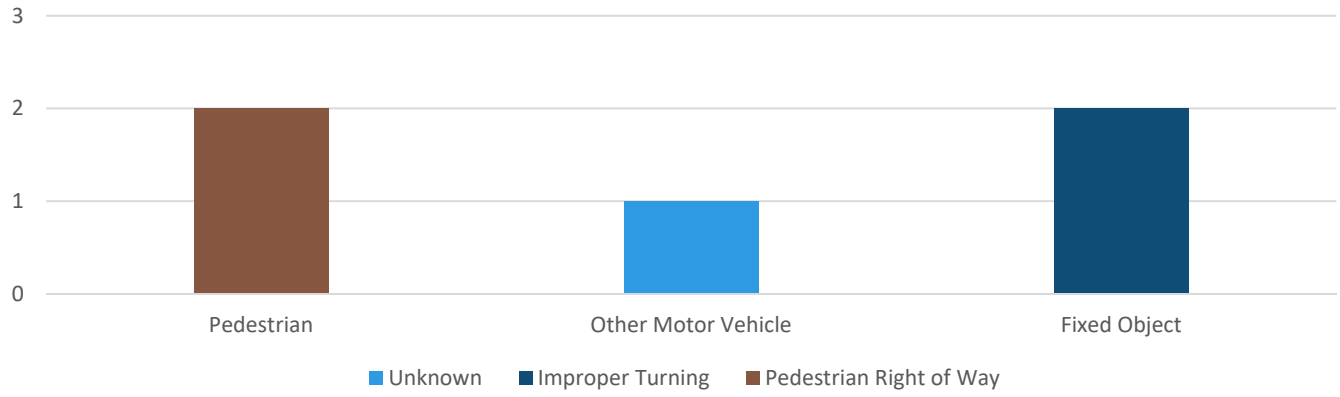
Figure 21: KSI Collisions: Type and Motor Vehicle Involved With



VIOLATION CATEGORY BY MOTOR VEHICLE INVOLVED WITH

For all KSI collisions, the improper turning violation category led to 2 fixed object collisions and pedestrian right of way violation category led to 2 pedestrian collisions. The results, with violation category and motor vehicle involved with, are shown in **Figure 22 .**

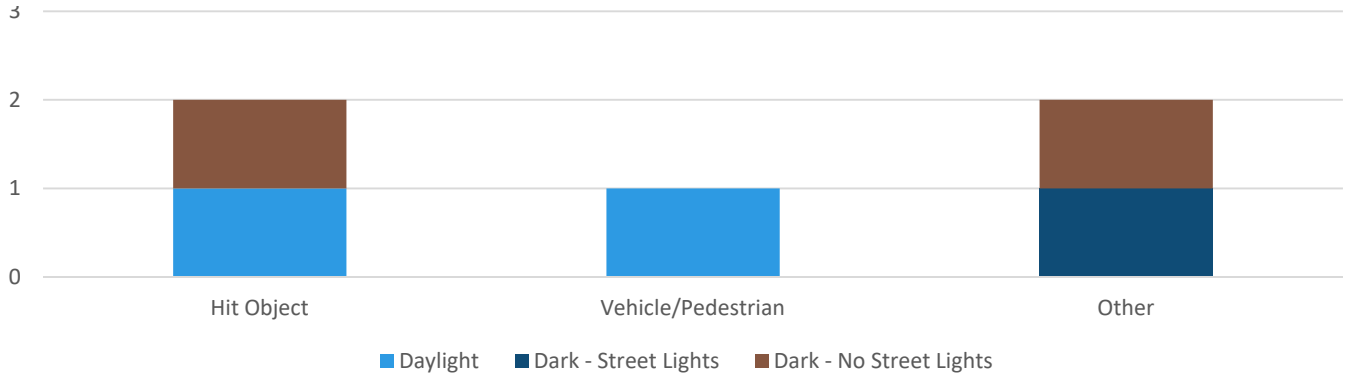
Figure 22: KSI Collisions: Motor Vehicle Involved With and Location Type



LIGHTING CONDITIONS BY COLLISION TYPE

For all KSI collisions, 2 collisions occurred in the daylight and 3 collisions occurred in the dark. The hit object collisions occurred one each in daylight and in the dark on streets without street lights. The vehicle/pedestrian collision occurred during the daylight. **Figure 23** shows fatal and severe injury collisions locations as well as lighting conditions.

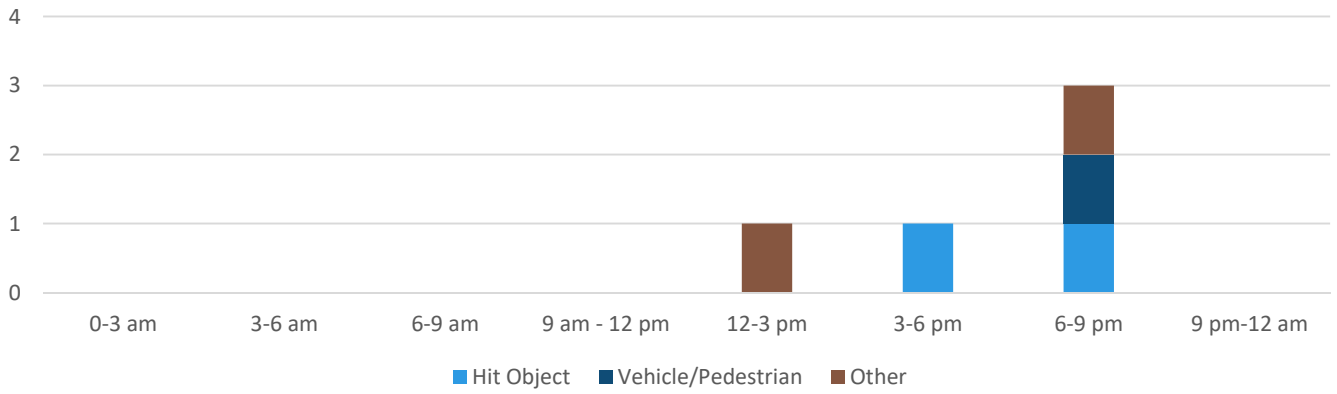
Figure 23: KSI Collisions: Collisions Type and Lighting Condition



LOCATION TYPE BY TIME OF DAY

For all KSI collisions, most occurred during the 6:00 p.m. to 9:00 p.m. time period, including a hit object, vehicle/pedestrian, and other collision. KSI collisions also occurred between 12:00 p.m. to 3:00 p.m. and 3:00 p.m. to 6:00 p.m. **Figure 24** shows killed and severe injury collisions fatal and severe injury collisions by location type and time of day.

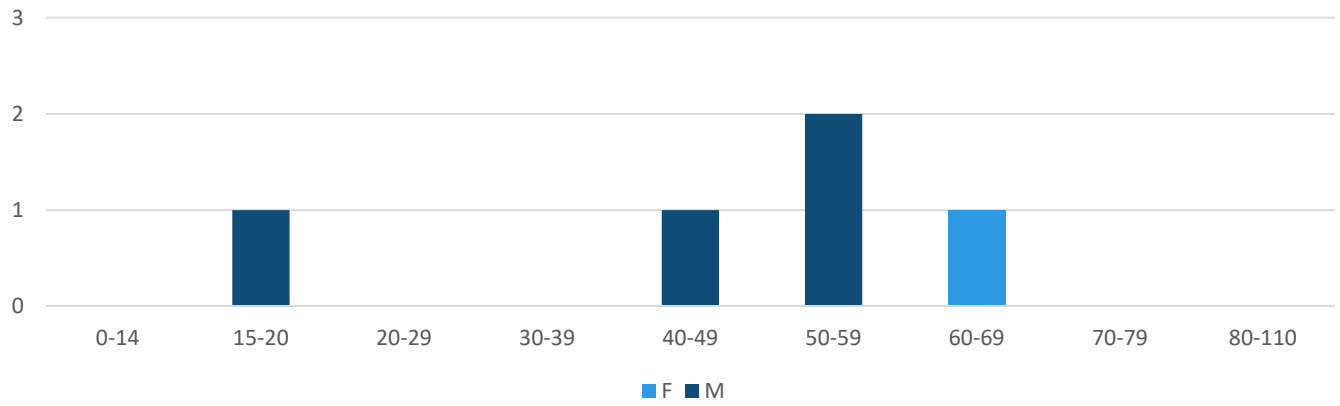
Figure 24: KSI Collisions: Time of Day and Location Type



GENDER VS AGE

For KSI collisions, the sex of the party at fault was more likely to be male than male (80% of KSI collisions were caused by males vs 20% caused by females). The party at fault for KSI collisions are also more likely to be older, with the majority caused by those age 40 or older (80%). **Figure 25** Illustrates the gender and age of the party at fault for KSI collisions.

Figure 25: KSI Collisions by Gender and Age



Geographic Collision Analysis

This section describes a detailed geographic collision analysis performed for injury collisions occurring on roadway segments and at intersections in the Town of Moraga. The above collision analysis was used to identify five main collision factors that highlight the top trends among collisions in Moraga. These five collision factors were identified to be hit object collisions, broadside collisions, pedestrian collisions, nighttime collisions, and improper turning collisions.

Hit Object Collisions

Hit object collisions represented the 2nd highest proportion of collisions of all severity (25%), as well as the highest percentage of KSI collisions (40%) (besides Other/Not Stated). **Figure 26** shows the distribution of hit object collisions throughout Moraga between 2015 and 2019. These collisions occurred on Moraga Rd, Augusta Dr, Canyon Rd, Corliss Dr, Moraga Wy, and Sullivan Dr.

Broadside Collisions

Broadside collisions represented 27% of all collisions, the most of any collision type. Additionally, 20% of all injury collisions were caused by an automobile right-of-way violation, which often lead to broadside collisions. **Figure 27** shows the distribution of broadside collisions throughout Moraga between 2015 and 2019. These collisions occurred on Moraga Rd, Alta Mesa, St. Marys Rd, Country Club Dr, Moraga Wy, Rheem Blvd, and School St.

Pedestrian Collisions

40% of KSI collisions in Moraga involved pedestrians, the most of any category (tied with fixed object), as well as making up 7% of collisions of all severity. Additionally, 40% of KSI collisions were caused by a pedestrian right of way violation. **Figure 28** shows the distribution of pedestrian collisions throughout Moraga between 2015 and 2019. These collisions occurred on Moraga Rd, Camino Pablo, Moraga Wy, Donald Dr, Eileen Ct, and St. Marys Rd.

Nighttime Collisions

60% of all KSI collisions occurred at night, as well as 31% of collisions of all severities. **Figure 29** shows the distribution of nighttime collisions throughout Moraga between 2015 and 2019. These collisions occurred on Moraga Rd, Moraga Wy, Camino Pablo, Canyon Rd, Corliss Dr, Larch Ave, Rheem Blvd, and Sullivan Dr.

Improper Turning Collisions

Improper turning caused collisions accounted for 40% of KSI collisions, as well as 15% of collisions of all severities. **Figure 30** shows the distribution of improper turning caused collisions throughout Moraga between 2015 and 2019. These collisions occurred on Moraga Rd, Campolindo Dr, Canyon Rd, Larch Ave, Moraga Wy, Rheem Blvd, and School St.

Figure 26. Town of Moraga Hit Object Collisions (2015-2019)

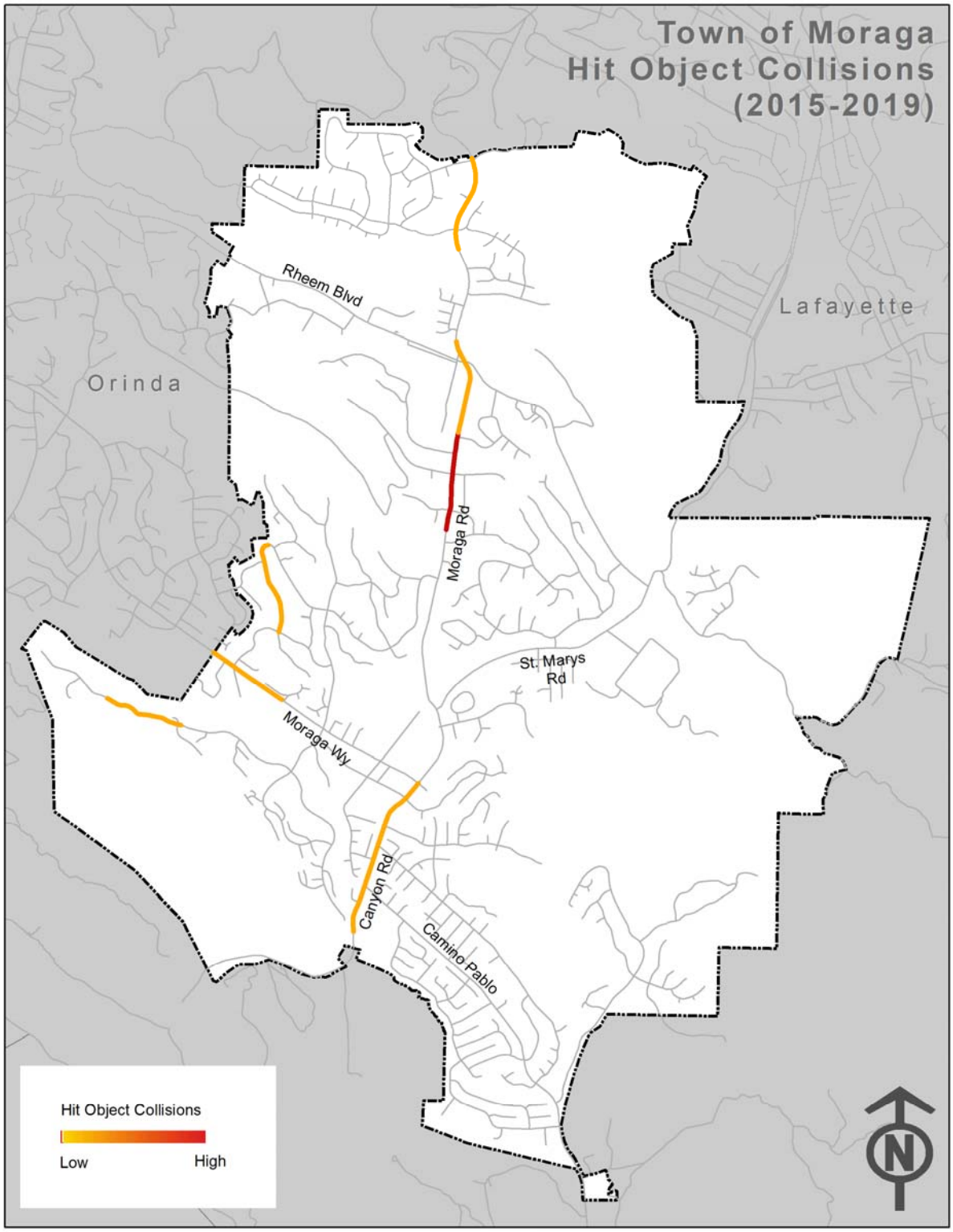


Figure 27. Town of Moraga Broadside Collisions (2015-2019)

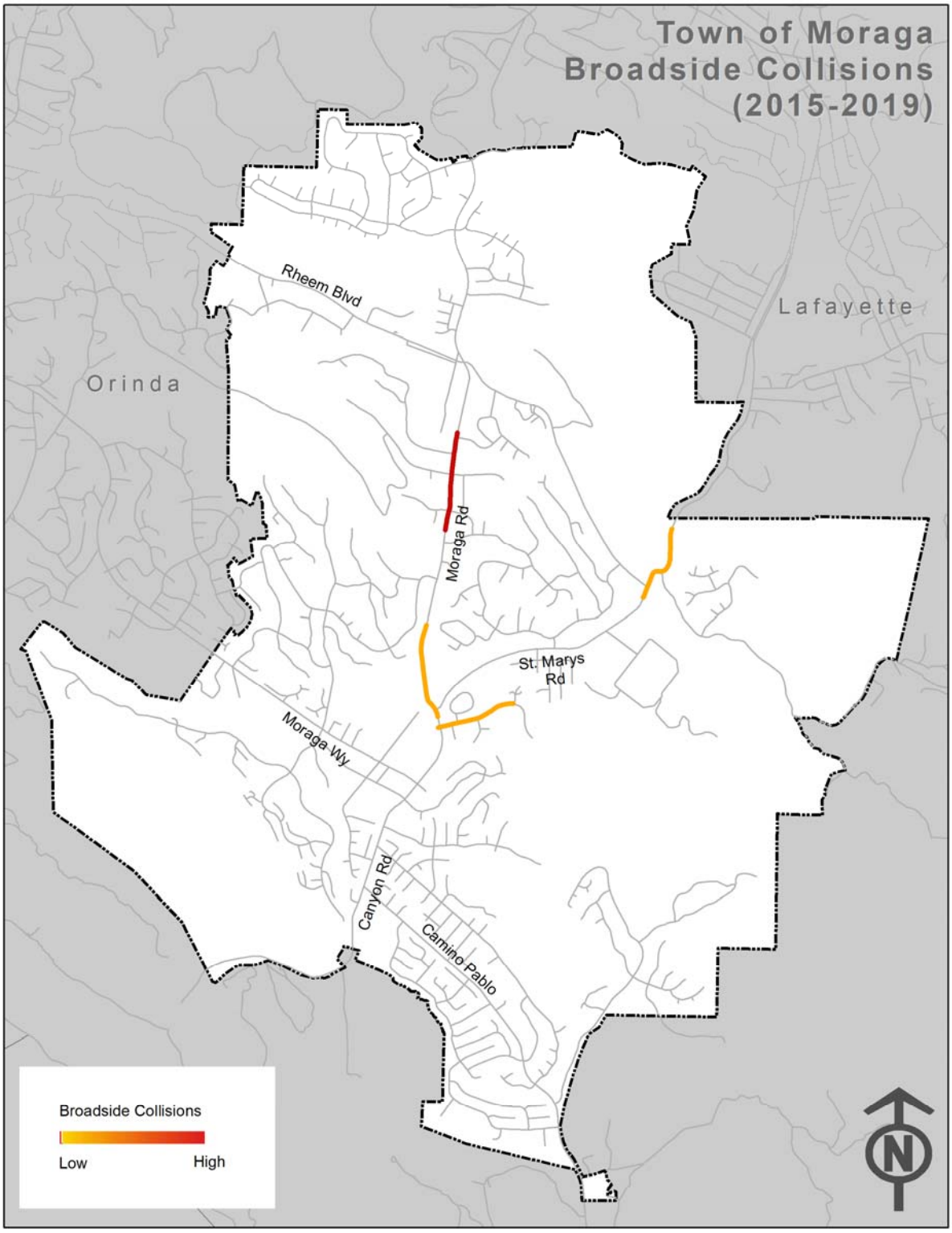


Figure 28. Town of Moraga Pedestrian Collisions (2015 - 2019)

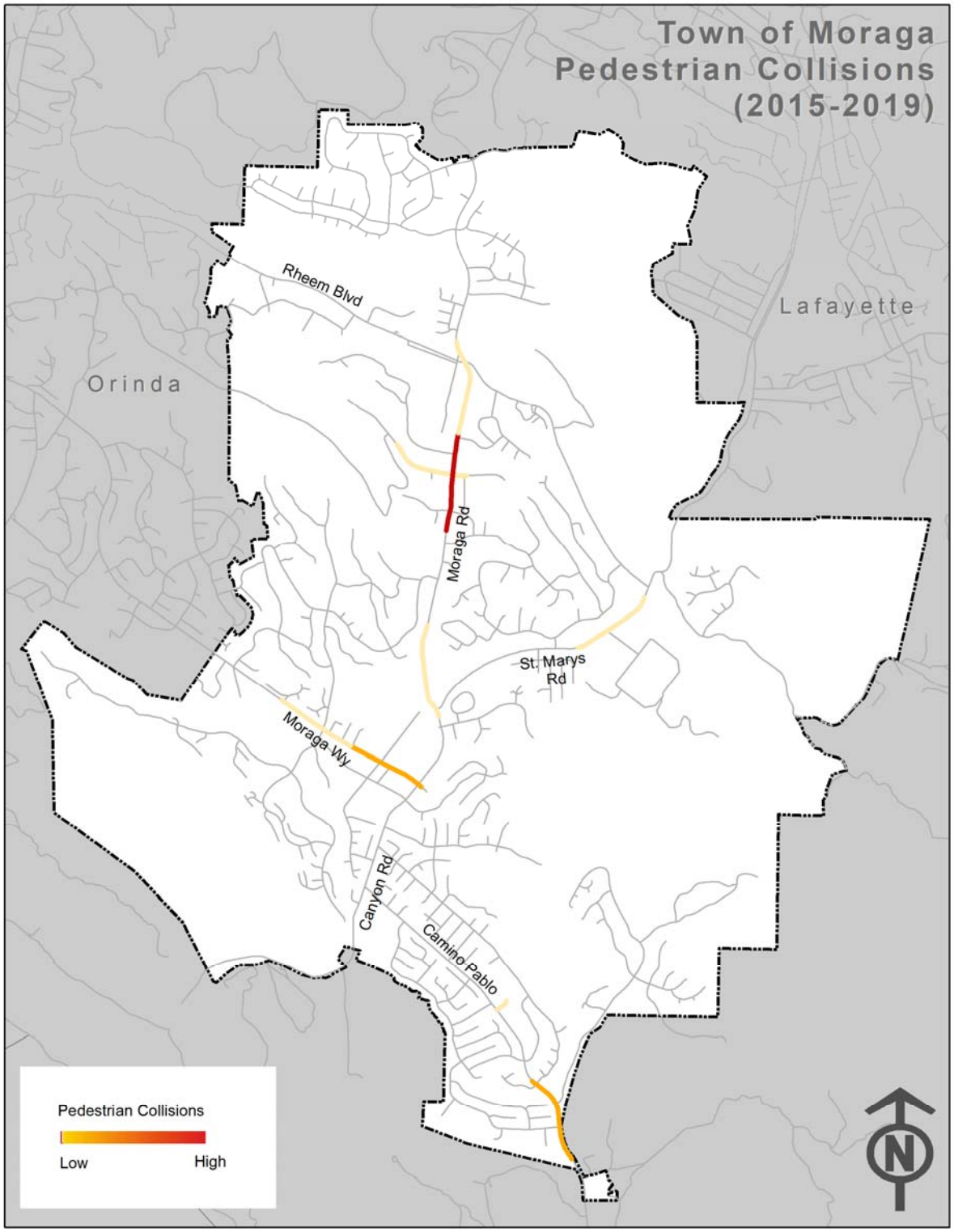


Figure 29. Town of Moraga Nighttime Collisions (2015 - 2019)

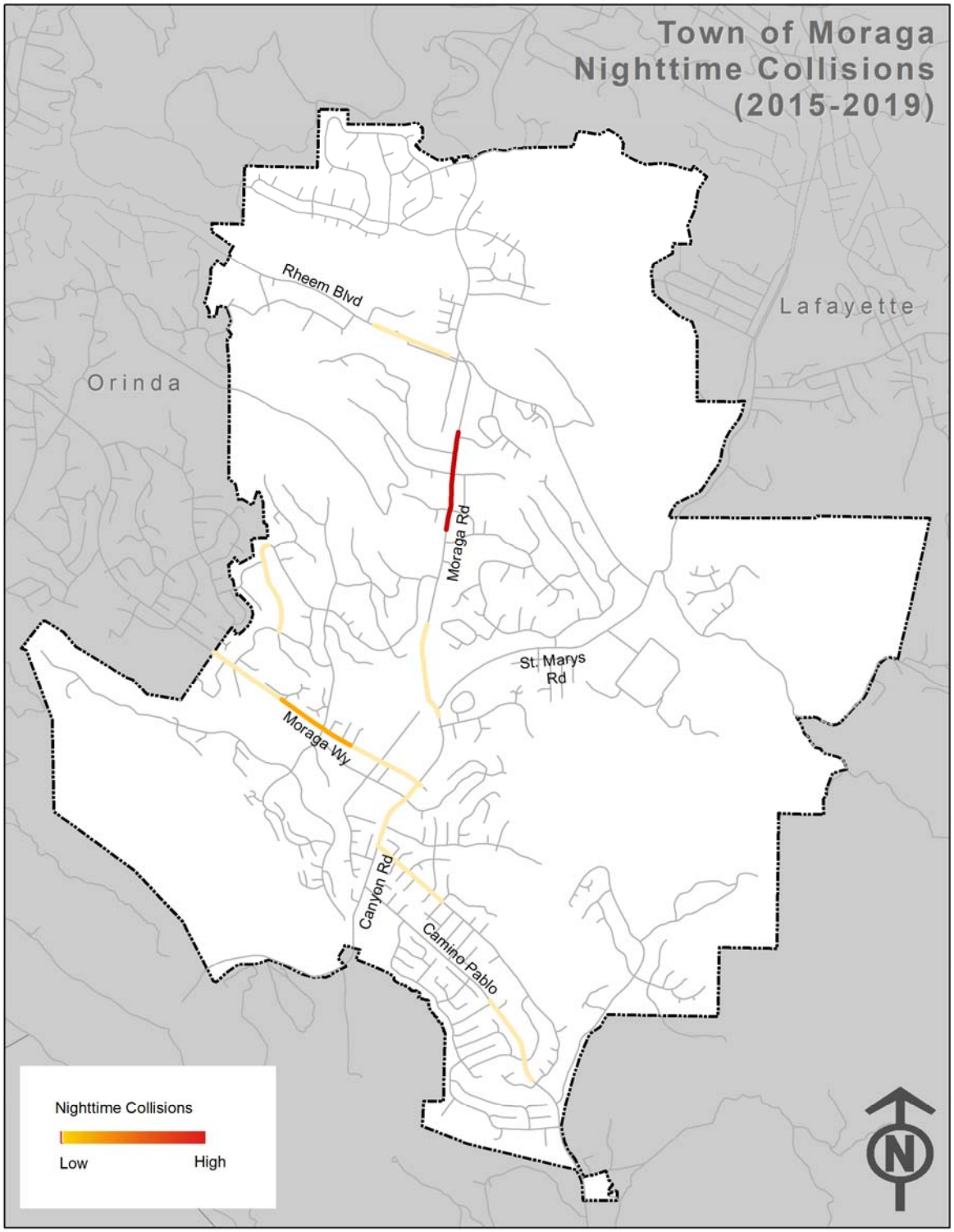
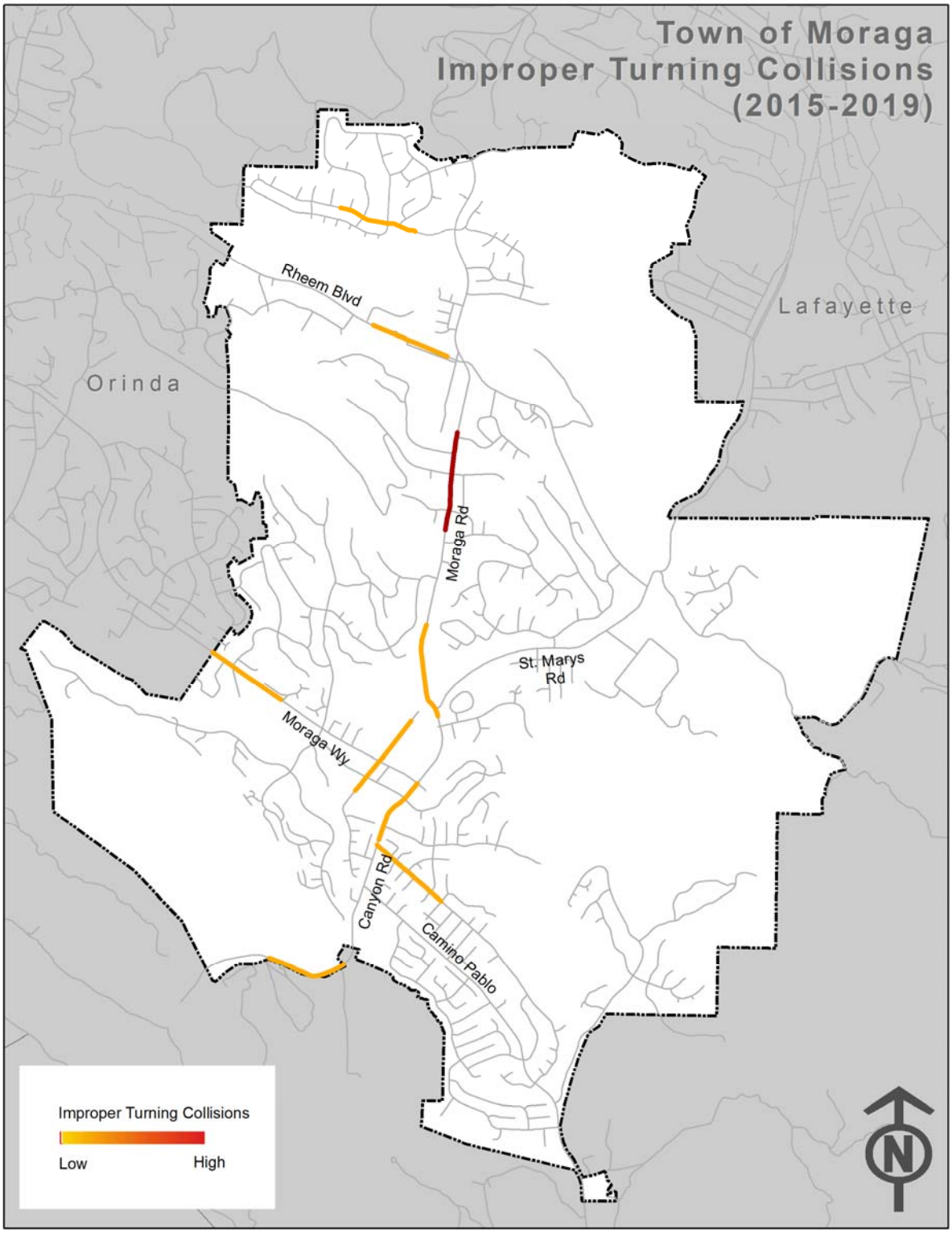


Figure 30. Town of Moraga Improper Turning Collisions (2015 - 2019)



COLLISION SEVERITY WEIGHT

Equivalent Property Damage Only (EPDO) method was used to identify the high severity collision network. The EPDO method accounts for both the severity and frequency of collisions by converting each collision to an equivalent number of property damage only (PDO) collisions. The EPDO method assigns a crash cost and score to each collision according to the severity of the crash weighted by the comprehensive crash cost. These EPDO scores are calculated using a simplified version of the comprehensive crash costs per HSIP Cycle 10 application. The weights used in the analysis are shown below in **Table 3**.

Table 3. EPDO Score used in HSIP Cycle 10

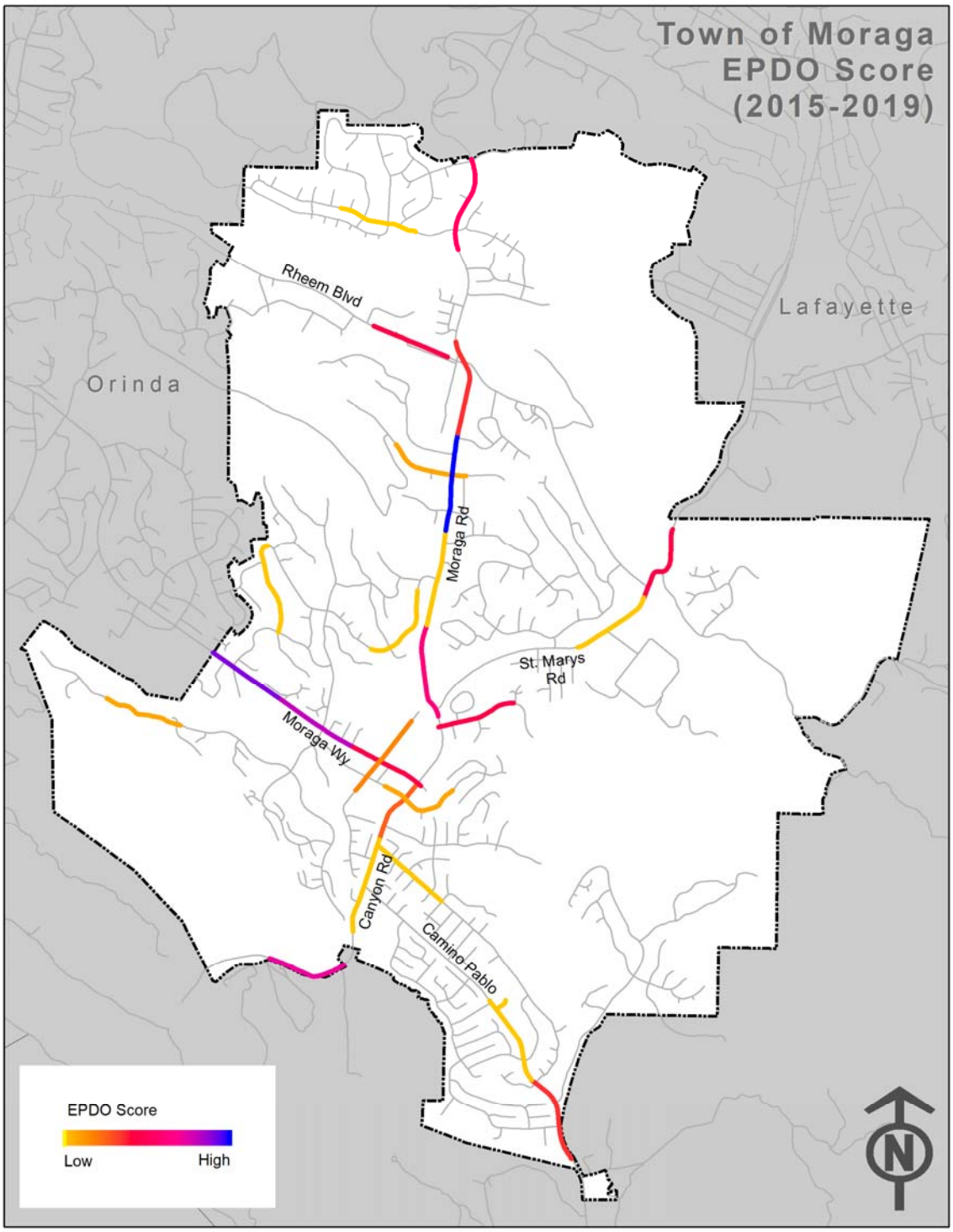
Collision Severity	EPDO Score
Fatal and Severe Injury Combined	165*
Visible Injury	11
Possible Injury	6
PDO	1

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

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

The EPDO scores for all collisions can then be aggregated in a variety of ways to identify collision patterns, such as location hot-spots. The weighted injury collisions for the Town of Moraga were geolocated onto Moraga's road network. GIS is then used to calculate the EPDO score for each roadway segment and intersection town wide, which is then ranked according to its score. **Figure 31** shows the location and geographic concentration of injury collisions by their EPDO score.

