



Solano County

Local Road Safety Plan Update

Final Report

August 2024

TABLE OF CONTENTS

Executive Summary.....	1
Chapter 1 Introduction.....	3
What is a LRSP?	3
Process.....	3
Vision Statement of the Solano County LRSP	4
Goals and Objectives of the Solano County LRSP	4
Study Area and Demographic Information	6
Safety Partners.....	8
Chapter 2 Existing Planning Efforts	12
Relevant City and County Planning Documents and Projects	12
Chapter 3 Collision Data Collection and Analysis	18
Data Collection	20
Collision Data Analysis Results	20
Preliminary Analysis	21
F+SI Collisions.....	26
Collision Severity Weight.....	38
High Injury Network	40
Cut-Through Traffic	45
Chapter 3 Summary	46
Chapter 4 Emphasis Areas	48
The 5 E's of Traffic Safety.....	48
Existing Traffic Safety Efforts in Solano County	48
Factors Considered in the Determination of Emphasis Areas.....	50
Chapter 5 Countermeasure Identification	59
Countermeasure Toolbox.....	59
Chapter 6 Safety Projects	63
Chapter 7 Evaluation and Implementation.....	69
Implementation.....	69
Monitoring and Evaluation	71
LRSP Update	71



FIGURES

Figure 1: Study Area.....	6
Figure 2: Solano County LRSP Project Website	8
Figure 3: Solano County LRSP Webpage on COunty Website.....	9
Figure 4: Interactive Map Comment Responses.....	10
Figure 5: Public Comments on Traffic Safety by Category.....	11
Figure 6: Injury Collisions Unincorporated Solano County (2018-2022)	19
Figure 7: Collisions by Severity (2018-2022).....	20
Figure 8: Five Year Collision Trend.....	21
Figure 9: Intersection and Roadway Collisions – All Injury Collisions	22
Figure 10: Collision Type – All Injury Collisions and F+SI Collisions.....	22
Figure 11: Violation Categories: All Injury Collisions and F+SI Collisions	23
Figure 12: Motor Vehicle Involved with: All Injury Collisions and F+SI CollisionS	23
Figure 13: Transportation Modes: All Injury Collisions and F+SI Collisions	24
Figure 14: Lighting Conditions: All Injury Collisions vs. F+SI Collisions	24
Figure 15: Weather Conditions: All Injury Collisions and F+SI Collisions	25
Figure 16: Time of Day: All Injury Collisions and F+SI Collisions	25
Figure 17: Intersection and Roadway Segment Collisions – F+SI Collisions	26
Figure 18: F+SI Collisions in Solano County (2018-2022).....	27
Figure 19: F+SI Collisions: Collision Type and Location Type (2018-2022)	28
Figure 20: F+SI Collisions: Violation Category and Location Type (2018-2022)	28
Figure 21: F+SI Collisions: Motor Vehicle Involved With and Location Type (2018-2022).....	29
Figure 22: F+SI Collisions: Lighting and Location Type (2018-2022)	29
Figure 23: F+SI Collisions: Weather vs Location Type (2018-2022)	30
Figure 24: F+SI Collisions: Time of Day and Location Type (2018-2022)	30
Figure 25: F+SI Collisions by Gender and Age.....	31
Figure 26: F+SI Collisions by Collision Type and Movement Preceding Collisions of Party at Fault.....	31
Figure 27: Solano County Hit Object Collisions (2018-2022)	33
Figure 28: Solano County Improper Turning Collisions (2018-2022).....	34
Figure 29: Solano County Broadside Collisions (2018-2022)	35
Figure 30: Solano County Nighttime Collisions (2018-2022)	36
Figure 31: Solano County DUI Collisions (2018-2022).....	37
Figure 32: Solano County Severity Index	39
Figure 33: Solano County High Injury Intersections	41
Figure 34: Solano County High Injury Roadway Segments	42



TABLES

Table 1: Solano County Commute to Work	7
Table 2: Collisions by Severity and Facility Type	21
Table 3: EPDO Score used in Highway Safety Improvement Program	38
Table 4: High Injury Intersections.....	43
Table 5: High Injury Corridors.....	44
Table 6: Existing Traffic Safety Efforts in Solano County	49
Table 7: Emphasis Area 1 Strategies	51
Table 8: Emphasis Area 2 Strategies	52
Table 9: Emphasis Area 3 Strategies	53
Table 10: Emphasis Area 4 Strategies.....	54
Table 11: Emphasis Area 5 Strategies.....	55
Table 12: Emphasis Area 6 Strategies.....	56
Table 13: Emphasis Area 7 Strategies.....	57
Table 14: Emphasis Area 8 Strategies.....	58
Table 15: Non-Signalized Intersection Countermeasures	60
Table 16: Roadway Segment Countermeasures.....	61
Table 17: List of Viable Safety Projects	65
Table 18. List of Countermeasures	68
Table 19: List of Potential Funding Sources.....	70

APPENDICES

- Appendix A: List of Public Outreach Comments
- Appendix B: Matrix of Planning Goals, Policies, and Projects
- Appendix C: Consolidated Collision Database
- Appendix D: Countermeasure Toolbox
- Appendix E: Local Roadway Safety Manual (LRSM) Excerpt
- Appendix F: HSIP Analyzers (2024)



GLOSSARY

5 E's – Abbreviation for Education, Enforcement, Engineering, Equity and Emergency Medical Services: A traffic engineering approach for improving safety on the roadways.

ACS – Abbreviation for American Community Survey: A U.S. Census survey that helps local officials, community leaders, and businesses understand the changes taking place in their communities.

ADT – Abbreviation for average daily traffic: Refers to vehicle traffic volumes.

BCR – Abbreviation for benefit-cost ratio: Indicator used to quantify project benefits in relation to project costs.

LRSP – Abbreviation for local road safety plan. A document that provides a framework for identifying, analyzing, and prioritizing roadway safety improvements on local roads.

CHP - Abbreviation for California Highway Patrol.

CRF – Abbreviation for crash reduction factor: The percentage of expected effect of a countermeasure or safety project to decrease collisions.

Collision Severity – Defined as the intensity of collisions typically in the following categories: fatal (F), severe injury (SI), other visible injury and complaint of pain (Other), and property damage only (PDO).

EMS – Abbreviation emergency medical services.

EPDO – Abbreviation for equivalent property damage only.

FHWA – Abbreviation for Federal Highway Administration: The federal agency responsible managing the nation's highway system, including bridges and tunnels.

HSIP – Abbreviation for Highway Safety Improvement Program: A roadway safety funding program managed by Caltrans, California State Department of Transportation.

F+SI – Abbreviation for fatal and severe injury collisions.

LRSM – Abbreviation for Local Roadway Safety Manual: A Manual for California's Local Road Owners.

Primary Violation Factor/Primary Collision Factor – Defined as contributing causes of collisions.

SWITRS - Abbreviation for Statewide Integrated Traffic Records System: A database managed by California Highway Patrol that collects and processes data gathered from collision scenes.

TIMS - Abbreviation for Transportation Injury Mapping System: A collision database managed by UC Berkeley SafeTREC system.



EXECUTIVE SUMMARY

The Solano County 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 in the unincorporated areas of Solano County. This plan is an update to 2023 LRSP. The LRSP aims to eliminate fatal and severe injury (F+SI) collisions through a holistic approach that includes setting a prioritized list of improvements under the 5 E's of traffic safety (Education, Enforcement, Engineering, Equity and Emergency Medical Services [EMS]) 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 can also be a living document, one that is routinely reviewed and updated by County staff and their safety partners to reflect evolving collision trends and community needs and priorities. With the LRSP as a guide, the County will be ready to apply for grant funds, such as the federal Highway Safety Improvement Program (HSIP) through Caltrans. This document summarizes the collision analysis, identifies high-risk locations and recommends countermeasures at each of these high-risk locations. This document is organized into seven chapters as follows:

CHAPTER 1 – INTRODUCTION

The Introduction presents the study, describes how this report is organized, summarizes the vision and goals, shows the study area, details how the report is organized, introduces the safety partners and summarized the community outreach.

CHAPTER 2 – LITERATURE REVIEW

This chapter summarizes County and regional planning documents and projects that are relevant to the LRSP. It ensures that the recommendations of the LRSP are in line with established goals, objectives, policies, or projects.

CHAPTER 3 – COLLISION DATA COLLECTION AND ANALYSIS

This chapter summarizes the data analysis approach and presents preliminary as well as detailed collision analyses and findings. The analysis of F+SI collisions is performed by facility type (intersection and roadway segment). Collision data was obtained and analyzed for a five-year period from 2018 to 2022 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).

CHAPTER 4 – EMPHASIS AREAS

Emphasis areas are a focus of the LRSP that are identified through the various collision types and factors resulting in F+SI collisions within Solano County. The eight emphasis areas for Solano County are:

- Address Roadway Segment Collisions (collisions further than 250 feet of intersections)
- Reduce Hit Object and Roadway Departure Collisions
- Reduce Improper Turning Collisions
- Address Driving Under the Influence Collisions
- Reduce Broadside Collisions
- Reduce Nighttime Collisions
- Reduce Motorcycle Collisions
- Address Younger Adult Party at Fault Collisions



CHAPTER 5 – 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 County potential countermeasures for each location that can be implemented either in future HSIP calls for projects, or using other funding sources, such as the Solano County Capital Improvement Program. Non-engineering countermeasures were also selected using the 5 E's strategies, and are included with the emphasis areas and described in Chapter 5.

CHAPTER 6 – SAFETY PROJECTS

A set of five safety projects were created for high-risk intersections and roadway segments, using groups of HSIP approved countermeasures that can help improve safety at the high-risk locations. These safety project sets are:

- **Project 1** - Improve Safety at Non-Signalized Intersections: Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs, Install Flashing Beacons at Stop-Controlled Intersections, Install flashing beacons as advance warning.
- **Project 2** - Improve Safety at Non-Signalized Intersections: Upgrade intersection pavement markings, Install transverse rumble strips on approaches, Improve sight distance to intersection.
- **Project 3** - Improve Safety on Roadway Segments: Remove or relocate fixed objects outside of Clear Recovery Zone, Install/Upgrade signs with new fluorescent sheeting, Install delineators, reflectors and/or object markers.
- **Project 4** - Improve Safety on Roadway Segments: Install Guardrail, Install chevron signs on horizontal curves, Install dynamic/variable speed warning signs.
- **Project 5** - Improve Safety on Roadway Segments: Install centerline rumble strips/stripes, Install edgeline rumble strips/stripes, Add segment lighting.

CHAPTER 7 – EVALUATION AND IMPLEMENTATION

The LRSP is a guidance document that is recommended to be updated every two to five years by Solano County in coordination with its safety partners. The LRSP document provides engineering, education, enforcement, and EMS -related countermeasures (the 5 E's of traffic safety) that can be implemented throughout the County to eliminate F+SI collisions. The chapter includes a list of potential grant funding sources that can help to implement the identified safety projects and countermeasures. 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 eliminating F+SI collisions throughout the County. If the number of F+SI collisions does not decrease over time, then the emphasis areas and countermeasures should be re-evaluated.



CHAPTER 1 INTRODUCTION

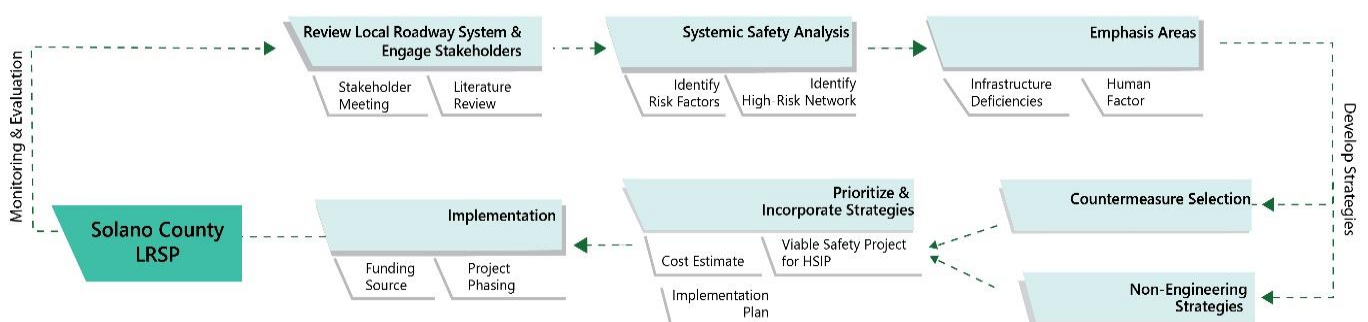
What is a LRSP?