Figure 31. Town of Moraga EPDO Score



High-Injury Network

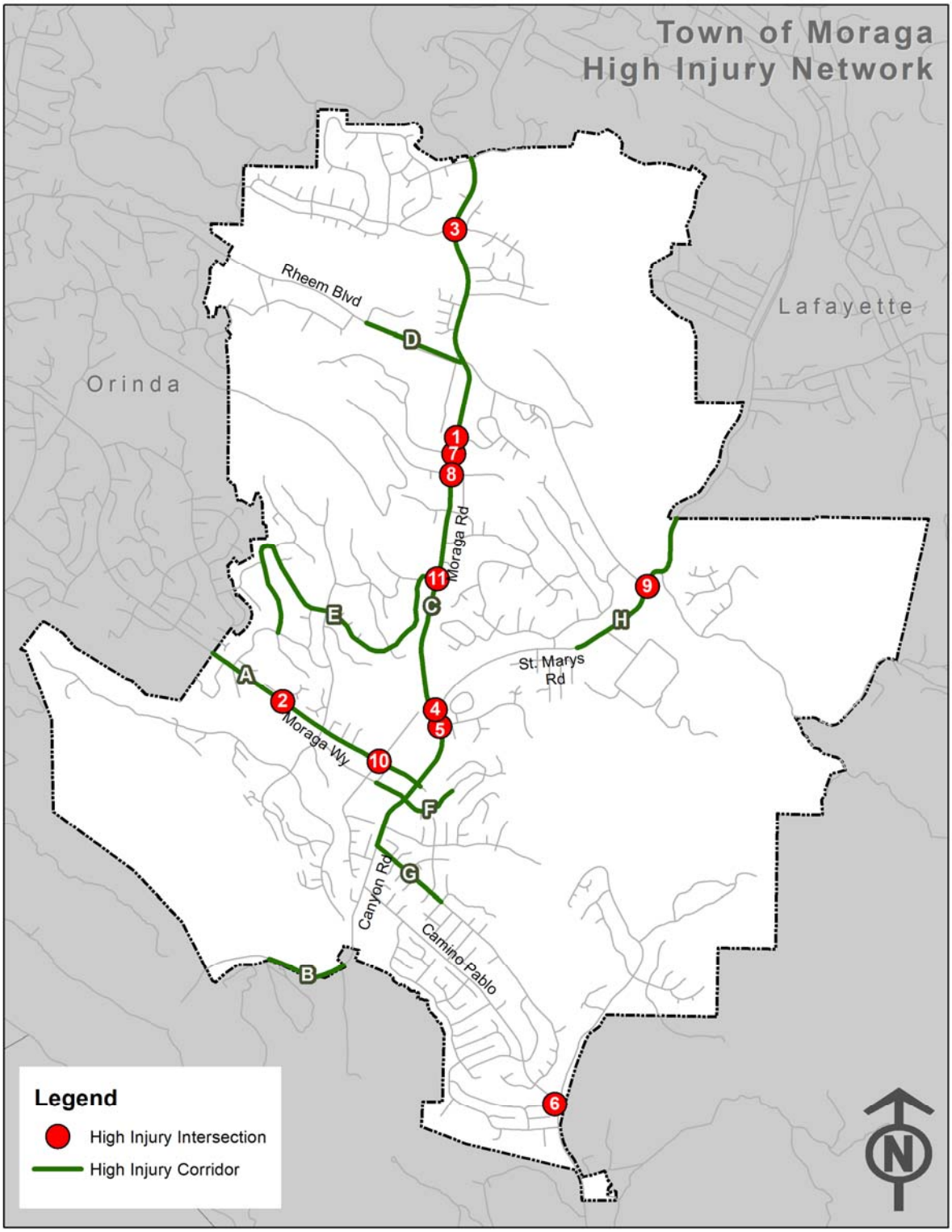
Following the detailed collision analysis, the next step was to identify the high-injury roadway segments and intersections in Moraga. The methodology for scoring the high injury locations is the same method as used in the severity weight section. **Figure 32** shows the top eight high-collision roadway segments, and top 11 high-collision intersections.

For the purposes of the high collision network analysis, intersections include collisions that occurred within 250 feet of it, and roadways include all collisions that occurred along the roadway except for collisions that occurred directly at an intersection. Such collisions are assigned a 0 value in distance from intersection value column in the Statewide Integrated Traffic Records System (SWITRS). Note that the EPDO score for each locations was calculated as follows:

EPDO Score = (165 x # of Fatal Collisions) + (165 x # of Severe Injury Collisions) + (11 x # of Other Visible Injury Collisions) + (6 x # of Complaint of Pain Collisions)

(Source: Local Roadway Safety Manual 2020, Caltrans)

Figure 32. Town of Moraga High Injury Network



Intersection Rankings

11 intersections were identified as high collision intersections. There were a total of 28 injury collisions that occurred at these intersections, including three KSI collisions. The intersection of Moraga Rd and Lucas Dr had the highest number of KSI collisions with two.

Table 4 lists the collision rate of the top 11 identified high-risk intersections along with their severity weight, number of injury collisions, and the number of KSI collisions.

Table 4. High Injury Intersections

ID	Intersection	Total Injury Collisions	KSI Collisions	Severity Weight
1	Moraga Rd at Lucas Dr	6	2	374
2	Moraga Wy at Moraga Valley Ln	1	1	165
3	Moraga Rd at Campolindo Dr	3	0	28
4	Moraga Rd at St. Marys Rd	3	0	28
5	Moraga Rd at Alta Mesa	3	0	23
6	Camino Pablo at Sanders Ranch Rd	2	0	22
7	Moraga Rd at Ascot Dr	3	0	18
8	Moraga Rd at Donald Dr	2	0	17
9	Rheem Blvd at St. Marys Rd	2	0	17
10	Moraga Wy at School St	2	0	12
11	Moraga Rd at Corliss Dr	1	0	6

Corridor Rankings

Eight corridors were identified as high collision corridors. There was a total 23 injury collisions on these corridors, of which two were KSI collisions. The Moraga Wy and Canyon Rd corridors had one KSI collision each.

Table 5 lists the collision rate of the top eight identified high-collision corridors along with the number of KSI collisions, total injury collisions, corridor length, and severity weight.

Table 5. High Injury Corridors

ID	Intersection	Total Injury Collisions	KSI Collisions	Length (miles)	Severity Weight
A	Moraga Wy: Town Limit to Moraga Rd	5	1	1.0	199
B	Canyon Rd: 300' E of Valle Vista Staging Area to Town Limit (East)	1	1	0.3	165
C	Moraga Rd/Canyon Rd: Larch Ln to Town Limit (North)	10	0	3.1	85
D	Rheem Blvd: La Salle Dr to Moraga Rd	2	0	0.4	12
E	Corliss Dr/Sullivan Dr: Hardie Dr to Moraga Rd	2	0	1.6	12
F	Country Club Dr: Viader Dr to 875' E of Southard Ct	1	0	0.4	11
G	Larch Ave: Canyon Rd to Baitx Ave	1	0	0.4	6
H	St. Marys Rd: 500' E of Stafford Rd to Town Limit	1	0	0.8	6

Summary

Between 2015 and 2019, a total of 190 collisions occurred within the Town of Moraga, of which 60 resulted in an injury and five resulted in a fatality or severe injury. Among all collisions, the most prominent collision types were broadside and hit object collisions, while automobile right-of-way and improper turning were the most common violation types. The intersection with the most KSI crashes was Moraga Rd at Lucas Dr with two, while the Moraga Wy and Canyon Dr. corridors each had one KSI collision.

Five prominent collision factors that emerged were: **hit object collisions, broadside collisions, pedestrian collisions, nighttime collisions, and improper turning collisions.** Each of these is described in turn.

Hit object collisions represented the 2nd highest proportion of collisions of all severity (25%), as well as the highest percentage of KSI collisions (40%). These collisions occurred on Moraga Rd, Augusta Dr, Canyon Rd, Corliss Dr, Moraga Wy, and Sullivan Dr. Improvements to mitigate hit object collisions could include installing shoulder rumble strips, widening shoulders, installing guard rails, installing object markers, or establishing a clear recovery zone.

Broadside collisions represented 27% of all collisions, the most of any collision type. Additionally, 20% of all injury collisions were caused by an automobile right-of-way violation, which often lead to broadside collisions. These collisions occurred on Moraga Rd, Alta Mesa, St. Marys Rd, Country Club Dr, Moraga Wy, Rheem Blvd, and School St. Broadside collisions can potentially be mitigated by increasing the visibility of an intersection through updated pavement markings, new or updated signage, lighting, advance flashing beacons, and improving sight distance.

40% of KSI collisions in Moraga involved pedestrians, the most of any category (tied with fixed object), as well as making up 7% of collisions of all severity. Additionally, 40% of KSI collisions were caused by a pedestrian right of way violation. These collisions occurred on Moraga Rd, Camino Pablo, Moraga Wy, Donald Dr, Eileen Ct, and St. Marys Rd. Addressing these types of collisions helps to make Moraga's transportation network safe for all modes of travel. Countermeasures such as traffic calming, high visibility crosswalks, Rectangular Rapid Flashing Beacons (RRFBs), sidewalk bulb outs, advanced flashing warning signs, can all help to address pedestrian collisions.

60% of all KSI collisions occurred at night, as well as 31% of collisions of all severities. These collisions occurred on Moraga Rd, Moraga Wy, Camino Pablo, Canyon Rd, Corliss Dr, Larch Ave, Rheem Blvd, and Sullivan Dr. Many different factors can contribute to nighttime collisions, such as low lighting levels that can be targeted with countermeasure, but extraneous factors can also contribute to nighttime collisions, such as alcohol use or sleepiness/fatigue. Improvements such as installing new lighting, upgrading existing lighting to a higher lumen, installing and upgrade signs with new fluorescent sheeting and installing pedestrian improvements with lighting elements such as RRFBs (rectangular rapid flashing beacons) and HAWKs can help make these locations safer for all road users.

Improper turning collisions accounted for 40% of KSI collisions, as well as 15% of collisions of all severities. These collisions occurred on Moraga Rd, Campolindo Dr, Canyon Rd, Larch Ave, Moraga Wy, Rheem Blvd, and School St. Countermeasures such as improving sight distance at intersections, installing dedicated left turn lanes, median splitter islands on minor road approaches, and raised medians can help to mitigate improper turning caused collisions.

The next steps in the LRSP will be to identify emphasis areas based on the collision analysis presented in this memo. The most prominent collision types, violations, and human behaviors will be selected for inclusion as an emphasis area, as these represent the most prominent traffic safety issues in Moraga. Each emphasis area will be accompanied with strategies corresponding to the E's of traffic safety to comprehensively make the Town of Moraga safer for all modes of transportation.

5. EMPHASIS AREAS

Emphasis areas are focus areas for the LRSP that are identified through the comprehensive collision analysis of the identified high injury locations within the Town of Moraga. Emphasis areas help in identifying appropriate safety strategies and countermeasures with the greatest potential to reduce collisions occurring at these high injury locations. They can include (but not be limited to): specific collision types, human behaviors, facility types, and specific locations or corridors.

This chapter summarizes the top seven (7) emphasis areas identified for the Town of Moraga. These emphasis areas were derived from the consolidated high injury collision database (**Appendix B**) where top injury factors were identified by combining the data manually. Along with findings from the data analysis, stakeholder input was also considered while identifying emphasis areas specific to the Town of Moraga.

The identified emphasis areas are as follows:

1. Improve Intersection Safety (Collisions within 250 feet of an intersection)
2. Address Hit Object Collisions
3. Address Broadside Collisions & Automobile Right-of-Way Violations
4. Improve Bicycle & Pedestrian Safety
5. Address Nighttime Collisions
6. Improve Safety Around Schools
7. Address Improper Turning Violations

The 5 E's of Traffic Safety

The LRSP utilizes a comprehensive approach to safety incorporating the "5 E's of traffic safety": **E**ngineering, **E**nforcement, **E**ducation, **E**quity, and **E**mergency Medical Services (EMS). This approach recognizes that not all locations can be addressed solely by infrastructure improvements. Incorporating the 5 E's of traffic safety is often required to ensure successful implementation of 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 be used to supplement enforcement and improve the efficiency of each strategy. Education can also be employed in the short-term to address high crash locations until the recommended infrastructure project can be implemented. Similarly, Emergency Medical Services entails strategies around supporting organizations that provide rapid response and care when responding to collisions causing injury, by stabilizing victims and transporting them to medical facilities.

Existing Traffic Safety Efforts in the Town of Moraga

The Town of Moraga and partner agencies have already planned and implemented safety strategies corresponding to the 5 E's of traffic safety. The strategies detailed in this memorandum can supplement these existing programs and concentrate them on high injury collision locations and crash types. These initiatives are summarized in the following table:

Table 6: Existing Programs Summary

Document/ Program	Description	E's Addressed
511 Contra Costa	To eliminate unnecessary vehicle trips, 511 Contra Costa encourages students to walk, bike, carpool, or take the bus to school whenever possible. Their Youth Transportation programs offer tips for safe walking/biking to school, partners with Safe Routes to School, and promotes events such as Walk and Bike to School Days.	Education
Town of Moraga Police Department and Moraga-Orinda Fire District	Town of Moraga Police Department and Moraga-Orinda Fire District provide traffic enforcement and emergency response to collisions occurring within Town limits.	Enforcement, EMS
Town of Moraga General Plan	The Circulation Element of the General Plan stipulates the goals and policies for safe, reliable, and accessible transportation needs in Moraga. The intention is to guide the development of Moraga in a way that is multi-modal friendly and accessible to all users of the road.	Engineering
Moraga Walk/Bike Plan	The Town's Walk/Bike Plan was developed to guide the Town's decisions regarding walking and biking over the next decade. The plan includes a set of engineering projects for on and off street bicycle and pedestrian facilities, as well as non-engineering support programs.	Engineering, Education
Moraga School District	The Moraga School District offers educational information on biking and walking to and from school on the district's website, as a resource to students and parents.	Education
Contra Costa Countywide Comprehensive Transportation Plan (2017)	This comprehensive document on transportation in Contra Costa County recommends and prioritizes projects that promote safety in the County's transportation network.	Engineering

Factors Considered in the Determination of Emphasis Areas

This section presents collision data analysis of collision types, factors, facility types, and roadway geometries analyzed for the various emphasized areas. Emphasis areas were determined by factors that led to the highest amount of injury collisions, with a specific emphasis on fatal and severe (KSI) injury collisions. The Town of Moraga experienced a total of 49 injury collisions at high injury network locations during the 2015-2019 study period, including 5 KSI collisions. The data presented below in each emphasis area is based on these collisions. Emphasis areas were also informed by stakeholder feedback and comments from Moraga residents on the project website's interactive map tool.

Each emphasis area is accompanied by comprehensive programs, policies, and countermeasures to reduce collisions on Town roads in that specific emphasis area. It will provide the basis by which the countermeasure toolbox is developed for each identified high injury location.

Note: Engineering countermeasures are based on the Caltrans Local Roadway Safety Manual and are used in HSIP calls for projects. They are categorized as follows:

- S = Signalized Intersections Countermeasures
- NS = Non-Signalized Intersections Countermeasures
- R = Roadway Segments Countermeasures

An excerpt of the Caltrans Local Roadway Safety Manual providing additional details on each countermeasure is included in **Appendix B**.

Emphasis Area 1 – Improve Intersection Safety

Intersection collisions made up the vast majority of collisions occurring on the Moraga high injury network during the study period, a total of 73%. Three out of the five KSI collisions occurred at intersections. The following collision data is based on only intersection collisions on the high injury network in the Town of Moraga, followed by E's strategies selected to address intersection collisions.

31%
Broadside Collisions

47%
Involved Pedestrian or Bike

42%
Occurred on Moraga Rd

Table 7. Emphasis Area 1 Strategies

Objective: Reduce the number of fatal and severe injury collisions at intersections.			
	Strategy	**Performance Measure**	**Agencies/ Organizations**
Education	Conduct public information and education campaign for intersection safety laws regarding traffic signals, stop signs, and turning left or right.	Number of education campaigns or residents reached.	Town/Police Department
Enforcement	Targeted enforcement at high-injury intersections to monitor right-of-way violations, speed limit laws and other violations that occur at intersections.	Decrease in number of citations and/or warnings issued over time due to increased driver compliance.	Police Department
Engineering	• S02, Improve signal hardware • S03, Improve signal timing • S09, Install raised pavement markers • S17PB, Install pedestrian countdown signal heads • S21PB, Modify signal phasing to implement a Leading Pedestrian Interval • NS03, Install signals • NS06, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs • NS07, Upgrade intersection pavement markings • NS08, Install Flashing Beacons at Stop-Controlled Intersections • S10/NS09, Install flashing beacons as advance warning • NS10, Install transverse rumble strips on approaches • NS11, Improve sight distance to intersection (Clear Sight Triangles) • NS13, Install splitter-islands on the minor road approaches • S12/NS14, Install raised median on approaches	Number of intersections improved.	Town
EMS	S05, Install emergency vehicle pre-emption systems Improve resource of deployment for emergency responses to collision sites. Ensure emergency routes are clear and well defined	EMS vehicle response time.	Town/Fire District & EMS Response Teams

Emphasis Area 2 – Address Hit Object Collisions

8 (16%) of the high injury network collisions were hit object collisions, including 2 fatal or severe injury (KSI) collisions. The only fatal collision occurring in Town limits between 2015 and 2019 was a hit object collision. In addition, 38% of the hit object collisions occurred due to an improper turning violation. The following is based on only hit object injury collisions on the high injury network, followed by E's strategies to address them.

38%
Occurred at Night

2 of 5
KSI Collisions

50%
Roadway Segments

Table 8. Emphasis Area 2 Strategies

Objective:			
Reduce the number of fatal and severe injury hit object collisions.			
	Strategy	**Performance Measure**	**Agencies/ Organizations**
Education	Conduct public information and education campaigns on risks that can lead to hit object collisions, such as unsafe speeds, distracted driving, improper turning and driving under the influence.	Number of education campaigns or residents reached.	Town/Police Department
Enforcement	Targeted enforcement at high-injury locations where hit object collisions are more common.	Decrease in number of citations and/or warnings issued over time due to increased driver compliance.	Police Department
Engineering	• S10/NS09, Install flashing beacon as advance warning • NS06, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs • R01, Add Segment Lighting • R02, Remove or relocate fixed objects outside of Clear Recovery Zone • R04, Install Guardrail • R15, Widen shoulder • R22, Install/Upgrade signs with new fluorescent sheeting (regulatory or warning) • R23, Install chevron signs on horizontal curves • R24 or R25, Install curve advance warning signs • R26, Install dynamic/variable speed warning signs • R27, Install delineators, reflectors and/or object markers • R28, Install edge-lines and centerlines • R31, Install edge-line rumble strips/stripes	Number of locations improved.	Town
EMS	S05, Install emergency vehicle pre-emption systems Improve resource of deployment for emergency responses to collision sites. Ensure emergency routes are clear and well defined	EMS vehicle response time.	Town/ Fire District & EMS Response Teams

Emphasis Area 3 – Address Broadside Collisions & Automobile Right-of-Way Violations

14 (29%) of the high injury network collisions were broadside collisions, of which 64% were caused by an automobile right-of-way violation. These two factors are combined into a single emphasis area due to the strong correlation between automobile right-of-way violations and broadside collisions. The following collision data is based on only broadside injury collisions on the high injury network of the Town of Moraga, followed by E's strategies to address them.

79%
At Intersections

36%
Involved a Bicycle

64%
Involved Another Vehicle

Table 9. Emphasis Area 3 Strategies

Objective:			
Reduce the number of fatal and severe injury broadside collisions.			
	Strategy	**Performance Measure**	**Agencies/ Organizations**
Education	Conduct public information and education campaigns for intersection safety laws regarding traffic lights, stop signs and turning left or right.	Number of education campaigns or residents reached.	Town/Police Department
Enforcement	Targeted enforcement at high-injury locations where violations that lead to broadside collisions are more common, such as automobile right of way and traffic signal/stop sign violations.	Decrease in number of citations and/or warnings issued over time due to increased driver compliance.	Police Department
Engineering	• S02, Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number • S03, Improve signal timing (coordination, phases, red, yellow, or operation) • S08, Convert signal to mast arm (from pedestal-mounted) • S09, Install raised pavement markers and striping (Through Intersection) • S16/NS04/NS05, Convert intersection to roundabout • NS02, Convert to all-way STOP control (from 2-way or Yield control) • NS03, Install signals • NS06, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs • NS07, Upgrade intersection pavement markings (NS.I.) • NS08, Install flashing beacons at stop controlled intersections • NS09, Install flashing beacons as advance warning (NS.I.) • NS10, Install transverse rumble strips on approaches • NS11, Improve sight distance to intersection (Clear Sight Triangles) • NS13, add splitter-islands on the minor road approaches • S12/NS14, install raised median on approaches	Number of locations improved to mitigate broadside collisions.	Town
EMS	S05, Install emergency vehicle pre-emption systems Improve resource of deployment for emergency responses to collision sites. Ensure emergency routes are clear and well defined	EMS vehicle response time.	Town/ Fire District & EMS Response Teams

Emphasis Area 4 – Improve Bicycle & Pedestrian Safety

20 (41%) of collisions on the high injury network involved either a bicycle or pedestrian, including two severe injury collisions. Pedestrian collisions were among the top collision types among KSI collisions. In addition, a high number of community comments on traffic safety in Moraga included concerns about bicycle & pedestrian related safety (especially around schools and the Lafayette-Moraga Regional Trail). The following collision data is based on only bicycle and pedestrian collisions on the high injury network of the Town of Moraga, followed by E's strategies to address them.

10%
KSI Collisions

85%
At Intersections

30%
Occurred on Moraga Rd

Table 10. Emphasis Area 4 Strategies

Objective:			
Reduce the number of fatal and severe injury collisions involving bicyclists and pedestrians.			
	Strategy	**Performance Measure**	**Agencies/ Organizations**
Education	Conduct pedestrian safety campaigns and outreach to raise their awareness of pedestrian safety needs through media outlets, social media, and public events. Partner with Safe Routes to School to conduct bicycle and pedestrian safety programs in Moraga's schools.	Number of education campaigns or residents reached.	Town/School District/ Police Department
Enforcement	Targeted enforcement at high-injury locations especially near schools, trails, and other areas where pedestrians are more present. Continue to place a high priority on enforcement of motorist and pedestrian violations that most frequently cause injuries and fatalities among pedestrians.	Decrease in number of citations and/or warnings issued over time due to increased driver compliance.	Police Department
Engineering	• S17PB, Install pedestrian countdown signal heads • S18PB, Install pedestrian crossing (S.I.) • S20PB, Install advance stop bar before crosswalk (Bicycle Box) • S21PB, Modify signal phasing to implement a Leading Pedestrian Interval • NS19PB, Install raised medians (refuge islands) • NS21PB/R35PB, Install/upgrade pedestrian crossing (with enhanced safety features) • NS22PB, Install Rectangular Rapid Flashing Beacon (RRFB) • NS23PB, Install pedestrian signal (including Pedestrian Hybrid Beacon (HAWK)) • R32PB, Install bike lanes • R33PB, Install separated bike lanes • R34PB, Install sidewalk/pathway (to avoid walking along roadway) • R37PB, Install Rectangular Rapid Flashing Beacons (RRFB) • High-visibility ladder crosswalks • Mid-block curb extension • In-road yield sign for pedestrian crossing at crosswalk with pedestrian flags • Intersection bulb-outs	Number of locations improved.	Town
EMS	S05, Install emergency vehicle pre-emption systems Improve resource of deployment for emergency responses to collision sites. Ensure emergency routes are clear and well defined, particularly to areas and times of high pedestrian activity.	EMS vehicle response time.	Town/ Fire District & EMS Response Teams

Emphasis Area 5 – Address Nighttime Collisions

11 (22%) of high injury network collisions occurred at night or in low light (dawn/dusk) conditions, including three KSI collisions (60%). The following collision data is based on only nighttime injury collisions on the high injury network of Town of Moraga, followed by E's strategies selected to address nighttime collisions.

38%
Involved Alcohol

27%
Improper Turning Violations

36%
Involved Pedestrian or Bike

Table 11. Emphasis Area 5 Strategies

Objective:			
Reduce the number of fatal and severe injury collisions that occur at night or dawn/dusk.			
	Strategy	**Performance Measure**	**Agencies/ Organizations**
Education	Develop an awareness program to inform motorists of safe nighttime driving habits and the dangers of drunk driving, as well as high-injury collision locations and the most common violations/collision types occurring at night.	Number of education campaigns or residents reached.	Town/Police Department
Enforcement	Targeted enforcement at high-injury intersections and roadway locations where nighttime collisions are more common. Establish DUI checkpoints at night where appropriate.	Decrease in number of citations and/or warnings issued over time due to increased driver compliance.	Police Department
Engineering	• S01, Add intersection lighting (Signalized Intersection => S.I.) • S02, Improve signal hardware • S09, Install raised pavement markings and striping (through intersection) • S10, Install flashing beacons as advance warning (S.I.) • NS01, Add intersection lighting • NS06, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs • NS07, Upgrade intersection pavement markings (NS.I.) • NS08, Install Flashing Beacons at Stop-Controlled Intersections • NS09, Install flashing beacons as advance warning (NS.I.) • NS22PB/R37PB, Install Rectangular Rapid Flashing Beacon (RRFB) • R01, Add Segment Lighting • R02, Remove or relocate fixed objects outside of Clear Recovery Zone • R22, Install/Upgrade signs with new fluorescent sheeting (regulatory or warning) • R24 or R25, Install curve advance warning signs • R27, Install delineators, reflectors and/or object markers • R28, Install edge-lines and centerlines • R31, Install edge-line rumble strips/stripes	Number of locations improved.	Town
EMS	S05, Install emergency vehicle pre-emption systems Improve resource of deployment for emergency responses to collision sites. Ensure emergency routes are clear and well defined	EMS vehicle response time.	Town/ Fire District & EMS Response Teams

Emphasis Area 6 – Improve Safety around Schools

When considering all injury collisions, 9 occurred within ¼ mile of a school (15%), while 26 occurred within ½ mile of a school (43%), including two KSI collisions. Safety around schools was a common concern among the LRSP stakeholders and community comments. The following collision data is based on only injury collisions within ½ mile of a school in the Town of Moraga, followed by E's strategies selected to address them

38%
Involved Bike or Pedestrian

46%
Occurred between 7am-9am or 4pm-6pm

31%
Hit Object Collisions

Table 12. Emphasis Area 6 Strategies

Objective:			
Reduce the number of fatal and severe injury collisions that occur around schools.			
	Strategy	**Performance Measure**	**Agencies/ Organizations**
Education	Conduct school safety campaigns and outreach to raise their awareness of traffic safety needs at schools. Participate in Safe Routes to School programs to teach students how to walk and ride their bike safely.	Number of education campaigns or residents reached.	Town/School District/Police Department
Enforcement	Targeted enforcement at high-risk locations especially near schools during peak congestion times. Deploy crossing guards (or additional), during peak school drop off and pick up times	Decrease in number of citations and/or warnings issued over time due to increased driver compliance.	Police Department/School District
Engineering	• R26, Install dynamic/variable speed warning signs • NS19PB, Install raised medians (refuge islands) • NS21PB/R35PB, Install/upgrade pedestrian crossing (with enhanced safety features) • NS22PB/R37PB, Install Rectangular Rapid Flashing Beacons (RRFB) • NS23PB, Install Pedestrian Signal (including Pedestrian Hybrid Beacon (HAWK)) • R34PB, Install sidewalk/pathway (to avoid walking along roadway) • R33PB, Install separated bike lanes • High-visibility ladder crosswalks • Install school area signage with speed feedback • Mid-block curb extension • In-road yield sign for pedestrian crossing at crosswalk	Number of locations improved.	Town
EMS	S05, Install emergency vehicle pre-emption systems Improve resource of deployment for emergency responses to collision sites. Ensure emergency routes are clear and well defined	EMS vehicle response time.	Town/ Fire District & EMS Response Teams

Emphasis Area 7 – Address Improper Turning Violations

8 (16%) of collisions on the high injury network were a result of improper turning, two of which were KSI collisions. The following collision data is based on only improper turning caused injury collisions on the high injury network of the Town of Moraga, followed by E's strategies selected to address them.

38%
Involved Fixed Object

38%
Occurred at Night

75%
At Intersections

Table 13. Emphasis Area 7 Strategies

Objective:			
Reduce the number of fatal and severe injury collisions that result from improper turning violations.			
	Strategy	**Performance Measure**	**Agencies/ Organizations**
Education	Conduct public information and education campaign for safety laws regarding traffic lights, stop signs, and turning left or right.	Number of education campaigns or residents reached.	Town/Police Department
Enforcement	Targeted enforcement at high-risk locations where improper turning violations are more common.	Decrease in number of citations and/or warnings issued over time due to increased driver compliance.	Police Department/School District
Engineering	• S02, Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number • S03, Improve signal timing (coordination, phases, red, yellow, or operation) • S09, Install raised pavement markers and striping (Through Intersection) • S12/NS14, Install raised median on approaches • S14/NS15, Create directional median openings to allow (and restrict) left turns and u-turns • S16/NS04/NS05, Convert intersection to roundabout • NS06, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs • NS07, Upgrade intersection pavement markings (NS.I.) • NS13, Install splitter islands on minor road approaches • S01/NS01/R01, Add Lighting • R22, Install/Upgrade signs with new fluorescent sheeting (regulatory or warning) • R23, Install chevron signs on horizontal curves • R24 or R25, Install curve advance warning signs • R27, Install delineators, reflectors and/or object markers • R28, Install edge-lines and centerlines	Number of locations improved.	Town
EMS	S05, Install emergency vehicle pre-emption systems Improve resource of deployment for emergency responses to collision sites. Ensure emergency routes are clear and well defined	EMS vehicle response time.	Town/ Fire District & EMS Response Teams

6. COUNTERMEASURE SELECTION

Identification of Countermeasures

Upon the identification of high-risk locations and Emphasis Areas, the next step was to identify appropriate safety countermeasures. The Caltrans Local Roadway Safety Manual (LRSM) provides 82 countermeasures, of which 21 are eligible in the current HSIP call for signalized intersections, 23 for un-signalized intersections, and 38 for roadway segments. The LRSM provides guidance on where to apply the countermeasures including the crash types each countermeasure would address, and a Crash Reduction Factor (CRF) for each countermeasure. The Federal Highway Administration (FHWA) CMF Clearinghouse and published research papers were reviewed by the project team to gain additional insight on CRFs and effectiveness of specific countermeasures.

The project team conducted a thorough review of the high-injury locations (intersections and roadway segments) using aerial photography, Google Maps Street View software, and in-person site visits. Crash characteristics of all collisions occurring on the High Injury Network were considered. After combining the physical and collision characteristics, the project team developed a table of preliminary countermeasures that address each of the seven identified Emphasis Areas. The table was refined by selecting up to four countermeasures for each high-risk location that were most commonly recommended among all Emphasis Areas. By doing this, the project team was able to identify countermeasures with the greatest opportunity for systemic implementation.

Countermeasure Toolbox

Engineering countermeasures were selected for each of the high-risk locations and for the emphasis areas. These were based off of approved countermeasures from the Caltrans Local Roadway Safety Manual (LRSM) used in HSIP grant calls for projects. The intention is to give the Town potential countermeasures for each location that can be implemented either in future HSIP calls for projects, or using other funding sources, such as the Town's Capital Improvement Program. Non-engineering countermeasures were also selected using the 5 E's strategies, and are included with the emphasis areas. The countermeasure toolbox in **Appendix C** details the draft countermeasures for each high-risk location and emphasis area, separated by intersections and roadway segments. While not all of these countermeasures will be included in the resulting safety projects, they are included to give the Town a toolbox for implementing future safety improvements through other means, such as the Town's Capital Improvement Program.

Table 14 provides a description of each countermeasure along with the crash reduction factor (CRF), federal funding eligibility, and opportunity for systemic implementation. An excerpt of the LRSM, detailing each available HSIP countermeasure referenced in the recommendations tables, is included as **Appendix D**.

Table 14. Countermeasures selected for the Town of Moraga

Code	Countermeasure Name	Countermeasure Description	CRF	Federal Funding	Systemic Approach Opportunity
S01	Add intersection lighting	Provision of lighting at intersection.	40%	90%	Medium
S02	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	Includes 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.	15%	90%	Very High
S03	Improve signal timing (coordination, phases, red, yellow, or operation)	Includes adding phases, lengthening clearance intervals, eliminating or restricting higher-risk movements, and coordinating signals at multiple locations.	15%	50%	Very High
S09	Install raised pavement markers and striping (Through Intersection)	Adding clear pavement markings can guide motorists through complex intersections. When drivers approach and traverse through complex intersections, drivers may be required to perform unusual or unexpected maneuvers	10%	90%	Very High
S10	Install flashing beacons as advance warning (S.I.)	Increased driver awareness of an approaching signalized intersection and an increase in the driver's time to react.	30%	90%	Medium
S11	Improve pavement friction (High Friction Surface Treatments)	Improving the skid resistance at locations with high frequencies of wet road crashes and/or failure to stop crashes	55%	90%	Medium
S12	Install raised median on approaches (S.I.)	Raised medians next to left turn lanes at intersections offer a cost effective means for reducing crashes and improving operations at higher volume intersections	25%	90%	Medium
S20PB	Install advance stop bar before crosswalk (Bicycle Box)	Signalized Intersections with a marked crossing, where significant bicycle and/or pedestrians volumes are known to occur.	15%	90%	Very High
S21PB	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	Addition of LPI gives pedestrians the opportunity to enter an intersection 3-7 seconds before vehicles are given a green indication; only minor signal timing alteration is required.	60%	90%	Very High
NS01	Install splitter-islands on the minor road approaches	Splitter islands can provide a positive separation between turning vehicles on a through road and vehicles stopped on the minor road approach. Also allows for an extra stop sign at an intersection.	40%	90%	Medium
NS02	Install raised medians on approaches	Channels traffic approaching an intersection	25%	90%	Medium
NS03	Install raised medians (refuge islands)	Decreases the level of exposure of pedestrians to traffic and allows pedestrians to only cross one direction of traffic at a time	45%	90%	Medium
NS05	Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)	Enhances pedestrian crossings with high visibility patterns, yield lines, pedestrian signage, etc. to warn drivers of the presence of pedestrians	35%	90%	Medium

Code	Countermeasure Name	Countermeasure Description	CRF	Federal Funding	Systemic Approach Opportunity
NS06	Add intersection lighting (NS.I.)	Provision of lighting at intersection.	40%	90%	Medium
NS07	Convert to all-way STOP control (from 2-way or Yield control)	Unsignalized intersection locations that have a crash history and have no controls on the major roadway approaches. However, all-way stop 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.	50%	90%	High
NS08	Install Signals	Installation of traffic signals	25%	90%	Low
NS09	Convert intersection to roundabout (from 2-way stop or Yield control)	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.	Varies	90%	Low
NS11	Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs	Additional regulatory and warning signs at or prior to intersections will help enhance the ability of approaching drivers to percieve them	15%	90%	Very High
NS12	Upgrade intersection pavement markings (NS.I.)	Typical improvements include "Stop Ahead" markings and the addition of centerlines and stop bars	25%	90%	Very High
NS13	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.	15%	90%	High
NS14	Install flashing beacons as advance warning (NS.I.)	Installation of advance flashing beacoms to call drivers attention to intersection control signs	30%	90%	High
NS19PB	Improve sight distance to intersection (Clear Sight Triangles)	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.	20%	90%	High
NS21PB	Improve pavement friction (High Friction Surface Treatments)	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	55%	90%	Medium

Code	Countermeasure Name	Countermeasure Description	CRF	Federal Funding	Systemic Approach Opportunity
		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.			
NS22PB	Install splitter-islands on the minor road approaches	The installation of a splitter island allows for the addition of a stop sign in the median to make the intersection more conspicuous.	40%	90%	Medium
R01	Add Segment Lighting	Provision of lighting along roadways.	35%	90%	Medium
R02	Remove or relocate fixed objects outside of Clear Recovery Zone	Known 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.	35%	90%	High
R21	Improve pavement friction (High Friction Surface Treatments)	Improving the skid resistance at locations with high frequencies of wet road crashes and/or failure to stop crashes	55%	90%	High
R22	Install/Upgrade signs with new fluorescent sheeting (regulatory or warning)	Additional or new signage can address crashes caused by lack of driver awareness or complaince of roadway signing.	15%	90%	Very High
R23	Install chevron signs on horizontal curves	Roadways that have an unacceptable level of crashes on relatively sharp curves during periods of light and darkness.	40%	90%	Very High
R25	Install curve advance warning signs (flashing beacon)	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.	30%	90%	High
R26	Install dynamic/variable speed warning signs	Includes the addition of dynamic speed warning signs (also known as Radar Speed Feedback Signs)	30%	90%	High
R27	Install delineators, reflectors and/or object markers	Installation of delineators, reflectors and/or object markers are intended to warn drivers of an approaching curve or fixed object that cannot easily be removed.	15%	90%	Very High
R28	Install edge-lines and centerlines	Any road with a history of run-off-road right, head-on, opposite-direction-sideswipe, or run-off-road-left crashes is a candidate for this treatment -install where the existing lane delineation is not sufficient to assist the motorist in understanding the existing limits of the roadway. Depending on the width of the roadway, various combinations of edge line	25%	90%	Very High

Code	Countermeasure Name	Countermeasure Description	CRF	Federal Funding	Systemic Approach Opportunity
		and/or center line pavement markings may be the most appropriate.			
R30	Install centerline rumble strips/stripes	Center Line rumble strips/stripes can be used on virtually any roadway – especially those with a history of head-on crashes.	20%	90%	High
R31	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.	15%	90%	High
R32PB	Install bike lanes	Roadway segments noted as having crashes between bicycles and vehicles or crashes that may be preventable with a buffer/shoulder.	35%	90%	High
R33PB	Install Separated Bike Lanes	Separated bikeways are most appropriate on streets with high volumes of bike traffic and/or high bike-vehicle collisions, presumably in an urban or suburban area. Separation types range from simple, painted buffers and flexible delineators, to more substantial separation measures including raised curbs, grade separation, bollards, planters, and parking lanes.	45%	90%	High
R34PB	Install sidewalk/pathway (to avoid walking along roadway)	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.	80%	90%	Medium
R35PB	Install/upgrade pedestrian crossing (with enhanced safety features)	Roadway segments with no controlled crossing for a significant distance in high-use midblock crossing areas and/or multilane roads locations. flashing beacons, curb extensions, medians and pedestrian crossing islands and/or other safety features should be added to complement the standard crossing elements.	35%	90%	Medium
R37PB	Install Rectangular Rapid Flashing Beacon (RRFB)	Rectangular Rapid Flashing Beacon (RRFB) includes pedestrian-activated flashing lights and additional signage that enhance the visibility of marked crosswalks and alert motorists to pedestrian crossings. It uses an irregular flash pattern that is similar to emergency flashers on police vehicles. RRFBs are installed at unsignalized intersections and mid-block pedestrian crossings	35%	90%	Medium

* Code: S - Signalized intersection improvements
NS - Non-signalized intersection improvements
R - Roadway segment improvements

7. VIABLE SAFETY PROJECTS

This chapter summarizes the process of selecting safety projects as part of the analysis for the Moraga Local Roadway Safety Plan (LRSP). The next step after the identification of high-risk locations, emphasis areas and applicable countermeasures was to identify location specific safety improvements for all high-risk roadway segments and intersections.

Specific countermeasures and improvements were selected from the 2020 Local Roadway Safety Manual (LRSM) from Caltrans, where:

- S refers to improvements at signalized locations,
- NS refers to improvements at non-signalized locations, and
- R refers to improvements at roadway segments.

The corresponding number refers to the countermeasure number in the LRSM (2020). The countermeasures were grouped into safety projects for high-risk intersections and roadway segments. A total of five safety projects were developed. All countermeasures were identified based on the technical teams' assessment of viability that consisted of extensive analysis, observations, Town staff input, and stakeholder/community input. The most applicable and appropriate countermeasures as identified have been grouped together to form projects that can help make high-injury locations safer.

Table 15 lists the safety projects for high-risk intersections and roadway segments, along with total base planning level cost (2022 dollar amounts) estimates and the resultant preliminary Benefit-Cost (B/C) Ratio. The "Total Benefit" estimates were calculated for the proposed improvements being evaluated in the proactive safety analysis. This "Total Benefit" is divided by the "Total Cost per Location" estimates for the proposed improvements, giving the resultant B/C Ratio. The B/C Ratio Calculation follows the methodology as mentioned in the LRSM (2020).

Appendix E lists the detailed methodology to calculate B/C Ratio, as well as the complete cost, benefit and B/C Ratio calculation spreadsheet.

These safety projects were chosen based on the previously completed collisions analysis, which was used to identify main collision attributes that were found to be leading factors of fatal and severe collisions in Moraga. These collision factors are shown below, as well as viable safety projects that can help address these factors.

Hit Object Collisions: Hit object collisions represented the 2nd highest proportion of collisions of all severity (25%), as well as the highest percentage of KSI collisions (40%). Viable safety projects to help address these collisions include installing delineators, reflectors, and object markers; upgrading/installing signs with new fluorescent sheeting; installing flashing beacons in advance of intersection; upgrading/installing additional stop signs or other intersection warning signs; adding intersection lighting, and improving pavement friction.

Pedestrian Collisions: 40% of KSI collisions in Moraga involved pedestrians, the most of any category (tied with fixed object), as well as making up 7% of collisions of all severity. Safety projects to address these include installing a leading pedestrian interval (LPI) at signalized intersections, installing high visibility crosswalks, and Rectangular Rapid Flashing Beacons.

Broadside Collisions: Broadside collisions represented 27% of all collisions, the most of any collision type. Additionally, 20% of all injury collisions were caused by an automobile right-of-way violation, which often lead to broadside collisions. Viable safety projects to help address these collisions include improving signal timing, installing raised pavement markers, installing intersection lighting, improving pavement friction, installing/upgrading larger stop signs or other intersection regulatory/warning signs, and installing flashing beacons as advance warning.

Nighttime Collisions: 60% of all KSI collisions occurred at night, as well as 31% of collisions of all severities. Viable safety projects to help address these collisions include installing advance warning flashing beacons, installing additional or larger warning/regulatory signs, upgrading signs with new fluorescent sheeting, installing raised pavement markers, adding intersection lighting, installing high visibility crosswalks and Rectangular Rapid Flashing Beacons, and installing delineators/reflectors/object markers.

Improper Turning Collisions: Improper turning caused collisions accounted for 40% of KSI collisions, as well as 15% of collisions of all severities. Viable safety projects to help address these collisions include advance warning flashing beacons, upgrading/installing signs with new fluorescent sheeting, installing delineators, reflectors, or object markers, installing larger or additional stop or regulatory/warning signs, and installing raised pavement markings.

The next step in the process will be to prepare grant ready materials for HSIP Cycle 11 applications. TJKM has scoped to provide the Town with materials for up to two applications. However, it should be noted that while the LRSP projects were based on high-injury locations, HSIP applications can be expanded to include many locations across the Town. TJKM can work with the Town to identify additional locations that may be beneficial to add to the HSIP application and calculate the BCR. Note that HSIP is a competitive grant funding source based on a benefit/cost analysis. The benefit value is calculated automatically based on crash data document by law enforcement and standard cost data. The cost of some measures may adversely impact the benefit to cost ratio making the grant application less competitive for funding.

Below is the list of identified projects for the Town of Moraga, with a preliminary cost estimate for each location and the resulting benefit-cost ratio of the project (the title of each countermeasure is located in a separate table below). The cost per location includes construction costs, Plans, Specifications, and Estimates (PS&E), environmental reporting costs, construction engineering costs, and a 10% contingency. Construction costs are based on industry standards in the Bay Area and TJKM's knowledge and experience of the area. Our team is consistently updating our unit prices to match current construction costs.

Table 15. List of Viable Safety Projects

Location	CM1	CM2	CM3	Cost per Location	Total Cost	B/C Ratio
Project 1 – Non-Signalized Intersections (Install/Upgrade Larger Stop Signs or other Intersection Regulatory/ Warning Signs, Install Flashing Beacon as Advance Warning, and Install Rectangular Rapid Flashing Beacon)						
Moraga Rd at Lucas Dr	NS06		NS22PB	$127,792	$461,342	27.05
Moraga Wy at Moraga Valley Ln	NS06	NS09		$80,892		
Moraga Rd at Alta Mesa	NS06	NS09		$80,542		
Camino Pablo at Sanders Ranch Rd	NS06			$8,512		
Rheem Blvd at St. Marys Rd	NS06	NS09		$82,502		
Moraga Rd at Corliss Dr	NS06	NS09		$81,102		
Project 2: Pedestrian Set Aside Application (Install/Upgrade Ped Crossing (Roadway Segments &Uncontrolled Locations)						
Moraga Wy: Town Limit to Moraga Rd	R35PB			$31,220	$243,712	N/A*
Moraga Rd/Canyon Rd: Larch Ln to Town Limit (North)	R35PB			$129,570		
Rheem Blvd: La Salle Dr to Moraga Rd	R35PB			$31,920		
Moraga Wy at Moraga Valley Rd		NS21PB		$39,802		
Moraga Rd at Corliss Dr		NS21PB		$11,200		
Project 3: Signalized Intersections (Modify signal phasing to implement Leading Pedestrian Interval, Install Raised Pavement Markers and Striping, and Improve Signal Timing)						
Moraga Rd at Campolindo Dr	S21PB	S09	S03	$16,450	$82,712	26.26
Moraga Rd at St. Marys Rd	S21PB	S09	S03	$16,240		
Moraga Rd at Ascot Dr	S21PB	S09	S03	$16,870		
Moraga Rd at Donald Dr	S21PB	S09	S03	$16,870		
Moraga Wy at School St	S21PB	S09	S03	$16,282		
Project 4: Non-Signalized Intersections (Improve pavement friction (HFST) and Add Intersection Lighting)						
Moraga Rd at Lucas Dr	NS12			$147,854	$458,370	28.41
Moraga Wy at Moraga Valley Ln	NS12	NS01		$310,516		
Project 5: Roadway Segments: Install/Upgrade Signs with new fluorescent sheeting and Install Delineators, Reflectors and/or Object Markers						
Moraga Wy: Town Limit to Moraga Rd	R22	R27		$36,610	$227,220	18.72
Canyon Rd: 300' E of Valle Vista Staging Area to Town Limit (East)	R22	R27		$18,410		
Moraga Rd/Canyon Rd: Larch Ln to Town Limit (North)	R22	R27		$117,145		
Rheem Blvd: La Salle Dr to Moraga Rd	R22	R27		$7,595		
Country Club Dr: Viader Dr to 875' E of Southard Ct	R22	R27		$12,915		
Larch Ave: Canyon Rd to Baitx Ave	R22	R27		$10,185		
St. Marys Rd: 500' E of Stafford Rd to Town Limit	R22	R27		$13,440		
Corliss Dr/Sullivan Dr: Hardie Dr to Moraga Rd	R22	R27		$10,920		

Notes: CM – countermeasure. B/C ratio is the dollar amount of benefits divided by the cost of the countermeasure.

*Pedestrian set aside applications do not require a collision history and as such do not include a BCR

Countermeasure Name
S03 – Improve signal timing (coordination, phases, red, yellow, or operation)
S09 – Install raised pavement markers and striping (through intersection)
S21PB – Modify signal phasing to implement a Leading Pedestrian Interval (LPI)
NS01 – Install intersection lighting (NS.I.)
NS06 - Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs
NS09 - Install flashing beacons as advance warning (NS.I.)
NS12 – Improve pavement friction (High Friction Surface Treatments)
NS21PB – Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)
NS22PB – Install Rectangular Rapid Flashing Beacon (RRFB)
R22 - Install/upgrade signs with new fluorescent sheeting (regulatory or warning)
R27 - Install delineators, reflectors and/or object markers
R35PB - Install/upgrade pedestrian crossing (with enhanced safety features)

8. IMPLEMENTATION AND EVALUATION

This chapter describes the steps the Town may take to evaluate the success of this plan and steps needed to update the plan in the future. The LRSP is a guidance document and requires periodic updates to assess its efficacy and re-evaluate potential solutions. It is recommended to update the plan every two to five years in coordination with the identified safety partners. This document was developed based on community needs, stakeholder input, and collision analysis conducted to identify priority emphasis areas throughout the Town. The implementation of strategies under each emphasis area would aim to reduce KSI collisions in the coming years.

Implementation

The LRSP is a guidance document that is recommended to be updated every two to five years in coordination with the safety partners. The LRSP document provides engineering, education, enforcement, and emergency medical service-related countermeasures that can be implemented throughout the Town to reduce KSI collisions. It is recommended that the Town of Moraga implement the selected projects in high-collision locations in coordination with other projects proposed for the Town's infrastructure development in their future Capital Improvement Plans. After implementing countermeasures, the performance measures for each emphasis area should be evaluated annually. The most important measure of success of the LRSP should be reducing KSI collisions throughout the Town. If the number of KSI collisions does not decrease over time, then the emphasis areas and countermeasures should be re-evaluated.

Funding is a critical component of implementing any safety project. While the HSIP program is a common source of funding for safety projects, there are numerous other funding sources that could be pursued for such projects. (See **Table 16** below).

Table 16: List of Potential Funding Sources

Funding Source	Funding Agency	Amount Available	Next Estimated Call for Projects	Applicable E's	Notes
Active Transportation Program	Caltrans, California Transportation Commission, MTC	~$450 million per cycle (every two years)	2022	Engineering, Education	Can use used for most active transportation related safety projects as well as education programs. Funding available through Caltrans or MTC
Highway Safety Improvement Program	Caltrans		May 2022	Engineering	Most common grant source for safety projects
One Bay Area Grant (OBAG) Cycle 3	MTC (Combines various federal funds)	$750 million for 2023-2026	County & Local Program: 2022	Engineering	Distributes federal funding to cities and counties in MTC region.
Office of Traffic Safety Grants	California Office of Traffic Safety	Varies by grant	Closes January 31st annually	Education, Enforcement, Emergency Response	10 grants available to address various components of traffic safety
Affordable Housing and Sustainable Communities Program	Strategic Growth Council and Dept. of Housing and Community Development	~$405 million	2022	Engineering, Education	Must be connected to affordable housing projects; typically focuses on bike/pedestrian infrastructure/programs
Urban Greening	California Natural Resources Agency	$28.5 million	2022	Engineering	Focused on bike/pedestrian infrastructure and greening public spaces
Local Streets and Road Maintenance and Rehabilitation	CTC (distributed to local agencies)	$1.5 billion statewide	N/A; distributed by formula	Engineering	Typically pays for road maintenance type projects
RAISE Grant	USDOT	~$1 billion	2022	Engineering	Typically used for larger infrastructure projects
Sustainable Transportation Equity Project	California Air Resources Board	~$19.5 million	TBD; most recent call in 2020	Engineering, Education	Targets projects that will increase transportation equity in disadvantaged communities
Transformative Climate Communities	Strategic Growth Council	~$90 million	TBD; most recent call in 2020	Engineering	Funds community-led projects that achieve major reductions in greenhouse gas emissions in disadvantaged communities.

Monitoring and Evaluation

For the success of the LRSP, it is crucial to monitor and evaluate the five E-strategies continuously. Monitoring and evaluation help provide accountability, ensures the effectiveness of the countermeasures for each emphasis area, and help making decisions on the need for new strategies. The process would help the Town make informed decisions regarding the implementation plan's progress and accordingly, update the goals and objectives of the plan.

After implementing countermeasures, the strategies should be evaluated annually as per their performance measures. The evaluation should be recorded in a before-after study to validate the effectiveness of each countermeasure as per the following observations:

- Number of KSI collisions
- Number of police citations
- Number of public comments and concerns

Evaluation should be conducted during similar time periods and durations each year. The most important measure of success of the LRSP should be reduction in KSI collisions throughout the Town. If the number of KSI collisions doesn't decrease initially, then the countermeasures should be evaluated as per the other observations, as mentioned above. The effectiveness of the countermeasures should be compared to the goals for each emphasis area.

LRSP Update

The LRSP is a guidance document and is recommended to be updated every two to five years after adoption. After monitoring performance measures focused on the status and progress of the E's strategies in each emphasis area, the next LRSP update can be tailored to resolve any continuing safety problems. An annual stakeholder meeting with the safety partners is also recommended to discuss the progress for each emphasis area and oversee the implementation plan. The document should then be updated as per the latest collision data, emerging trends, and the E's strategies' progress and implementation.

Appendix A: Summary of Planning Documents

Table 1: Matrix of Planning Goals, Policies, and Projects

Document	Highlights
TOWN OF MORAGA GENERAL PLAN (2002)	• Policy C1.1 Roadway Engineering and Maintenance. Apply standard engineering principles in the design, construction and maintenance of all roadways to make them safe for all users, including bicyclists, pedestrians and equestrians. In support of community design and environmental goals, consider allowing narrower street widths, consistent with Town standards, when it can be demonstrated that public safety concerns are adequately addressed. • Policy C1.3 Ensure that traffic mitigation measures are specifically identified and reasonably demonstrated to be feasible and effective. Traffic mitigation measures may include a roadway or intersection improvement, public or private mass transportation improvement, or any other feasible solution that reduces trip volumes or enhances roadway capacity. • C1.6 Street Maintenance. Conduct street maintenance at reasonably high standards to avoid long-term repair and replacement costs and to ensure a safe and comfortable street system. • C1.8 Priority Roadway Improvements. Identify priority roadway improvement projects to guide project funding decisions, including both capacity-enhancing projects and safety related projects. • C1.9 Traffic Enforcement. Provide sufficient resources to maintain a high level of traffic safety through law enforcement. • C1.10 Traffic Education. Disseminate traffic educational materials to transportation users to encourage ridesharing bus transit, and safe use of streets and highways. • C1.11 Emergency Vehicle Access. Maintain and improve critical transportation facilities for emergency vehicle access and emergency evacuation needs. • C3.1 Commercial Area Traffic Safety. Maintain effective and safe vehicle circulation into, out of, and within commercial areas • C4.1 Pedestrian Circulation. Provide a safe, continuous and connected system of pedestrian pathways through the Town, including sidewalks, paths, trails and appropriate crosswalks along all principal streets, to link residential neighborhoods, commercial areas, community facilities such as schools and parks, and other important destinations. • C4.2 Bicycle Circulation. Develop a complete bicycle system with direct, continuous, interconnected pathways between residential and commercial areas, community facilities, commuter corridors and transit hubs. • C4.3 Transit. Encourage the use of transit to and from the Lamorinda BART stations.

Document	Highlights
MORAGA WALK BIKE PLAN (2016)	• Planning Process – The planning process for the Walk | Bike Plan was meant to provide a comprehensive framework for addressing the Town's key objectives with respect to walking and biking. • Community survey – Identified locations for intersection improvements, obstacles to biking and their improvements, location for bike racks, locations for sidewalk improvements. This task consisted of gathering information from the general public and from key stakeholders on the needs and concerns of local pedestrians and cyclists; the barriers, obstacles and challenges to walking and biking in Moraga; specific problem areas and locations; and ideas and suggestions for improving conditions. The Walk | Bike Plan process developed a set of recommended physical and non-physical improvements to enhance walking and biking in Moraga. • Pedestrian Project Goals: describes a set of recommended infrastructure projects to improve conditions for pedestrians in Moraga. The recommended projects are meant to respond to the needs, concerns and suggestions expressed by the community through the needs assessment process. The focus of the Walk | Bike Plan is on on-street facilities such as sidewalks. • Bicycle Project Goals: The plan designates a town-wide network of on-street bikeways and proposes a set of segment-specific improvements. Town staff and the plan consultants developed a preliminary bikeway network based on the input received from the public on needs and concerns. It is intended to provide connections to the town's existing trail system, among other key destinations. Street intersections were improved for pedestrians shown in bikeway network map of the town like enforces green bike lanes, pole –mount traffic mirrors, two-stage queue box, and multi lane signaled intersection. • Way-finding signage program: The plan includes a signage program to help pedestrians, cyclists, drivers to contribute to the town's identity and sense of place and encouraging viability of walking and biking for transportation and recreation. • Support programs and other actions: Infrastructure and other facilities are targeted for improvements or their existing conditions for pedestrians and cyclists and are also important for non-physical improvements and changes to long-standing practices. • Cost of proposed improvements: The estimated cost to implement the plan is $3.42 million, or $228,000 annually.
MORAGA CENTER SPECIFIC PLAN (2010)	• Vision: To create an attractive and vibrant shopping and living environment to serve the needs of the entire Moraga community. • The MCSP, as articulated in the General Plan, embraces the following Goals and Policies:

Document	Highlights
	o G) Traffic, Access, Circulation, and Parking: Address traffic access and circulation issues and provide adequate parking to meet current and projected needs, located and designed consistent with the area's pedestrian orientation o H) Pedestrian and Bicycle Circulation: Create an environment that encourages walking and biking, with appropriate amenities and connections to adjacent residential neighborhoods. Consider providing some flexibility in parking standards in return for effective strategies and amenities that promote the use of alternative transportation modes • Pedestrian and Bicycle Circulation: A network of sidewalks and streets that will comprise the roadway system will facilitate pedestrian and bicycle circulation within the MCSP area. - Additional 5' (minimum) bike lane should be provided between a parking space and moving lanes. - Link Moraga- Lafayette Regional Trail. - Trail incorporated in the improvements be implemented in the redevelopment/ extension to school Street. - Additional internal and external trails are also contemplated to provide additional opportunities.
TOWN OF MORAGA CAPITAL IMPROVEMENT PROGRAM (FY 2021/22)	• Goals and Priorities: Continue work on a financial plan to sustain core operations of the Town, including unfunded storm drain, asset replacement and pension needs, and develop and adopt a five-year CIP budget strategy. Maintain and improve fiscal discipline by adopting a balanced budget, continuing high quality fiscal reporting, and continuing to position the Town for long-term fiscal sustainability and operational efficiency. Highlighted Projects • Corliss Drive One-Way Safe Routes to School (CIP 21-404): This project is to install pedestrian access on Corliss drive near Los Perales Elementary School (from Woodside Drive to Arroyo Drive) to provide a safer path for students to walk to School. The project is envisioned to limit traffic to one-way to create adequate space to create a multi-use protected path on Corliss Drive. • Pavement Reconstruction (CIP 22-401): This project is to reconstruct the streets with the lowest PCI using full-depth reclamation treatment or other appropriate rehabilitation methods. Construction will be spread over two years and is scheduled to occur in FYs 2022/23 and 2023/24. On-Going Transportation Projects • Livable Moraga Road- Corridor Plan and Improvements: Improve bicycle, pedestrian, and vehicular safety and mobility along Moraga Road between the Moraga Center and

Document	Highlights
	Campolindo High School. Project description includes conducting community engagement process, plan and develop alternatives for Moraga Road for use by all modes, and beautification. • Canyon Road Bridge Replacement: A permanent bridge is needed to replace the temporary one-lane bridge that replaced the original landslide-damaged bridge in 2017. The Canyon Road Bridge is one of five critical access points to Moraga. Previous Caltrans inspections of the original bridge determined that it qualified for replacement funding through the Caltrans Highway Bridge Program (HBP). The Town has completed the Phase 1 construction which consists of building the eastern half of the permanent bridge. Phase 2 will construct the western half of the bridge and fully open the bridge in late 2021. • Minor Traffic Safety Program: This program is intended to provide traffic engineering services to complete minor traffic safety improvements. The Town has been contracting traffic engineering services to collect traffic data like traffic volumes and speed data as a basis for making minor traffic safety improvements, such as traffic signage, controlled intersection improvements, traffic calming devices, speed signs based on re certifying speed limits for enforcement. • Bollinger Canyon/St Marys Rd/Rheem Blvd Roundabouts: The planning project is to complete 35% level engineering design plans for two roundabouts on St. Mary's Road at Rheem Boulevard and Bollinger Canyon Road and relocate trail to create safer pedestrian and bicycle crossing. • Pavement Resurfacing: Annually review Pavement Management System analysis, assess current needs, and allocate appropriate funds to provide cost-effective pavement maintenance. • Pedestrian improvement routes: Pedestrian Improvement Program's goal is to encourage the use of walking for recreation and as a mode of transportation. This includes providing a continuous pedestrian path for the community to use. This may be in the form of a sidewalk or multi-use paths throughout the Town of Moraga. • Annual Street Repairs: Pavement Repairs Project is to address existing failures, defects or deficiencies in pavements, curb & gutter, sidewalks, ADA improvements, and traffic striping & markings. This will help extend the life of the pavement until the appropriate treatment is applied to the street, and provide some necessary safety repairs. This project will consolidate the pavement repair operational budget, striping and markings operational budget,

Document	Highlights
	ADA compliance program, and the annual street repairs project from prior budgets. • Pedestrian Push Button Upgrade: As part of the ADA Improvement Program, the Audible Pedestrian Push Button Upgrade Project will upgrade all existing pedestrian push buttons to ADA-compliant audible pedestrian push buttons at all signalized intersections within the Town. This project will replace approximately 45 pedestrian pushbuttons with audible pedestrian push buttons (APBB). • Moraga Rd Complete Streets The ultimate project will include roadway realignment and intersection improvements with a multiuse path, sidewalks, and bike lanes. • Canyon Rd (Moraga Wy to Sanders Dr) Complete Streets Construct a continuous multiuse path, sidewalks, and bike lanes, as well as a roadway realignment and intersection improvements. • Local Road Safety Plan: The LRSP offers a proactive approach to addressing safety needs demonstrates responsiveness to safety challenges. It is also shown to reduce fatally and severe crashes, advance a risk-based data-driven and systemic approach to improving safety, prioritize projects, leverage funding opportunities and develop lasting partnerships through education, engineering, enforcement, and emergency response. A Local Road Safety Plan (LRSP) will provide Moraga with an opportunity to address safety needs in their jurisdictions. The LRSP creates a framework to systematically identify and analyze safety problems and recommend safety improvements. • HSIP Cycle 10 Safety Improvements Installation of pedestrian improvements including signage and striping to improve crosswalk visibility and improve pedestrian safety at various locations in Moraga • Pavement Reconstruction: The construction is spread over two calendar years. The project will take the streets with the lowest PCI and reconstruct the street using full-depth reclamation treatment or other appropriate rehabilitation methods.
Contra Costa Countywide Bike and Pedestrian Plan (2018)	Goals • Encourage more people to walk and bicycle • Increase safety and security for pedestrians and bicyclists • Create a safe, connected, and comfortable network of bikeways and walkways for all ages and abilities • Increase the livability and attractiveness of Contra Costa's communities and districts

Document	Highlights
	• Equitably serve all of Contra Costa's communities while ensuring that public investments are focused on projects with the greatest benefits Objectives • Increase the share of trips made by walking and bicycling in Contra Costa • Reduce the rate of pedestrian and bicycle fatalities and injuries per capita • Increase the number of miles of low-stress bikeways in Contra Costa • Increase the number of jurisdictions in Contra Costa with bicycle, pedestrian, or active transportation plans • Integrate complete street principles and best practices into Authority funding and design guidance
Contra Costa Countywide Transportation Safety Policy and Implementation Guide (2021)	Potential Safety Improvements • A. SIGNAL TIMING & PHASING o Additional Signal Heads o Extend Pedestrian Crossing Time o Flashing Yellow Turn Phase o Leading Pedestrian Interval o Pedestrian Phase Recall o Replace Permissive with Protected Left Turn o Pedestrian Scramble o Reduce Cycle Lengths o Coordinated Signal Operation o Extend Green Time for Bikes o Extend Yellow and All Red Time • B. INTERSECTION & ROADWAY DESIGN o Close Slip Lane o Raised Intersection o Convert Two-Way Stop to All-Way Stop o Install Sidewalk o Protected Intersection o Raised Median o Lane Narrowing o Road Diet o Widen Shoulder o Roundabout o Signal Head Improvements o Traffic Circles o Programmable Signals/Visors/Louvers o Edge Line/Center Line Rumble Strips o Hardened Centerlines • C. BIKEWAY DESIGN o Bicycle Crossing (Solid Green Paint) o Bicycle Signal/Exclusive Bike Phase o Bike Detection

Document	Highlights
	○ Class I Bicycle Path or Mixed Use Trail ○ Bike Box ○ Class II Bike Lane ○ Class IV Separated Bikeway ○ Green Bike Lane Conflict Zone Markings ○ Two-Stage Turn Queue Bike Box • D. PEDESTRIAN CROSSINGS ○ Install Pedestrian Countdown Timer ○ Pedestrian Hybrid Beacon (PHB) ○ Curb Extension ○ High-Visibility Crosswalk ○ Pedestrian Median Barrier ○ Raised Crosswalk ○ Pedestrian Refuge Island ○ Rectangular Rapid Flashing Beacon (RRFB) ○ Reduce Curb Radius ○ ADA-Compliant Directional Curb Ramps and Audible Push Buttons ○ Extended Time Push Button • E. SIGNS & MARKINGS ○ Prohibit Right-Turn-on-Red ○ Advance Yield Markings ○ Advance Stop Markings ○ Pedestrian Signs • F. OTHER ○ Access Management ○ Intersection & Street Scale Lighting • Remove Obstructions for Sightlines
CCTA Transportation Expenditure Plan (2020)	Goals • Relieve Traffic Congestion on Highways and Interchanges • Make Bus, Ferry, Passenger Train, and BART Rides Safer, Cleaner, and More Reliable • Provide Accessible and Safe Transportation for Children, Seniors, Veterans, and People with Disabilities • Improve Transportation in Our Communities Projects • Enhance I-80, I-580 (Richmond-San Rafael Bridge), Transit, and BART Corridor • Improve Transit Reliability Along the I-80 Corridor • Relieve Congestion and Improve Local Access Along the I-80 Corridor • Improve Traffic Flow on Major Roads in West County • Enhance Ferry Service and Commuter Rail in West County • Improve Traffic Flow and Local Access to Richmond-San Rafael Bridge Along I-580 and Richmond Parkway Seamless Connected Transportation Options

Document	Highlights
CCTA Countywide Comprehensive Transportation Plan (2017)	• GOAL 1: Support the efficient, safe, and reliable movement of people and goods using all available travel modes • GOAL 2: Manage growth to sustain Contra Costa's economy, preserve its environment and support its communities • GOAL 3: Expand safe, convenient and affordable alternatives to the single-occupant vehicle • GOAL 4: Maintain the transportation system • GOAL 5: Continue to invest wisely to maximize the benefits of available funding

Contra Costa County Transportation Analysis Guidelines (2020)	Transportation Policy Framework
	• Senate Bill 743 – California Environmental Quality Act
	• County General Plan
	  • Growth Management Element
	  • Transportation and Circulation Element
	• Capital Road Improvement & Preservation Program
	• Complete Streets
	  • Contra Costa County Complete Streets Principles
	  • Contra Costa County Complete Streets Implementation Measures
	• Vision Zero Contra Costa County
	• County Ordinance Code
	  • Section 74-4.006 – Electric Vehicle ("EV") Charging
	  • Chapter 82-16 – Off-Street Parking
	  • Chapter 82-32 – Transportation Demand Management
	  • Title 9 - Subdivisions
	• Contra Costa Transportation Authority
	  • CCTA Technical Procedures
	  • CCTA Countywide Bicycle and Pedestrian Plan
	  • CCTA Action Plans for Routes of Regional Significance