Solano County is updating its 2023 LRSP to enhance safety for all modes of transportation and users of all ages and abilities. The LRSP is a localized data-driven traffic safety plan that provides opportunities to address roadway safety needs and eliminating F+SI collisions. The emphasis is on reducing F+SI crashes because of the life-ending and life-changing effects of such collisions; if in the process the number of less severe injuries and property-damage only collisions is also reduced that will be an added benefit. The LRSP creates a framework to systematically identify and analyze traffic safety-related issues, and recommend safety projects and countermeasures. The LRSP facilitates the development of local agency partnerships and collaboration, resulting in the development of a prioritized list of improvements that can qualify for federal 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 used in preparing this LRSP involved the following steps (and shown in the graphic below):

- 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 document



Vision Statement of the Solano County LRSP

The County and its safety partners envision the elimination of F+SI on roadways within unincorporated Solano County by creating an equitable, sustainable, multimodal transportation system where people of all ages and abilities can travel free from harm.

Goals and Objectives of the Solano County LRSP

GOAL #1: SYSTEMATICALLY IDENTIFY AND ANALYZE ROADWAY SAFETY PROBLEMS AND RECOMMEND IMPROVEMENTS

Objective 1: Use the Systemic Safety Analysis data-driven process to identify traffic collisions in the unincorporated areas (with an emphasis on F+SI collisions); where, when, and how they are occurring, and implement appropriate and proven rural road countermeasures.

Objective 2: Improve roadway planning, design, operations, and connectivity to enhance safety and mobility for users of all ages and abilities, with consideration to other rural roadway users (such as agricultural vehicles).

Objective 3: Implement traffic calming strategies to discourage speeding and other unsafe driving behaviors on residential streets, and on rural roadways where appropriate.

Objective 4: Ensure that all recommended improvements are consistent with County goals, as well as state and federal plans and goals (such as, but not limited to: California Strategic Highway Safety Plan, and the FHWA Local and Rural Road Safety Program).

Objective 5: Identify areas where cut-through traffic is occurring on unincorporated county roads as a result of increased congestion on nearby freeways, and implement strategies to improve safety along these corridors.

GOAL 2: IMPROVE THE SAFETY OF PEDESTRIANS AND BICYCLISTS BY USING PROVEN AND EFFECTIVE COUNTERMEASURES

Objective 1: Identify safety issues and hot spot locations where bicycle and pedestrian collisions occur in Solano County's unincorporated areas, and treat with appropriate and effective engineering countermeasures.

Objective 2: Provide educational programs for bicyclists, pedestrians, and motorists to inform them how to be safe in the public right-of-way; either through Solano Transportation Authority's (STA's) Safe Routes to School, law enforcement programs, or other public/private sponsored programs.

Objective 3: Improve sidewalks, walkways, and crossings to be free of hazards and increase the safety of crossing pedestrians.



GOAL 3: ENSURE COORDINATION AND COOPERATION OF KEY STAKEHOLDERS TO IMPLEMENT ROADWAY SAFETY IMPROVEMENTS AND EMERGENCY RESPONSE TO COLLISIONS WITHIN SOLANO COUNTY

Objective 1: Coordinate between County Departments, CHP, Sheriff's Office, Fire Districts, School Districts, and EMS agencies to ensure a coordinated and cooperative response to traffic safety, including:

- Implementation of safety improvements
- Public education on safely traveling in the public right-of-way, regardless of mode
- Enforcement of traffic safety laws in the public right-of-way
- Minimizing impacts to emergency response times

Objective 2: Coordinate with local, regional, and state partners (such as STA and Caltrans), to identify and address traffic safety issues and ensure a coordinated response.

Objective 3: Coordinate with Solano County's incorporated cities to address mutual traffic safety concerns, and/or those near city limits.

GOAL 4: CONTINUALLY SEEK FUNDING FOR SAFETY IMPROVEMENTS

Objective 1: Ensure the LRSP meets HSIP guidelines in order to apply for funding for identified countermeasures.

Objective 2: Provide a list of prioritized improvements that guide County investments and grant funding applications.

Objective 3: Continually seek funding sources to implement engineering, education, enforcement, and emergency response solutions to roadway safety issues in Solano County.

GOAL 5: ENSURE THAT SAFETY IMPROVEMENTS ARE MADE IN A MANNER THAT IS FAIR AND EQUITABLE FOR ALL SOLANO COUNTY RESIDENTS

Objective 1: Where feasible, implement community outreach to inform the public about upcoming safety improvements and seek their input.

Objective 2: Provide a forum for residents to submit traffic safety related concerns; and for County staff and officials to respond to concerns.

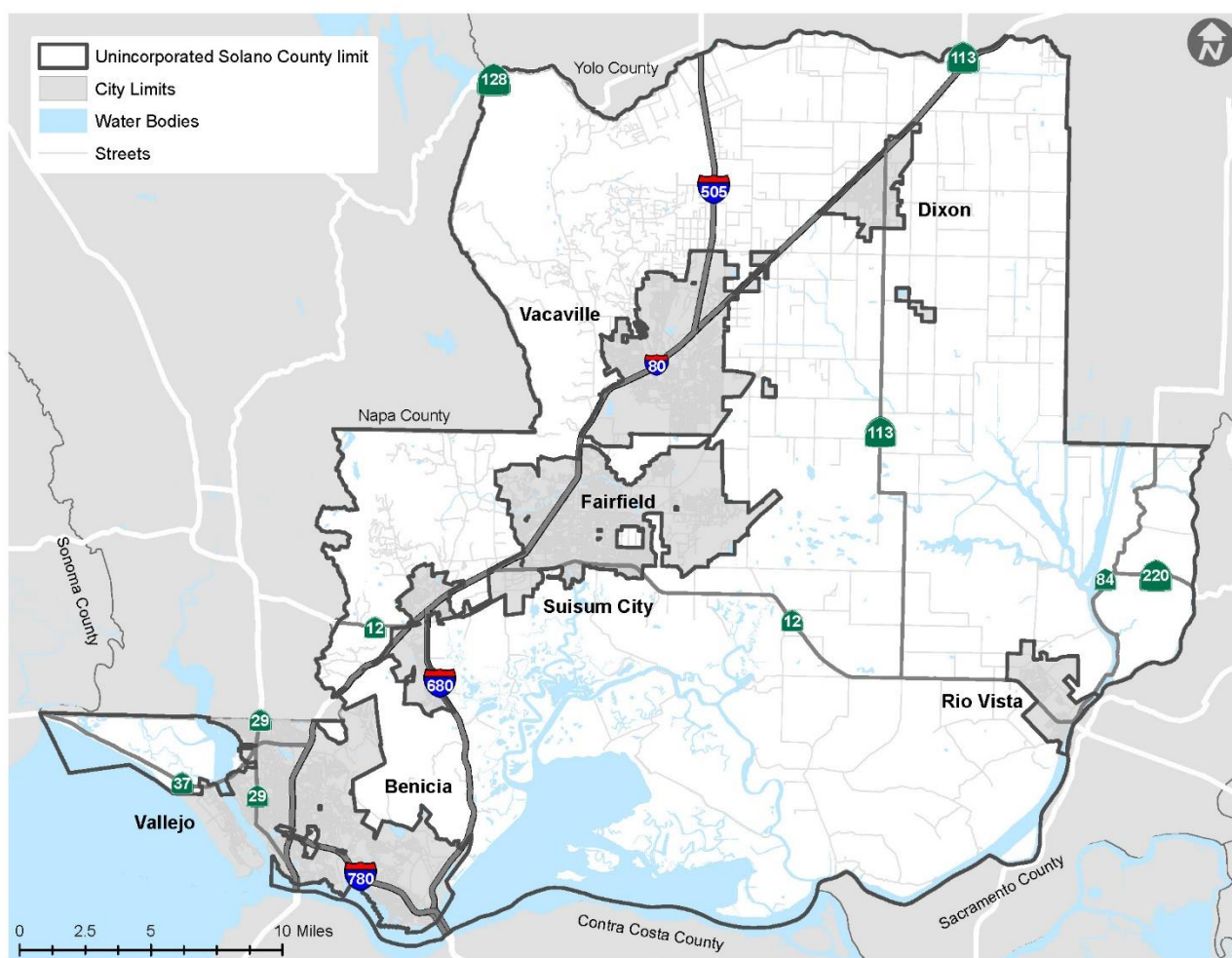
Objective 3: Ensure the consideration of equity when selecting where to make traffic safety improvements.



Study Area and Demographic Information

Solano County is located in the northeastern edge of the San Francisco Bay Area on Interstate 80 (I-80) midway between Sacramento and San Francisco. The County's estimated population is 453,491 (US Census 2020). According to 2020 census, the estimated population in the unincorporated areas of Solano County was 19,862. I-80 is the highest volume freeway in the county, connecting it with the rest of the Bay Area and Sacramento; supported by I-680, I-780, and I-505; as well as State Route (SR) 12, SR 29, and SR 113. Solano County is bordered by Napa County and Sonoma County to the west, Yolo County to the north and east, Sacramento County to the east, and Contra Costa County to the south. The study area is mapped in **Figure 1**.

FIGURE 1: STUDY AREA



COMMUTE TO WORK

According to the U.S. Census Bureau's American Community Survey (ACS) 2018-2022 5-Year Estimates¹, 75% of Solano County commuters get to work by driving alone which is higher than state rate of 68%. The second most common method is work from home. The different modes of transportation used by Solano County residents to commute to work are shown in **Table 1**.

TABLE 1: SOLANO COUNTY COMMUTE TO WORK

COMMUTE TO WORK	SOLANO COUNTY	CALIFORNIA
Drive Alone	75%	68%
Carpool/Rideshare	10%	10%
Public Transportation	1%	4%
Walk	1%	2%
Bicycle/Motorcycle/Taxi Cab	1%	2%
Work from Home	12%	14%

1

<https://data.census.gov/table/ACSDT5Y2022.B08541?q=Solano%20County.%20California&t=Transportation>



Safety Partners

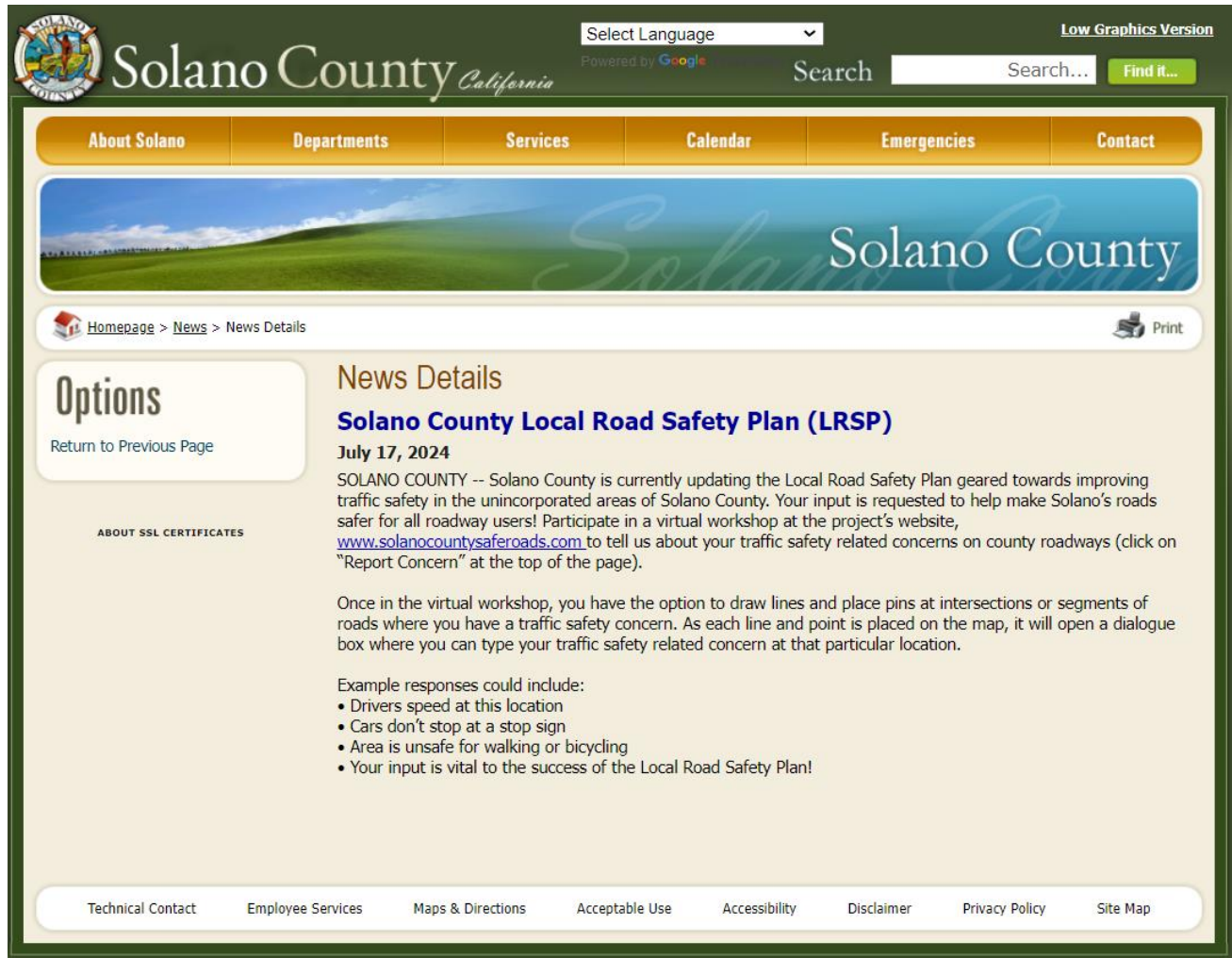
Safety partners are vital to the development of an LRSP and the implementation of priority projects. For Solano County, these include County Departments, California Highway Patrol (CHP), and the Solano Transportation Authority (STA).