Appendix B: Consolidated High Injury Collision Database

CASE_ID	ACCIDENT_Y	COLLISION_	COLLISION1	Hour	PRIMARY_RD	SECONDARY_	DISTANCE	DIRECTION	INTERSECTI	TJKM_Inter
7199989	2016	2016-10-18	1403	14	CANYON RD	VALLE VISTA	300	S	N	N
8737313	2018	2018-09-13	1802	18	MORAGA WY WEST	HARDIE DR	298		N	N
8343451	2017	2017-02-17	1811	18	MORAGA RD	LUCAS DR	0		Y	Y
6976701	2015	2015-04-30	2036	20	MORAGA WY	MORAGA VALLEY LN	0		Y	Y
8543060	2017	2017-12-16	1729	17	MORAGA RD	LUCAS DR	0		Y	Y
8716185	2018	2018-05-09	1815	18	MORAGA RD	KENDALL CIR	141	S	N	Y
8462889	2017	2017-08-07	1733	17	MORAGA RD	LUCAS DR	518	N	N	N
8123843	2016	2016-05-30	2054	20	MORAGA WY	VIADER WY	15	W	N	Y
8962082	2019	2019-09-30	1422	14	COUNTRY CLUB DR	VIADER DR	339	E	N	N
8381145	2017	2017-04-10	2034	20	MORAGA WY	MORAGA VALLEY LN	293	W	N	N
8958550	2019	2019-07-30	1607	16	SANDERS DR	CANYON DR	8	W	N	Y
8409244	2017	2017-06-24	1718	17	MORAGA RD	SAINT MARYS RD	675	N	N	N
8161581	2016	2016-08-01	1623	16	MORAGA RD	CAMPOLINDO DR	123	S	N	Y
8878963	2019	2019-05-06	1520	15	N MORAGA RD	LUCAS DR	0		Y	Y
8119418	2016	2016-08-18	2039	20	SAINT MARYS RD	MORAGA RD	0		Y	Y
8799065	2019	2019-01-31	1218	12	CAMPOLINDO DR	MORAGA RD	0		Y	Y
8982983	2019	2019-10-18	1556	15	MORAGA RD	ALTA MESA DR	0		Y	Y
8879053	2019	2019-06-02	1114	11	DONALD DR	MORAGA RD	0		Y	Y
8875548	2019	2019-05-04	1824	18	SANDERS RANCH RD	CAMINO PABLO	0		-	Y
7039722	2015	2015-07-07	1048	10	CAMINO PABLO	SANDERS RANCH RD	0		Y	Y
7128190	2015	2015-09-24	1640	16	SAINT MARYS RD	RHEEM BL	0		Y	Y
7124685	2015	2015-10-27	1404	14	S MORAGA RD	LUCAS DR	0		Y	Y
8496801	2017	2017-10-01	1548	15	MORAGA RD	LUCAS DR	0		Y	Y
8588226	2018	2018-03-01	1559	15	SAINT MARYS RD	MORAGA RD	0		Y	Y
8381188	2017	2017-05-20	1429	14	MORAGA RD	LUCAS DR	0		Y	Y
6863070	2015	2015-02-05	1045	10	MORAGA WY	VIADER DR	277	E	N	N
8119773	2016	2016-08-02	803	8	RHEEM BL	LA SALLE DR	200	E	N	Y
6860190	2015	2015-02-12	1710	17	MORAGA RD	SAINT MARYS RD	710	N	N	N
7039607	2015	2015-07-21	1013	10	RHEEM BL	CENTER ST	412	W	N	N
8803225	2018	2018-12-13	826	8	MORAGA RD	ASCOT DR	263	S	N	N
8160381	2016	2016-10-14	1420	14	MORAGA RD	SAINT MARYS RD	1088	N	N	N
8625028	2018	2018-03-17	1023	10	MORAGA RD	SAINT MARYS RD	691	N	N	N
8207533	2016	2016-12-07	2025	20	LARCH AV	LARCH LN	50	W	N	Y
8462702	2017	2017-09-08	1448	14	SAINT MARYS RD	ALEMANY ST	21	W	N	Y
8462881	2017	2017-08-03	305	3	CANYON DR	COUNTRY CLUB DR	168	S	N	Y
8543056	2017	2017-12-30	2305	23	MORAGA WY	VIADER DR	275	E	N	N
8410724	2017	2017-06-06	800	8	MORAGA WY	SCHOOL ST	0		Y	Y
8539550	2018	2018-01-03	1503	15	MORAGA RD	ALTA MESA	0		Y	Y
8633131	2018	2018-05-26	1450	14	SCHOOL ST	MORAGA WY	0		Y	Y
8918308	2019	2019-07-05	1132	11	MORAGA RD	SAINT MARYS RD	0		Y	Y
8160383	2016	2016-10-07	2200	22	MORAGA RD	DONALD DR	0		Y	Y

CASE_ID	WEATHER_1	WEATHER_2	TOW_AWAY	COLLISIO_1	ColSev1	ColSev2	ColSev3	ColSev4	EPDO_Score	NUMBER_KIL	NUMBER_INJ	PARTY_COUN
7199989	A	-	Y	1	1	0	0	0	165	1	0	1
8737313	A	-	Y	2	0	1	0	0	165	0	1	2
8343451	C	-	N	2	0	1	0	0	165	0	1	2
6976701	A	-	N	2	0	1	0	0	165	0	1	2
8543060	A	-	N	2	0	1	0	0	165	0	1	2
8716185	A	-	Y	3	0	0	1	0	11	0	1	1
8462889	A	-	N	3	0	0	1	0	11	0	2	3
8123843	A	-	N	3	0	0	1	0	11	0	1	2
8962082	A	-	Y	3	0	0	1	0	11	0	1	2
8381145	A	-	N	3	0	0	1	0	11	0	1	2
8958550	A	-	N	3	0	0	1	0	11	0	1	2
8409244	A	-	Y	3	0	0	1	0	11	0	1	3
8161581	A	-	N	3	0	0	1	0	11	0	1	2
8878963	A	-	N	3	0	0	1	0	11	0	1	2
8119418	A	-	N	3	0	0	1	0	11	0	1	2
8799065	A	-	N	3	0	0	1	0	11	0	1	2
8982983	A	-	N	3	0	0	1	0	11	0	1	2
8879053	A	-	N	3	0	0	1	0	11	0	1	2
8875548	A	-	N	3	0	0	1	0	11	0	1	2
7039722	A	-	N	3	0	0	1	0	11	0	1	2
7128190	A	-	Y	3	0	0	1	0	11	0	1	2
7124685	B	-	N	3	0	0	1	0	11	0	1	2
8496801	A	-	N	3	0	0	1	0	11	0	1	2
8588226	C	G	Y	3	0	0	1	0	11	0	1	3
8381188	A	-	Y	3	0	0	1	0	11	0	2	2
6863070	B	-	N	4	0	0	0	1	6	0	1	2
8119773	A	-	N	4	0	0	0	1	6	0	1	2
6860190	A	-	N	4	0	0	0	1	6	0	1	2
7039607	A	-	N	4	0	0	0	1	6	0	1	2
8803225	A	-	Y	4	0	0	0	1	6	0	1	1
8160381	C	-	Y	4	0	0	0	1	6	0	4	2
8625028	A	B	Y	4	0	0	0	1	6	0	1	2
8207533	C	-	N	4	0	0	0	1	6	0	1	2
8462702	A	-	N	4	0	0	0	1	6	0	1	2
8462881	A	-	N	4	0	0	0	1	6	0	1	1
8543056	A	-	Y	4	0	0	0	1	6	0	1	2
8410724	A	-	N	4	0	0	0	1	6	0	1	2
8539550	B	C	N	4	0	0	0	1	6	0	1	2
8633131	A	-	N	4	0	0	0	1	6	0	1	2
8918308	A	-	N	4	0	0	0	1	6	0	1	2
8160383	A	-	Y	4	0	0	0	1	6	0	1	2

CASE_ID	PRIMARY_CO	PCF_CODE_O	PCF_VIOL_C	PCF_VIOLAT	PCF_VIOL_S	HIT_AND_RU	TYPE_OF_CO	MVIW	PED_ACTION	ROAD_SURFA	ROAD_COND_
7199989	A	-	8	22107		N	H	I	A	A	H
8737313	A	-	8	22107		N	E	I	A	A	H
8343451	A	-	10	21950		N	G	B	B	B	H
6976701	A	-	0	20001		F	H	C	A	A	H
8543060	A	-	10	21950	A	N	E	B	B	A	H
8716185	A	-	5	21650	A	N	E	I	A	A	H
8462889	A	-	10	21952		N	G	B	F	A	H
8123843	A	-	11	21954	A	N	G	B	E	A	H
8962082	A	-	9	21804	A	N	D	C	A	A	H
8381145	A	-	13	22515	B	N	G	I	-	A	H
8958550	A	-	6	21750		N	B	G	A	A	D
8409244	A	-	4	21703		N	C	C	A	A	H
8161581	A	-	21	22106		N	E	J	A	A	D
8878963	A	-	9	21801	A	N	D	C	A	A	H
8119418	A	-	11	21954	A	N	G	B	D	A	H
8799065	A	-	9	21804	A	N	G	G	A	A	H
8982983	A	-	-	0		N	C	I	A	A	H
8879053	A	-	10	21950	A	N	G	B	A	A	H
8875548	A	-	12	22450	A	N	-	B	B	-	H
7039722	A	-	12	22450		N	G	B	B	A	H
7128190	A	-	9	21804	B	N	D	G	A	A	H
7124685	A	-	5	21650	1	N	D	G	A	A	H
8496801	A	-	9	21801	A	N	D	G	A	A	H
8588226	A	-	3	22350		N	C	C	A	B	H
8381188	A	-	9	21804	A	N	D	C	A	A	H
6863070	D	-	0	0		N	G	B	D	A	H
8119773	A	-	8	22103		N	D	C	A	A	H
6860190	A	-	3	22350		N	C	C	A	A	H
7039607	D	-	0	0		N	H	G	A	A	H
8803225	A	-	17	21663		N	E	I	A	A	H
8160381	A	-	9	21804	A	N	D	C	A	B	H
8625028	A	-	3	22350		N	C	C	A	A	H
8207533	A	-	8	22107		N	B	E	A	B	H
8462702	B	-	22	0		N	G	B	C	A	H
8462881	A	-	8	22107		N	E	I	A	A	H
8543056	A	-	7	21658	A	N	D	C	A	A	H
8410724	A	-	9	21801	A	N	D	G	A	A	H
8539550	A	-	9	21802	A	N	D	C	A	B	H
8633131	A	-	8	22107		N	B	G	A	A	H
8918308	A	-	8	22100	A	N	D	G	A	A	H
8160383	A	-	8	22107		N	F	C	A	A	H

CASE_ID	ROAD_COND1	LIGHTING	CONTROL_DE	CHP_ROAD_T	PEDESTRIAN	BICYCLE_AC	MOTORCYCLE	TRUCK_ACCI	NOT_PRIVAT	ALCOHOL_IN
7199989	-	A	D	0					Y	
8737313	-	A	D	0					Y	
8343451	-	C	D	0	Y				Y	
6976701	-	C	D	0					Y	Y
8543060	-	D	D	0	Y				Y	
8716185	-	A	A	0					Y	
8462889	-	A	D	0	Y				Y	
8123843	-	A	-	0	Y				Y	
8962082	-	A	D	0					Y	
8381145	-	C	D	0	Y				Y	
8958550	-	A	D	0		Y			Y	
8409244	-	A	D	0					Y	
8161581	-	A	D	0					Y	
8878963	-	A	D	0			Y		Y	
8119418	-	C	D	0	Y				Y	Y
8799065	-	A	D	0		Y			Y	
8982983	-	A	D	0			Y		Y	
8879053	-	A	A	0		Y			Y	
8875548	-	A	-	0	Y				Y	
7039722	-	A	A	0	Y				Y	
7128190	-	A	D	0		Y			Y	
7124685	-	A	A	0		Y			Y	
8496801	-	A	A	0		Y			Y	
8588226	-	A	A	0					Y	
8381188	-	A	A	0					Y	
6863070	-	A	D	0	Y				Y	
8119773	-	A	D	0			Y		Y	
6860190	-	A	D	0					Y	
7039607	-	A	D	0		Y			Y	
8803225	-	A	D	0					Y	
8160381	-	A	D	0					Y	
8625028	-	A	D	0					Y	
8207533	-	D	D	0					Y	
8462702	-	A	D	0	Y				Y	
8462881	-	C	D	0			Y		Y	
8543056	-	C	D	0					Y	
8410724	-	A	A	0		Y			Y	
8539550	-	A	D	0					Y	
8633131	-	A	A	0		Y			Y	
8918308	-	A	A	0		Y			Y	
8160383	-	C	A	0					Y	

CASE_ID	STWD_VEHTY	CHP_VEHTYP	COUNT_SEVE	COUNT_VISI	COUNT_COMP	COUNT_PED_	COUNT_PED1	COUNT_BICY	COUNT_BI_1	COUNT_MC_K
7199989	A	1	0	0	0	0	0	0	0	0
8737313	A	1	1	0	0	0	0	0	0	0
8343451	A	1	1	0	0	0	1	0	0	0
6976701	-		1	0	0	0	0	0	0	0
8543060	A	1	1	0	0	0	1	0	0	0
8716185	A	1	0	1	0	0	0	0	0	0
8462889	A	1	0	2	0	0	2	0	0	0
8123843	N	60	0	1	0	0	1	0	0	0
8962082	D	22	0	1	0	0	0	0	0	0
8381145	A	7	0	1	0	0	1	0	0	0
8958550	I	11	0	1	0	0	0	0	1	0
8409244	A	1	0	1	0	0	0	0	0	0
8161581	-		0	1	0	0	0	0	0	0
8878963	A	1	0	1	0	0	0	0	0	0
8119418	N	60	0	1	0	0	1	0	0	0
8799065	L	4	0	1	0	0	0	0	1	0
8982983	C	3	0	1	0	0	0	0	0	0
8879053	A	1	0	1	0	0	0	0	1	0
8875548	A	1	0	1	0	0	1	0	0	0
7039722	-		0	1	0	0	1	0	0	0
7128190	A	1	0	1	0	0	0	0	1	0
7124685	L	4	0	1	0	0	0	0	1	0
8496801	A	1	0	1	0	0	0	0	1	0
8588226	A	1	0	1	0	0	0	0	0	0
8381188	A	1	0	1	1	0	0	0	0	0
6863070	-	-	0	0	1	0	1	0	0	0
8119773	A	1	0	0	1	0	0	0	0	0
6860190	-		0	0	1	0	0	0	0	0
7039607	-	-	0	0	1	0	0	0	1	0
8803225	A	1	0	0	1	0	0	0	0	0
8160381	A	1	0	0	4	0	0	0	0	0
8625028	A	1	0	0	1	0	0	0	0	0
8207533	A	1	0	0	1	0	0	0	0	0
8462702	A	1	0	0	1	0	1	0	0	0
8462881	C	2	0	0	1	0	0	0	0	0
8543056	A	7	0	0	1	0	0	0	0	0
8410724	A	1	0	0	1	0	0	0	1	0
8539550	A	1	0	0	1	0	0	0	0	0
8633131	A	1	0	0	1	0	0	0	1	0
8918308	A	1	0	0	1	0	0	0	1	0
8160383	A	1	0	0	1	0	0	0	0	0

CASE_ID	COUNT_MC_I	PRIMARY_RA	SECONDARY1	LATITUDE	LONGITUDE	COUNTY	CITY	POINT_X	POINT_Y	EPDO_Sco_1	Hit_Object
7199989	0	-	-			CONTRA COSTA	MORAGA	-122.138573	37.82291414		0
8737313	0	-	-			CONTRA COSTA	MORAGA	-122.1418991	37.8409996		1
8343451	0	-	-			CONTRA COSTA	MORAGA	-122.1247999	37.85548995		0
6976701	0	-	-			CONTRA COSTA	MORAGA	-122.1379999	37.83888996		0
8543060	0	-	-			CONTRA COSTA	MORAGA	-122.1247999	37.85548995		1
8716185	0	-	-			CONTRA COSTA	MORAGA	-122.1242065	37.85797119		1
8462889	0	-	-			CONTRA COSTA	MORAGA	-122.1244467	37.85688502		0
8123843	0	-	-			CONTRA COSTA	MORAGA	-122.1296864	37.83501856		0
8962082	0	-	-			CONTRA COSTA	MORAGA	-122.129486	37.83356		0
8381145	0	-	-			CONTRA COSTA	MORAGA	-122.1388436	37.83933745		0
8958550	0	-	-			CONTRA COSTA	MORAGA	-122.130034	37.831258		0
8409244	0	-	-			CONTRA COSTA	MORAGA	-122.1269407	37.84021656		0
8161581	0	-	-			CONTRA COSTA	MORAGA	-122.1251983	37.86808258		1
8878963	1	-	-			CONTRA COSTA	MORAGA	-122.124791	37.855507		0
8119418	0	-	-			CONTRA COSTA	MORAGA	-122.12612	37.83851997		0
8799065	0	-	-			CONTRA COSTA	MORAGA	-122.1252	37.868429		0
8982983	1	-	-			CONTRA COSTA	MORAGA	-122.125711	37.837497		0
8879053	0	-	-			CONTRA COSTA	MORAGA	-122.125139	37.853167		0
8875548	0	-	-			CONTRA COSTA	MORAGA	-122.116219	37.814299		0
7039722	0	-	-			CONTRA COSTA	MORAGA	-122.1162799	37.81428997		0
7128190	0	-	-			CONTRA COSTA	MORAGA	-122.10972	37.84639996		0
7124685	0	-	-			CONTRA COSTA	MORAGA	-122.1247999	37.85548995		0
8496801	0	-	-			CONTRA COSTA	MORAGA	-122.1247999	37.85548995		0
8588226	0	-	-			CONTRA COSTA	MORAGA	-122.1261215	37.83852005		0
8381188	0	-	-			CONTRA COSTA	MORAGA	-122.1247999	37.85548995		0
6863070	0	-	-			CONTRA COSTA	MORAGA	-122.1287833	37.83465845		0
8119773	1	-	-			CONTRA COSTA	MORAGA	-122.131287	37.86230519		0
6860190	0	-	-			CONTRA COSTA	MORAGA	-122.1269579	37.84031174		0
7039607	0	-	-			CONTRA COSTA	MORAGA	-122.1262479	37.86070482		0
8803225	0	-	-			CONTRA COSTA	MORAGA	-122.1250687	37.85371017		1
8160381	0	-	-			CONTRA COSTA	MORAGA	-122.1271369	37.84134035		0
8625028	0	-	-			CONTRA COSTA	MORAGA	-122.1269455	37.84025955		0
8207533	0	-	-			CONTRA COSTA	MORAGA	-122.1283433	37.82865769		0
8462702	0	-	-			CONTRA COSTA	MORAGA	-122.112892	37.843587		0
8462881	1	-	-			CONTRA COSTA	MORAGA	-122.1289333	37.83278128		1
8543056	0	-	-			CONTRA COSTA	MORAGA	-122.1287895	37.83466089		0
8410724	0	-	-			CONTRA COSTA	MORAGA	-122.1303699	37.8352899		0
8539550	0	-	-			CONTRA COSTA	MORAGA	-122.1258698	37.83745956		0
8633131	0	-	-			CONTRA COSTA	MORAGA	-122.1303711	37.835289		0
8918308	0	-	-			CONTRA COSTA	MORAGA	-122.12614	37.838522		0
8160383	0	-	-			CONTRA COSTA	MORAGA	-122.1251399	37.85315991		0

CASE_ID	Broadside	Pedestri_1
7199989	0	0
8737313	0	0
8343451	0	1
6976701	0	0
8543060	0	1
8716185	0	0
8462889	0	1
8123843	0	1
8962082	1	0
8381145	0	0
8958550	0	0
8409244	0	0
8161581	0	0
8878963	1	0
8119418	0	1
8799065	0	0
8982983	0	0
8879053	0	1
8875548	0	1
7039722	0	1
7128190	1	0
7124685	1	0
8496801	1	0
8588226	0	0
8381188	1	0
6863070	0	1
8119773	1	0
6860190	0	0
7039607	0	0
8803225	0	0
8160381	1	0
8625028	0	0
8207533	0	0
8462702	0	1
8462881	0	0
8543056	1	0
8410724	1	0
8539550	1	0
8633131	0	0
8918308	1	0
8160383	0	0

CASE_ID	ACCIDENT_Y	COLLISION_	COLLISION1	Hour	PRIMARY_RD	SECONDARY_	DISTANCE	DIRECTION	INTERSECTI	TJKM_Inter
9019063	2019	2019-10-21	1553	15	MORAGA RD	ASCOT DR	0		Y	Y
7197936	2016	2016-01-16	1945	19	MORAGA RD	ASCOT DR	0		Y	Y
6807582	2015	2015-01-08	1455	14	SAINT MARYS RD	RHEEM BL	0		Y	Y
8918162	2019	2019-05-10	1721	17	MORAGA RD	ASCOT DR	0		Y	Y
8691606	2018	2018-05-03	1228	12	MORAGA RD	ALTA MESA DR	0		Y	Y
7197728	2016	2016-02-08	1538	15	MORAGA RD	MORAGA RD 300 BLOCK	0		N	Y
6976505	2015	5/17/2015	1200	12	CORLISS DR	178 CORLISS DR	0		Y	Y
7124824	2015	11/22/2015	2146	21	SULLIVAN DR	PGE POLE #110259131	0		Y	Y

CASE_ID	WEATHER_1	WEATHER_2	TOW_AWAY	COLLISIO_1	ColSev1	ColSev2	ColSev3	ColSev4	EPDO_Score	NUMBER_KIL	NUMBER_INJ	PARTY_COUN
9019063	A	-	Y	4	0	0	0	1	6	0	1	1
7197936	B	-	Y	4	0	0	0	1	6	0	1	2
6807582	B	-	Y	4	0	0	0	1	6	0	1	3
8918162	A	-	N	4	0	0	0	1	6	0	1	2
8691606	A	-	Y	4	0	0	0	1	6	0	2	2
7197728	A	-	Y	4	0	0	0	1	6	0	1	3
6976505	A	-	Y	4	0	0	0	1	6	0	1	2
7124824	A	-	Y	4	0	0	0	1	6	0	1	1

CASE_ID	PRIMARY_CO	PCF_CODE_O	PCF_VIOL_C	PCF_VIOLAT	PCF_VIOL_S	HIT_AND_RU	TYPE_OF_CO	MVIW	PED_ACTION	ROAD_SURFA	ROAD_COND_
9019063	A	-	17	21657		N	E	B	A	A	H
7197936	A	-	12	21453	A	N	D	C	A	B	H
6807582	A	-	4	21703		N	C	D	A	A	H
8918162	A	-	3	22350		N	C	C	A	A	H
8691606	A	-	9	21804	A	N	D	C	A	A	G
7197728	A	-	3	22350		N	C	C	A	A	H
6976505	A	-	7	21658	A	N	A	C	A	A	H
7124824	A	-	1	23152	B	N	E	I	A	A	H

CASE_ID	ROAD_COND1	LIGHTING	CONTROL_DE	CHP_ROAD_T	PEDESTRIAN	BICYCLE_AC	MOTORCYCLE	TRUCK_ACCI	NOT_PRIVAT	ALCOHOL_IN
9019063	-	A	D	0					Y	
7197936	-	C	A	0					Y	
6807582	-	A	A	0					Y	
8918162	-	A	A	0					Y	
8691606	-	A	D	0					Y	
7197728	-	A	D	0					Y	
6976505	-	A	D	0					Y	
7124824	-	D	D	0					Y	Y

CASE_ID	STWD_VEHTY	CHP_VEHTYP	COUNT_SEVE	COUNT_VISI	COUNT_COMP	COUNT_PED_	COUNT_PED1	COUNT_BICY	COUNT_BI_1	COUNT_MC_K
9019063	A	7	0	0	1	0	0	0	0	0
7197936	A	8	0	0	1	0	0	0	0	0
6807582	-		0	0	1	0	0	0	0	0
8918162	D	22	0	0	1	0	0	0	0	0
8691606	I	11	0	0	2	0	0	0	0	0
7197728	A	7	0	0	1	0	0	0	0	0
6976505	-		0	0	1	0	0	0	0	0
7124824	A	1	0	0	1	0	0	0	0	0

CASE_ID	COUNT_MC_I	PRIMARY_RA	SECONDARY1	LATITUDE	LONGITUDE	COUNTY	CITY	POINT_X	POINT_Y	EPDO_Sco_1	Hit_Object
9019063	0	-	-			CONTRA COSTA	MORAGA	-122.124964	37.854475		1
7197936	0	-	-			CONTRA COSTA	MORAGA	-122.12497	37.85442994		0
6807582	0	-	-			CONTRA COSTA	MORAGA	-122.10972	37.84639996		0
8918162	0	-	-			CONTRA COSTA	MORAGA	-122.124969	37.854469		0
8691606	0	-	-			CONTRA COSTA	MORAGA	-122.1258698	37.83745956		0
7197728	0	-	-			CONTRA COSTA	MORAGA	-122.1252349	37.86805893		0
6976505	0	-				CONTRA COSTA	MORAGA	-122.1304286	37.84216346		
7124824	0	-				CONTRA COSTA	MORAGA	-122.139574	37.84857806		

CASE_ID	Broadside	Pedestri_1
9019063	0	1
7197936	1	0
6807582	0	0
8918162	0	0
8691606	1	0
7197728	0	0
6976505		
7124824		

Appendix C: Countermeasure Toolbox

Table 3: Countermeasures for High Injury Intersections

ID	Intersection	Control	Consolidated CMs (HSIP-Eligible - Refer to LRSM* 2020)				Additional CM (non-HSIP)**	EA - 1 Improve Intersection Safety			EA - 2 Address Hit Object Collisions			EA - 3 Address Broadside Collisions & Automobile Right-of-Way Violations			EA - 4 Improve Bicycle and Pedestrian Safety			EA - 5 Address Nighttime Collisions			EA - 6 Improve Safety Around Schools			EA - 7 Address Improper Turning Violations		
			CM1	CM2	CM3	CM4		CM1	CM2	CM3	CM1	CM2	CM3	CM1	CM2	CM3	CM1	CM2	CM3	CM1	CM2	CM3	CM1	CM2	CM3	CM1	CM2	CM3
1	Moraga Rd at Lucas Dr	Stop Controlled	NS11	NS22PB	NS06	NS14		NS11	NS14	NS22PB	NS11	NS12		NS11	NS06	NS12	NS22PB	NS19PB		NS01	NS06					NS06	NS14	NS13
2	Moraga Wy at Moraga Valley Ln	Stop Controlled	NS09	NS14	NS13	NS01		NS01	NS09	NS14	NS09	NS12	NS14	NS14	NS09	NS13				NS01	NS06	NS09				NS14	NS13	
3	Moraga Rd at Campolindo Dr	Signalized	S02	S09	S20PB	S21PB		S02	S09	S21PB	S10	S02		S02	S03	S09	S20PB	S21PB		S02	S09	S10	S20PB	S21PB	S10	S09	S12	
4	Moraga Rd at St. Marys Rd	Signalized	S02	S09	S21PB	S10		S02	S09	S21PB	S10	S02		S02	S03	S09	S20PB	S21PB		S02	S09	S10	S10	S20PB	S21PB	S02	S09	
5	Moraga Rd at Alta Mesa	Stop Controlled	NS06	NS09	NS11	NS13	Consider converting y	NS06	NS11	NS09	NS09	NS12		NS11	NS06	NS09				NS01	NS06	NS09				NS06	NS13	
6	Camino Pablo at Sanders Ranch Rd	Stop Controlled	NS06	NS07	NS08	NS12		NS06	NS07		NS12	NS07	NS06	NS07	NS06	NS12	NS06	NS08	NS21PB	NS01	NS06	NS08				NS06	NS07	
7	Moraga Rd at Ascot Dr	Signalized	S02	S03	S09	S21PB		S02	S09	S21PB	S02	S11		S02	S03	S09	S20PB	S21PB		S02	S09					S02	S09	
8	Moraga Rd at Donald Dr	Signalized	S03	S09	S08	S21PB		S08	S09	S21PB	S10	S02		S02	S03	S09	S20PB	S21PB		S02	S09					S02	S09	
9	Rheem Blvd at St. Marys Rd	Stop Controlled	NS01	NS05	NS09	NS06		NS01	NS11	NS05	NS09	NS11		NS05	NS11	NS09	NS21PB	NS08	NS06	NS01	NS06	NS08				NS06	NS07	
10	Moraga Wy at School St	Signalized	S02	S09	S20PB	S21PB		S02	S21PB	S03	S02	S03		S02	S03	S09	S20PB	S21PB		S02	S09	S12	S20PB	S21PB		S08	S09	S12
11	Moraga Rd at Corliss Dr	Stop Controlled	NS09	NS03*	NS06	NS11	Conduct signal warran	NS03	NS06	NS09	NS09	NS11		NS03	NS11	NS09	NS21PB	NS09	NS19PB	NS01	NS06	NS09				NS06	NS07	NS13

*If warranted

Code	Countermeasure Name
HSIP/Non-HSIP Code	
S01	Add intersection lighting
S02	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number
S03	Improve signal timing (coordination, phases, red, yellow, or operation)
S09	Install raised pavement markers and striping (Through Intersection)
S10	Install flashing beacons as advance warning (S.I.)
S11	Improve pavement friction (High Friction Surface Treatments)
S12	Install raised median on approaches (S.I.)
S20PB	Install advance stop bar before crosswalk (Bicycle Box)
S21PB	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)

Code	Countermeasure Name
NS01	Add intersection lighting (NS.I.)
NS02	Convert to all-way STOP control (from 2-way or Yield control)
NS03	Install Signals
NS05	Convert intersection to roundabout (from 2-way stop or Yield control)
NS06	Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs
NS07	Upgrade intersection pavement markings (NS.I.)
NS08	Install Flashing Beacons at Stop-Controlled Intersections
NS09	Install flashing beacons as advance warning (NS.I.)
NS11	Improve sight distance to intersection (Clear Sight Triangles)
NS12	Improve pavement friction (High Friction Surface Treatments)
NS13	Install splitter-islands on the minor road approaches
NS14	Install raised median on approaches (NS.I.)
NS19PB	Install raised medians (refuge islands)
NS21PB	Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)
NS22PB	Install Rectangular Rapid Flashing Beacon (RRFB)

Table 4: Countermeasures for High Injury Roadway Segments

ID	Roadway Segment	Consolidated CMs (HSIP-Eligible - Refer to LRSM* 2020)				Additional CM (non-HSIP)**	EA - 1 Improve Intersection Safety			EA - 2 Address Hit Object Collisions			EA - 3 Address Broadside Collisions & Automobile Right-of-Way Violations			EA - 4 Improve Bicycle and Pedestrian Safety			EA - 5 Address Nighttime Collisions			EA - 6 Improve Safety Around Schools			EA - 7 Address Improper Turning Violations		
		CM1	CM2	CM3	CM4		CM1	CM2	CM3	CM1	CM2	CM3	CM1	CM2	CM3	CM1	CM2	CM3	CM1	CM2	CM3	CM1	CM2	CM3	CM1	CM2	CM3
A	Moraga Wy: Town Limit to Moraga Rd	R22	R27	R35PB	R37PB					R27	R21	R31				R35PB	R37PB		R22	R27		R37PB			R22	R27	
B	Canyon Rd: 300' E of Valle Vista Staging Area to Town Limit (East)	R28	R31	R27	R22					R28	R27	R31				R37PB			R23	R22	R27				R22	R31	R28
C	Moraga Rd/Canyon Rd: Larch Ln to Town Limit (North)	R27	R31	R22	R37PB	Refresh edgeline and lane striping in locations not done				R02	R27	R31				R33PB	R34PB	R37PB	R22	R27	R31	R26	R34PB	R37PB	R22	R27	R31
D	Rheem Blvd: La Salle Dr to Moraga Rd	R22	R27	R35PB	R01					R02	R27	R22				R32PB	R35PB		R01	R22	R27				R22	R27	
E	Country Club Dr: Viader Dr to 875' E of Southard Ct	R37PB	R22	R27	R28	RRFB at Country Club/Canyon intersection										R37PB			R22	R27	R28				R22	R27	R28
F	Larch Ave: Canyon Rd to Baitx Ave	R22	R27	R34PB	R01					R27	R01					R35PB	R34PB		R01	R22	R27				R22	R27	R28
G	St. Marys Rd: 500' E of Stafford Rd to Town Limit	R37PB	R35PB	R30	R31					R02	R27	R31				R32PB	R35PB	R37PB	R01	R22	R27				R22	R27	R31
H	Corliss Dr/Sullivan Dr: Hardie Dr to Moraga Rd	R25	R37PB	R34PB	R26	Refresh crosswalk striping at Corliss/Wakefield. Install RRFB				R27	R25					R34PB	R36PB	R37PB	R25	R22	R27	R26	R34PB	R37PB	R22	R27	R25

Code	Countermeasure Name
R01	Add Segment Lighting
R02	Remove or relocate fixed objects outside of Clear Recovery Zone
R21	Improve pavement friction (High Friction Surface Treatments)
R22	Install/Upgrade signs with new fluorescent sheeting (regulatory or warning)
R23	Install chevron signs on horizontal curves
R25	Install curve advance warning signs (flashing beacon)
R26	Install dynamic/variable speed warning signs
R27	Install delineators, reflectors and/or object markers
R28	Install edge-lines and centerlines
R30	Install centerline rumble strips/stripes
R31	Install edgeline rumble strips/stripes
R32PB	Install bike lanes
R33PB	Install Separated Bike Lanes
R34PB	Install sidewalk/pathway (to avoid walking along roadway)
R35PB	Install/upgrade pedestrian crossing (with enhanced safety features)
R36PB	Install raised pedestrian crossing
R37PB	Install Rectangular Rapid Flashing Beacon (RRFB)