This stakeholder outreach was supplemented by a project website (www.solanocountysaferoads.com), with an interactive map tool platform. The interactive map was used to solicit input from Solano County residents outside the confines of traditional meetings. **Figure 2** illustrates the project website of Solano County LRSP and **Figure 3** shows the webpage of Solano County LRSP on County website.

FIGURE 2: SOLANO COUNTY LRSP PROJECT WEBSITE



FIGURE 3: SOLANO COUNTY LRSP WEBPAGE ON COUNTY WEBSITE



A total of 23 comments were submitted through interactive map platform from June 10, 2024 to August 20, 2024. **Figure 4** illustrates the locations of public comments on the map. Shaded area in map represents the unincorporated Solano County and blue dots and blue lines represents a comment from community member. A list of all public comments is included in **Appendix A**.

The most common commented traffic safety issue was traffic congestion and pot holes. Highway 12 (CA-12) was the most commented street, followed by Liberty Island Rd. Highway 12 (CA-12) was referred to the most as the street with traffic congestion issues, with five comments combined. **Figure 5** refers to the summary of public outreach by location and pertinent issue per location.



FIGURE 4: INTERACTIVE MAP COMMENT RESPONSES

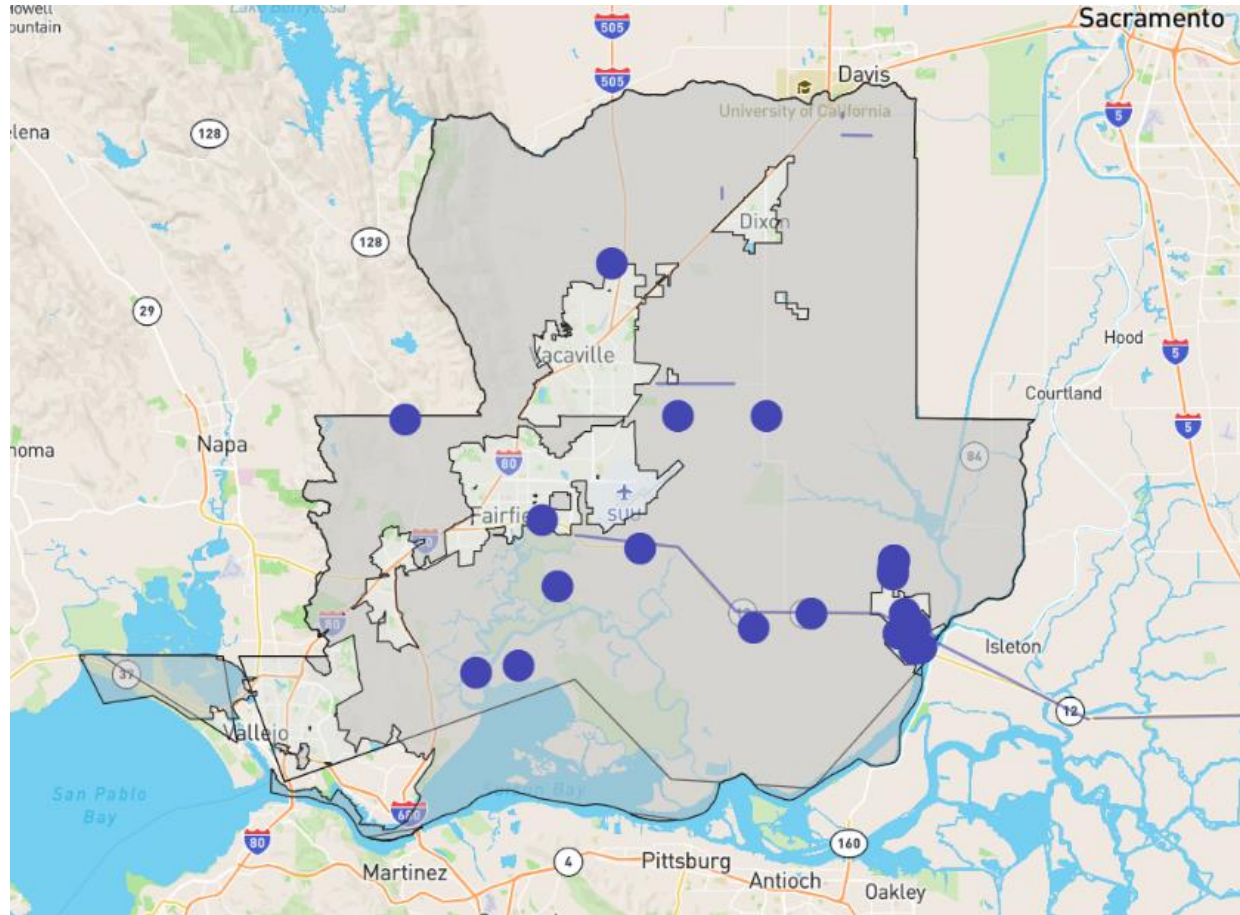
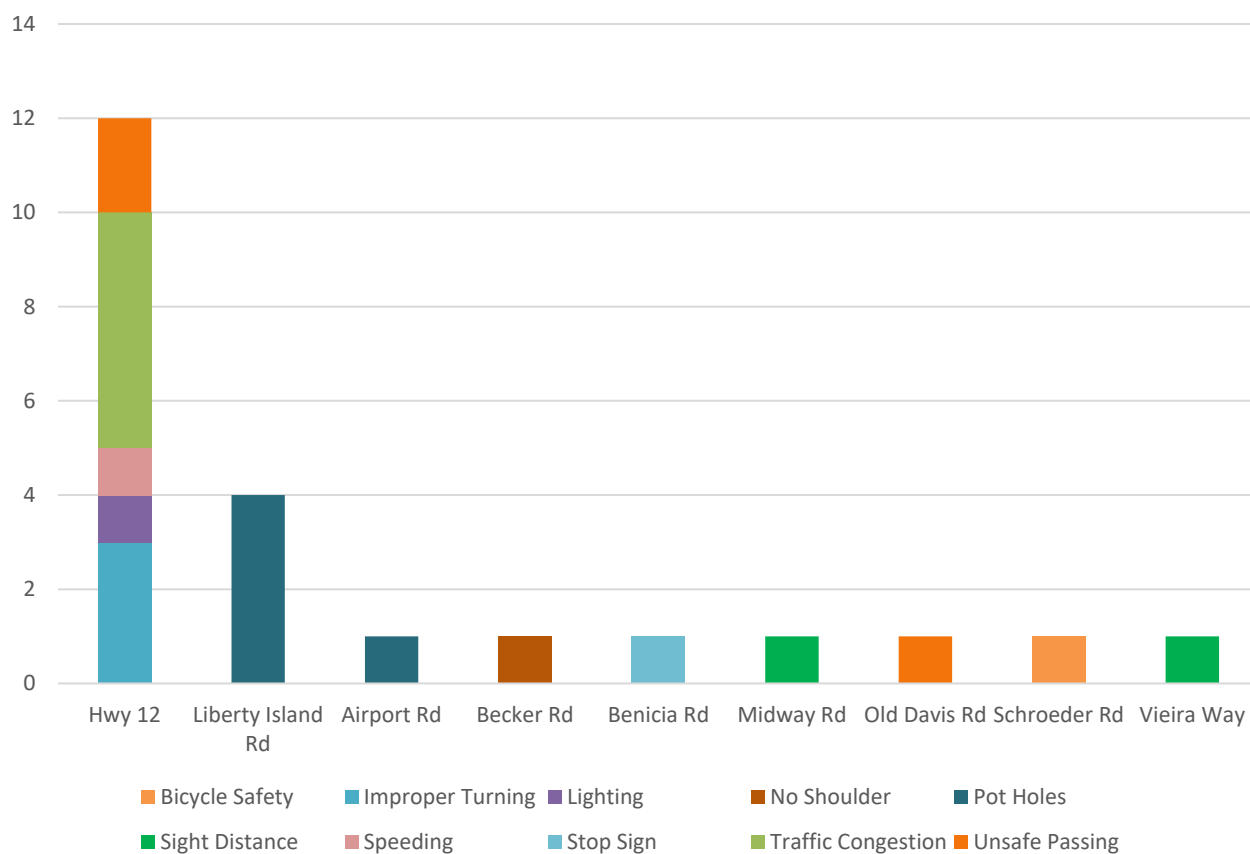


FIGURE 5: PUBLIC COMMENTS ON TRAFFIC SAFETY BY CATEGORY



Note: Category was chosen based on the primary issue listed in the comment. Each comment was assigned to the major road if at an intersection.

CHAPTER 2 EXISTING PLANNING EFFORTS

This Chapter summarizes the planning documents, projects underway, and studies reviewed for the Solano County LRSP. The review was conducted to ensure that the LRSP vision, goals, and strategies are aligned with established vision, goals, and strategies. The documents reviewed are listed below:

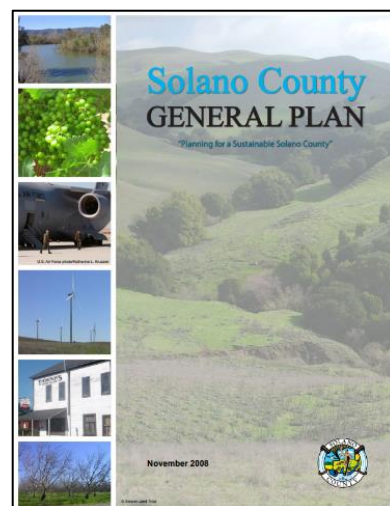
- Solano County General Plan Transportation and Circulation Element
- 2018 Solano Travel Safety Plan
- Solano Countywide Active Transportation Plan
- Solano Countywide Active Transportation Plan - Unincorporated County Chapter
- Suisun Valley Strategic Plan
- Middle Green Valley Specific Plan
- Solano 2040 Comprehensive Transportation Plan
- Solano Priority Conservation Area Assessment and Implementation Plan
- Solano County Public Works Capital Improvement Plan

Many of Solano County's existing planning documents contain safety related goals that work together to reduce/eliminate F+SI collisions, including in the 2018 Solano Travel Safety Plan, Solano Countywide Active Transportation Plan, and the County's General Plan. The LRSP will build upon these goals and prior efforts. The following is a brief description of each of these documents and how they informed the development of the LRSP. A detailed list of upcoming projects and relevant policies is listed in **Appendix B**.

Relevant City and County Planning Documents and Projects

SOLANO COUNTY GENERAL PLAN TRANSPORTATION AND CIRCULATION ELEMENT (2008)

The General Plan was adopted by the Board of Supervisors and an "orderly growth management" element was supported by more than 70% of Solano County voters in 2008. The Transportation and Circulation chapter of the General Plan sets forth the policy framework to shape circulation within Solano County. While it primarily addresses roadways, it also considers bicycle and pedestrian systems, rail service, bus transit, air service, and waterway activity. The Transportation and Circulation chapter guides new investment choices within the county and assists in determining the role of new development in addressing future circulation issues. Overarching themes of the Transportation and Circulation chapter are to reduce reliance on automobile travel, providing accessible travel resources for all county residents, providing a range of sustainable travel choices that serve county residents and business, and improving circulation serving the county's agricultural community.



The Transportation and Circulation chapter contains goals regarding the following:

- Maintaining and improving current transportation systems to remedy safety and congestion issues
- Creating coordinated approaches with other agencies and cities to improve transportation corridors and facilities
- Encouraging land use patterns that maximize access and mobility options
- Minimizing congestion and greenhouse gas emissions
- Encouraging transit use
- Encouraging bicycling and walking
- Maintaining the safe, convenient transfer of goods and services from agricultural lands and industrial locations to regional and interregional transportation facilities

2018 SOLANO TRAVEL SAFETY PLAN (2018)

The Solano Travel Safety Plan was developed to identify and address traffic safety issues throughout the county. It was the fourth iteration of the plan, with previous versions developed in 1998, 2005, and 2016. The 2018 version was developed to be the County's Systemic Safety Analysis Report (SSAR), and included a comprehensive analysis of five years of traffic collision data for all seven cities and the unincorporated county. This was done to identify collision trends, such as crash types and violation types. These factors were used to identify specific countermeasures and project lists for each jurisdiction to be eligible for federal HSIP funding.

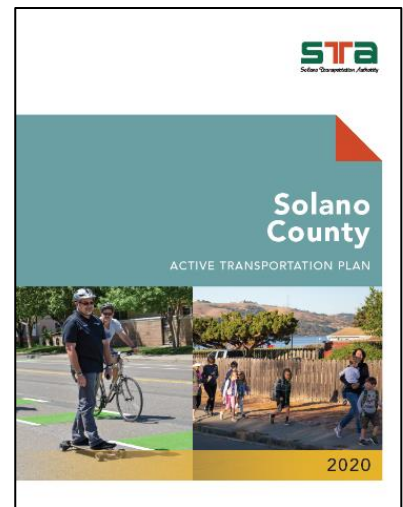
In the unincorporated County, recommended HSIP-eligible projects focused on paving and/or widening shoulders, installing additional signs/pavement markings/flashing warning signs, installing advance beacons and warning/regulatory signs, and converting intersection control to roundabouts. The treatments were suggested on Fry Road, Solar Hills Drive, Porter Road, SR-113, Meridian Road, Putah Creek Road, and Pitt School Road. Additional countermeasures that are ineligible for HSIP were also suggested.



SOLANO COUNTYWIDE ACTIVE TRANSPORTATION PLAN (2020)

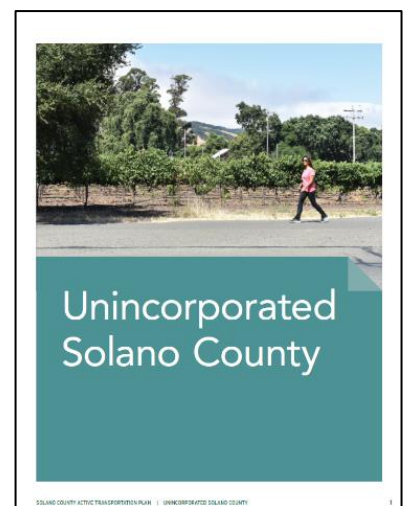
The Solano County Active Transportation Plan (ATP) provides a framework to help the STA and partnering organizations identify projects that will improve active transportation conditions throughout Solano County. It combines four previous plans into one cohesive plan and establishes countywide priorities, project lists, and program guidance which STA and local jurisdictions can use to help people of all ages and abilities feel comfortable walking and bicycling.

Development of the plan included a robust public outreach campaign in each jurisdiction, data driven analyses to identify the areas which have the highest propensity to produce walking and bicycling trips, and ultimately a list of recommended projects and all ages and abilities backbone network. A total of 312 bikeway projects and 148 pedestrian projects were recommended to form a connected active transportation network, improve access to schools and transit, and develop a regional trail network that enhances existing regional trails.



SOLANO ATP – UNINCORPORATED COUNTY CHAPTER (2020)

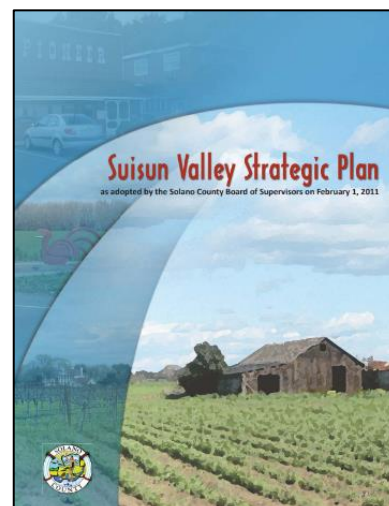
The Solano Countywide Active Transportation Plan was developed with a specific chapter for each jurisdiction in Solano County, so that it may serve as their own ATP. This includes one for the unincorporated areas of Solano County, which is primarily rural except for two small urbanized pockets within Vallejo. The chapter includes a summary of demographics of active transportation users in the unincorporated area, the existing pedestrian and bicycle networks, and an analysis of bicycle/pedestrian collisions on county roadways. Most of the bicycle network in the unincorporated county is focused on connections between the incorporated cities. Pedestrian facilities exist in isolated pockets; facilities are sparse due to the rural nature of the unincorporated areas. The suggested backbone network reflects this. A total of 117.2 miles of bikeways is recommended, primarily focusing on connecting cities. 14.5 miles of pedestrian facilities are also recommended, mostly in focused nodes or the unincorporated areas of Vallejo.



SUISUN VALLEY STRATEGIC PLAN (2010)

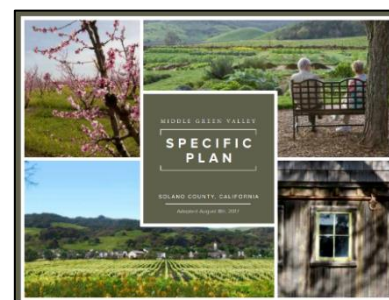
The Suisun Valley Strategic Plan lays out a vision to protect the rural, agricultural nature of the region and (among other things), provide infrastructure to support the growth and development of Suisun Valley. The study area is generally defined as the area between the City of Fairfield to the south and east, Green Valley to the west, and Napa County to the north. Planned improvements for Suisun Valley roadways will handle the expected increase in vehicle traffic volumes over the next twenty years, including an expected increase in non-auto traffic. The three-tier approach focuses on areas of immediate concern, including calming traffic, promoting active transportation, maintaining corridors for delivering goods and services, widening shoulders and providing pedestrian walkways, and addressing flooding concerns.

Suisun Valley wants to maintain its rural character. They want agricultural vehicles to continue to have access to roadways. They want to expand equestrian and pedestrian access and facilitate an expected increase of traffic in and through the valley for various purposes. Roadway improvements on the Valley's major roadways should be fit the character of the surrounding area, suitable to serve multiple modes of travel.



MIDDLE GREEN VALLEY SPECIFIC PLAN (2017)

The Middle Green Valley Specific Plan is a guide for the long-term realization of a series of connected and sustainable rural neighborhoods in the Middle Green Valley Specific Project Area of Solano County. It was built out of the recognized need to protect the unique rural qualities of the area, while providing a means for appropriate settlement patterns to take place. The study area includes agricultural and residential neighborhoods generally surrounding the intersection of Green Valley Road and Mason Road in the area northwest of the City of Fairfield.



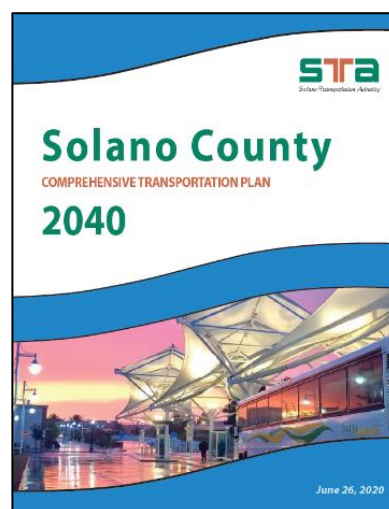
As it pertains to traffic safety, the Plan includes street, circulation, and signage standards for the neighborhoods encompassing the Middle Green Valley. This includes standards for roundabouts, rural collector roads, local roads, and neighborhood roads. Complete streets elements are incorporated into all standards, including the provision for bicycle and pedestrian access across all neighborhoods. It also includes streetscape design standards and planned trail infrastructure in the area.



SOLANO 2040 COMPREHENSIVE TRANSPORTATION PLAN (2020)

The purpose of the Comprehensive Transportation Plan (CTP) is to help the STA fulfill its mission to improve the quality of life by delivering transportation projects that ensure mobility, travel safety, and economic vitality for all. This is an update to the 2005 CTP and addresses 2050 goals. The CTP is a federally required long-range planning document that contributes to the Bay Area's Regional Transportation Plan (RTP). The CTP is generally divided into three elements: the Arterials, Highways, and Freeways Element; Active Transportation Element; and Transit and Rideshare Element.

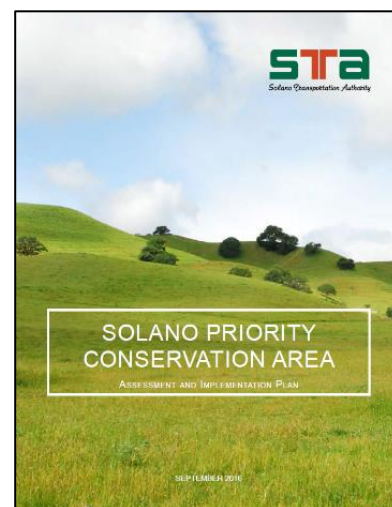
The CTP focuses on increasing multimodal access in the I-80 corridor, and providing more equitable access for seniors, people with disabilities, single parents, and those with limited means. Multimodal access in the I-80 corridor is defined as a linked series of Class I and Class II facilities from Davis and the Yolo/ Solano County line, along rural roads to and through Dixon to Vacaville; from there, along the Jepson Parkway to the Fairfield Linear Park, the North Connector, across the hills by way of McGary Road and the Solano Bikeway bike path, and finally along city streets in Vallejo to the Carquinez Bridge. A priority is to provide more facilities for pedestrian and bicyclist use of this transportation corridor. Each of the three elements includes priority projects divided into three tiers of project readiness. These elements assist STA when making funding decisions for roadway, active transportation, and transit projects.



SOLANO PRIORITY CONSERVATION AREA ASSESSMENT AND IMPLEMENTATION PLAN (2016)

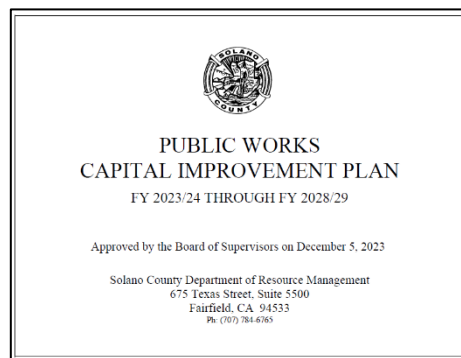
The STA created the Priority Conservation Area (PCA) Public Advisory Committee (PCA PAC) a stakeholder-based planning process—to identify project opportunities that enhance the County's already rich agricultural heritage, recreation options, and open space areas. STA identified potential new conservation areas based on PCA Guidelines established by the Association of Bay Area Governments. The PCA PAC recommended nine areas as appropriate for designation as PCAs. This includes five previously adopted PCAs, plus four new areas.

Eleven focus areas were recommended, all of which could qualify for PCA status under the ABAG PCA Guidelines. These included the existing PCAs identified in 2007 and 2013 and several new areas. Several PCAs included roadway improvements and trail improvements/access. As part of this plan, a series of Farm to Market Road projects were identified to improve public access to Suisun Valley by providing pedestrian and bicycle safety and access enhancements, signage, lighting, and staging areas to trailheads.



SOLANO COUNTY PUBLIC WORKS CAPITAL IMPROVEMENT PLAN (2024)

The Solano County Public Works Capital Improvement Program (CIP) outlines all roadway capital project investments from FY 2023-24 to FY 2028-29. This primarily includes road construction projects, right-of-way acquisition, rubberized chip seals, micro surfacing, paving projects, and bridge construction. Within road construction projects, the types of improvements include (but are not limited to): bicycle/pedestrian improvements, widen/pave shoulders, reconstruct and pave road, pavement overlay, sidewalk and gutter improvements, culvert replacements, road diets, guard rail repairs, intersection improvements, signal upgrades, refreshed striping, and more. The County's total CIP project cost is \$144.6 million, \$90 million of which remains unfunded.