Table 5: Non-Engineering Countermeasures

	Strategy	Performance Measure	Organizations to be involved
Education	Conduct public information and education campaign for intersection safety laws, unsafe speeds, distracted driving, and driving under the influence.	Number of education campaigns	Town/ Police Department
	Conduct pedestrian safety campaigns and outreach to raise their awareness of pedestrian safety needs through media outlets and social media.	Number of education campaigns	Town/ School District/ Police Department
	Conduct bicycle safety campaigns and outreach to raise their awareness of bicycle safety needs through media outlets and social media.	Number of education campaigns	Town/ School District/ Police Department
Enforcement	Targeted enforcement at high-risk locations.	Number of tickets issued.	Police Department
	Increase the number of personnel who have completed Advanced Roadside impaired Driving Enforcement (ARIDE) training	Number of personnel who have completed Advanced Roadside impaired Driving Enforcement (ARIDE) training	Police Department
Emergency Medical Services (EMS)	S05, Install emergency vehicle pre-emption systems	EMS vehicle response time.	Town/Fire District/EMS Response
	Increase the number of EMS/fire control personnel taking Traffic Incident Managmenet Training	number of EMS/fire controll personnel taking Traffic Incident Managmenet Traising	Fire District/EMS Response
Other	Prepare a Townwide Traffic Calming Plan	Completion of Plan	Town

Town of Moraga LRSP

Table 6: Countermeasure Descriptions

Signalized

Sr. No.	Code	Countermeasure Name	CM Description	CRF	Federal Funding	Systemic Approach Opportunity
HSIP/Non-HSIP Code						
1	S01	Add intersection lighting	Provision of lighting at intersection.	40%	100%	Medium
2	S02	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, a	Includes 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.	15%	100%	Very High
3	S03	Improve signal timing (coordination, phases, red, yellow, or operation)	Includes adding phases, lengthening clearance intervals, eliminating or restricting higher-risk movements, and coordinating signals at multiple locations.	15%	50%	Very High
9	S09	Install raised pavement markers and striping (Through Intersection)	Adding clear pavement markings can guide motorists through complex intersections. When drivers approach and traverse through complex intersections, drivers may be required to perform unusual or unexpected maneuvers	10%	100%	Very High
10	S10	Install flashing beacons as advance warning (S.I.)	Increased driver awareness of an approaching signalized intersection and an increase in the driver's time to react.	30%	100%	Medium
11	S11	Improve pavement friction (High Friction Surface Treatments)	Improving the skid resistance at locations with high frequencies of wet road crashes and/or failure to stop crashes	55%	100%	Medium
12	S12	Install raised median on approaches (S.I.)	Raised medians next to left turn lanes at intersections offer a cost effective means for reducing crashes and improving operations at higher volume intersections	25%	90%	Medium
20	S20PB	Install advance stop bar before crosswalk (Bicycle Box)	Signalized Intersections with a marked crossing, where significant bicycle and/or pedestrians volumes are known to occur.	15%	100%	Very High
21	S21PB	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	Addition of LPI gives pedestrians the opportunity to enter an intersection 3-7 seconds before vehicles are given a green indication; only minor signal timing alteration is required.	60%	100%	Very High

Unsignalized

Sr. No.	Code	Countermeasure Name	CM Description	CRF	Federal Funding	Systemic Approach Opportunity
1	NS01	Add intersection lighting (NS.I.)	Provision of lighting at intersection.	40%	100%	Medium
2	NS02	Convert to all-way STOP control (from 2-way or Yield control)	Unsignalized intersection locations that have a crash history and have no controls on the major roadway approaches. However, all-way stop 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.	50%	100%	High
3	NS03	Install Signals	Installation of traffic signals	25%	100%	Low
5	NS05	Convert intersection to roundabout (from 2-way stop or Yield control)	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.	Varies	100%	Low
6	NS06	Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs	Additional regulatory and warning signs at or prior to intersections will help enhance the ability of approaching drivers to percieve them	15%	100%	Very High
7	NS07	Upgrade intersection pavement markings (NS.I.)	Typical improvements include "Stop Ahead" markings and the addition of centerlines and stop bars	25%	100%	Very High
8	NS08	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.	15%	100%	High
9	NS09	Install flashing beacons as advance warning (NS.I.)	Installation of advance flashing beacoms to call drivers attention to intersection control signs	30%	100%	High
11	NS11	Improve sight distance to intersection (Clear Sight Triangles)	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.	20%	90%	High
12	NS12	Improve pavement friction (High Friction Surface Treatments)	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.	55%	100%	Medium
13	NS13	Install splitter-islands on the minor road approaches	The installation of a splitter island allows for the addition of a stop sign in the median to make the intersection more conspicuous.	40%	90%	Medium
14	NS14	Install raised median on approaches (NS.I.)	Effective access management is key to improving safety at, and adjacent to, intersections. The number of intersection access points coupled with the speed differential between vehicles traveling along the roadway often contributes to crashes. Any access points within 250 feet upstream and downstream of an intersection are generally undesirable.	25%	90%	Medium
19	NS19PB	Install raised medians (refuge islands)	Intersections that have a long pedestrian crossing distance, a higher 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.	45%	90%	Medium
21	NS21PB	Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety feature	Non-signalized intersections where pedestrians are known to be crossing intersections that involve significant vehicular traffic. They are especially important at school crossings and intersections with turn pockets.flashing beacons, curb extensions, advanced "stop" or "yield" markings, and other safety features should be added to complement the standard crossing elements.	35%	100%	Medium
22	NS22PB	Install Rectangular Rapid Flashing Beacon (RRFB)	Rectangular Rapid Flashing Beacon (RRFB) includes pedestrian-activated flashing lights and additional signage that enhance the visibility of marked crosswalks and alert motorists to pedestrian crossings. It uses an irregular flash pattern that is similar to emergency flashers on police vehicles. RRFBs are installed at unsignalized intersections and mid-block pedestrian crossings.	35%	100%	Medium

CM Toolbox for Roadway Segments

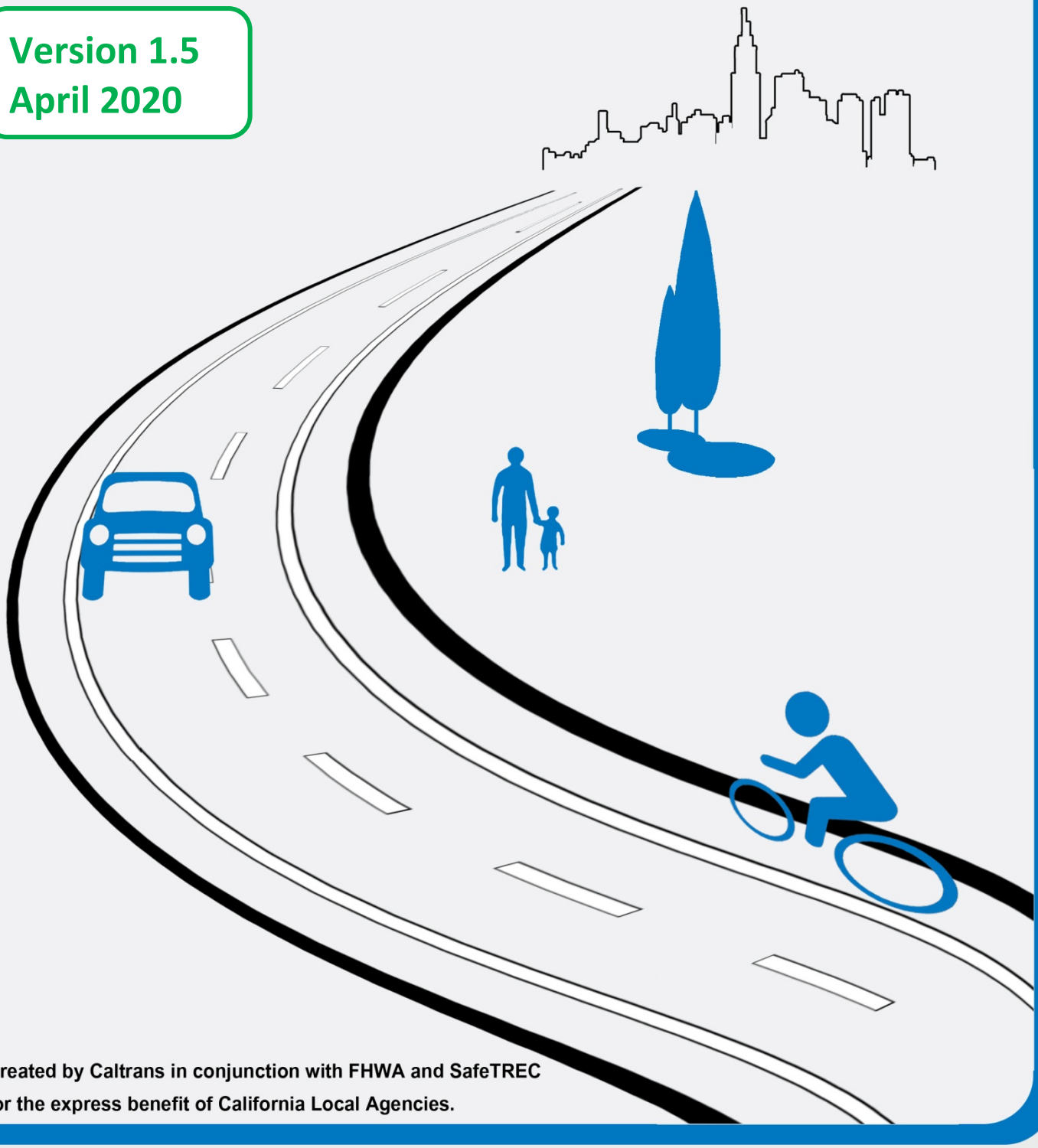
Sr. No.	Code	Countermeasure Name	CM Description	CRF	Federal Funding	Systemic Approach Opportunity
1	R01	Add Segment Lighting	Provision of lighting along roadways.	35%	100%	Medium
2	R02	Remove or relocate fixed objects outside of Clear Recovery Zone	Known locations or roadway segments prone to collisions 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.	35%	90%	High
21	R21	Improve pavement friction (High Friction Surface Treatments)	Improving the skid resistance at locations with high frequencies of wet road crashes and/or failure to stop crashes	55%	100%	High
22	R22	Install/Upgrade signs with new fluorescent sheeting (regulatory or warning)	Additional or new signage can address crashes caused by lack of driver awareness or complaince of roadway signing.	15%	100%	Very High
23	R23	Install chevron signs on horizontal curves	Roadways that have an unacceptable level of crashes on relatively sharp curves during periods of light and darkness.			
25	R25	Install curve advance warning signs (flashing beacon)	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.			
26	R26	Install dynamic/variable speed warning signs	Includes the addition of dynamic speed warning signs (also known as Radar Speed Feedback Signs)	30%	100%	High
27	R27	Install delineators, reflectors and/or object markers	Installation of delineators, reflectors and/or object markers are intended to warn drivers of an approaching curve or fixed object that cannot easily be removed.	15%	100%	Very High
28	R28	Install edge-lines and centerlines	Any road with a history of run-off-road right, head-on, opposite-direction-sideswipe, or run-off-road-left crashes is a candidate for this treatment -install where the existing lane delineation is not sufficient to assist the motorist in understanding the existing limits of the roadway. Depending on the width of the roadway, various combinations of edge line and/or center line pavement markings may be the most appropriate.	25%	100%	Very High
30	R30	Install centerline rumble strips/stripes	Center Line rumble strips/stripes can be used on virtually any roadway – especially those with a history of head-on crashes.	20%	100%	High
31	R31	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.	15%	100%	High
32	R32PB	Install bike lanes	Roadway segments noted as having crashes between bicycles and vehicles or crashes that may be preventable with a buffer/shoulder.	35%	90%	High
33	R33PB	Install Separated Bike Lanes	Separated bikeways are most appropriate on streets with high volumes of bike traffic and/or high bike-vehicle collisions, presumably in an urban or suburban area. Separation types range from simple, painted buffers and flexible delineators, to more substantial separation measures including raised curbs, grade separation, bollards, planters, and parking lanes.	45%	90%	High
34	R34PB	Install sidewalk/pathway (to avoid walking along roadway)	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.	80%	90%	Medium
35	R35PB	Install/upgrade pedestrian crossing (with enhanced safety features)	Roadway segments with no controlled crossing for a significant distance in high-use midblock crossing areas and/or multilane roads locations. flashing beacons, curb extensions, medians and pedestrian crossing islands and/or other safety features should be added to complement the standard crossing elements.	35%	90%	Medium
36	R36PB	Install raised pedestrian crossing	On lower-speed roadways, where pedestrians are known to be crossing roadways that involve significant vehicular traffic.	35%	90%	Medium
37	R37PB	Install Rectangular Rapid Flashing Beacon (RRFB)	Rectangular Rapid Flashing Beacon (RRFB) includes pedestrian-activated flashing lights and additional signage that enhance the visibility of marked crosswalks and alert motorists to pedestrian crossings. It uses an irregular flash pattern that is similar to emergency flashers on police vehicles. RRFBs are installed at unsignalized intersections and mid-block pedestrian crossings	35%	100%	Medium

Appendix D: LRSM Excerpt

Local Roadway Safety

A Manual for California's Local Road Owners

Version 1.5
April 2020



Created by Caltrans in conjunction with FHWA and SafeTREC
for the express benefit of California Local Agencies.

Caltrans

U. S. Department of Transportation
Federal Highway Administration

Safe Transportation
Research & Education Center
SafeTREC

Document History

Version 1.0: 4/20/2012

The California Department of Transportation - Division of Local Assistance developed the first version of the Local Roadway Safety Manual (Version 1.0) in 2012 to support the Cycle 5 HSIP call-for-projects.

Version 1.1: 4/26/2013

Based on feedback and lessons learned from Cycle 5, Caltrans updated Appendix B: "Table of Countermeasures and Crash Reduction Factors" to better clarify text in "Where to use", "Why it works", and "General Qualities" for several of the countermeasures included in the original manual.

No other changes were made to the Local Roadway Safety Manual as part of Version 1.1

Version 1.2: 03/10/2015

Based on feedback and lessons learned from Cycle 6, Caltrans made minor updates to the text of the document as needed for achieving consistency with overall Caltrans local HSIP guidance documents. The following sections were updated: 1.2, 4.2, 5.1, 6.2, and Appendix B, E, F & G.

Version 1.3: 04/29/2016

Caltrans made updates to the text of the document as needed in the following sections: 4.2, 5.1 and Appendix B.

Version 1.4: 06/08/2018

3/30/18 - Caltrans made updates to the crash costs in Appendix D, some of the website links in Appendix G, and some other texts of the document.
6/8/18 - Countermeasure S22 ("Modify signal phasing to implement a Leading Pedestrian Interval (LPI)") is added.

Version 1.5: April 2020

Caltrans added a few more countermeasures (e.g. Pedestrian Scramble, Install Separated Bike Lanes, Reduced Left-Turn Conflict Intersections, and Curve Shoulder widening), renumbered the countermeasures and updated the crash costs in Appendix D.

Future Updates:

In the future, Caltrans anticipates that additional changes will be needed to keep the Local Roadway Safety Manual consistent with future Calls-for-Projects' Guidelines and Application Instructions. In addition, new local HSIP programs, improvements to California data on local roadways, data analysis tools, and the latest safety research and methodologies may give rise to the need to make more significant changes to this manual.

Table of Contents

Appendix B: Table of Countermeasures and Crash Reduction Factors

The intent of the information contained in this appendix is to provide local agency safety practitioners with a list of effective countermeasures that are appropriate remedies to many common safety issues. The tables in Section 4.2 present a quick summary of the specific values that the Caltrans Division of Local Assistance uses to assess and select projects for its calls- for-projects. In addition to the same information as in Section 4.2, this appendix also includes notes for Caltrans HSIP calls-for-projects and "General information" regarding where the countermeasure should be used, why it works, the general qualities that can be used to suggest the potential complexity of installation, and information from FHWA CMF Clearinghouse on the type of crashes where the countermeasure is best used and a range of their expected overall effectiveness.

The countermeasures have been sorted into 3 categories: Signalized Intersection, Non-Signalized Intersection, and Roadway Segment. Pedestrian and bicycle related countermeasures have been included in each of these categories.

Caltrans gives careful consideration to the fair application of its calls-for-projects process. Starting in 2012, the award of safety funding has been solely based on a determined benefit-to-cost ratio for each project. The fixed set of countermeasures and CRFs included in these tables are intended to allow for all projects to be evaluated consistently and fairly throughout the project selection process. However, at this time, there are no CRFs/CMFs available for several safety improvements, such as: "dynamic/variable speed regulatory signs", "non-motorized signs and markings (regulatory and warning)", "Square-up (reduce curve radius) turn lanes" and non-infrastructure elements. These safety improvement items can be included in project applications, but they will not be included into the B/C ratio calculations, unless the safety improvements meet the intent of other separate countermeasures included in the attached lists. Caltrans is interested in adding these countermeasures (and many others) to these tables once CRFs/CMFs have been established. Caltrans will continue to periodically update this list of allowable countermeasures and CRFs as new safety research data becomes available. With this in mind, Caltrans is interested in feedback and suggestions from local agency safety practitioners on the overall countermeasure list as well as specific details of individual countermeasures, including locally developed safety effectiveness information.

Caltrans used the following references to assist its team in developing the information shown in the following tables. Safety Practitioners are encouraged to utilize these references for a more expansive list of countermeasures and CRFs / CMFs.

The Crash Modification Factors Clearinghouse
http://www.cmfclearinghouse.org/

NCHRP Report 500 Series: Volumes 4, 5, 6, 7, 10, 12, 13, and others
http://www.trb.org/Main/Blurbs/152868.aspx

Highway Safety Manual (HSM)

http://www.highwaysafetymanual.org

Pedestrian and Bicycle - Tools to Diagnose and Solve the Problem
https://safety.fhwa.dot.gov/ped_bike/tools_solve/

FHWA Local and Rural Road / Training, Tools, Guidance and Countermeasures for Locals
http://safety.fhwa.dot.gov/local_rural/training/

FHWA Desktop Reference for Crash Reduction Factors
https://safety.fhwa.dot.gov/tools/crf/resources/fhwasa08011/

For each countermeasure (CM):

(Title) CM No., CM Name

- CM No. is
  - S01 through S21PB for Intersection Countermeasures – Signalized,
  - NS01 through NS23PB for Intersection Countermeasures – Unsignalized, or
  - R01 through R38 for Roadway Countermeasures.

For HSIP Calls-for-projects:

- **Funding Eligibility -** 100%, 90% or 50%.
- **Crash Types Addressed -** "All", "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.
- **Notes -** Specific requirements are provided for utilizing the countermeasure on applications for Caltrans statewide calls-for-projects.
-

General Information:

- **Where to use** – Roadway segments and intersections with specific common characteristics can be addressed with similar countermeasures that are most effective.
- **Why it works** – A discussion of the benefit of a countermeasure is important to determine its appropriateness in addressing certain roadway crash types at areas with specific issues as determined by the data and roadway features.
- **General Qualities (Time, Cost and Effectiveness)** – This category is more subjective and can vary substantially. 'Time' refers to the approximate relative time it can take to implement the countermeasure. Costs can vary considerably due to local conditions, so 'cost' represents the relative cost of applying a countermeasure. A relative overall 'effectiveness' is also provided for some countermeasures. All of this subjective information may not be applicable to the unique circumstances for the agency and should not be utilized without verification by the safety practitioner.
- **FHWA CMF Clearinghouse**
  - **Crash Types Addressed** – In order to effectively reduce the number and severity of roadway crashes, it is necessary to match countermeasures to the crash types they are intended to address. Depending on the type of problem, one or more of a range of countermeasures could be the most effective way to reduce the number and severity of future crashes.

- **Crash Reduction Factor** – The crash reduction factor (CRF) is an indication of the effectiveness of a particular treatment, measured by the percentage of crashes it is expected to reduce. Note: As mentioned earlier in this section, the effectiveness of a countermeasure can also be expressed as a Crash Modification Factor (CMF), which is defined mathematically as 1 – CRF. However, this document uses CRFs as they can be more insightful when analyzing roadways for potential "reductions" in crashes. There is a range of CRF values that exist for each of the countermeasures (or similar countermeasures). The range of CRFs is provided to give local safety practitioners a clear understanding that they may need to go to the FHWA CMF Clearinghouse to find the most appropriate countermeasure and CRF for their specific projects and local prioritization.

B.1 Intersection Countermeasures – Signalized

S01, Add intersection lighting (Signalized Intersection => S.I.)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	"night" crashes	40%	20 years
Notes:	This CM only applies to "night" crashes (all types) occurring within limits of the proposed roadway lighting 'engineered' area.		

General information
Where to use:
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).
Why it works:
Providing lighting at the intersection itself, or both at the intersection and on its approaches, improves the safety of an intersection during nighttime conditions by (1) making drivers more aware of the surroundings at an intersection, which improves drivers' perception-reaction times, (2) enhancing drivers' available sight distances, and (3) improving the visibility of non-motorists. 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.
General Qualities (Time, Cost and Effectiveness):
A lighting project can usually be completed relatively quickly, but generally requires at least 1 year to implement because the lighting system must be designed and the provision of electrical power must be arranged. The provision of lighting involves both a fixed cost for lighting installation and an ongoing maintenance and power cost which results in a moderate to high cost. Some locations can result in high B/C ratios, but due to higher costs, these projects often result in medium to low B/C ratios.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Night, All	CRF:	20-74%

S02, Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	15%	10 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the upgraded signals. This CM does not apply to improvements like "battery backup systems", which do not provide better intersection/signal visibility or help drivers negotiate the intersection (unless applying past crashes that occurred when the signal lost power). If new signal mast arms are part of the proposed project, CM "S2" should not be used and the signal improvements would be included under CM "S7".		

General information
Where to use:
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.
Why it works:
Providing better visibility of intersection signals aids the drivers' advance perception of the upcoming intersection. Visibility and clarity of the signal should be improved without creating additional confusion for drivers.
General Qualities (Time, Cost and Effectiveness):
Installation costs and time should be minimal as these type strategies are classified as low cost and implementation does not typically require the approval process normally associated with more complex projects. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in low to moderate cost projects that are more appropriate to seek state or federal funding.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Rear-End, Angle	CRF:	0-46%

S03, Improve signal timing (coordination, phases, red, yellow, or operation)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
50%	All	15%	10 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new signal timing. For projects coordination signals along a corridor, the crashes related to side-street movements should not be applied. This CM does not apply to projects that only 'study' the signal network and do not make physical timing changes, including corridor operational studies and improvements to Traffic Operation Centers (TOCs). In Caltrans calls for projects, this CM has a HSIP reimbursement ratio of 50%, considering that it will improve the signal operation rather than merely the safety.		

General information				
Where to use:				
Locations that have a crash history at multiple signalized intersections. Signalization improvements may include adding phases, lengthening clearance intervals, eliminating or restricting higher-risk movements, and coordinating signals at multiple locations. Understanding the corridor or roadway's crash history can provide insight into the most appropriate strategy for improving safety.				
Why it works:				
Certain timing, phasing, and control strategies can produce multiple safety benefits. Sometimes capacity improvements come along with the safety improvements and other times adverse effects on delay or capacity occur. Corridor improvements often have the highest benefit but may take longer to implement. Projects focused on capacity improvements (without a separate focus on signal timing safety needs) may not result in a reduction in future crashes.				
General Qualities (Time, Cost and Effectiveness):				
In general, these low-cost improvements to multiple signalized intersections can be implemented in a short time. Typically these low cost improvements are funded through local funding by local maintenance crews. However, some projects requiring new interconnect infrastructure can have moderate to high costs making them more appropriate to seek state or federal funding. The expected effectiveness of this CM must be assessed for each individual project.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	0 - 41%

S04, Provide Advanced Dilemma-Zone Detection for high speed approaches

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	40%	10 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new detection and signal timing.		

General information				
Where to use:				
More rural/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.				
Why it works:				
Clearance times provide safe, orderly transitions in ROW assignment between conflicting streams of traffic. An Advanced Dilemma-Zone Detection system has several benefits relative to traditional multiple detector systems, which have upstream detection for vehicles in the dilemma zone but do not take the speed or size of individual vehicles into account. These benefits include: Reducing the frequency of red-light violations; Reducing the frequency of crashes associated with the traffic signal phase change (for example, rear-end and angle crashes); Reducing delay and stop frequency on the major road and a reduction in overall intersection delay.				
General Qualities (Time, Cost and Effectiveness):				
Installation costs should be low and the time to implement short. Additional modifications to the traffic signal controller may also necessary. In general, This CM can be very effective and can be considered on a systematic approach. Video detection equipment is now available for this purpose, making installation and maintenance more efficient.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	39%

S05, Install emergency vehicle pre-emption systems

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	Emergency Vehicle - only	70%	10 years
Notes:	This CM only applies to "E.V." crashes occurring on the approaches / influence area of the new pre-emption system.		

General information
Where to use:
Corridors that have a history of crashes involving emergency response vehicles. 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
Why it works:
Providing emergency vehicle preemption capability at a signal or along a corridor can be a highly effective strategy in two ways; any type of crash could occur as emergency vehicles try to navigate through intersections and as other vehicles try to maneuver out of the path of the emergency vehicles. In addition, a signal preemption system can decrease emergency vehicle response times therefore decreasing the time in receiving emergency medical attention, which is critical in the outcome of any crash. When data is not available for past crashes with emergency vehicles, an agency may consider combining the E.V. pre-emption improvements into a comprehensive project that also makes significant signal hardware and/or signal timing improvements.
General Qualities (Time, Cost and Effectiveness):
Costs for installation of a signal preemption system will vary from medium to high, based upon the number of signalized intersections at which preemption will be installed and the number of emergency vehicles to be outfitted with the technology. The number of detectors, a requirement for new signal controllers, and the intricacy of the preemption system could increase costs. This CM is considered systemic as it is usually implemented on a corridor-basis.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Emergency Vehicle - only	CRF:	70%

S06, Install left-turn lane and add turn phase (signal has no left-turn lane or phase before)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	55%	20 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new left turn lanes. This CM does NOT apply to converting a single-left into double-left turn.		

General information
Where to use:
Intersections that do not currently have a left turn lane or a related left-turn phase that 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. Agencies need to document their consideration of the MUTCD, Section 4D.19 guidelines; the section on implementing protected left-turn phases.
Why it works:
Left-turn lanes allow separation of left-turn and through-traffic streams, thus reducing the potential for rear-end collisions. Left-turn phasing also provides a safer opportunity for drivers to make a left-turn. The combination of left-turn storage and a left turn signal has the potential to reduce many collisions between left-turning vehicles and through vehicles and/or non-motorized road users.
General Qualities (Time, Cost and Effectiveness):
Implementation time may vary from months to years. At some locations, left-turn lanes can be quickly installed simply by restriping the roadway. At other locations, widening of the roadway, acquisition of additional right-of-way, and extensive environmental processes may be needed. Such projects require a substantial time for development and construction. Costs are highly variable and range from very low to high. Installing a protected left turn lane and phase where none exists results in a high Crash Reduction Factor and is often highly effective.

FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	17 - 58 %

S07, Provide protected left turn phase (left turn lane already exists)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	30%	20 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new left turn phases. This CM does NOT apply to converting a single-left into double-left turn (unless the single left is unprotected and the proposed double left will be protected).		

General information				
Where to use:				
Signalized intersections (with existing left turns pockets) that currently have a permissive left-turn or no left-turn protection that 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. Protected left-turn phases are warranted based on such factors as turning volumes, delay, visibility, opposing vehicle speed, distance to travel through the intersection, presence of non-motorized road users, and safety experience of the intersections. Agencies need to document their consideration of the MUTCD, Section 4D.19 guidelines; the section on implementing protected left-turn phases.				
Why it works:				
Left turns are widely recognized as the highest-risk movements at signalized intersections. Providing Protected left-turn phases (i.e., the provision for a specific phase for a turning movement) for signalized intersections with existing left turn pockets significantly improve the safety for left-turn maneuvers by removing the need for the drivers to navigate through gaps in oncoming/opposing through vehicles. Where left turn pockets are not protected, the pedestrian and bicyclist crossing phase often conflicts with these left turn maneuvers. Drivers focused on navigating the gaps of oncoming cars may not anticipate and/or perceive the non-motorized road users.				
General Qualities (Time, Cost and Effectiveness):				
If the existing traffic signal only requires a minor modification to allow for a protected left-turn phase, then the cost would also be low. The time to implement this countermeasure is short because there is no actual construction that has to take place. In-house signal maintainers can perform this operation once the proper signal phasing is determined so the cost is low. In addition, the countermeasure is tried and proven to be effective. Has the potential of being applied on a systemic/systematic approach.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Rear-End, Sideswipe, Broadside	CRF:	16 - 99%

S08, Convert signal to mast arm (from pedestal-mounted)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	30%	20 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the converted signal heads that are relocated from median and/or outside shoulder pedestals to signal heads on master arms over the travel-lanes. Projects using CM "S7" should not also apply "S2" in the B/C calc.		

General information				
Where to use:				
Intersections currently controlled by pedestal mounted traffic signals (in medians and/or on outside shoulder) that have a high frequency of right-angle and rear-end crashes occurring because drivers are 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. Care should be taken to place the new signal heads (with back plates) as close to directly over the center of the travel lanes as possible.				
Why it works:				
Providing better visibility of intersection signs and signals aids the drivers' advance perception of the upcoming intersection. Visibility and clarity of the signal should be improved without creating additional confusion or distraction for drivers.				
General Qualities (Time, Cost and Effectiveness):				
Dependent on the scope of the project. Costs are generally moderate for this type of project. There is usually no right-of-way costs, minimal roadway reconstruction costs, and a shorter project development timeline. At the same time, new mast arms can be expensive. Some locations can result in high B/C ratios, but due to moderate costs, some locations may result in medium to low B/C ratios.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Rear-End, Angle	CRF:	12 - 74%

S09, Install raised pavement markers and striping (Through Intersection)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	10%	10 years
Notes:	This CM only applies to crashes occurring in the intersection and influence areas of the new pavement markers and/or markings.		

General information
Where to use:
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. Driver confusion can exist in regard to choosing the proper turn path or where through-lanes do not line up. This is especially relevant at intersections where the overall pavement area of the intersection is large, and multiple turning lanes are involved or other unfamiliar elements are presented to the driver.
Why it works:
Adding clear pavement markings can guide motorists through complex intersections. When drivers approach and traverse through complex intersections, drivers may be required to perform unusual or unexpected maneuvers. Providing more effective guidance through an intersection will minimize the likelihood of a vehicle leaving its appropriate lane and encroaching upon an adjacent lane.
General Qualities (Time, Cost and Effectiveness):
Costs of implementing this strategy will vary based on the scope and number of applications. Applying raised pavement markers is relatively low cost but can be variable and determined largely by the material used for pavement markings (paint, thermoplastic, epoxy, RPMs etc.). When using this type delineators, an issue of concern is the cost-to-service-life of the material. (Note: When HSIP safety funding is used for these installations in high-wear-locations, the local agency is expected to maintain the improvement for a minimum of 10 years.) When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Wet, Night, All	CRF:	10 - 33%

S10, Install flashing beacons as advance warning (S.I.)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	30%	10 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new flashing beacons.		

General information
Where to use:
At signalized intersections with crashes that are a result of drivers being unaware of the intersection or are unable to see the traffic control device in time to comply.
Why it works:
Increased driver awareness of an approaching signalized intersection and an increase in the driver's time to react. Driver awareness of both downstream intersections and traffic control devices is critical to intersection safety. Crashes often occur when the driver is unable to perceive an intersection, signal head or the back of a stopped queue in time to react. Advance flashing beacons can be used to supplement and call driver attention to intersection control signs. Most advance warning flashing beacons can be powered by solar, thus reducing the issues relating to power source.
General Qualities (Time, Cost and Effectiveness):
Before choosing this CM, the agency needs to confirm the ability to provide power to the site (solar may be an option). Flashing beacons can be constructed with minimal design, environmental and right-of-way issues and have relatively low costs. This combined with a relatively high CRF, can result in high B/Cs for locations with a history of crashes and lead to a high effectiveness.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Rear End, Angle	CRF:	36 - 62%

S11, Improve pavement friction (High Friction Surface Treatments)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	55%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the improved friction overlay. This CM is not intended to apply to standard chip-seal or open-graded maintenance projects for long segments of corridors or structure repaving projects intended to fix failed pavement.		

General information				
Where to use:				
Nationally, this countermeasure is referred to as "High Friction Surface Treatments" or HFST. 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.				
Why it works:				
Improving the skid resistance at locations with high frequencies of wet-road crashes and/or failure to stop crashes can result in reductions of 50 percent for wet-road crashes and 20 percent for total crashes. Applying HFST can double friction numbers, e.g. low 40s to high 80s. This CM represents a special focus area for both FHWA and Caltrans, which means there are extra resources available for agencies interested in more details on High Friction Surface Treatment projects.				
General Qualities (Time, Cost and Effectiveness):				
This strategy can be relatively inexpensive and implemented in a short timeframe. The installation would be done by either agency personnel or contractors and can be done by hand or machine. In general, This CM can be very effective and can be considered on a systematic approach.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Wet, Night, ALL	CRF:	10 - 62 %

S12, Install raised median on approaches (S.I.)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	25%	20 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new raised median. All new raised medians funded with HSIP funding must not include the removal of the existing roadway structural section and must be doweled into the existing roadway surface. This new requirement is being implemented to maximize the safety-effectiveness of the limited HSIP funding and to minimize project impacts.		