CHAPTER 3 COLLISION DATA COLLECTION AND ANALYSIS

This chapter summarizes the analysis of collisions that occurred in unincorporated Solano County between January 2018 and December 2022, as part of the LRSP. This chapter includes the following sections:

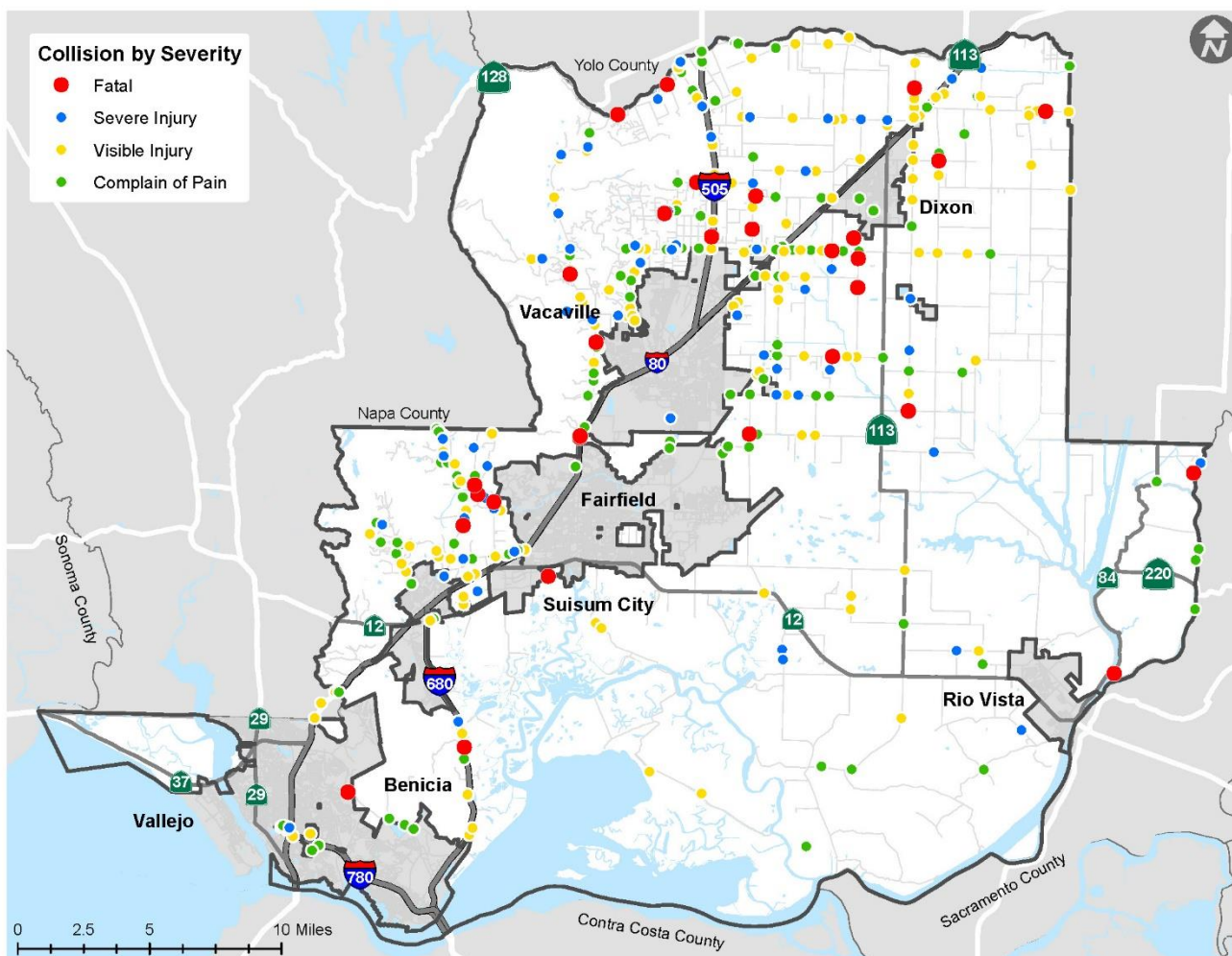
- Data Collection
- Collision Data Analysis
- F+SI Collision Analysis
- Geographic Collision Analysis
- High Injury Network
- Summary

The LRSP focuses on systemically identifying and analyzing traffic safety issues and recommends appropriate safety improvements. The chapter starts with a comprehensive analysis of collisions of all severity in unincorporated Solano County, including with F+SI collisions. Doing so gives a complete picture of collision trends that are occurring among all injury collisions, which can then be compared with trends occurring among only F+SI collisions. Trends such as collision severity, type of collision, primary collision factor, lighting, weather and time of the day were analyzed. Following this, a more detailed analysis was conducted for F+SI collisions that occurred on the County's roadways, including analyzing intersection and roadway segment collisions separately.

After this data was separated between intersection collisions and roadway segment collisions, a comprehensive evaluation was conducted based on: collision severity, type of collision, primary collision factor, lighting, weather, and time of the day. A list of high-injury intersections and roadway segments were then identified and ranked based on the calculation of the equivalent property damage only (EPDO) scoring system. **Figure 6** illustrates all the F+SI collisions that have occurred in unincorporated Solano County from January 1, 2018 to December 31, 2022.



FIGURE 6: INJURY COLLISIONS UNINCORPORATED SOLANO COUNTY (2018-2022)



Data Collection

Analysts use collision data 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 (2018 to 2022) was retrieved from the Transportation Injury Mapping System (TIMS) and the SWITRS. Collisions that occurred on state routes were excluded for this analysis. The data was analyzed and plotted in ArcMap to identify high-risk intersections and roadway segments.

Collision Data Analysis Results

COLLISION CLASSIFICATION

There were a total of 481 injury collisions reported on unincorporated County roads from 2018 to 2022. Out of these, 185 collisions (39%) led to a complaint of pain injury and 194 collisions (40%) led to a visible injury. There were 102 F+SI collisions, of which 72 collisions (15%) led to a severe injury and 30 collisions (6%) led to fatality. **Figure 7** illustrates the classification of collisions based on severity.

The analysis first includes a comparative evaluation between injury collisions and F+SI 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 F+SI collisions. F+SI collisions cause the most damage to those affected. The aftermath of these collisions can lead to great expenses for jurisdiction administration. The LRSP process thus focuses on F+SI collision locations to proactively identify and counter safety issues leading to these death and severe injury.

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**.

FIGURE 7: COLLISIONS BY SEVERITY (2018-2022)

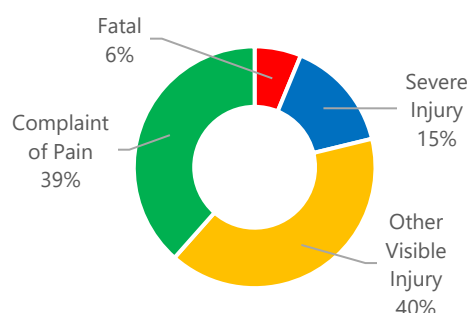


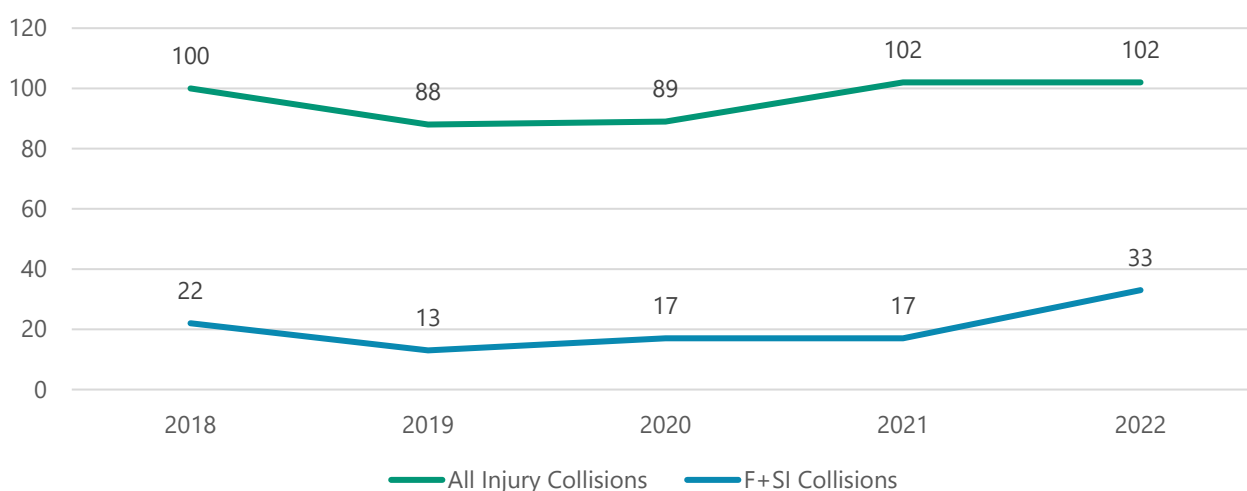
TABLE 2: COLLISIONS BY SEVERITY AND FACILITY TYPE

COLLISION SEVERITY	ROADWAY SEGMENT	INTERSECTION	TOTAL
Fatal	24	6	30
Severe Injury	40	32	72
Subtotal F+SI	64	38	102
Visible Injury	103	91	194
Complaint of Pain	91	94	185
Total (All Injury)	258	223	481

Preliminary Analysis

YEARLY TREND

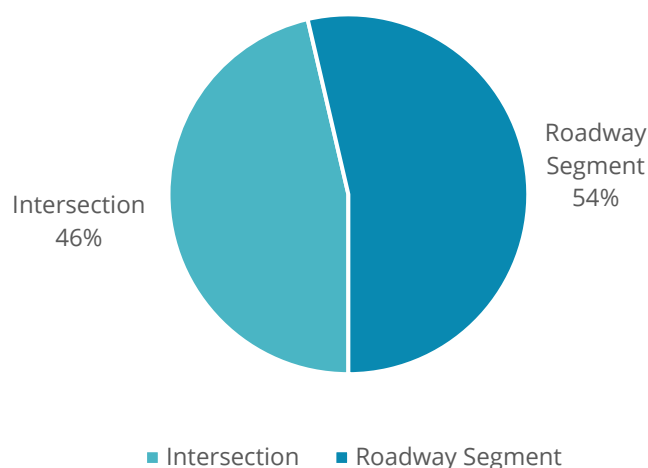
The total number of reported injury collisions decreased from 2018 to 2022. The year with the highest number of collisions was 2021 and 2022 (102 collisions each), while the year with the lowest number of collisions was 2019 (88 collisions). A total of 102 F+SI collisions occurred on County roads in unincorporated Solano County during the study period, increasing from 2018 to 2022. The least number of F+SI collisions occurred in 2019 (13 collisions), while the most occurred in 2022 (33 collisions). **Figure 8** illustrates the five-year collision trend for all injury collisions and F+SI collisions.

FIGURE 8: FIVE YEAR COLLISION TREND

ROADWAY SEGMENTS AND INTERSECTIONS

When evaluating location, the majority of collisions occurred along roadway segments rather than at intersections. In unincorporated Solano County, 54% of all collisions (258 collisions) occurred on roadway segments whereas 46% (223 collisions) occurred at intersections. A slightly stronger trend towards roadway segment collisions (63%) is seen when looking only at F+SI collisions. This classification by facility type can be observed in **Figure 9**.

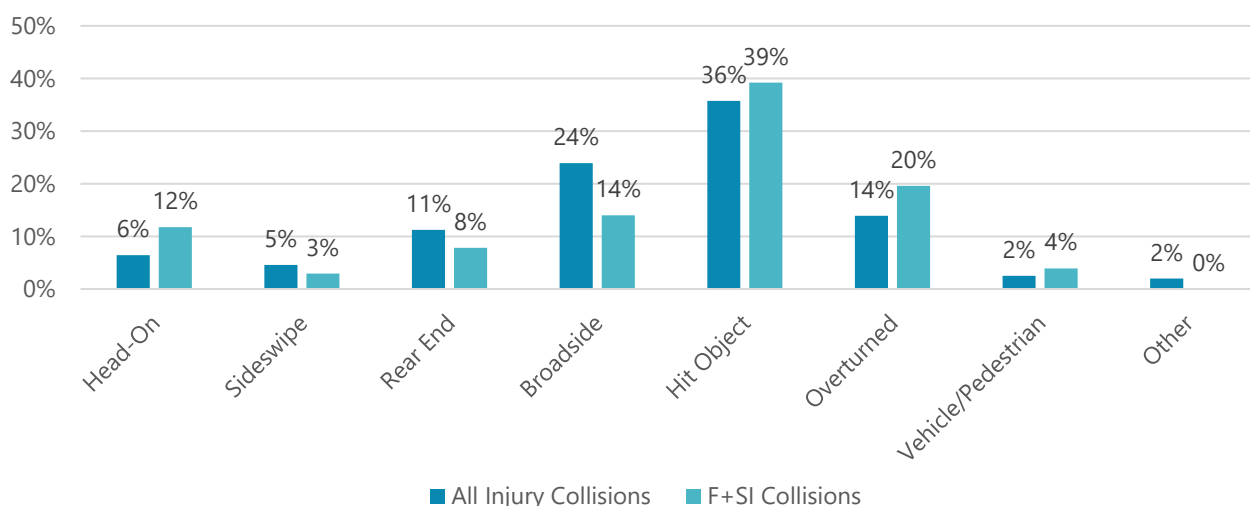
FIGURE 9: INTERSECTION AND ROADWAY COLLISIONS – ALL INJURY COLLISIONS



COLLISION TYPE

The most commonly occurring all injury collision types were hit object (36%) and broadside (24%). The collision types for F+SI collisions follow a slightly different pattern, where the most commonly occurring collision types were hit object (36%), overturned vehicle (20%), and broadside (14%). **Figure 10** illustrates the collision type for all injury collisions as well as F+SI collisions.

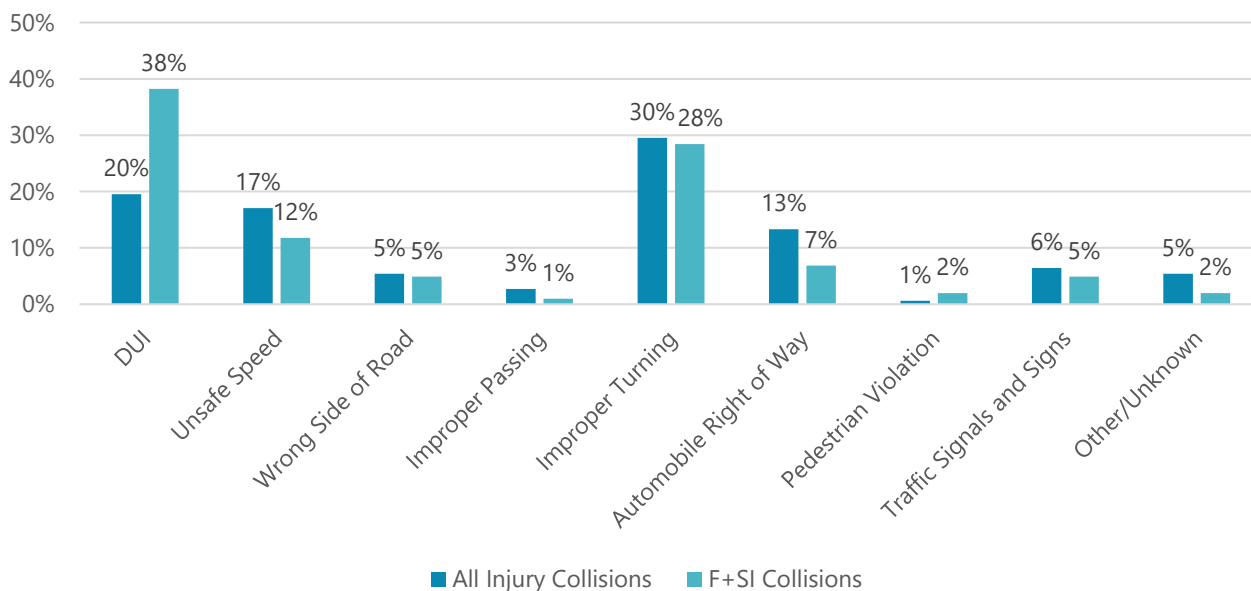
FIGURE 10: COLLISION TYPE – ALL INJURY COLLISIONS AND F+SI COLLISIONS



PRIMARY COLLISION FACTOR

The primary collision factor is determined from the type of violation noted by law enforcement officials at the site. For all injury collisions, the most common violation category was observed to be improper turning (30%) and driving under the influence (DUI) (20%). The most common primary violation categories for F+SI collisions were DUI (38%), improper turning (28%) and unsafe speed (12%). **Figure 11** illustrates the violation category for all injury collisions and F+SI collisions.

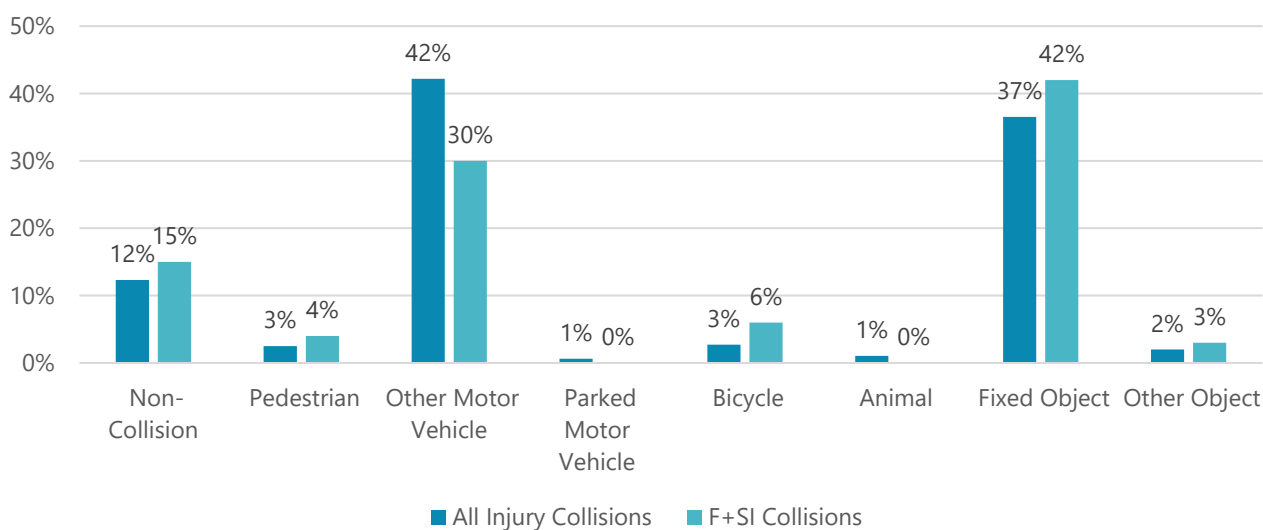
FIGURE 11: VIOLATION CATEGORIES: ALL INJURY COLLISIONS AND F+SI COLLISIONS



MOTOR VEHICLE INVOLVED WITH

Motor vehicles involved in a collision with an object, a person, an animal, and another vehicle is noted by law enforcement. For all injury collisions, 42% occurred when motor vehicles collided with other vehicles. This was followed by motor vehicles colliding with fixed objects (37%) and non-collisions (e.g., overturned) (12%). For F+SI collisions, 42% involved a fixed object, 30% of the collisions involved another motor vehicle, and 15% were classified as a non-collision. **Figure 12** illustrates the motor vehicle involved with category for all injury collisions as well as F+SI collisions.

FIGURE 12: MOTOR VEHICLE INVOLVED WITH: ALL INJURY COLLISIONS AND F+SI COLLISIONS

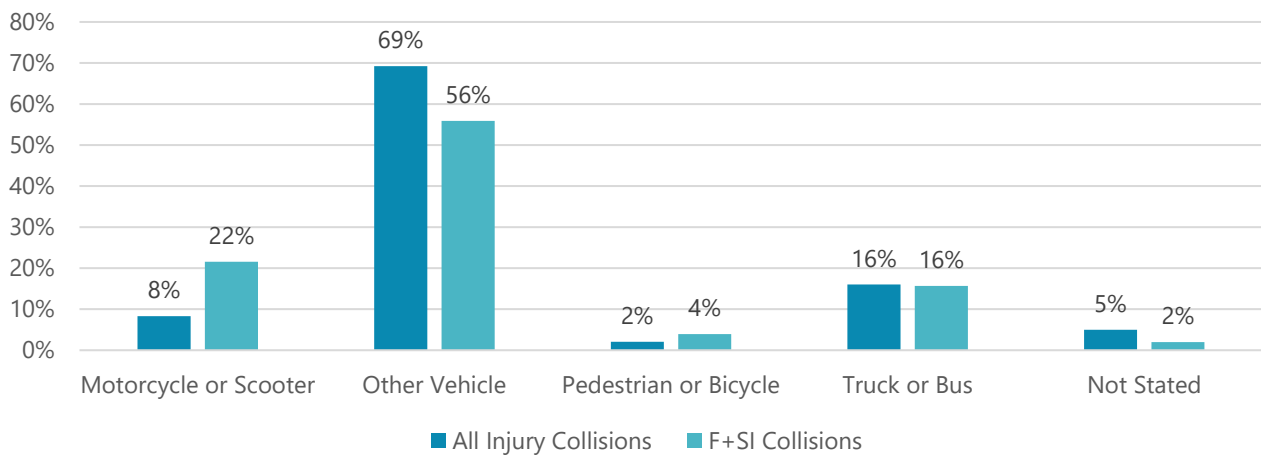


TRANSPORTATION MODES

In addition to motor vehicle involved with, modes include a more detailed breakdown of the vehicle type at fault in the accident, including motorcycles and trucks. For all injury collisions, the majority occurred with another vehicle (69%), followed by truck or bus (16%). Collisions with other vehicles also makes up the majority of F+SI collisions, but motorcycle/scooter collisions comprise a significant percentage, underscoring the fact that riding scooters and motorcycles is more vulnerable to a fatality or severe injury.

Figure 13 illustrates the percentage for all injury collisions as well as F+SI collisions by mode.

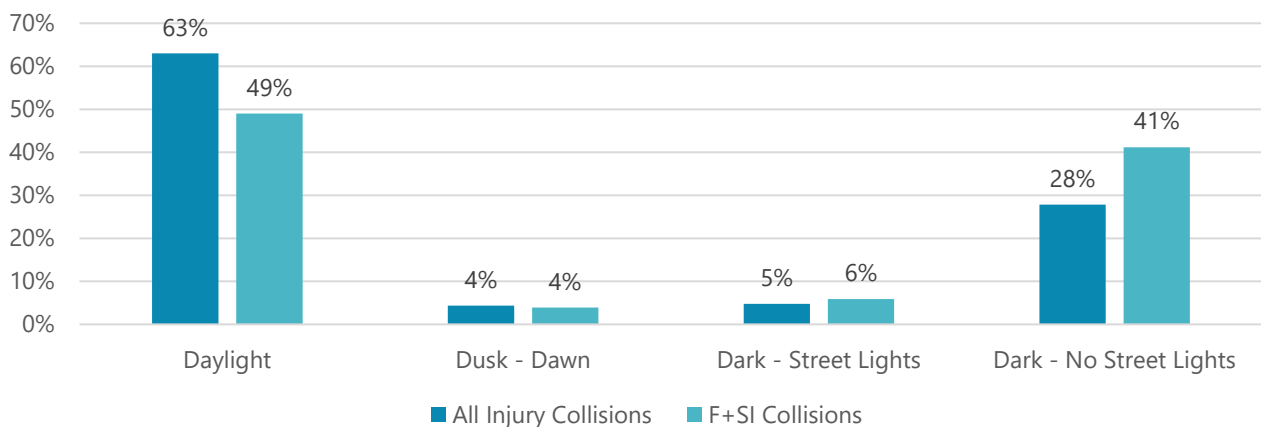
FIGURE 13: TRANSPORTATION MODES: ALL INJURY COLLISIONS AND F+SI COLLISIONS



LIGHTING

For all injury collisions, 63% of collisions occurred in daylight, while 28% of collisions occurred in the dark on streets with no street lights. For F+SI collisions, 49% of collisions occurred in daylight and 41% of collisions occurred in the dark on streets with no street lights. **Figure 14** illustrates the lighting condition for all injury collisions and F+SI collisions.

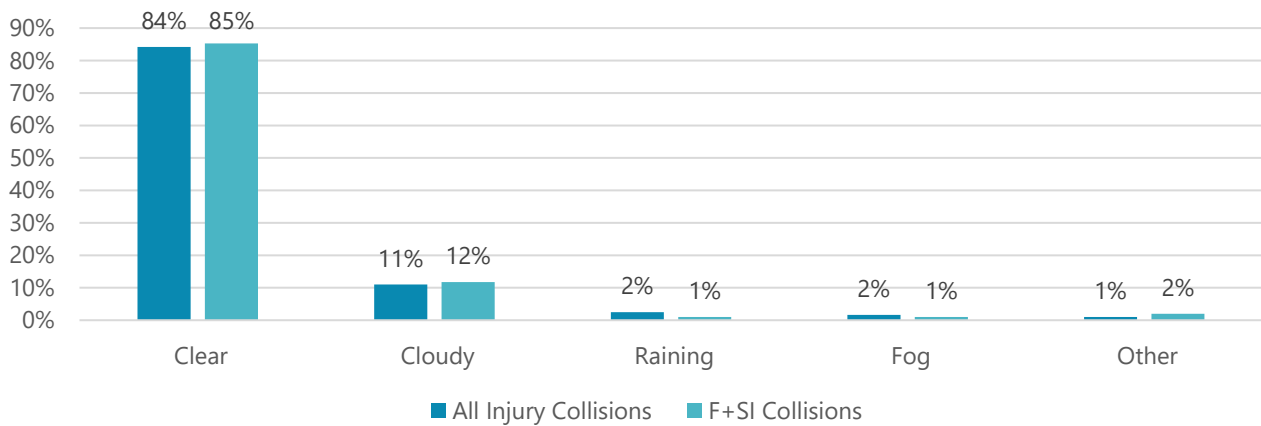
FIGURE 14: LIGHTING CONDITIONS: ALL INJURY COLLISIONS VS. F+SI COLLISIONS



WEATHER

For all injury collisions, the vast majority occurred during clear weather conditions (84%). For F+SI collisions similar trends have been observed, with 85% of the collisions having occurred during clear weather conditions. **Figure 15** illustrates the percent distribution of weather conditions during an occurrence of all injury collisions as well as F+SI collisions.