General information				
Where to use:				
Intersections noted as having turning movement crashes near the intersection as a result of insufficient access control. Application of this CM should be based on current crash data and a clearly defined need to restrict or accommodate the movement.				
Why it works:				
Raised medians next to left-turn lanes at intersections offer a cost-effective means for reducing crashes and improving operations at higher volume intersections. The raised medians prohibit left turns into and out of driveways that may be located too close to the functional area of the intersection.				
General Qualities (Time, Cost and Effectiveness):				
Raised medians at intersections may be most effective in retrofit situations where high volumes of turning vehicles have degraded operations and safety, and where more extensive CMs would be too expensive because of limited right-of-way and the constraints of the built environment. The result is This CM can be very effective and can be considered on a systematic approach. Raised medians can often be installed directly over the existing pavement. When agencies opt to install landscaping in conjunction with new raised medians, the portion of the cost for landscaping and other non-safety related items that exceeds 10% of the project total cost is not federally participated and must be funded by the applicant.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Angle	CRF:	21 -55 %

S13PB, Install pedestrian median fencing on approaches

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring on the approaches/influence area of the new pedestrian median fencing.		

General information				
Where to use:				
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, then installing a continuous pedestrian barrier in the median may be a viable solution.				
Why it works:				
Adding pedestrian median fencing has the opportunity to enhance pedestrian safety at locations noted as being problematic involving pedestrians running/darting across the roadway outside the intersection crossings. Pedestrian median fencing can significantly reduce this safety issue by creating a positive barrier, forcing pedestrians to the designated pedestrian crossing.				
General Qualities (Time, Cost and Effectiveness):				
Costs associated with this strategy will vary widely depending on the type and placement of the median fencing. Impacts to transit and other land uses may need to be considered and controversy can delay the implementation. In general, this CM can be effective as a spot-location approach.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	25- 40%

S14, Create directional median openings to allow (and restrict) left-turns and U-turns (S.I.)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	50%	20 years
Notes:	This CM only applies to crashes occurring in the intersection / influence area of the new directional openings.		

General information				
Where to use:				
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.				
Why it works:				
Restricting turning movement into and out of an intersection can help reduce conflicts between through and turning traffic. The number of access points, coupled with the speed differential between vehicles traveling along the roadway, contributes to crashes. Affecting turning movements by either allowing them or restricting them, based on the application, can ensure safe movement of traffic.				
General Qualities (Time, Cost and Effectiveness):				
Turn prohibitions that are implemented by closing a median opening can be implemented quickly. The cost of this strategy will depend on the treatment. Impacts to businesses and other land uses must be considered and controversy can delay the implementation. In general, This CM can be very effective and can be considered on a systematic approach.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	51%

S15, Reduced Left-Turn Conflict Intersections (S.I.)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	50%	20 years
Notes:	This CM only applies to crashes occurring in the intersection / influence area of the new Reduced Left-Turn Conflict.		

General information

Where to use and Why it works:

Reduced left-turn conflict intersections are geometric designs that alter how left-turn movements occur in order to simplify decisions and minimize the potential for related crashes. Two highly effective designs that rely on U-turns to complete certain left-turn movements are known as the restricted crossing U-turn (RCUT) and the median U-turn (MUT).

Restricted Crossing U-turn (RCUT):

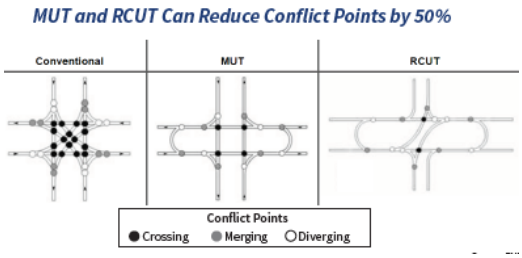
The RCUT intersection modifies the direct left-turn and through movements from cross-street approaches. Minor road traffic makes a right turn followed by a U-turn at a designated location (either signalized or unsignalized) to continue in the desired direction.

The RCUT is suitable for a variety of circumstances, including along rural, high-speed, four-lane, divided highways or signalized routes. It also can be used as an alternative to signalization or constructing an interchange. RCUTs work well when consistently used along a corridor, but also can be used effectively at individual intersections.

Median U-turn (MUT)

The MUT intersection modifies direct left turns from the major approaches. Vehicles proceed through the main intersection, make a U-turn a short distance downstream, followed by a right turn at the main intersection. The U-turns can also be used for modifying the cross-street left turns.

The MUT is an excellent choice for heavily traveled intersections with moderate left-turn volumes. When implemented at multiple intersections along a corridor, the efficient two-phase signal operation of the MUT can reduce delay, improve travel times, and create more crossing opportunities for pedestrians and bicyclists.



General Qualities (Time, Cost and Effectiveness):

Implementing this strategy may take from months to years, depending on whether additional R/W is required. Such projects require a substantial time for development and construction. Costs are highly variable and range from very low to high. The expected effectiveness of this CM must be assessed for each individual location.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Angle/Left-turn/Rear-End/All	CRF:	34.8-100%

S16, Convert intersection to roundabout (from signal)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	Varies	20 years
Notes:	This CM only applies to crashes occurring in influence area of the new roundabout. This CM is not intended for mini-roundabouts. The benefit of this CM is calculated using Caltrans procedure. The CRF is dependent on the ADT, project location (Rural/Urban) and the roundabout type (1 lane or 2 lanes). The benefit comes from both the reduction in the number and the severity of the crashes.		

General information				
Where to use:				
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.				
Why it works:				
The types of conflicts that occur at roundabouts are different from those occurring at conventional intersections; namely, conflicts from crossing and left-turn movements are not present in a roundabout. The geometry of a roundabout forces drivers to reduce speeds as they proceed through the intersection. This helps keep the range of vehicle speed narrow, which helps reduce the severity of crashes when they do occur. Pedestrians only have to cross one direction of traffic at a time at roundabouts, thus reducing their potential for conflicts.				
General Qualities (Time, Cost and Effectiveness):				
Provision of a roundabout requires substantial project development. The need to acquire right-of-way is likely and will vary from site to site and depends upon the geometric design. These activities may require up to 4 years or longer to implement. Mini-roundabouts may be able to be built more expediently with signs and markings, but do not have the same CRFs as those shown in this CM. Costs are variable, but construction of a roundabout to replace an existing signalized intersection are relatively high. The result is this CM may have reduced relative-effectiveness compared to other CMs.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	35 - 67%

S17PB, Install pedestrian countdown signal heads

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	Pedestrian and Bicycle	25%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the intersection/crossing with the new countdown heads.		

General information				
Where to use:				
Signals that have signalized pedestrian crossing with walk/don't walk indicators and where there have been pedestrian vs. vehicle crashes.				
Why it works:				
A pedestrian countdown signal contains a timer display and counts down the number of seconds left to finish crossing the street. 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. Countdown signals begin counting down either when the "WALK" or when the flashing "DON'T WALK" interval appears and stop at the beginning of the steady "DON'T WALK" interval. These signals also have been shown to encourage more pedestrians to use the pushbutton rather than jaywalk.				
General Qualities (Time, Cost and Effectiveness):				
Costs and time of installation will vary based on the number of intersections included in this strategy and if it requires new signal controllers capable of accommodating the enhancement. When considered at a single location, these low cost improvements are usually funded through local funding by local crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	25%

S18PB, Install pedestrian crossing (S.I.)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	Pedestrian and Bicycle	25%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the intersection/crossing with the new crossing. This CM is not intended to be used for high-cost aesthetic enhancements to intersection crosswalks (i.e. stamped concrete or stamped asphalt).		

General information				
Where to use:				
Signalized Intersections with no marked crossing and pedestrian signal heads, where pedestrians are known to be crossing intersections that involve significant turning movements. They are especially important at intersections with (1) multiphase traffic signals, such as left-turn arrows and split phases, (2) school crossings, and (3) double-right or double-left turns. At signalized intersections, pedestrian crossings are often safer when the left turns have protected phases that do not overlap the pedestrian walk phase.				
Why it works:				
Adding pedestrian crossings has the opportunity to enhance pedestrian safety at locations noted as being problematic. Nearly one-third of all pedestrian-related crashes occur at or within 50 feet of an intersection. Of these, 30 percent may involve a turning vehicle. Another 22 percent of pedestrian crashes involve a pedestrian either running across the intersection or darting out in front of a vehicle whose view was blocked just prior to the impact. Finally, 16 percent of these intersection-related crashes occur because of a driver violation (e.g., failure to yield right-of-way). When agencies opt to install aesthetic enhancement to intersection crosswalks like stamped concrete/asphalt, the project design and construction costs can significantly increase. For HSIP applications, these costs must be accounted for in the B/C calculation, but these costs (over standard crosswalk markings) must be tracked separately and are not federally reimbursable and will increase the agency's local-funding share for the project costs.				
General Qualities (Time, Cost and Effectiveness):				
Costs associated with this strategy will vary widely, depending if curb ramps and sidewalk modifications are required with the crossing. When considered at a single location, these low cost improvements may be funded through local funding by local crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate to high cost projects that are appropriate to seek state or federal funding.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	25%

S19PB, Pedestrian Scramble

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	Pedestrian and Bicycle	40%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the intersection with the new pedestrian crossing.		

General information				
Where to use:				
Pedestrian Scramble is a form of pedestrian "WALK" phase at a signalized intersection in which all vehicular traffic is required to stop, allowing pedestrians/bicyclists to safely cross through the intersection in any direction, including diagonally. Pedestrian Scramble may be considered at signalized intersections with very high pedestrian/bicycle volumes, e.g. in an urban business district.				
Why it works:				
Pedestrian Scramble has been shown to reduce injury risk and increase bicycle ridership due to its perceived safety and comfort.				
General Qualities (Time, Cost and Effectiveness):				
Not involving any additional R/W, Pedestrian Scramble should not require a long development process and should be implemented reasonably soon. A systemic approach may be used in implementing this CM, resulting in cost efficiency with low to moderate cost.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	-10% to 51%

S20PB, Install advance stop bar before crosswalk (Bicycle Box)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	Pedestrian and Bicycle	15%	10 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the intersection-crossing with the new advanced stop bars.		

General information
Where to use:
Signalized Intersections with a marked crossing, where significant bicycle and/or pedestrians volumes are known to occur.
Why it works:
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.)
General Qualities (Time, Cost and Effectiveness):
Costs and time of installation will vary based on the number of intersections included in this strategy and if it requires new signal controllers capable of accommodating the enhancement. When considered at a single location, these low cost improvements are usually funded through local funding by local crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	35%

S21PB, Modify signal phasing to implement a Leading Pedestrian Interval (LPI)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	Pedestrian and Bicycle	60%	10 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the intersections with signalized pedestrian crossing with the newly implemented Leading Pedestrian Interval (LPI).		

General information
Where to use:
Intersections with signalized pedestrian crossing that have high turning vehicles volumes and have had pedestrian vs. vehicle crashes.
Why it works:
A leading pedestrian interval (LPI) gives pedestrians the opportunity to enter an intersection 3-7 seconds before vehicles are given a green indication. With this head start, pedestrians can better establish their presence in the crosswalk before vehicles have priority to turn left. LPIs provide (1) increased visibility of crossing pedestrians; (2) reduced conflicts between pedestrians and vehicles; (3) Increased likelihood of motorists yielding to pedestrians; and (4) enhanced safety for pedestrians who may be slower to start into the intersection.
General Qualities (Time, Cost and Effectiveness):
Costs for implementing LPIs are very low, since only minor signal timing alteration is required. This makes it an easy and inexpensive countermeasure that can be incorporated into pedestrian safety action plans or policies and can become routine agency practice. When considered at a single location, the LPI is usually local-funded. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	59%

B.2 Intersection Countermeasures – Non-signalized

NS01, Add intersection lighting (NS.I.)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	Night	40%	20 years
Notes:	This CM only applies to "night" crashes (all types) occurring within limits of the proposed roadway lighting 'engineered' area.		

General information				
Where to use:				
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).				
Why it works:				
Providing lighting at the intersection itself, or both at the intersection and on its approaches, improves the safety of an intersection during nighttime conditions by (1) making drivers more aware of the surroundings at an intersection, which improves drivers' perception-reaction times, (2) enhancing drivers' available sight distances, and (3) improving the visibility of non-motorists. Intersection lighting is of particular benefit to non-motorized users as lighting not only helps them navigate the intersection, but also helps drivers see them better.				
General Qualities (Time, Cost and Effectiveness):				
A lighting project can usually be completed relatively quickly, but generally requires at least 1 year to implement because the lighting system must be designed and the provision of electrical power must be arranged. The provision of lighting involves both a fixed cost for lighting installation and an ongoing maintenance and power cost. For rural intersections, studies have shown the installation of streetlights reduced nighttime crashes at unlit intersections and can be more effective in reducing nighttime crashes than either rumble strips or overhead flashing beacons. Some locations can result in high B/C ratios, but due to higher costs, these projects often result in medium to low B/C ratios.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Night, All	CRF:	25- 50%

NS02, Convert to all-way STOP control (from 2-way or Yield control)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	50%	10 years
Notes:	This CM only applies to crashes occurring in the intersection and/or influence area of the new control. CA-MUTCD warrant must be met.		

General information				
Where to use:				
Unsignalized intersection locations that have a crash history and have no controls on the major roadway approaches. However, all-way stop 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. MUTCD warrants should always be followed.				
Why it works:				
All-way stop control can reduce right-angle and turning collisions at unsignalized intersections by providing more orderly movement at an intersection, reducing through and turning speeds, and minimizing the safety effect of any sight distance restrictions that may be present. Advance public notification of the change is critical in assuring compliance and reducing crashes.				
General Qualities (Time, Cost and Effectiveness):				
The costs involved in converting to all-way stop control are relatively low. All-way stop control can normally be implemented at multiple intersections with just a change in signing on intersection approaches, and typically are very quick to implement. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Left-turn, Angle	CRF:	6 - 80%

NS03, Install signals

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	30%	20 years
Notes:	This CM only applies to crashes occurring in the intersection and/or influence area of the new signals. **All new signals must meet MUTCD "safety" warrants: 4, 5 or 7.** Given the over-arching operational changes that occur when an intersection is signalized, no other intersection CMs can be applied to the intersection crashes in conjunction with this CM.		

General information				
Where to use:				
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. Refer to the CA MUTCD, Section 4C.01, Studies and Factors for Justifying Traffic Control Signals.				
Why it works:				
Traffic signals have the potential to reduce the most severe type crashes but will likely cause an increase in rear-end collisions. A reduction in overall injury severity is likely the largest benefit of traffic signal installation.				
General Qualities (Time, Cost and Effectiveness):				
Typical traffic signal costs fall in the medium to high category and are affected by application, type of signal and right-of-away considerations. Projects of this magnitude should only be considered after alternate and lesser means of correction have been evaluated. Some locations can result in high B/C ratios, but due to higher costs, these projects often result in medium to low B/C ratios.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	0 - 74%

NS04, Convert intersection to roundabout (from all way stop)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	Varies	20 years
Notes:	This CM only applies to crashes occurring in the intersection and/or influence area of the new control. The benefit of this CM is calculated using Caltrans procedure. The CRF is dependent on the ADT, project location (Rural/Urban) and the roundabout type (1 lane or 2 lanes). The benefit comes from both the reduction in the number and the severity of the crashes.		

General information				
Where to use:				
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.				
Why it works:				
Roundabouts provide an important alternative to signalized and all-way stop-controlled intersections. Modern roundabouts differ from traditional traffic circles in that they operate in such a manner that traffic entering the roundabout must yield the right-of-way to traffic already in it. Roundabouts can serve moderate traffic volumes with less delay than all-way stop-controlled intersections and provide fewer conflict points. Crashes at roundabouts tend to be less severe because of the speed constraints and elimination of left-turn and right-angle movements.				
General Qualities (Time, Cost and Effectiveness):				
Construction of roundabouts are usually relatively costly and major projects, requiring the environmental process, right-of-way acquisition, and implementation under an agency's long-term capital improvement program. (For this reason, roundabouts may not be appropriate for California's Federal Safety Programs that have relatively short delivery requirements.) Even with roundabouts higher costs, they still can have a relatively high effectiveness.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Left-turn, Angle	CRF:	12 - 78 %

NS05, Convert intersection to roundabout (from 2-way stop or Yield control)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	Varies	20 years
Notes:	This CM only applies to crashes occurring in the intersection and/or influence area of the new control. The benefit of this CM is calculated using Caltrans procedure. The CRF is dependent on the ADT, project location (Rural/Urban) and the roundabout type (1 lane or 2 lanes). The benefit comes from both the reduction in the number and the severity of the crashes.		

General information				
Where to use:				
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.				
Why it works:				
Roundabouts provide an important alternative to signalized and all-way stop-controlled intersections. Modern roundabouts differ from traditional traffic circles in that they operate in such a manner that traffic entering the roundabout must yield the right-of-way to traffic already in it. Roundabouts can serve moderate traffic volumes with less delay than all-way stop-controlled intersections and provide fewer conflict points. Crashes at roundabouts tend to be less severe because of the speed constraints and elimination of left-turn and right-angle movements.				
General Qualities (Time, Cost and Effectiveness):				
Construction of roundabouts are usually relatively costly and major projects, requiring the environmental process, right-of-way acquisition, and implementation under an agency's long-term capital improvement program. (For this reason, roundabouts may not be appropriate for California's Federal Safety Programs that have relatively short delivery requirements.) Even with roundabouts higher costs, they still can have a relatively high effectiveness.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Left-turn, Angle	CRF:	12 - 78 %

NS06, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	15%	10 years
Notes:	This CM only applies to crashes occurring in the influence area of the new signs. The influence area must be determined on a location by location basis.		

General information				
Where to use:				
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.				
Why it works:				
The visibility of intersections and, thus, the ability of approaching drivers to perceive them can be enhanced by installing larger regulatory and warning signs at or prior to intersections. A key to success in applying this strategy is to select a combination of regulatory and warning sign techniques appropriate for the conditions on a particular unsignalized intersection approach.				
General Qualities (Time, Cost and Effectiveness):				
Signing improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number of signs. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	11 - 55%

NS07, Upgrade intersection pavement markings (NS.I.)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	25%	10 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new pavement markings. This CM is not intended to be used for general maintenance activities (i.e. the replacement of existing pavement markings in-kind) and must include upgraded safety features over the existing pavement markings and striping.		

General information
Where to use:
Unsignalized intersections that are not clearly visible to approaching motorists, particularly approaching motorists on the major road. The strategy is particularly 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.
Why it works:
The visibility of intersections and, thus, the ability of approaching drivers to perceive them can be enhanced by installing appropriate pavement delineation in advance of and at intersections will provide approaching motorists with additional information at these locations. Providing visible stop bars on minor road approaches to unsignalized intersections can help direct the attention of drivers to the presence of the intersection. Drivers should be more aware that the intersection is coming up, and therefore make safer decisions as they approach the intersection.
General Qualities (Time, Cost and Effectiveness):
Pavement marking improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number of markings. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding. Note: When federal safety funding is used for these installations in high-wear-locations, the local agency is expected to maintain the improvement for a minimum of 10 years.

FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	13 - 60%

NS08, Install Flashing Beacons at Stop-Controlled Intersections

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	15%	10 years
Notes:	This CM only applies to crashes occurring on the stop-controlled approaches / influence area of the new beacons.		

General information
Where to use:
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.
Why it works:
Flashing beacons provide a visible signal to the presence of an intersection and can be very effective in rural areas where there may be long stretches between intersections as well as locations where night-time visibility of intersections is an issue.
General Qualities (Time, Cost and Effectiveness):
Flashing beacons can be constructed with minimal design, environmental and right-of-way issues and have relatively low costs. Before choosing this CM, the agency needs to confirm the ability to provide power to the site (solar may be an option). In general, This CM can be very effective and can be considered on a systematic approach.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Angle, Rear-End	CRF:	5-34%

NS09, Install flashing beacons as advance warning (NS.I.)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	30%	10 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new beacons placed in advance of the intersection.		

General information				
Where to use:				
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.				
Why it works:				
Advance flashing beacons can be used to supplement and call driver attention to intersection control signs. Flashing beacons are intended to reinforce driver awareness of the stop or yield signs and to help mitigate patterns of crashes related to intersection regulatory sign violations. Most advance warning flashing beacons can be powered by solar, thus reducing the issues relating to power source.				
General Qualities (Time, Cost and Effectiveness):				
Use of flashing beacons requires minimal development process, allowing flashing beacons to be installed within a short time period. Before choosing this CM, the agency needs to confirm the ability to provide power to the site (solar may be an option). In general, This CM can be very effective and can be considered on a systematic approach.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Angle, Rear-End	CRF:	36 - 62%

NS10, Install transverse rumble strips on approaches

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	20%	10 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new rumble strips.		

General information				
Where to use:				
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.				
Why it works:				
When motorists are traveling along the roadway, they are sometimes unaware they are approaching an intersection. This is especially true on rural roads, as there may be fewer clues indicating an intersection ahead. Transverse rumble strips warn motorists that something unexpected is ahead that they need to pay attention to.				
General Qualities (Time, Cost and Effectiveness):				
Use of transverse rumble strips requires minimal development process, allowing transverse rumble strips to be installed within a short time period. In general, This CM can be very effective and can be considered on a systematic approach, although care should be taken to not over-use this CM. Note: When federal safety funding is used for these installations in high-wear-locations, the local agency is expected to maintain the improvement for a minimum of 10 years.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	0 - 35%

NS11, Improve sight distance to intersection (Clear Sight Triangles)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	20%	10 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the significantly improved new sight distance. Minor/incidental improvements to sight distance would not likely result in the CRF shown below.		

General information				
Where to use:				
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.				
Why it works:				
Adequate sight distance for drivers at stop or yield-controlled approaches to intersections has long been recognized as among the most important factors contributing to overall safety at unsignalized intersections. By removing sight distance restrictions (e.g., vegetation, parked vehicles, signs, buildings) from the sight triangles at stop or yield-controlled intersection approaches, drivers will be able see approaching vehicles on the main line, without obstruction and therefore make better decisions about entering the intersection safely.				
General Qualities (Time, Cost and Effectiveness):				
Projects involving clearing sight obstructions on the highway right-of-way can typically be accomplished quickly, assuming the objects are readily moveable. Clearing sight obstructions on private property requires more time for discussions with the property owner. Costs will generally be low, assuming that in most cases the objects to be removed are within the right-of-way. In general, this CMs can be very effective and can be implemented by agencies' maintenance staff and/or implemented on a systematic approach. Usually only high-cost removals would be good candidates for Caltrans Federal Safety Funding. Note: When federal safety funding is used to remove vegetation that has the potential to grow back, the local agency is expected to maintain the improvement for a minimum of 10 years.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	11 - 56%

NS12, Improve pavement friction (High Friction Surface Treatments)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	55%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the improved friction overlay. This CM is not intended to apply to standard chip-seal or open-graded maintenance projects for long segments of corridors or structure repaving projects intended to fix failed pavement.		

General information				
Where to use:				
Nationally, this countermeasure is referred to as "High Friction Surface Treatments" or HFST. 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.				
Why it works:				
Improving the skid resistance at locations with high frequencies of wet-road crashes and/or failure to stop crashes can result in reductions of 50 percent for wet-road crashes and 20 percent for total crashes. Applying HFST can double friction numbers, e.g. low 40s to high 80s. This CM represents a special focus area for both FHWA and Caltrans, which means there are extra resources available for agencies interested in more details on High Friction Surface Treatment projects.				
General Qualities (Time, Cost and Effectiveness):				
This strategy can be relatively inexpensive and implemented in a short timeframe. The installation would be done by either agency personnel or contractors and can be done by hand or machine. In general, This CM can be very effective and can be considered on a systematic approach.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Wet, Night, ALL	CRF:	10 - 62 %

NS13, Install splitter-islands on the minor road approaches

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	40%	20 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of **the new splitter island on the minor road approaches.**		

General information
Where to use:
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.
Why it works:
The installation of splitter islands allows for the addition of a stop sign in the median to make the intersection more conspicuous. Additionally, the splitter island on the minor-road provides for a positive separation between turning vehicles on the through road and vehicles stopped on the minor road approach.
General Qualities (Time, Cost and Effectiveness):
Splitter islands at non-signalized intersections can usually be installed with minimal roadway reconstruction and relatively quickly. In general, This CM can be very effective and can be considered on a systematic approach.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Angle, Rear-End	CRF:	35 - 100 %

NS14, Install raised median on approaches (NS.I.)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	25%	20 years
Notes:	This CM 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. This new requirement is being implemented to maximize the safety-effectiveness of the limited HSIP funding and to minimize project impacts.		

General information
Where to use:
Where related or nearby turning movements affect the safety and operation of an intersection. Effective access management is key to improving safety at, and adjacent to, intersections. The number of intersection access points coupled with the speed differential between vehicles traveling along the roadway often contributes to crashes. Any access points within 250 feet upstream and downstream of an intersection are generally undesirable.
Why it works:
Raised medians with left-turn lanes at intersections offer a cost-effective means for reducing crashes and improving operations at higher volume intersections. The raised medians also prohibit left turns into and out of driveways that may be located too close to the functional area of the intersection.
General Qualities (Time, Cost and Effectiveness):
Raised medians at intersections may be most effective in retrofit situations where high volumes of turning vehicles have degraded operations and safety, and where more extensive approaches would be too expensive because of limited right-of-way and the constraints of the built environment. Because raised medians limit property access to right turns only, the need for providing alternative access ways should be considered. In general, This CM can be very effective and can be considered on a systematic approach. When agencies opt to install landscaping in conjunction with new raised medians, the portion of the cost for landscaping and other non-safety related items that exceeds 10% of the project total cost is not federally participated and must be funded by the applicant.

FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	20 - 39 %

NS15, Create directional median openings to allow (and restrict) left-turns and u-turns (NS.I.)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	50%	20 years
Notes:	This CM only applies to crashes occurring in the intersection / influence area of the new directional openings.		

General information				
Where to use:				
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.				
Why it works:				
Agencies are increasingly using access management techniques on urban and suburban arterials to manage the number of conflicts experienced at an intersection. A key element of access management is to restrict certain movements, create directional median openings, or close median openings that are deemed too close to an intersection.				
General Qualities (Time, Cost and Effectiveness):				
Turn prohibitions that are implemented by closing a median opening can usually be implemented quickly. Costs are highly variable but in many cases could be considered low. In some cases this strategy may involve acquiring access or constructing replacement access; those actions will significantly increase the cost of the project. Impacts to businesses and other land uses must be considered and controversy can delay the implementation. In general, This CM can be very effective and can be considered on a systematic approach.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	51%

NS16, Reduced Left-Turn Conflict Intersections (NS.I.)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	50%	20 years
Notes:	This CM only applies to crashes occurring in the intersection / influence area of the new Reduced Left-Turn Conflict.		

General information

Where to use and Why it works:

Reduced left-turn conflict intersections are geometric designs that alter how left-turn movements occur in order to simplify decisions and minimize the potential for related crashes. Two highly effective designs that rely on U-turns to complete certain left-turn movements are known as the restricted crossing U-turn (RCUT) and the median U-turn (MUT).

Restricted Crossing U-turn (RCUT):

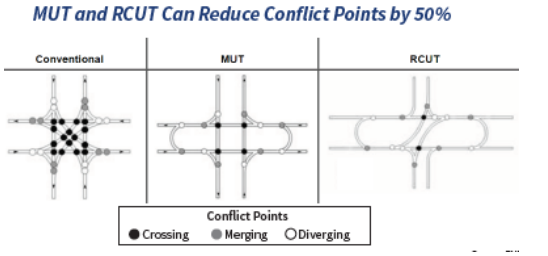
The RCUT intersection modifies the direct left-turn and through movements from cross-street approaches. Minor road traffic makes a right turn followed by a U-turn at a designated location (either signalized or unsignalized) to continue in the desired direction.

The RCUT is suitable for a variety of circumstances, including along rural, high-speed, four-lane, divided highways or signalized routes. It also can be used as an alternative to signalization or constructing an interchange. RCUTs work well when consistently used along a corridor, but also can be used effectively at individual intersections.

Median U-turn (MUT)

The MUT intersection modifies direct left turns from the major approaches. Vehicles proceed through the main intersection, make a U-turn a short distance downstream, followed by a right turn at the main intersection. The U-turns can also be used for modifying the cross-street left turns.

The MUT is an excellent choice for heavily traveled intersections with moderate left-turn volumes. When implemented at multiple intersections along a corridor, the efficient two-phase signal operation of the MUT can reduce delay, improve travel times, and create more crossing opportunities for pedestrians and bicyclists.



General Qualities (Time, Cost and Effectiveness):

Implementing this strategy may take from months to years, depending on whether additional R/W is required. Such projects require a substantial time for development and construction. Costs are highly variable and range from very low to high. The expected effectiveness of this CM must be assessed for each individual location.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Angle/Left-turn/Rear-End/All	CRF:	34.8-100%

NS17, Install right-turn lane (NS.I.)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	20%	20 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new right-turn lanes. This CM is not eligible for use at existing all-way stop intersections.		

General information				
Where to use:				
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.				
Why it works:				
The strategy is targeted to reduce the frequency of rear-end collisions resulting from conflicts between vehicles turning right and following vehicles and vehicles turning right and through vehicles coming from the left on the cross street. Right-turn lanes also remove slow vehicles that are decelerating to turn right from the through-traffic stream, thus reducing the potential for rear-end collisions. Right-turn lanes can increase the length of the intersection crossing and create an additional potential conflict point for non-motorized users.				
General Qualities (Time, Cost and Effectiveness):				
Implementing this strategy may take from months to years. At some locations, right-turn lanes can be quickly and simply installed by restriping the roadway. At other locations, widening of the roadway, acquisition of additional right-of-way, and extensive environmental processes may be needed. Such projects require a substantial time for development and construction. Costs are highly variable and range from very low to high. The expected effectiveness of this CM must be assessed for each individual location.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	14 - 26 %

NS18, Install left-turn lane (where no left-turn lane exists)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	35%	20 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new left-turn lanes. This CM does NOT apply to converting a single-left into double-left turn. This CM is not eligible for use at existing all-way stop intersections.		

General information				
Where to use:				
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 appropriate.				
Why it works:				
Adding left-turn lanes remove vehicles waiting to turn left from the through-traffic stream, thus reducing the potential for rear-end collisions. Because they provide a sheltered location for drivers to wait for a gap in opposing traffic, left-turn lanes may encourage drivers to be more selective in choosing a gap to complete the left-turn maneuver. This strategy may reduce the potential for collisions between left-turn and opposing through vehicles.				
General Qualities (Time, Cost and Effectiveness):				
Implementing this strategy may take from months to years. At some locations, left-turn lanes can be quickly and simply installed by restriping the roadway. At other locations, widening of the roadway, acquisition of additional right-of-way, and extensive environmental processes may be needed. Such projects require a substantial time for development and construction. Costs are highly variable and range from very low to high. The expected effectiveness of this CM must be assessed for each individual location.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	9 -55 %

NS19PB, Install raised medians (refuge islands)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	45%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the crossing with the new islands. 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. This new requirement is being implemented to maximize the safety-effectiveness of the limited HSIP funding and to minimize project impacts.		

General information
Where to use:
Intersections that have a long pedestrian crossing distance, a higher 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.
Why it works:
Raised pedestrian refuge islands, or medians at crossing locations along roadways, are another strategy to reduce exposure between pedestrians and motor vehicles. Refuge islands and medians that are raised (i.e., not just painted) provide pedestrians more secure places of refuge during the street crossing. They can stop partway across the street and wait for an adequate gap in traffic before completing their crossing.
General Qualities (Time, Cost and Effectiveness):
Median and pedestrian refuge areas are a low-cost countermeasure to implement. This cost can be applied to retrofit improvements or if it is a new construction project, implementing this countermeasure is even more cost-effective. In general, This CM can be very effective and can be considered on a systematic approach. When agencies opt to install landscaping in conjunction with new raised medians, the portion of the cost for landscaping and other non-safety related items that exceeds 10% of the project total cost is not federally participated and must be funded by the applicant.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian and Bicycle	CRF:	30 - 56 %

NS20PB, Install pedestrian crossing at uncontrolled locations (signs and markings only)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	Pedestrian and Bicycle	25%	10 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the intersection/crossing with the new crossing. This CM is not intended to be used for high-cost aesthetic enhancements to intersection crosswalks (i.e. stamped concrete or stamped asphalt).		

General information
Where to use:
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. See Zegeer study (Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations) for additional guidance regarding when to install a marked crosswalk.
Why it works:
Adding pedestrian crossings has the opportunity to enhance pedestrian safety at locations noted as being problematic. Pavement markings delineate a portion of the roadway that is designated for pedestrian crossing. These markings will often be different for controlled verses uncontrolled locations. The use of "ladder", "zebra" or other enhanced markings at uncontrolled crossings can increase both pedestrian and driver awareness to the increased exposure at the crossing. Incorporating advanced "stop" or “yield" markings provides an extra safety buffer and can be effective in reducing the 'multiple-threat' danger to pedestrians. Nearly one-third of all pedestrian-related crashes occur at or within 50 feet of an intersection. Of these, 30 percent may involve a turning vehicle. There are several types of pedestrian crosswalks, including: continental, ladder, zebra, and standard. When agencies opt to install aesthetic enhancement to intersection crosswalks like stamped concrete/asphalt, the project design and construction costs can significantly increase. For HSIP applications, these costs must be accounted for in the B/C calculation, but these costs (over standard crosswalk markings) must be tracked separately and are not federally reimbursable and will increase the agency's local-funding share for the project costs.
General Qualities (Time, Cost and Effectiveness):
Costs associated with this strategy will vary widely, depending upon if curb ramps and sidewalk modifications are required with the crossing. When considered at a single location, these low cost improvements are usually funded through local funding by local crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian and Bicycle	CRF:	25 %

NS21PB, Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	Pedestrian and Bicycle	35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the new crossing (influence area) with enhanced safety features. This CM is not intended to be used for high-cost aesthetic enhancements to intersection crosswalks (i.e. stamped concrete or stamped asphalt).		