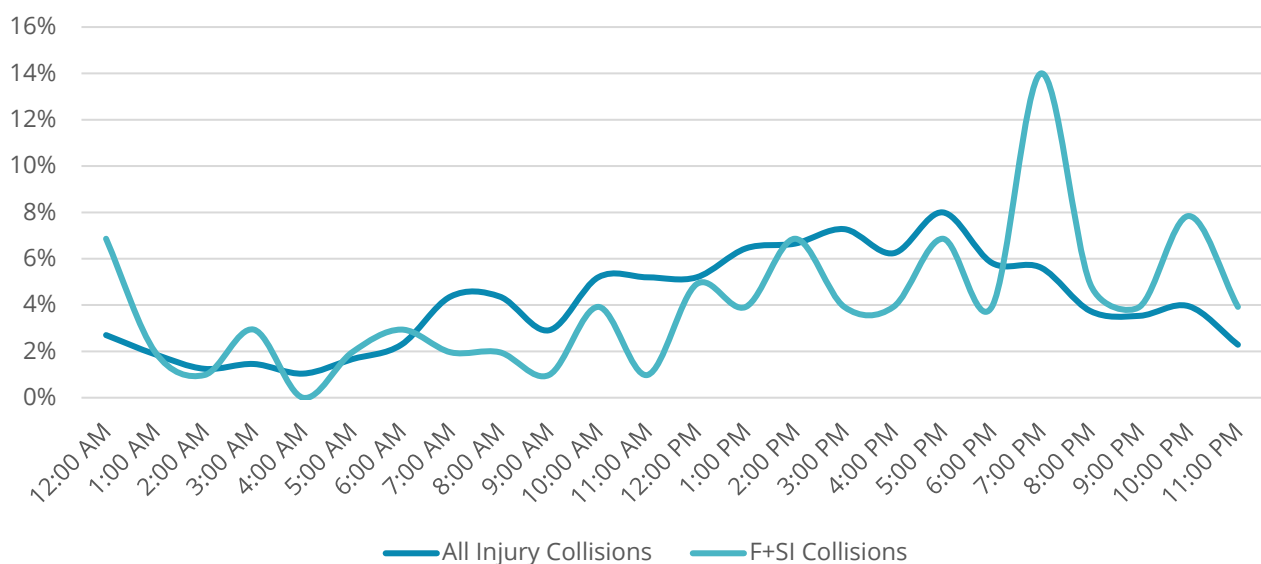
FIGURE 15: WEATHER CONDITIONS: ALL INJURY COLLISIONS AND F+SI COLLISIONS



TIME OF DAY

For all injury collisions, the hour with the most number of collisions was between 5:00 p.m. to 6:00 p.m. (8%), while the hours with the fewest number of collisions was between 2:00 a.m. to 5:00 a.m. (1% each). For all F+SI collisions, the maximum number of collisions occurred between 7:00 p.m. to 8:00 p.m. (14%). Other notable hours that had high F+SI collisions were 10:00 p.m. to 11:00 p.m. (8%), 2:00 p.m. to 3:00 p.m. (7%), and 5:00 p.m. to 6:00 p.m. (7%). The six-hour period beginning at 2:00 pm. and ending at 8:00 p.m. had 39% of F+SI collisions. **Figure 16** illustrates the percentage of collisions occurring during each hour of the day for all injury collisions as well as F+SI collisions.

FIGURE 16: TIME OF DAY: ALL INJURY COLLISIONS AND F+SI COLLISIONS



F+SI Collisions

This section describes a detailed cross-tabulation collision analysis performed for F+SI collisions occurring at roadway segments and intersections in unincorporated Solano County. Of the total 102 F+SI collisions that occurred during the study period (2018-2022), 64 collisions (63%) occurred on roadway segments and 38 collisions (37%) occurred at intersections. This distribution is illustrated in **Figure 17**.

FIGURE 17: INTERSECTION AND ROADWAY SEGMENT COLLISIONS – F+SI COLLISIONS

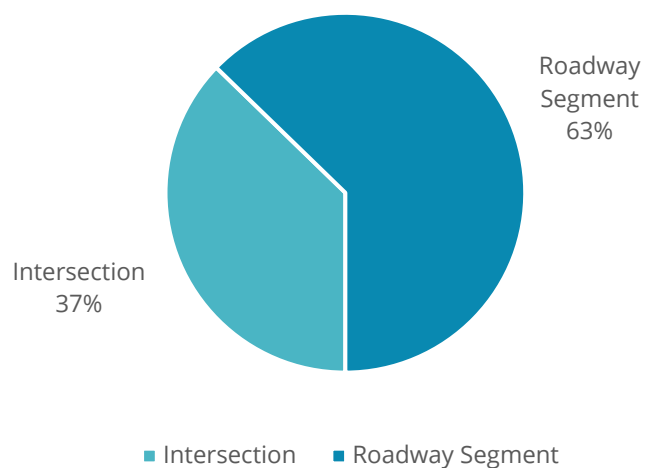
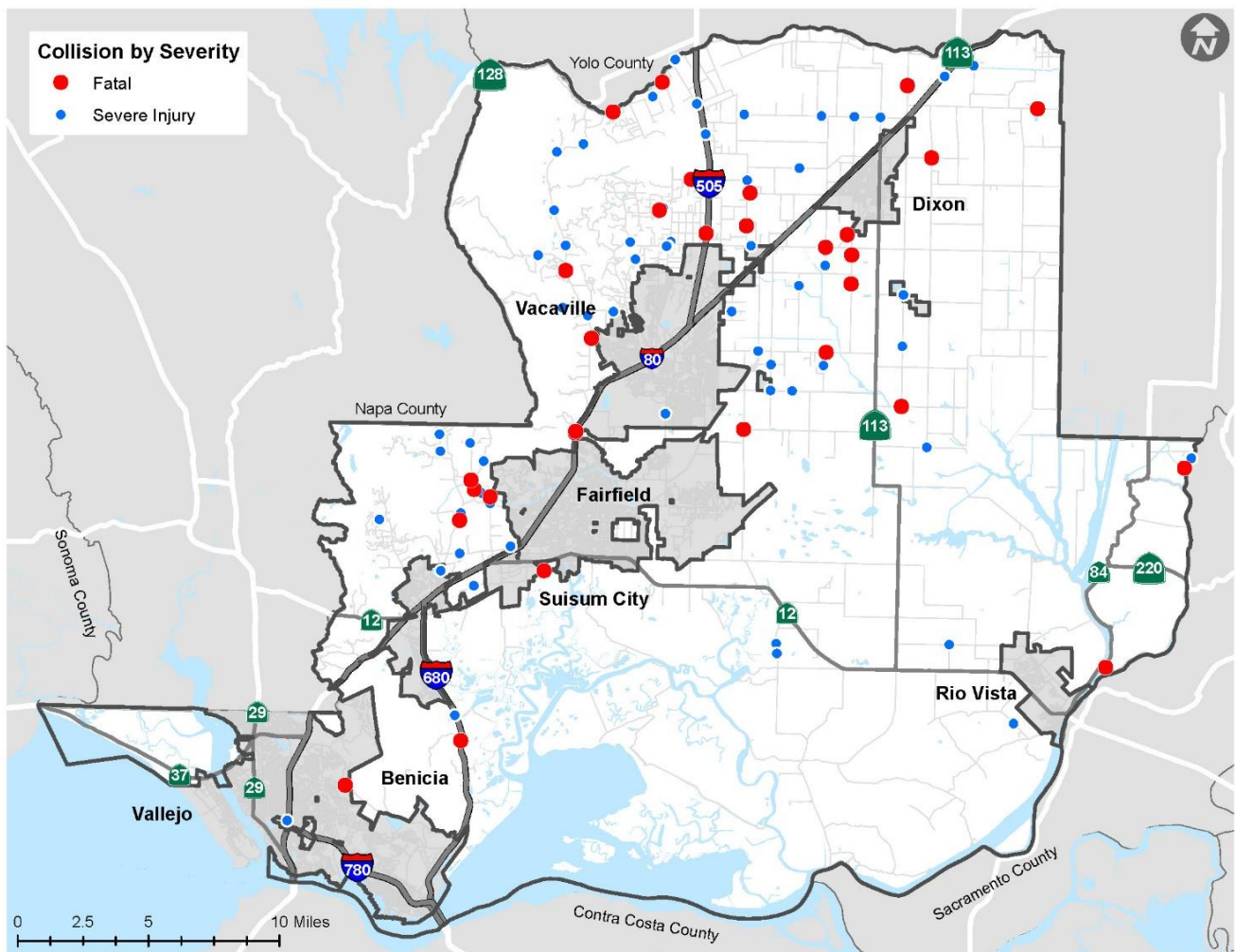


Figure 18 maps the F+SI collisions that occurred in unincorporated Solano County during the study period.

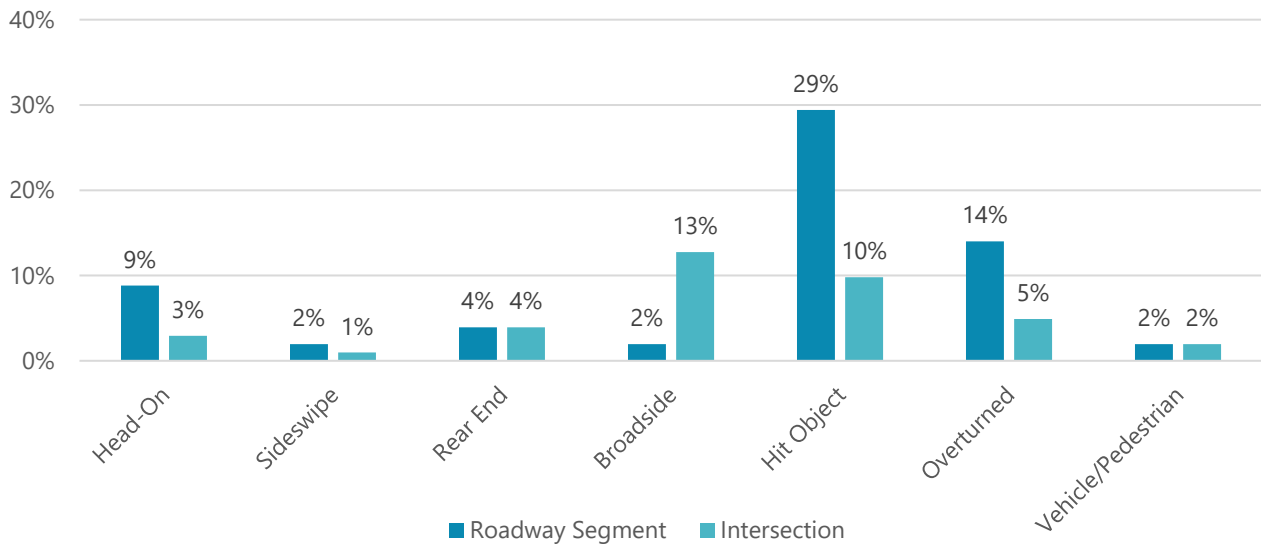
FIGURE 18: F+SI COLLISIONS IN SOLANO COUNTY (2018-2022)



COLLISION TYPE AND LOCATION TYPE

The most common F+SI collision type was hit objects. These collisions were most likely to occur on roadway segments, along with overturned and broadside collisions. Broadside collisions that led to an F+SI more commonly occurred at intersections. **Figure 19** shows F+SI collisions locations as well as the collision type.

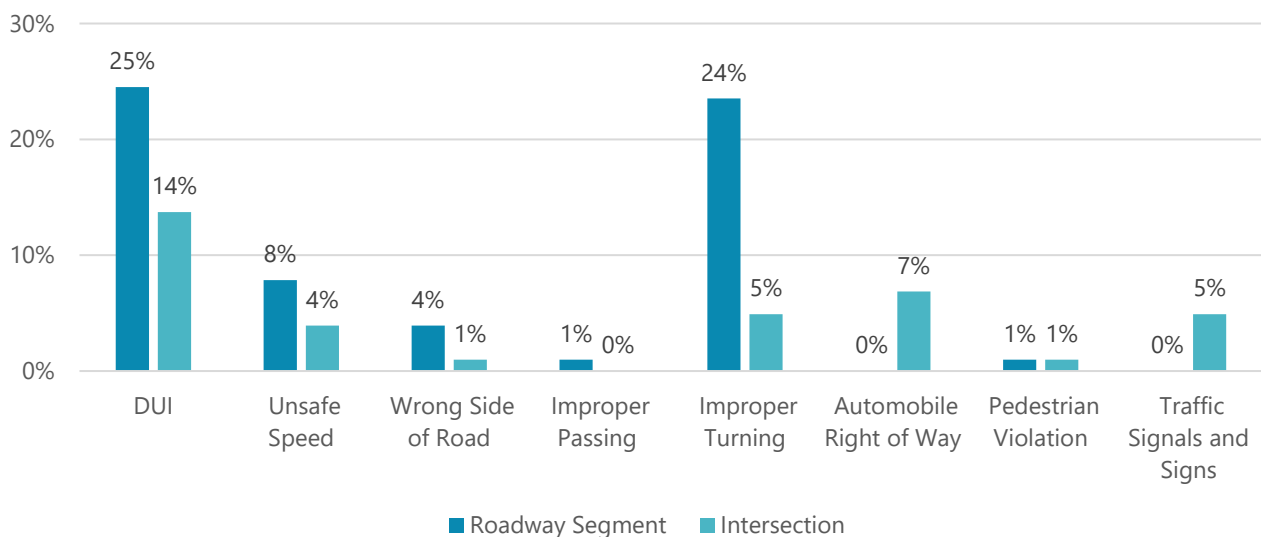
FIGURE 19: F+SI COLLISIONS: COLLISION TYPE AND LOCATION TYPE (2018-2022)



VIOLATION CATEGORY AND LOCATION TYPE

The most common F+SI collision type were DUI, improper turning, and unsafe speed collisions. These F+SI collisions primarily occurred on roadway segments. DUI was also the most common violation category at intersections, followed by automobile right of way and traffic signals and signs. **Figure 20** shows F+SI collisions as well as the location type and violation category.