General information
Where to use:
Non-signalized intersections where pedestrians are known to be crossing intersections that involve significant vehicular traffic. They are especially important at school crossings and intersections with turn pockets. Based on the Zegeer study (Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations) at many locations, a marked crosswalk alone may not be sufficient to adequately protect non-motorized users. In these cases, **flashing beacons, curb extensions, advanced "stop" or "yield" markings, and other safety features** should be added to complement the standard crossing elements.
Why it works:
Adding pedestrian crossings that include enhances safety features has the opportunity to enhance pedestrian safety at locations noted as being especially problematic. The enhanced safety elements help delineate a portion of the roadway that is designated for pedestrian crossing. Incorporating advanced "yield" markings provide an extra safety buffer and can be effective in reducing the 'multiple-threat' danger to pedestrians. Nearly one-third of all pedestrian-related crashes occur at or within 50 feet of an intersection. When agencies opt to install aesthetic enhancement to intersection crosswalks like stamped concrete/asphalt, the project design and construction costs can significantly increase. For HSIP applications, these costs must be accounted for in the B/C calculation, but these costs (over standard crosswalk markings) must be tracked separately and are not federally reimbursable and will increase the agency's local-funding share for the project costs.
General Qualities (Time, Cost and Effectiveness):
Costs associated with this strategy will vary widely, depending upon the types of enhanced features that will be combined with the standard crossing improvements. The need for new curb ramps and sidewalk modifications will also be a factor. This CM may be effectively and efficiently implemented using a systematic approach with more than one location and can have relatively high B/C ratios based on past non-motorized crash history.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian and Bicycle	CRF:	37%

NS22PB, Install Rectangular Rapid Flashing Beacon (RRFB)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	Pedestrian and Bicycle	35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the influence area (expected to be a maximum of within 250') of the crossing which includes the RRFB.		

General information
Where to use:
Rectangular Rapid Flashing Beacon (RRFB) includes pedestrian-activated flashing lights and additional signage that enhance the visibility of marked crosswalks and alert motorists to pedestrian crossings. It uses an irregular flash pattern that is similar to emergency flashers on police vehicles. RRFBs are installed at unsignalized intersections and mid-block pedestrian crossings.
Why it works:
RRFBs can enhance safety by increasing driver awareness of potential pedestrian conflicts and reducing crashes between vehicles and pedestrians at unsignalized intersections and mid-block pedestrian crossings. The addition of RRFB may also increase the safety effectiveness of other treatments, such as crossing warning signs and markings.
General Qualities (Time, Cost and Effectiveness):
RRFBs are a lower cost alternative to traffic signals and hybrid signals. This CM can often be effectively and efficiently implemented using a systematic approach with numerous locations.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	7 – 47.4%

NS23PB, Install Pedestrian Signal (including Pedestrian Hybrid Beacon (HAWK))

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	Pedestrian and Bicycle	55%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the intersection/crossing with the new signal.		

General information				
Where to use:				
Intersections noted as having a history of pedestrian vs. vehicle crashes and in areas where the likelihood of the pedestrian presence is high. Corridors should also be assessed to determine if there are adequate safe opportunities for non-motorists to cross and if a pedestrian signal, or a Pedestrian Hybrid Beacon (PHB) (also called High-Intensity Activated crossWalK beacon (HAWK)) are needed to provide an active warning to motorists when a pedestrian is in the crosswalk.				
Why it works:				
Adding a pedestrian signal has the opportunity to greatly enhance pedestrian safety at locations noted as being problematic. Nearly one-third of all pedestrian-related crashes occur at or within 50 feet of an intersection. In combination with this CM, better guidance signs and markings for non-motorized and motorized roadway users should be considered, including: sign and markings directing pedestrians and cyclists on appropriate/legal travel paths and signs and markings warning motorists of non-motorized uses of the roadway that should be expected.				
General Qualities (Time, Cost and Effectiveness):				
The cost of improvements are generally high, but can vary dependent on the type of signal and overall scope of the project. In most cases the project duration can be short. The expected effectiveness of this CM must be assessed for each individual location.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian and Bicycle	CRF:	15 - 69%

B.3 Roadway Countermeasures

R01, Add Segment Lighting

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	Night	35%	20 years
Notes:	This CM only applies to "night" crashes (all types) occurring within limits of the proposed roadway lighting 'engineered' area.		

General information				
Where to use:				
Where to use: 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.				
Why it works:				
Providing roadway lighting improves the safety during nighttime conditions by (1) making drivers more aware of the surroundings, which improves drivers' perception-reaction times, (2) enhancing drivers' available sight distances to perceive roadway characteristic in advance of the change, and (3) improving non-motorist's visibility and navigation.				
General Qualities (Time, Cost and Effectiveness):				
It expected that projects of this type may be constructed in a year or two and are relatively costly. There are several types of costs associated with providing lighting, including the cost of providing a permanent source of power to the location, the cost for the luminaire supports (i.e., poles), and the cost for routinely replacing the bulbs and maintenance of the luminaire supports. Some locations can result in high B/C ratios, but due to higher costs, these projects often result in medium to low B/C ratios.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Night, All	CRF:	18 - 69 %

R02, Remove or relocate fixed objects outside of Clear Recovery Zone

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	35%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new clear recovery zone (per Caltrans' HDM).		

General information				
Where to use:				
Known 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.				
Why it works:				
While this strategy does not prevent the vehicle leaving the roadway, it does provide a mechanism to reduce the severity of a resulting crash. A clear zone is an unobstructed, traversable roadside area that allows a driver to stop safely or regain control of a vehicle that has left the roadway. Removing or moving fixed objects, flattening slopes, or providing recovery areas reduces the likelihood of a crash.				
General Qualities (Time, Cost and Effectiveness):				
Projects involving removing fixed objects from highway right-of-way can typically be accomplished quickly, assuming the objects are readily moveable. Clearing objects on private property requires more time for discussions with the property owner. Costs will generally be low, assuming that in most cases the objects to be removed are within the right-of-way. This CMs can be very effective and can be implemented by agencies' maintenance staff and/or implemented on a systematic approach. High-cost removals or removals implemented using a systematic approach would be good candidates for Caltrans Federal Safety Funding.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Fixed Object	CRF:	17 - 100 %

R03, Install Median Barrier

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	25%	20 years
Notes:	Note: For Caltrans' statewide Calls-for-Projects, this CM only applies to crashes occurring within the limits of the new barrier.		

General information
Where to use:
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 PDO 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. It is recommended to review the warrants as outlined in Chapter 7 of the Caltrans Traffic Manual when considering whether to install median barriers.
Why it works:
This strategy is designed to prevent head-on collisions by providing a barrier between opposing lanes of traffic. The variety of median barriers available makes it easier to choose a site-specific solution. The main advantage is the reduction of the severity of the crashes. The key to success would be in selecting an appropriate barrier based on the site, previous crash history, maintenance needs, and median width.
General Qualities (Time, Cost and Effectiveness):
This strategy would in many cases be possible to implement within a short period after site selection. Costs will vary depending on the type of median barrier selected and whether the strategy is implemented as a stand-alone project or incorporated as part of a reconstruction or resurfacing effort. Maintenance costs and worker exposure will also vary depending on the type of barrier selected. The expected effectiveness of this CM must be assessed for each individual location.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Head-on	CRF:	0 - 94 %

R04, Install Guardrail

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	25%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new guardrail. This CM is not intended to be used for general maintenance activities (i.e. the replacement of existing damaged rail). For projects proposing to upgrade existing guardrail to current standards, this CM and corresponding CRF should only be applied to locations where past crash data or engineering judgment applied to the existing rail conditions suggests the upgraded guardrail may result in fewer or less severe crashes (justifying the use of the 25% CRF for this CM).		

General information
Where to use:
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. New and upgraded guardrail and end-treatments must meet current safety standards; see Method for Assessing Safety Hardware (MASH) for more information. Caltrans (or other national accepted guidance) slope/height criteria need to be considered and documented.
Why it works:
Guardrail redirects a vehicle away from embankment slopes or fixed objects and dissipates the energy of an errant vehicle.
General Qualities (Time, Cost and Effectiveness):
Strategies range from relatively inexpensive too costly. Costly projects may include those that upgrade existing guardrail applications to more semi-rigid and rigid barrier systems over extended distances. In general, this CMs can be effective and can be implemented by agencies' maintenance staff and/or implemented on a systematic approach.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Fixed Object, Run-off Road	CRF:	11 - 78 %

R05, Install impact attenuators

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	25%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the new attenuators. This CM is not intended to be used for general maintenance activities (i.e. the replacement of existing damaged attenuators). For projects proposing to upgrade existing attenuators to current standards, this CM and corresponding CRF should only be applied to locations where past crash data or engineering judgment applied to the existing attenuator conditions suggests the upgraded attenuators may result in fewer or less severe crashes (justifying the use of the 25% CRF for this CM).		

General information				
Where to use:				
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. New and upgraded barrier end-treatments must meet current safety standards; see MASH for more information.				
Why it works:				
Attenuators bring an errant vehicle to a more-controlled stop or redirect the vehicle away from a rigid object. Attenuators are effective at absorbing impact energy and increasing occupant safety. They also tend to draw attention to the fixed object, which helps drivers steer clear of the fixed objects.				
General Qualities (Time, Cost and Effectiveness):				
Costs depending on the scope of the project, type(s) used, and associated ongoing maintenance costs. Time to install is fairly quick once site is identified.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Fixed Object, Run-off Road	CRF:	5 - 50 %

R06, Flatten side slopes

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	30%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new side slopes. Minor/incidental flattening of side slopes would not likely result in the CRF shown below and may not be appropriate for use in Caltrans B/C calculations.		

General information				
Where to use:				
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.				
Why it works:				
Flattened slopes provide a greater area for a driver to regain control of a vehicle. Steep slopes, ditches or unprotected hazardous drops-offs adjacent to a travel lane offer little opportunities to correct an inappropriate action by a driver and can result in sever crashes.				
General Qualities (Time, Cost and Effectiveness):				
Roadside modifications range from relatively inexpensive to very costly. Strategies that include creating safer side slopes where none exists can be moderately expensive based on the scope of the project and the associated clearing, grading, etc. The potential for high environmental and right-of-way impacts is high which can take several years to clear. In other cases This CM can be effective and can be implemented by agencies' maintenance staff and/or implemented on a systematic approach.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Fixed Object, Run-off Road	CRF:	5 - 62 %

R07, Flatten side slopes and remove guardrail

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	40%	20 years
Notes:	This CM only applies to crashes occurring within the limits of both the removed guardrail and the new side slopes.		

General information
Where to use:
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.
Why it works:
Flattened side slopes and an unobstructed clear zone provide a greater area for a driver to regain control of a vehicle. The existing guardrail may help protect the steep slopes, fixed objects, or unprotected hazardous drops-offs adjacent to a travel lane, but removing all of these obstacles generally improves safety.
General Qualities (Time, Cost and Effectiveness):
Roadside modifications range from relatively inexpensive to very costly. Strategies that include creating safer side slopes where none exists can be moderately expensive based on the scope of the project and the associated clearing, grading, etc. The potential for high environmental and right-of-way impacts is high which can take several years to clear.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Roll Over, Fixed Object	CRF:	42%

R08, Install raised median

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	25%	20 years
Notes:	This CM only applies to crashes occurring within the limits 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. This new requirement is being implemented to maximize the safety-effectiveness of the limited HSIP funding and to minimize project impacts.		

General information
Where to use:
Areas 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. Application of raised medians on roadways with higher speeds is not advised - instead a median barrier should be considered. Including landscaping in new raised medians can be counterproductive to the HSIP safety goals and should only be done in ways that do not increase drivers' exposure to fixed objects and that will maintain driver's sight distance needs throughout the life of the proposed landscaping. **Agencies need to consider and document impacts of additional turning movements at nearby intersections.**
Why it works:
Adding raised medians is a particularly effective strategy as it adds to or reallocates the existing cross section to incorporate a buffer between the opposing travel lanes and reinforces the limits of the travel lane. Raised median may also be used to limit unsafe turning movements along a roadway.
General Qualities (Time, Cost and Effectiveness):
In some cases this strategy may be a retrofit into the existing roadway by utilizing a portion of the existing paved shoulder. These raised medians can be installed directly over the existing pavement. Cost and time to implement could significantly increase if the paved area is not sufficient to include a median. The surface treatment of the raised median also significantly affects their cost-effectiveness: standard concrete or other hardscape surfaces are usually more cost effective than landscaped medians. When agencies opt to install landscaping in conjunction with new raised medians, the project design and construction costs can significantly increase due to excavation, backfill/top-soil, water-connection, irrigation, planting, maintenance needed for the landscaping. When agencies opt to install landscaping in conjunction with new raised medians, the portion of the cost for landscaping and other non-safety related items that exceeds 10% of the project total cost is not federally participated and must be funded by the applicant.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Head-on	CRF:	20 - 75 %

R09, Install median (flush)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	15%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new flush median. The new median must be a minimum of 4 feet wide (or "wider" if a narrow median exists before the proposed project).		

General information				
Where to use:				
Areas 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.				
Why it works:				
Adding medians is a particularly effective strategy as it adds to or reallocates the existing cross section to incorporate a narrow buffer median between opposing flows, thereby providing a greater opportunity to correct an errant maneuver and further reinforce the limits of the travel lane. Application widths can vary based on the available cross section and intended application. Additional safety can be provided by combining this CM with rumble strips.				
General Qualities (Time, Cost and Effectiveness):				
In some cases this strategy may be retrofitted into the existing roadway by utilizing a portion of the existing paved shoulder and can ultimately be as simple as restriping the roadway. Costs and time to implement could significantly increase if the paved area is not sufficient to include a median.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	15 - 78 %

R10PB, Install pedestrian median fencing

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring on the approaches/influence area of the new pedestrian median fencing.		

General information				
Where to use:				
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.				
Why it works:				
Adding pedestrian median fencing has the opportunity to enhance pedestrian safety at locations noted as being problematic involving pedestrians running/darting across the roadway outside designated pedestrian crossings. Pedestrian median fencing can significantly reduce this safety issue by creating a positive barrier, forcing pedestrians to the designated pedestrian crossing.				
General Qualities (Time, Cost and Effectiveness):				
Costs associated with this strategy will vary widely depending on the type and placement of the median fencing. Impacts to transit and other land uses may need to be considered and controversy can delay the implementation. In general, this CM can be effective as a spot-location approach.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	25 - 40%

R11, Install acceleration/ deceleration lanes

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	25%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new accel/decel lanes on high speed roadways. Significant improvements to the merge length for lane-drop locations is also an acceptable use of this CM.		

General information				
Where to use:				
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. This CM can also be used to improve the safety of merging vehicles at a lane-drop location.				
Why it works:				
A lane that does not provide enough deceleration length and storage space for turning traffic may cause the turn queue to back up into the adjacent through lane. This can contribute to rear-end and sideswipe crashes. An acceleration lane is an auxiliary or speed-change lane that allows vehicles to accelerate to highway speeds (high speed roadways) before entering the through-traffic lanes of a highway. Additionally, if acceleration by entering traffic takes place directly on the traveled way, it may disrupt the flow of through-traffic and cause rear-end and sideswipe collisions.				
General Qualities (Time, Cost and Effectiveness):				
Costs are highly variable. Where sufficient median or shoulder space exists it may be possible to provide acceleration/deceleration lanes at a moderate cost. Where the roadway must be widened and additional right-of-way must be acquired, higher costs and a lengthy time-to-construct are likely. The expected effectiveness of this CM must be assessed for each individual location.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Sideswipe, Rear-End	CRF:	10 - 75 %

R12, Widen lane (initially less than 10 ft)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	25%	20 years
Notes:	Note: For Caltrans' statewide Calls-for-Projects, this CM only applies to crashes occurring within the limits of the widened lanes. Widening must a minimum of 1 foot.		

General information				
Where to use:				
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 pavement width less than 10 feet.				
Why it works:				
Increasing pavement width can affect almost all crash types. A common practice is to widen the traveled way on horizontal curves to make operating conditions on curves comparable to those on tangents. Speed is a primary consideration when evaluating potential adverse impacts of lane width on safety. On high-speed, rural two-lane highways, an increased risk of cross-centerline head-on or cross-centerline sideswipe crashes is a concern because drivers may have more difficulty staying within the travel lane.				
General Qualities (Time, Cost and Effectiveness):				
Costs will depend on the amount of reconstruction necessary and on whether additional right-of-way is required. In general, this is one of the higher-cost strategies recommended, but it can also be very beneficial. Since this is a relatively expensive treatment, one of the keys to creating a cost effective project with at least a medium B/C ratio is targeting higher-hazard roadways.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	5 - 70 %

R13, Add two-way left-turn lane (without reducing travel lanes)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	30%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new lane, where an existing median did not already exist.		

General information
Where to use:
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.
Why it works:
Two-way left-turn lanes provide a buffer between opposing directions of travel and separate left turning traffic from through traffic. They can also help to allow vehicles to begin to accelerate before entering the through-traffic lanes. They reduce the disruption of flow of through-traffic and reducing rear-end and sideswipe collisions. For some roadways the option of converting a four-lane undivided arterials to three-lane roadways with a center left-turn lane and bike lanes should be considered (see "Road Diet" CM.)
General Qualities (Time, Cost and Effectiveness):
In some cases this strategy may be retrofitted into the existing roadway by utilizing a portion of the existing paved shoulder and can ultimately be as simple as restriping the roadway. Costs and time to implement could significantly increase if the paved area is not sufficient to include a median, requiring new right-of-way, and having significant environmental impacts. The expected effectiveness of this CM must be assessed for each individual location as the B/C ratios will vary from low to high.

FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	8 - 50 %

R14, Road Diet (Reduce travel lanes from 4 to 3 and add a two way left-turn and bike lanes)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	30%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new lane striping. "Intersection" crashes can only be applied when they resulted from turning movements that had no designated turn lanes/phases in the existing condition and the Road Diet will provide turn lanes/phases for these movements. This CM does not apply to roadway sections that already included left turn lanes or two way left turn lanes before the lane reductions. New bike lanes are also expected to be part of these projects. Pre-approval from the HSIP program manager is needed for: 1) the use of this CM without removing a travel lane in each direction and/or without adding new bike lanes; and/or 2) if any pavement is planned to be removed for the purpose of adding landscaping, planter-boxes, or other non-roadway user features.		

General information
Where to use:
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 2 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.
Why it works:
The application of this strategy usually reduces the roadway segment speeds and serious head-on crashes. In many cases the extra pavement width can be used for the installation of bike lanes. In addition to increasing bicycle safety, these bike lanes can improve the safety of on-street parking.
General Qualities (Time, Cost and Effectiveness):
Implementation would require more time than in other low-cost treatments to complete environmental analyses, traffic studies and public input. Projects that only require new lane markings and minor signalization modifications will have relatively low cost and can be very effective and can be considered on a systematic approach. These striping and signal modification costs should be considered part of this CM and not an additional CM. (If additional signal hardware improvements are being made, over what is needed for the road diet, then the Improve Signal Hardware CM may also be used.) Often road diet projects need a seal-coat placed on the roadway to fully remove the old striping. These seal coats are considered part of the proper installation of this CM. In contrast, structural-overlays should not be considered part of this CM and are not considered eligible for funding in the California Local HSIP.

FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	26 - 43 %

R15, Widen shoulder

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	30%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new paved shoulder. A minimum of 2 feet width must be added and the new/resulting shoulders must be a minimum of 4 feet wide. This CM is not eligible unless it is done as the last step of an "incremental approach", for which the agency documents that: 1) they have already pursued and installed lower cost and lower impact CMs (i.e. signing/striping upgrades to MUTCD standards/recommendations, rumble strips, etc.), 2) they have already monitored the crash occurrences after these improvements were installed, and 3) the 'after' crash rate is still unacceptably high. This 'incremental approach' (or a special exception from the HSIP program manager) must be documented in the Narrative Questions in the application and a summary of the 'before' and 'after' crash analysis must be attached to the application.		

General information				
Where to use:				
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.				
Why it works:				
Based on the best available research, adding shoulder or widening an existing shoulder provides a greater area to regain control of a vehicle, as well as lateral clearance to roadside objects such as guardrail, signs and poles. They may also provide space for disabled vehicles to stop or drive slowly, provide increased sight distance for through vehicles and for vehicles entering the roadway, and in some cases reduce passing conflicts between motor vehicles and bicyclists and pedestrians. The likely safety benefits for adding or widening an existing shoulder generally increase as the widening width increases - practitioners should refer to NCHRP Report 500 Series, the CMF Clearinghouse or other references for more details.				
General Qualities (Time, Cost and Effectiveness):				
Shoulder widening costs would depend on whether new right-of-way is required and whether extensive roadside modification is needed. Since shoulder widening can be a relatively expensive treatment, one of the keys to creating a cost effective project with at least a medium B/C ratio is targeting higher-hazard roadways.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Fixed Object, Run-off Road, Sideswipe	CRF:	15 - 75 %

R16, Curve Shoulder widening (Outside Only)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	45%	20 years
Notes:	This CM only applies to crashes occurring within the limits (or influence area) of the new shoulder widening at curves. A minimum of 2-4 feet width must be added to the outside of horizontal curves and the new traversable shoulder must be a minimum of 4 feet wide.		

General information	
Where to use:	
Roadway curves noted as having frequent lane departure crashes due to inadequate or no shoulders, resulting in an unsuccessful attempt to reenter the roadway.	
Why it works:	
Adding shoulders (outside only) creates a recovery area in which a driver can regain control of a vehicle, as well as lateral clearance to roadside objects.	
General Qualities (Time, Cost and Effectiveness):	
To minimize the R/W needs and the cost, only outside shoulder at curves is to be widened. This CM can be implemented in a relatively short timeframe.	
FHWA CMF Clearinghouse:	NA

R17, Improve horizontal alignment (flatten curves)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	50%	20 years
Notes:	This CM only applies to crashes occurring within the limits (or influence area) of the improved alignment. **This CM is not eligible unless** it is done as the last step of an "incremental approach", including: the agency documents that: 1) they have already pursued and installed lower cost and lower impact CMs (i.e. signing/striping upgrades to MUTCD standards/recommendations, rumble strips, etc.), 2) they have already monitored the crash occurrences after these improvements were installed, and 3) the 'after' crash rate is still unacceptably high. This 'incremental approach' (or a special exception from the HSIP program manager) must be documented in the Narrative Questions in the application and a summary of the agency's 'before' and 'after' crash analysis must be attached to the application.		

General information				
Where to use:				
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.				
Why it works:				
Increasing the radius of a horizontal curve can be very effective in improving the safety performance of the curve. Curve modification reduces the likelihood of a vehicle leaving its lane, crossing the roadway centerline, or leaving the roadway at a horizontal curve; and minimizes the adverse consequences of leaving the roadway. Horizontal alignment improvement projects are expected to include standard/improved superelevation elements, which should be considered part of this CM and not an additional CM.				
General Qualities (Time, Cost and Effectiveness):				
This strategy is a long-term, higher-cost alternative for improving the safety of a horizontal curve because it usually involves total reconstruction of the roadway. It may also require acquisition of additional right-of-way and an environmental review. This strategy, albeit costly, has shown that increasing the radius of curvature can significantly reduce total curve-related crashes by up to 80 percent. The expected effectiveness of this CM must be assessed for each individual location.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	24 - 90%

R18, Flatten crest vertical curve

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	25%	20 years

Notes:	This CM only applies to crashes occurring within the limits (or influence area) of the improved alignment. This CM is not eligible unless it is done as the last step of an "incremental approach", including: the agency documents that: 1) they have already pursued and installed lower cost and lower impact CMs (i.e. signing/striping upgrades to MUTCD standards/recommendations, rumble strips, etc.), 2) they have already monitored the crash occurrences after these improvements were installed, and 3) the 'after' crash rate is still unacceptably high. This 'incremental approach' (or a special exception from the HSIP program manager) must be documented in the Narrative Questions in the application and a summary of the agency's 'before' and 'after' crash analysis must be attached to the application.

General information

Where to use:

The target for this strategy is usually unsignalized intersections with restricted 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.

Why it works:

Adequate sight distance for drivers at stopped approaches to intersections has long been recognized as among the most important factors contributing to overall intersection safety. Vertical alignment improvement projects are expected to include standard/improved superelevation elements, which should be considered part of this CM and not an additional CM.

General Qualities (Time, Cost and Effectiveness):

Projects involving changing the horizontal and/or vertical alignment to provide more sight distance are quite extensive and usually take several years to accomplish. If additional right-of-way is required or environmental impacts are expected, these projects will require a substantial period of time. Since this is usually an expensive treatment, one of the keys to creating a cost effective project with at least a medium B/C ratio is targeting higher-hazard locations.

FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	20 - 51 %

R19, Improve curve superelevation

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	45%	20 years

Notes:	This CM only applies to crashes occurring within the limits (or influence area) of the improved superelevation. This CM does not apply to sections of roadways where the horizontal or vertical alignments are changing via another CM.

General information

Where to use:

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.

Why it works:

Superelevation works with friction between the tires and pavement to counteract the forces on the vehicle associated with cornering. Many curves may have inadequate superelevation because of vehicles traveling at higher speeds than were originally designed for, because of loss of effective superelevation after resurfacing, or because of changes in design policy after the curve was originally constructed.

General Qualities (Time, Cost and Effectiveness):

This strategy can be a higher-cost alternative for improving the safety of a curve because it involves reconstruction to some degree. Other projects may be able to be constructed by simple overlays and minimal reconstruction of roadways features. When simple overlay fixes are pursued, a systematic installation approach may be appropriate. The expected effectiveness of this CM must be assessed for each individual location.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Run-off Road, All	CRF:	40 - 50 %

R20, Convert from two-way to one-way traffic

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	35%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new one-way sections.		

General information
Where to use:
One-way streets can offer improved signal timing and accommodate odd-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 creates new problems. Care must be taken not to create conditions that cause driver confusion and erratic maneuvers.
Why it works:
Studies have shown a 10 to 50-percent reduction in total crashes after conversion of a two-way street to one-way operation. While studies have shown that con-version of two-way streets to one-way generally reduces pedestrian crashes, one-way streets tend to have higher speeds which creates new problems. At the same time, this strategy (1) increases capacity significantly and (2) can have safety-related drawbacks including pedestrian confusion and minor sideswipe crashes.
General Qualities (Time, Cost and Effectiveness):
The costs will vary depending on length of treatment and if the conversion requires modification to signals. Conversion costs can be high to build "crossovers" where the one-way streets convert back to two-way streets and to rebuild traffic signals. It's also likely that these types of modifications will require public involvement and could significantly add to the time it takes to complete the project. The expected effectiveness of this CM must be assessed for each individual location.

FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	26 - 43 %

R21, Improve pavement friction (High Friction Surface Treatments)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	55%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the improved friction overlay. This CM is not intended to apply to standard chip-seal or open-graded **maintenance** projects for long segments of corridors or structure repaving projects intended to fix failed pavement.		

General information
Where to use:
Nationally, this countermeasure is referred to as "High Friction Surface Treatments" or HFST. Areas as noted having 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.
Why it works:
Improving the skid resistance at locations with high frequencies of wet-road crashes and/or failure to stop crashes can result in a reduction of 50 percent for wet-road crashes and 20 percent for total crashes. Applying HFST can double friction numbers, e.g. low 40s to high 80s. This CM represents a special focus area for both FHWA and Caltrans, which means there are extra resources available for agencies interested in more details on High Friction Surface Treatment projects.
General Qualities (Time, Cost and Effectiveness):
This strategy can be relatively inexpensive and implemented in a short timeframe. The installation would be done by either agency personnel or contractors and can be done by hand or machine. In general, This CM can be very effective and can be considered on a systematic approach.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Wet, Rear-End, All	CRF:	17 - 68 %

R22, Install/Upgrade signs with new fluorescent sheeting (regulatory or warning)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	15%	10 years

Notes:	This CM only applies to crashes occurring within the influence area of the new/upgraded signs. This CM is not intended for maintenance upgrades of street-name, parking, guide, or any other signs without a primary focus on roadway safety. **This CM 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. The overall sign audit scope (or a special exception from the HSIP program manager) must be documented in the Narrative Questions in the application. Based on the scope of the project/audit, it may be appropriate to combine other CMs in the B/C calculation.

General information

Where to use:

The target for this strategy should be on roadway segments with patterns of head on, nighttime, non-intersection, run-off road, and sideswipe crashes related to lack of driver awareness of the presence of a specific roadway feature or regulatory requirement. Ideally this type of safety CM would be combined with other sign evaluations and upgrades (install chevrons, warning signs, delineators, markers, beacons, and relocation of existing signs per MUTCD standards.)

Why it works:

This strategy primarily addresses crashes caused by lack of driver awareness (or compliance) roadway signing. It is intended to get the drivers attention and give them a visual warning by using fluorescent yellow sheeting (or other retroreflective material).

General Qualities (Time, Cost and Effectiveness):

Signing improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number of signs. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding. When considering any type of federally funded sign upgrade project, California local agencies are encouraged to consider "Roadway Safety Signing Audit (RSSA) and Upgrade Projects". Including RSSAs in the development phase of sign projects are expected to identify non-standard (per MUTCD) sign features and missing signs that may otherwise go unnoticed. More information on RSSA is available on the Local Assistance HSIP webpage.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Head on, Run-off road, Sideswipe, Night	CRF:	18 - 35%

R23, Install chevron signs on horizontal curves

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	40%	10 years
Notes:	This CM only applies to crashes occurring within the influence area of the new signs. (i.e. only through the curve).		

General information				
Where to use:				
Roadways that have an unacceptable level of crashes on relatively sharp curves during periods of light and darkness. Ideally this type of safety CM would be combined with other sign evaluations and upgrades (install warning signs, delineators, markers, beacons, and relocation of existing signs per MUTCD standards.)				
Why it works:				
Post-mounted chevrons are intended to warn drivers of an approaching curve and provide tracking information and guidance to the drivers. While they are intended to act as a warning, it should also be remembered that the posts, placed along the roadside, represent a possible object with which an errant vehicle can crash into. Design of posts to minimize damage and injury is an important part of the considerations to be made when selecting these treatments.				
General Qualities (Time, Cost and Effectiveness):				
Signing improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number of signs. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding. When considering any type of federally funded sign upgrade project, California local agencies are encouraged to consider "Roadway Safety Signing Audit (RSSA) and Upgrade Projects". Including RSSAs in the development phase of sign projects are expected to identify non-standard (per MUTCD) sign features and missing signs that may otherwise go unnoticed. More information on RSSA is available on the Local Assistance HSIP webpage.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Run-off Road, All	CRF:	6 - 64 %

R24, Install curve advance warning signs

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	25%	10 years
Notes:	This CM only applies to crashes occurring within the influence area of the new signs. (i.e. only through the curve)		

General information				
Where to use:				
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 CM would be combined with other sign evaluations and upgrades (install warning signs, chevrons, delineators, markers, beacons, and relocation of existing signs per MUTCD standards.)				
Why it works:				
This strategy primarily addresses problem curves, and serves as an advance warning of an unexpected or sharp curve. It provides advance information and gives drivers a visual warning that their added attention is needed.				
General Qualities (Time, Cost and Effectiveness):				
Signing improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number of signs. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding. When considering any type of federally funded sign upgrade project, California local agencies are encouraged to consider "Roadway Safety Signing Audit (RSSA) and Upgrade Projects". Including RSSAs in the development phase of sign projects are expected to identify non-standard (per MUTCD) sign features and missing signs that may otherwise go unnoticed. More information on RSSA is available on the Local Assistance HSIP webpage.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Run-off Road, All	CRF:	20 - 30 %

R25, Install curve advance warning signs (flashing beacon)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	30%	10 years
Notes:	This CM only applies to crashes occurring within the influence area of the new signs. (i.e. only through the curve)		

General information				
Where to use:				
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.				
Why it works:				
This strategy primarily addresses problem curves, and serves as an enhanced advance warning of an unexpected or sharp curve. It provides advance information and gives drivers a visual warning that their added attention is needed. Flashing beacons are an added indication that a curve may be particularly challenging.				
General Qualities (Time, Cost and Effectiveness):				
Use of flashing beacons requires minimal development process, allowing flashing beacons to be installed within a short time period. Before choosing this CM, the agency needs to confirm the ability to provide power to the site (solar may be an option). In general, This CM can be very effective and can be considered on a systematic approach.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	30 %

R26, Install dynamic/variable speed warning signs

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	30%	10 years
Notes:	This CM only applies to crashes occurring within the influence area of the new signs. (i.e. through the curve) {**This CM does not apply to dynamic regulatory speed warning signs.** There are currently no nationally accepted CRFs for dynamic regulatory signs (also known as Radar Speed Feedback Signs). CRFs are being developed and Caltrans hopes to include these CMs and CRFs in future calls for projects.}		

General information				
Where to use:				
Curvilinear roadways that have an unacceptable level of crashes due to excessive speeds on relatively sharp curves.				
Why it works:				
This strategy primarily addresses crashes caused by motorists traveling too fast around sharp curves. It is intended to get the drivers attention and give them a visual warning that they may be traveling over the recommended speed for the approaching curve. Care should be taken to limit the placement of these signs to help maintain their effectiveness.				
General Qualities (Time, Cost and Effectiveness):				
Use of dynamic speed warning signs requires minimal development process, allowing them to be installed within a short time period. Before choosing this CM, the agency needs to confirm the ability to provide power to the site (solar may be an option). In general, This CM can be very effective and can be considered on a systematic approach.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	0 - 41 %

R27, Install delineators, reflectors and/or object markers

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	15%	10 years
Notes:	This CM only applies to crashes occurring within the limits / influence area of the new features. {**This is not a striping-related CM**}		

General information
Where to use:
Roadways that have an unacceptable level of crashes on curves (relatively flat to sharp) during periods of light and darkness. Any road with a history of fixed object crashes is a candidate for this treatment, as are roadways with similar fixed objects along the roadside that have yet to experience crashes. If a fixed object cannot be relocated or made break-away, placing an object marker can provide additional information to motorists. Ideally this type of safety CM would be combined with other sign evaluations and upgrades (install warning signs, chevrons, beacons, and relocation of existing signs per MUTCD standards.)
Why it works:
Delineators, reflectors and/or object markers are intended to warn drivers of an approaching curve or fixed object that cannot easily be removed. They are intended to provide tracking information and guidance to the drivers. They are generally less costly than Chevron Signs as they don't require posts to place along the roadside, avoiding an additional object with which an errant vehicle can crash into.
General Qualities (Time, Cost and Effectiveness):
These improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number of locations. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in low to moderate cost projects that are more appropriate to seek state or federal funding. When considering any type of federally funded sign upgrade project, California local agencies are encouraged to consider "Roadway Safety Signing Audit (RSSA) and Upgrade Projects". Including RSSAs in the development phase of sign projects are expected to identify non-standard (per MUTCD) sign features and missing signs that may otherwise go unnoticed. More information on RSSA is available on the Local Assistance HSIP webpage.

FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	0 - 30 %

R28, Install edge-lines and centerlines

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	25%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the new centerlines and/or edge-lines. This CM is not intended to be used for general maintenance activities (i.e. the replacement of existing striping and RPMs in-kind) and must include upgraded safety features over the existing striping. For two lane roadways allowing passing, a striping audit must be done to ensure the passing limits meeting the MUTCD standards. Both the centerline and edge-lines are expected to be upgraded, unless prior approval is granted by Caltrans staff in writing and attached to application.		

General information				
Where to use:				
Any road with a history of run-off-road right, head-on, opposite-direction-sideswipe, or run-off-road-left crashes is a candidate for this treatment - install where the existing lane delineation is not sufficient to assist the motorist in understanding the existing limits of the roadway. Depending on the width of the roadway, various combinations of edge line and/or center line pavement markings may be the most appropriate. Incorporating raised/reflective pavement markers (RPMs) into centerlines (and edge-lines) should be considered as it has been shown to improve safety.				
Why it works:				
Installing edge-lines and centerlines where none exists or making significant upgrades to existing lines (paint to thermoplastic, adding audible disks/bumps in the thermoplastic stripes, or adding RPMs) are intended/designed to help drivers who might leave the roadway because of their inability to see the edge of the roadway along the horizontal edge of the pavement or cross-over the centerline of the roadway into oncoming traffic. New pavement marking products tend to be more durable, are all-weather, more visible, and have a higher retroreflectivity than traditional pavement markings.				
General Qualities (Time, Cost and Effectiveness):				
These improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number and length of locations. This CM can be effectively and efficiently implemented using a systematic approach with numerous and long locations, resulting in low to moderate cost projects that are more appropriate to seek state or federal funding. When considering any type of federally funded striping upgrade project, California local agencies are encouraged to consider "Roadway Safety Striping Audit and Upgrade Projects". Including wide-scale striping audits in the development phase of striping projects are expected to identify non-standard (per MUTCD) striping/marking features, no-passing zone limits needing adjustment, and missing striping/markings that may otherwise go unnoticed. More information on this concepts is available on the Local Assistance HSIP webpage under an RSSA example document. Note: When federal safety funding is used for these installations in high-wear-locations, the local agency is expected to maintain the improvement for a minimum of 10 years.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Head-on, Run-off Road, All	CRF:	0 - 44 %

R29, Install no-passing line

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	45%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the new or extended no-passing zones.		

General information
Where to use:
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. General restriping projects can be good opportunities to reevaluate and incorporate new no-passing zones limits. The incorporation 'No Passing Zone' pennants should also be considered when reevaluating the limits of no-passing zones. Installing no-passing limits in areas that are not warranted may reduce the overall safety of the corridor as drivers may become frustrated and attempt passing maneuvers at other locations without the necessary sight distance.
Why it works:
When the centerline markings do not differentiate between passing and no-passing areas, drivers may have difficulty determining where passing maneuvers can be completed safely. Providing clear and engineered passing and no-passing areas can encourage drivers to wait patiently for safe passing areas and avoid aggressively looking for passing opportunities.
General Qualities (Time, Cost and Effectiveness):
These improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number and length of locations. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous and long locations, resulting in low to moderate cost projects that are more appropriate to seek state or federal funding.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Head-on, Side-swipe	CRF:	40 - 53%

R30, Install centerline rumble strips/stripes

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	20%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the new rumble strips/stripes.		

General information
Where to use:
Center Line rumble strips/stripes can be used on virtually any roadway – 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.
Why it works:
Rumble strips provide an auditory indication and tactile rumble when driven on, alerting drivers that they are drifting out of their travel lane, giving them time to recover before they depart the roadway or cross the center line. Additionally, rumble stripes (pavement marking in the rumble itself) provide an enhanced marking, especially in wet dark conditions.
General Qualities (Time, Cost and Effectiveness):
These improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number and length of locations. This CM can be effectively and efficiently implemented using a systematic approach with numerous and long locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Head-on, Side-swipe, All	CRF:	15 - 68%

R31, Install edgeline rumble strips/stripes

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	All	15%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the new rumble strips/stripes.		

General information
Where to use:
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.
Why it works:
Rumble strips provide an auditory indication and tactile rumble when driven on, alerting drivers that they are drifting out of their travel lane, giving them time to recover before they depart the roadway or cross the center line. Additionally, rumble stripes (pavement marking in the rumble itself) provide an enhanced marking, especially in wet dark conditions.
General Qualities (Time, Cost and Effectiveness):
These improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number and length of locations. This CM can be effectively and efficiently implemented using a systematic approach with numerous and long locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Run-off Road	CRF:	10 - 41%

R32PB, Install bike lanes

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring within the limits of the Class II (not Class III) bike lanes. When an off-street bike-path is proposed that is not adjacent to the roadway, the applicant must document the engineering judgment used to determine which "Ped & Bike" crashes to apply.		

General information
Where to use:
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.
Why it works:
Most studies present evidence that bicycle lanes provide protection against bicycle/motor vehicle collisions. Bicycle lanes provide marked areas for bicyclist to travel along the roadway and provide for more predictable movements for both bicyclist and motorist. Evidence also shows that riding with the flow of vehicular traffic reduces bicyclists' chances of collision with a motor vehicle. Locations with bicycle lanes have lower rates of wrong-way riding. In combination with this CM, better guidance signs and markings for non-motorized and motorized roadway users should be considered, including: sign and markings directing cyclists on appropriate/legal travel paths and signs and markings warning motorists of non-motorized uses of the roadway that should be expected.
General Qualities (Time, Cost and Effectiveness):
Adding striped bicycle lanes can range from the simply restriping the roadway and minor signing to projects that require roadway widening, right-of-way, and environmental impacts. It is most cost efficient to create bike lanes during street reconstruction, street resurfacing, or at the time of original construction. The expected effectiveness of this CM must be assessed for each individual location. For simple installation scenarios, This CM can be very effective and can be considered on a systematic approach.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	0 - 53 %

R33PB, Install Separated Bike Lanes

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	45%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring within the limits of the separated bike lanes. When an off-street bike-path is proposed that is not adjacent to the roadway, the applicant must document the engineering judgment used to determine which "Ped & Bike" crashes to apply.		

General information

Where to use:

Separated bikeways are most appropriate on streets with high volumes of bike traffic and/or high bike-vehicle collisions, presumably in an urban or suburban area. Separation types range from simple, painted buffers and flexible delineators, to more substantial separation measures including raised curbs, grade separation, bollards, planters, and parking lanes. These options range in feasibility due to roadway characteristics, available space, and cost. In some cases, it may be possible to provide additional space in areas where pedestrian and bicyclists may interact, such as the parking buffer, or loading zones, or extra bike lane width for cyclists to pass one another.

Why it works:

Separated bike lanes provide increased safety and comfort for bicyclists beyond conventional bicycle lanes. By separating bicyclists from motor traffic, "protected" or physically separated bike lanes can offer a higher level of comfort and are attractive to a wider spectrum of the public. Intersections and approaches must be carefully designed to promote safety and facilitate left-turns for bicyclists from the primary corridor to cross street.

In combination with this CM, better guidance signs and markings for non-motorized and motorized roadway users should be considered, including: sign and markings directing cyclists on appropriate/legal travel paths and signs and markings warning motorists of non-motorized uses of the roadway that should be expected.

General Qualities (Time, Cost and Effectiveness):

The cost of Installing separated bike lanes can be low to medium or high, depending on whether roadway widening, right-of-way and environmental impacts are involved. It is most cost efficient to create bike lanes during street reconstruction, street resurfacing, or at the time of original construction. The expected effectiveness of this CM must be assessed for each individual location.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	3.7 - 100 %

R34PB, Install sidewalk/pathway (to avoid walking along roadway)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	80%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring within the limits of the new walkway. This CM is not intended to be used where an existing sidewalk is being replaced with a wider one, unless prior Caltrans approval is included in the application. When an off-street multi-use path is proposed that is not adjacent to the roadway, the applicant must document the engineering judgment used to determine which "Ped & Bike" crashes to apply.		

General information

Where to use:

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.

Why it works:

Sidewalks and walkways provide people with space to travel within the public right-of-way that is separated from roadway vehicles. The presence of sidewalks on both sides of the street has been found to be related to significant reductions in the "walking along roadway" pedestrian crash risk compared to locations where no sidewalks or walkways exist. Reductions of 50 to 90 percent of these types of pedestrian crashes. In combination with this CM, better guidance signs and markings for non-motorized and motorized roadway users should be considered, including: sign and markings directing pedestrians and cyclists on appropriate/legal travel paths and signs and markings warning motorists of non-motorized uses of the roadway that should be expected.

General Qualities (Time, Cost and Effectiveness):

Costs for sidewalks will vary, depending upon factors such as width, materials, and existing of curb, gutter and drainage. Asphalt curbs and walkways are less expensive, but require more maintenance. The expected effectiveness of this CM must be assessed for each individual location. These projects can be very effective in areas of high-pedestrian volumes with a past history of crashes involving pedestrians.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	65 - 89 %

R35PB, Install/upgrade pedestrian crossing (with enhanced safety features)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the influence area (expected to be a maximum of within 250') of the new crossing which includes new enhanced safety features. Note: This CM is not intended to be combined with the "Install raised pedestrian crossing" when calculating the improvement's B/C ratio. This CM is not intended to be used for high-cost aesthetic enhancements (i.e. stamped concrete or stamped asphalt).		

General information				
Where to use:				
Roadway segments with no controlled crossing for a significant distance in high-use midblock crossing areas and/or multilane roads locations. Based on the Zegeer study (Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations) at many locations, a marked crosswalk alone may not be sufficient to adequately protect non-motorized users. In these cases, flashing beacons, curb extensions, medians and pedestrian crossing islands and/or 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.				
Why it works:				
Adding pedestrian crossings has the opportunity to greatly enhance pedestrian safety at locations noted as being problematic. The enhanced safety elements, which may include curb extensions, medians and pedestrian crossing islands, beacons, and lighting, combined with pavement markings delineating a portion of the roadway that is designated for pedestrian crossing. Care must be taken to warn drivers of the potential for pedestrians crossing the roadway and enhanced improvements added to the crossing increase the likelihood of pedestrians crossing in a safe manner. In combination with this CM, better guidance signs and markings for non-motorized and motorized roadway users should be considered, including: sign and markings directing pedestrians and cyclists on appropriate/legal travel paths and signs. When agencies opt to install aesthetic enhancement to crossing like stamped concrete/asphalt, the project design and construction costs can significantly increase. For HSIP applications, these costs must be accounted for in the B/C calculation, but these costs (over standard crosswalk markings) must be tracked separately and are not federally reimbursable and will increase the agency's local-funding share for the project costs.				
General Qualities (Time, Cost and Effectiveness):				
Costs associated with this strategy will vary widely, depending on the extent of the curb extensions, raised medians, flashing beacons, and other pedestrian safety elements that are needed with the crossing. When considered at a single location, these improvements can sometimes be low cost and funded through local funding by local crews. This CM can often be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate to high cost projects that are appropriate to seek state or federal funding.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	8 - 56%

R36PB, Install raised pedestrian crossing

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the area with the new raised crossing. Note: This CM is not intended to be combined with the "Install pedestrian crossing (with enhanced safety features)" when calculating the improvement's B/C ratio.		

General information				
Where to use:				
On lower-speed roadways, where pedestrians are known to be crossing roadways that involve significant vehicular traffic. Based on the Zegeer study (Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations) at many locations, a marked crosswalk alone, may not be sufficient to adequately protect non-motorized users. 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.				
Why it works:				
Adding a raised pedestrian crossing has the opportunity to enhance pedestrian safety at locations noted as being especially problematic. The raised crossing encourages motorists to reduce their speed and provides improved delineation for the portion of the roadway that is designated for pedestrian crossing. In combination with this CM, better guidance signs and markings for non-motorized and motorized roadway users should be considered, including: sign and markings directing pedestrians and cyclists on appropriate/legal travel paths.				
General Qualities (Time, Cost and Effectiveness):				
Costs associated with this strategy will vary widely, depending upon the elements of the raised crossing and the need for new curb ramps and sidewalk modifications. This CM may be effectively and efficiently implemented using a systematic approach with more than one location and can have medium to high B/C ratios based on past non-motorized crash history.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	30 - 46%

R37PB, Install Rectangular Rapid Flashing Beacon (RRFB)

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
100%	Pedestrian and Bicycle	35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the influence area (expected to be a maximum of within 250') of the crossing which includes the RRFB.		

General information				
Where to use:				
Rectangular Rapid Flashing Beacon (RRFB) includes pedestrian-activated flashing lights and additional signage that enhance the visibility of marked crosswalks and alert motorists to pedestrian crossings. It uses an irregular flash pattern that is similar to emergency flashers on police vehicles. RRFBs are installed at unsignalized intersections and mid-block pedestrian crossings.				
Why it works:				
RRFBs can enhance safety by increasing driver awareness of potential pedestrian conflicts and reducing crashes between vehicles and pedestrians at unsignalized intersections and mid-block pedestrian crossings. The addition of RRFB may also increase the safety effectiveness of other treatments, such as crossing warning signs and markings.				
General Qualities (Time, Cost and Effectiveness):				
RRFBs are a lower cost alternative to traffic signals and hybrid signals. This CM can often be effectively and efficiently implemented using a systematic approach with numerous locations.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	7 – 47.4%

R38, Install Animal Fencing

For HSIP Calls-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Animal	80%	20 years
Notes:	This CM only applies to "animal" crashes occurring within the limits of the new fencing.		

General information				
Where to use:				
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).				
Why it works:				
Animal fencing helps to channelize the identified animals to a natural or man-made crossing, eliminating the conflict between vehicles and animals on the same place. Animal fencing is typically installed at a bridge location with its "run of need" dependent on the surrounding terrain.				
General Qualities (Time, Cost and Effectiveness):				
Time to install fencing can be moderate to lengthy depending on the environmental commitments and agreed upon solution to mitigating project impacts. Costs will be fairly low and depend on the "run of need" length. There will be minimal reoccurring maintenance costs on keeping the fence intact. The expected effectiveness of this CM must be assessed for each individual location.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Animal	CRF:	70 - 90 %

Appendix E: B/C Ratio Calculations

Years of Collision Data 5

CM R22 use 25%

25%

Cost, Benefit and B/C Ratio Calculation Table

FID	Location	CM 1	CM 2	CM 3	CM1_CRF	CM2_CRF	CM3_CRF	CM1_Life (Year)	CM2_Life (Year)	CM3_Life (Year)	Unused & Desired CM	Cost	Contingency Cost (10%)	Environmental Cost (5%)	PS&E Cost (10%)	Right of Way Engineering Cost (0%)	Appraisals, Acqusitions & Utilities Cost (0%)
	Project 3																
1	Moraga Rd at Campolindo Dr	S21PB	S09	S03	0.6	0.1	0.15	10	10	10		$ 11,750.00	$ 1,175.00	$ 587.50	$ 1,175.00		
2	Moraga Rd at St. Marys Rd	S21PB	S09	S03	0.6	0.1	0.15	10	10	10		$ 11,600.00	$ 1,160.00	$ 580.00	$ 1,160.00		
3	Moraga Rd at Ascot Dr	S21PB	S09	S03	0.6	0.1	0.15	10	10	10		$ 12,050.00	$ 1,205.00	$ 602.50	$ 1,205.00		
4	Moraga Rd at Donald Dr	S21PB	S09	S03	0.6	0.1	0.15	10	10	10		$ 12,050.00	$ 1,205.00	$ 602.50	$ 1,205.00		
5	Moraga Wy at School St	S21PB	S09	S03	0.6	0.1	0.15	10	10	10		$ 11,630.00	$ 1,163.00	$ 581.50	$ 1,163.00		
	Project 4																
1	Moraga Rd at Lucas Dr	NS12			0.55			10				$ 105,610.00	$ 10,561.00	$ 5,280.50	$ 10,561.00		
2	Moraga Wy at Moraga Valley Ln	NS12	NS01		0.55			10				$ 86,097.00	$ 8,609.70	$ 4,304.85	$ 8,609.70		
	Project 3 NIGHT																
2	Moraga Wy at Moraga Valley Ln	NS12	NS01			0.4			20			$ 135,700.00	$ 13,570.00	$ 6,785.00	$ 13,570.00		
	Project 1																
1	Moraga Rd at Lucas Dr	NS06		NS22PB	0.15		0.35	10		20		$ 91,280.00	$ 9,128.00	$ 4,564.00	$ 9,128.00		
2	Moraga Wy at Moraga Valley Ln	NS06	NS09		0.15	0.3		10	10			$ 57,780.00	$ 5,778.00	$ 2,889.00	$ 5,778.00		
3	Moraga Rd at Alta Mesa	NS06	NS09		0.15	0.3		10	10			$ 57,530.00	$ 5,753.00	$ 2,876.50	$ 5,753.00		
4	Camino Pablo at Sanders Ranch Rd	NS06			0.15			10				$ 6,080.00	$ 608.00	$ 304.00	$ 608.00		
5	Rheem Blvd at St. Marys Rd	NS06	NS09		0.15	0.3		10	10			$ 58,930.00	$ 5,893.00	$ 2,946.50	$ 5,893.00		
6	Moraga Rd at Corliss Dr	NS06	NS09		0.15	0.3		10	10			$ 57,930.00	$ 5,793.00	$ 2,896.50	$ 5,793.00		
	Project 5																
1	Moraga Wy: Town Limit to Moraga Rd	R22	R27		0.15	0.15		10	10			$ 26,150.00	$ 2,615.00	$ 1,307.50	$ 2,615.00		
2	Canyon Rd: 300' E of Valle Vista Staging Area to Town Limit (East)	R22	R27		0.15	0.15		10	10			$ 13,150.00	$ 1,315.00	$ 657.50	$ 1,315.00		
3	Moraga Rd/Canyon Rd: Larch Ln to Town Limit (North)	R22	R27		0.15	0.15		10	10			$ 83,675.00	$ 8,367.50	$ 4,183.75	$ 8,367.50		
4	Rheem Blvd: La Salle Dr to Moraga Rd	R22	R27		0.15	0.15		10	10			$ 5,425.00	$ 542.50	$ 271.25	$ 542.50		
5	Country Club Dr: Viader Dr to 875' E of Southard Ct	R22	R27		0.15	0.15		10	10			$ 9,225.00	$ 922.50	$ 461.25	$ 922.50		
6	Larch Ave: Canyon Rd to Baitx Ave	R22	R27		0.15	0.15		10	10			$ 7,275.00	$ 727.50	$ 363.75	$ 727.50		
7	St. Marys Rd: 500' E of Stafford Rd to Town Limit	R22	R27		0.15	0.15		10	10			$ 9,600.00	$ 960.00	$ 480.00	$ 960.00		
8	Corliss Dr/Sullivan Dr: Hardie Dr to Moraga Rd	R22	R27		0.15	0.15		10	10			$ 7,800.00	$ 780.00	$ 390.00	$ 780.00		
	Ped Set Aside																
1	Moraga Wy: Town Limit to Moraga Rd	R35PB										$ 22,300.00	$ 2,230.00	$ 1,115.00	$ 2,230.00		
2	Moraga Rd/Canyon Rd: Larch Ln to Town Limit (North)	R35PB										$ 92,550.00	$ 9,255.00	$ 4,627.50	$ 9,255.00		
3	Rheem Blvd: La Salle Dr to Moraga Rd	R35PB										$ 22,800.00	$ 2,280.00	$ 1,140.00	$ 2,280.00		
	Moraga Wy at Moraga Valley Rd	NS21PB										$ 28,430.00	$ 2,843.00	$ 1,421.50	$ 2,843.00		
4	Moraga Rd at Corliss Dr	NS21PB										$ 8,000.00	$ 800.00	$ 400.00	$ 800.00		

Countermeasure Name
NS05 - Convert intersection to roundabout (from 2-way stop or Yield control)
NS06 - Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs
NS07 - Upgrade intersection pavement markings
NS08 - Install flashing beacons at stop-controlled intersections
NS09 - Install flashing beacons as advance warning (NS.I.)
NS10 - Install transverse rumble strips on approaches
NS19PB - Install raised medians (refuge islands)
NS21PB - Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)
NS22PB - Install Rectangular Rapid Flashing Beacon (RRFB)
R22 - Install/Upgrade signs with new fluorescent sheeting (regulatory or warning)
R27 - Install delineators, reflectors and/or object markers

Cost, Benefit and B/C Ratio Calculation

15%

FID	Location	Construction Engineering (CE) Cost	Cost Per Location	All Locations (Cost 2021)	20% More	Collisions (2016-2020)					Property Damage Only	Crash Costs			
						Total #Collisions	Fatal	Severe Injury	Other Visible Injury	Complaint of Pain		Fatal	Severe Injury	Other Visible Injury	Compliant of Pain
	Project 3														
1	Moraga Rd at Campolindo Dr	$ 1,762.50	$ 16,450.00			2			2			$ -	$ -	$ 284,600	$ -
2	Moraga Rd at St. Marys Rd	$ 1,740.00	$ 16,240.00			3			2	1		$ -	$ -	$ 284,600	$ 80,900.00
3	Moraga Rd at Ascot Dr	$ 1,807.50	$ 16,870.00	$ 82,712.00	$ 99,254.40	4				4		$ -	$ -	$ -	$ 323,600.00
4	Moraga Rd at Donald Dr	$ 1,807.50	$ 16,870.00			2			1	1		$ -	$ -	$ 142,300	$ 80,900.00
5	Moraga Wy at School St	$ 1,744.50	$ 16,282.00			1				1		$ -	$ -	$ -	$ 80,900.00
	Project 4														
1	Moraga Rd at Lucas Dr	$ 15,841.50	$ 147,854.00	$ 268,389.80	$ 322,067.76	6		2	4			$ -	$ 5,060,000	$ 569,200	$ -
2	Moraga Wy at Moraga Valley Ln	$ 12,914.55	$ 120,535.80			1		1				$ -	$ 2,530,000	$ -	$ -
	Project 3 NIGHT														
2	Moraga Wy at Moraga Valley Ln	$ 20,355.00	$ 189,980.00	$ 189,980.00	$ 227,976.00	0		1				$ -	$ 2,530,000	$ -	$ -
	Project 1														
1	Moraga Rd at Lucas Dr	$ 13,692.00	$ 127,792.00			6		2	4			$ -	$ 5,060,000.00	$ 569,200	$ -
2	Moraga Wy at Moraga Valley Ln	$ 8,667.00	$ 80,892.00			1		1				$ -	$ 2,530,000.00	$ -	$ -
3	Moraga Rd at Alta Mesa	$ 8,629.50	$ 80,542.00			3			1	2		$ -	$ -	$ 142,300	$ 161,800.00
4	Camino Pablo at Sanders Ranch Rd	$ 912.00	$ 8,512.00	$ 461,342.00	$ 553,610.40	2			2			$ -	$ -	$ 284,600	$ -
5	Rheem Blvd at St. Marys Rd	$ 8,839.50	$ 82,502.00			2			1	1		$ -	$ -	$ 142,300	$ 80,900.00
6	Moraga Rd at Corliss Dr	$ 8,689.50	$ 81,102.00			1				1		$ -	$ -	$ -	$ 80,900.00
	Project 5														
1	Moraga Wy: Town Limit to Moraga Rd	$ 3,922.50	$ 36,610.00			5		1	2	2		$ -	$ 2,530,000.00	$ 284,600	$ 161,800.00
2	Canyon Rd: 300' E of Valle Vista Staging Area to Town Limit (East)	$ 1,972.50	$ 18,410.00			2	1			1		$ 2,530,000.00	$ -	$ -	$ 80,900.00
3	Moraga Rd/Canyon Rd: Larch Ln to Town Limit (North)	$ 12,551.25	$ 117,145.00			8			4	4		$ -	$ -	$ 569,200	$ 323,600.00
4	Rheem Blvd: La Salle Dr to Moraga Rd	$ 813.75	$ 7,595.00	$ 227,220.00	$ 272,664.00	2				2		$ -	$ -	$ -	$ 161,800.00
5	Country Club Dr: Viader Dr to 875' E of Southard Ct	$ 1,383.75	$ 12,915.00			1			1			$ -	$ -	$ 142,300	$ -
6	Larch Ave: Canyon Rd to Baitx Ave	$ 1,091.25	$ 10,185.00			1				1		$ -	$ -	$ -	$ 80,900.00
7	St. Marys Rd: 500' E of Stafford Rd to Town Limit	$ 1,440.00	$ 13,440.00			1			1			$ -	$ -	$ 142,300	$ -
8	Corliss Dr/Sullivan Dr: Hardie Dr to Moraga Rd	$ 1,170.00	$ 10,920.00			1				1		$ -	$ -	$ -	$ 80,900.00
	Ped Set Aside														
1	Moraga Wy: Town Limit to Moraga Rd	$ 3,345.00	$ 31,220.00			0						$ -	$ -	$ -	$ -
2	Moraga Rd/Canyon Rd: Larch Ln to Town Limit (North)	$ 13,882.50	$ 129,570.00			0						$ -	$ -	$ -	$ -
3	Rheem Blvd: La Salle Dr to Moraga Rd	$ 3,420.00	$ 31,920.00	$ 243,712.00	$ 292,454.40	0						$ -	$ -	$ -	$ -
	Moraga Wy at Moraga Valley Rd	$ 4,264.50	$ 39,802.00												
4	Moraga Rd at Corliss Dr	$ 1,200.00	$ 11,200.00			0						$ -	$ -	$ -	$ -

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R27 - Install delineators, reflectors and/or object markers

Cost, Benefit and B/C Ratio Calculation

FID	Location	PDO	Crash Costs	Total Crash Cost	CM Annual Benefit			CM Life Benefit			Benefit
					CM1_Benefit (Annual)	CM2_Benefit (Annual)	CM3_Benefit (Annual)	CM1_Benefit (Life)	CM2_Benefit (Life)	CM3_Benefit (Life)	Benefit per Location (Life)
	Project 3										
1	Moraga Rd at Campolindo Dr	$ -	$ 284,600.00		$ 34,152.00	$ 5,692.00	$ 8,538.00	$ 341,520.00	$ 56,920.00	$ 85,380.00	$ 483,820.00
2	Moraga Rd at St. Marys Rd	$ -	$ 365,500.00		$ 43,860.00	$ 7,310.00	$ 10,965.00	$ 438,600.00	$ 73,100.00	$ 109,650.00	$ 621,350.00
3	Moraga Rd at Ascot Dr	$ -	$ 323,600.00	$ 1,277,800	$ 38,832.00	$ 6,472.00	$ 9,708.00	$ 388,320.00	$ 64,720.00	$ 97,080.00	$ 550,120.00
4	Moraga Rd at Donald Dr	$ -	$ 223,200.00		$ 26,784.00	$ 4,464.00	$ 6,696.00	$ 267,840.00	$ 44,640.00	$ 66,960.00	$ 379,440.00
5	Moraga Wy at School St	$ -	$ 80,900.00		$ 9,708.00	$ 1,618.00	$ 2,427.00	$ 97,080.00	$ 16,180.00	$ 24,270.00	$ 137,530.00
	Project 4										
1	Moraga Rd at Lucas Dr	$ -	$ 5,629,200.00	$ 5,060,000	$ 619,212.00	$ -	$ -	$ 6,192,120.00	$ -	$ -	$ 6,192,120.00
2	Moraga Wy at Moraga Valley Ln	$ -	$ 2,530,000.00		$ 278,300.00	$ -	$ -	$ 2,783,000.00	$ -	$ -	$ 2,783,000.00
	Project 3 NIGHT										
2	Moraga Wy at Moraga Valley Ln	$ -	$ 2,530,000.00	$ 2,530,000	$ -	$ 202,400.00	$ -	$ -	$ 4,048,000.00	$ -	$ 4,048,000.00
	Project 1										
1	Moraga Rd at Lucas Dr	$ -	$ 5,629,200.00		$ 168,876.00	$ -	$ 394,044.00	$ 1,688,760.00	$ -	$ 7,880,880.00	$ 9,569,640.00
2	Moraga Wy at Moraga Valley Ln	$ -	$ 2,530,000.00		$ 75,900.00	$ 151,800.00	$ -	$ 759,000.00	$ 1,518,000.00	$ -	$ 2,277,000.00
3	Moraga Rd at Alta Mesa	$ -	$ 304,100.00		$ 9,123.00	$ 18,246.00	$ -	$ 91,230.00	$ 182,460.00	$ -	$ 273,690.00
4	Camino Pablo at Sanders Ranch Rd	$ -	$ 284,600.00	$ 9,052,000	$ 8,538.00	$ -	$ -	$ 85,380.00	$ -	$ -	$ 85,380.00
5	Rheem Blvd at St. Marys Rd	$ -	$ 223,200.00		$ 6,696.00	$ 13,392.00	$ -	$ 66,960.00	$ 133,920.00	$ -	$ 200,880.00
6	Moraga Rd at Corliss Dr	$ -	$ 80,900.00		$ 2,427.00	$ 4,854.00	$ -	$ 24,270.00	$ 48,540.00	$ -	$ 72,810.00
	Project 5										
1	Moraga Wy: Town Limit to Moraga Rd	$ -	$ 2,976,400.00		$ 89,292.00	$ 89,292.00	$ -	$ 892,920.00	$ 892,920.00	$ -	$ 1,785,840.00
2	Canyon Rd: 300' E of Valle Vista Staging Area to Town Limit (East)	$ -	$ 2,610,900.00		$ 78,327.00	$ 78,327.00	$ -	$ 783,270.00	$ 783,270.00	$ -	$ 1,566,540.00
3	Moraga Rd/Canyon Rd: Larch Ln to Town Limit (North)	$ -	$ 892,800.00		$ 26,784.00	$ 26,784.00	$ -	$ 267,840.00	$ 267,840.00	$ -	$ 535,680.00
4	Rheem Blvd: La Salle Dr to Moraga Rd	$ -	$ 161,800.00		$ 4,854.00	$ 4,854.00	$ -	$ 48,540.00	$ 48,540.00	$ -	$ 97,080.00
5	Country Club Dr: Viader Dr to 875' E of Southard Ct	$ -	$ 142,300.00	$ 7,088,300	$ 4,269.00	$ 4,269.00	$ -	$ 42,690.00	$ 42,690.00	$ -	$ 85,380.00
6	Larch Ave: Canyon Rd to Baitx Ave	$ -	$ 80,900.00		$ 2,427.00	$ 2,427.00	$ -	$ 24,270.00	$ 24,270.00	$ -	$ 48,540.00
7	St. Marys Rd: 500' E of Stafford Rd to Town Limit	$ -	$ 142,300.00		$ 4,269.00	$ 4,269.00	$ -	$ 42,690.00	$ 42,690.00	$ -	$ 85,380.00
8	Corliss Dr/Sullivan Dr: Hardie Dr to Moraga Rd	$ -	$ 80,900.00		$ 2,427.00	$ 2,427.00	$ -	$ 24,270.00	$ 24,270.00	$ -	$ 48,540.00
	Ped Set Aside										
1	Moraga Wy: Town Limit to Moraga Rd	$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -
2	Moraga Rd/Canyon Rd: Larch Ln to Town Limit (North)	$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -
3	Rheem Blvd: La Salle Dr to Moraga Rd	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Moraga Wy at Moraga Valley Rd										
4	Moraga Rd at Corliss Dr	$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -

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	Cost, Benefit and B/C Ratio Calculation	Total Benefit	B/C
FID	Location	Total_Benefit (Life)	B/C
	Project 3		
1	Moraga Rd at Campolindo Dr		
2	Moraga Rd at St. Marys Rd		
3	Moraga Rd at Ascot Dr	$ 2,172,260.00	26.26
4	Moraga Rd at Donald Dr		
5	Moraga Wy at School St		
	Project 4		
1	Moraga Rd at Lucas Dr		
2	Moraga Wy at Moraga Valley Ln	$ 8,975,120.00	33.44
	Project 3 NIGHT		
2	Moraga Wy at Moraga Valley Ln	$ 4,048,000.00	21.31
	Project 1		
1	Moraga Rd at Lucas Dr		
2	Moraga Wy at Moraga Valley Ln		
3	Moraga Rd at Alta Mesa		
4	Camino Pablo at Sanders Ranch Rd	$ 12,479,400.00	27.05
5	Rheem Blvd at St. Marys Rd		
6	Moraga Rd at Corliss Dr		
	Project 5		
1	Moraga Wy: Town Limit to Moraga Rd		
2	Canyon Rd: 300' E of Valle Vista Staging Area to Town Limit (East)		
3	Moraga Rd/Canyon Rd: Larch Ln to Town Limit (North)		
4	Rheem Blvd: La Salle Dr to Moraga Rd		
5	Country Club Dr: Viader Dr to 875' E of Southard Ct	$ 4,252,980.00	18.72
6	Larch Ave: Canyon Rd to Baitx Ave		
7	St. Marys Rd: 500' E of Stafford Rd to Town Limit		
8	Corliss Dr/Sullivan Dr: Hardie Dr to Moraga Rd		
	Ped Set Aside		
1	Moraga Wy: Town Limit to Moraga Rd		
2	Moraga Rd/Canyon Rd: Larch Ln to Town Limit (North)		
3	Rheem Blvd: La Salle Dr to Moraga Rd	$ -	0.00
	Moraga Wy at Moraga Valley Rd		
4	Moraga Rd at Corliss Dr		

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