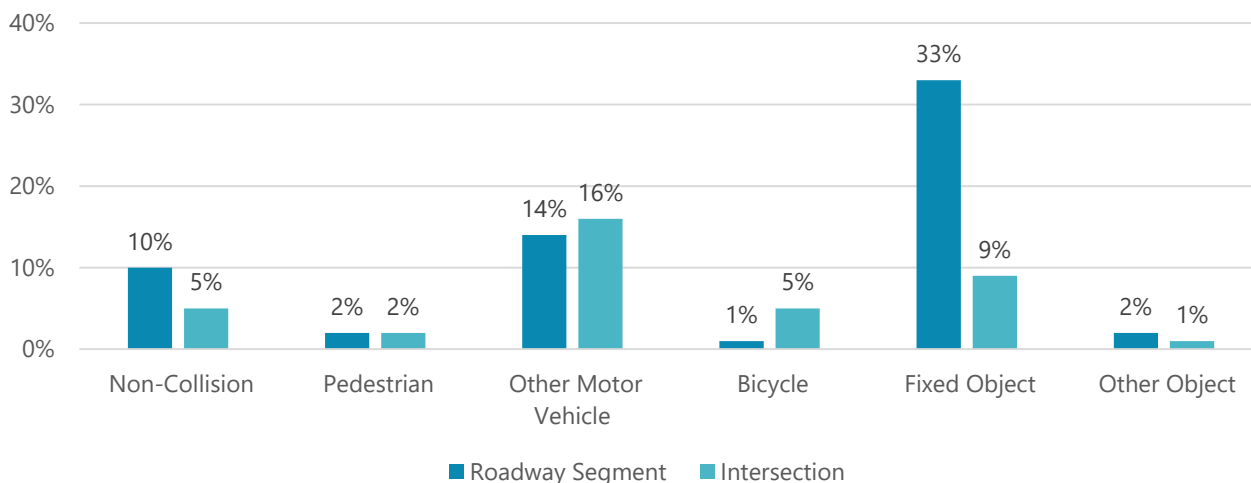
FIGURE 20: F+SI COLLISIONS: VIOLATION CATEGORY AND LOCATION TYPE (2018-2022)



MOTOR VEHICLE INVOLVED WITH AND LOCATION TYPE

Collisions involving a fixed object were the most common types of F+SI type collisions occurring on roadway segments. The same types of collisions occurred at intersections, however, more occurred with other motor vehicles than with fixed objects. **Figure 21** shows F+SI collision locations as well as the motor vehicle involved with category.

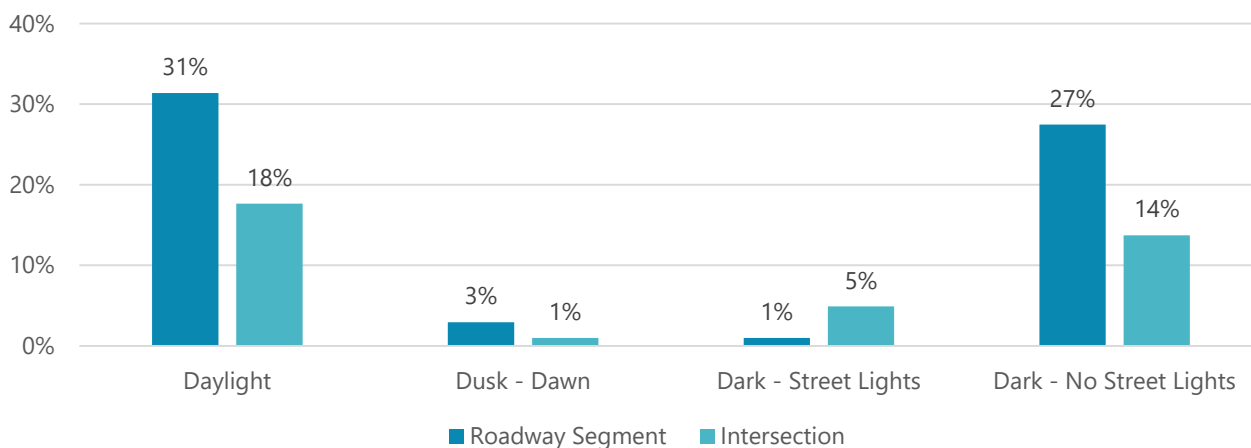
FIGURE 21: F+SI COLLISIONS: MOTOR VEHICLE INVOLVED WITH AND LOCATION TYPE (2018-2022)



LIGHTING AND LOCATION TYPE

Most F+SI collisions occurred in daylight on roadway segments. The second most common lighting condition for F+SI collisions was collisions that occurred in the dark with no street lights. **Figure 22** shows F+SI collision locations as well as lighting conditions.

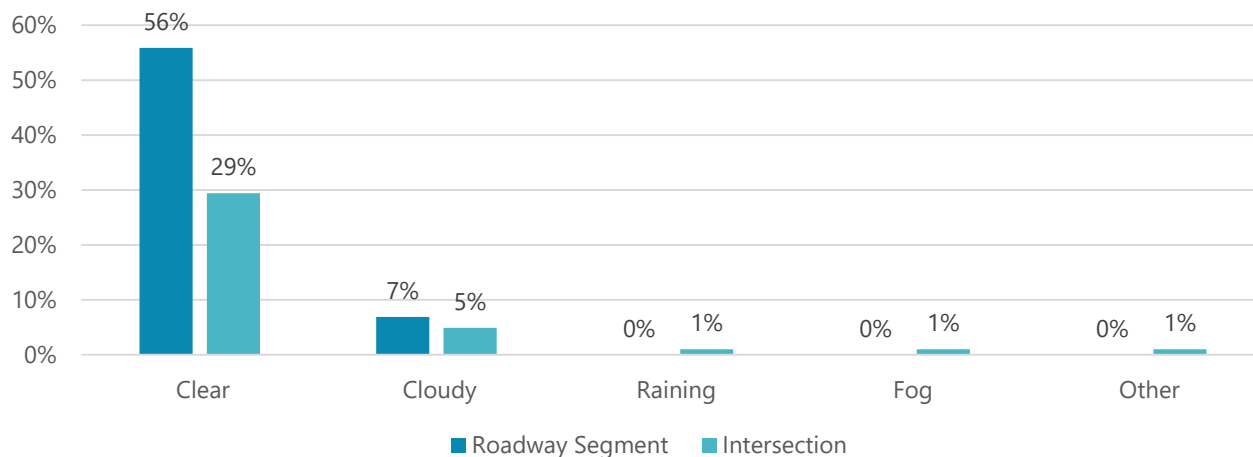
FIGURE 22: F+SI COLLISIONS: LIGHTING AND LOCATION TYPE (2018-2022)



WEATHER AND LOCATION TYPE

The majority of F+SI collisions occurred during clear weather on roadway segments and at intersections. **Figure 23** shows F+SI collision locations as well as weather conditions.

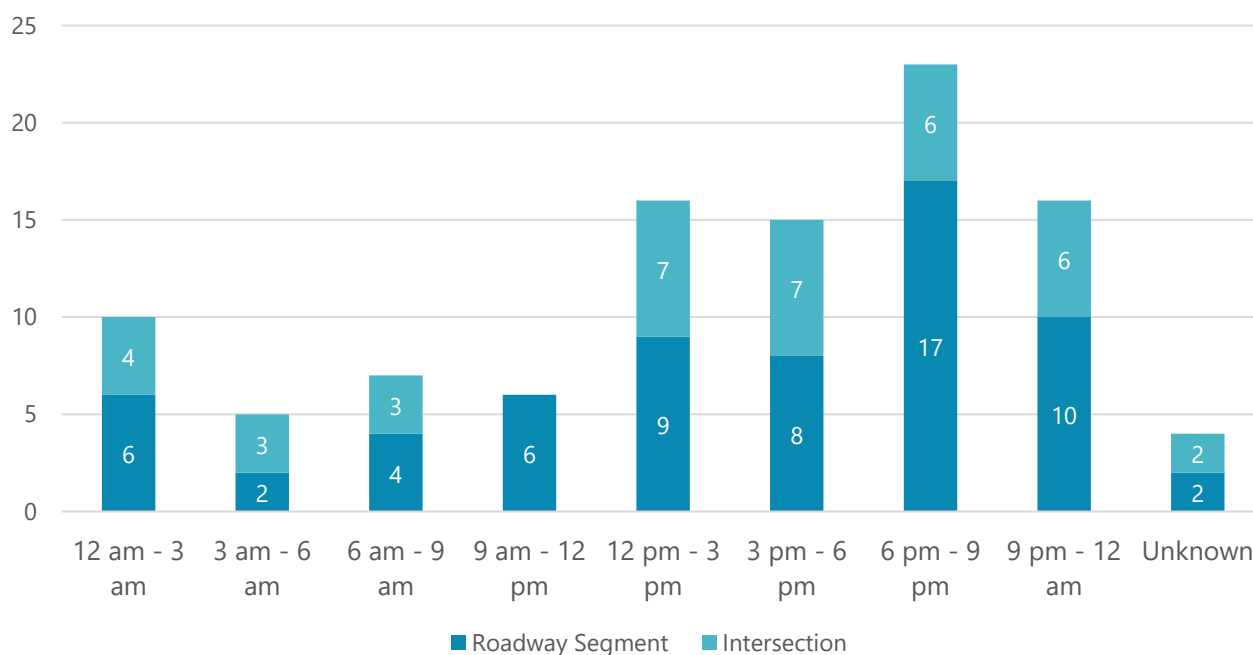
FIGURE 23: F+SI COLLISIONS: WEATHER VS LOCATION TYPE (2018-2022)



TIME OF DAY AND LOCATION TYPE

The time period with the most F+SI collisions was during 6:00 p.m. to 9:00 p.m. For roadway segments, the time period between 6:00 p.m. to 9:00 p.m. had highest collisions. **Figure 24** shows F+SI collisions by location type and time of day.

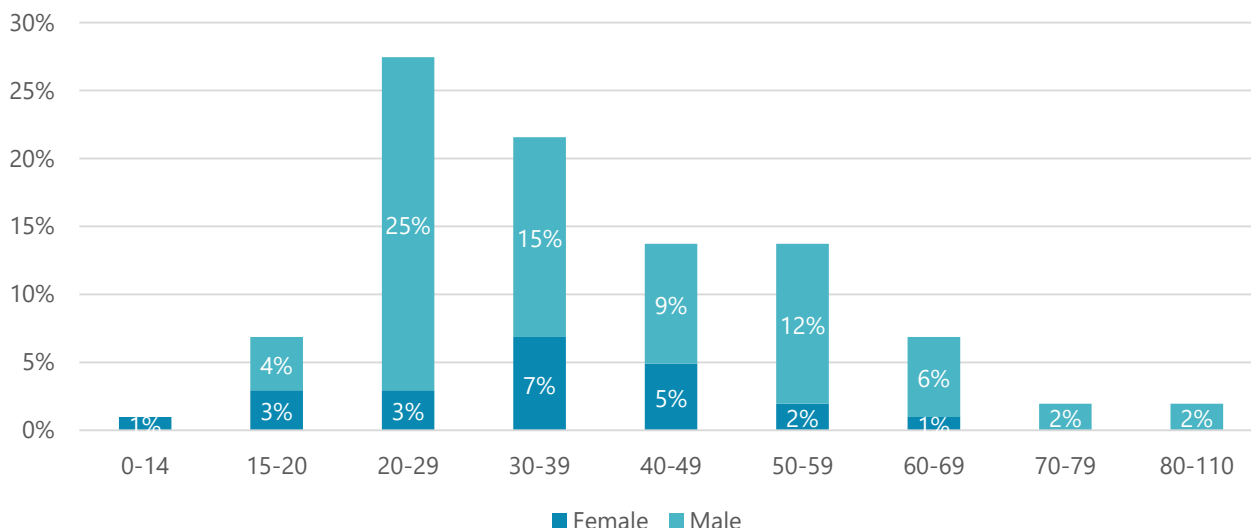
FIGURE 24: F+SI COLLISIONS: TIME OF DAY AND LOCATION TYPE (2018-2022)



GENDER AND AGE

For F+SI collisions, the gender of the party at fault was much more likely to be male than female (75% of F+SI collisions were caused by a male). The party at fault was also more likely to be younger, with the largest age group being 20-29 years (28%). Parties at fault under 40 years of age accounts for just over half (57%) of all F+SI collisions. **Figure 25** illustrates the gender and age of the party at fault for F+SI collisions.

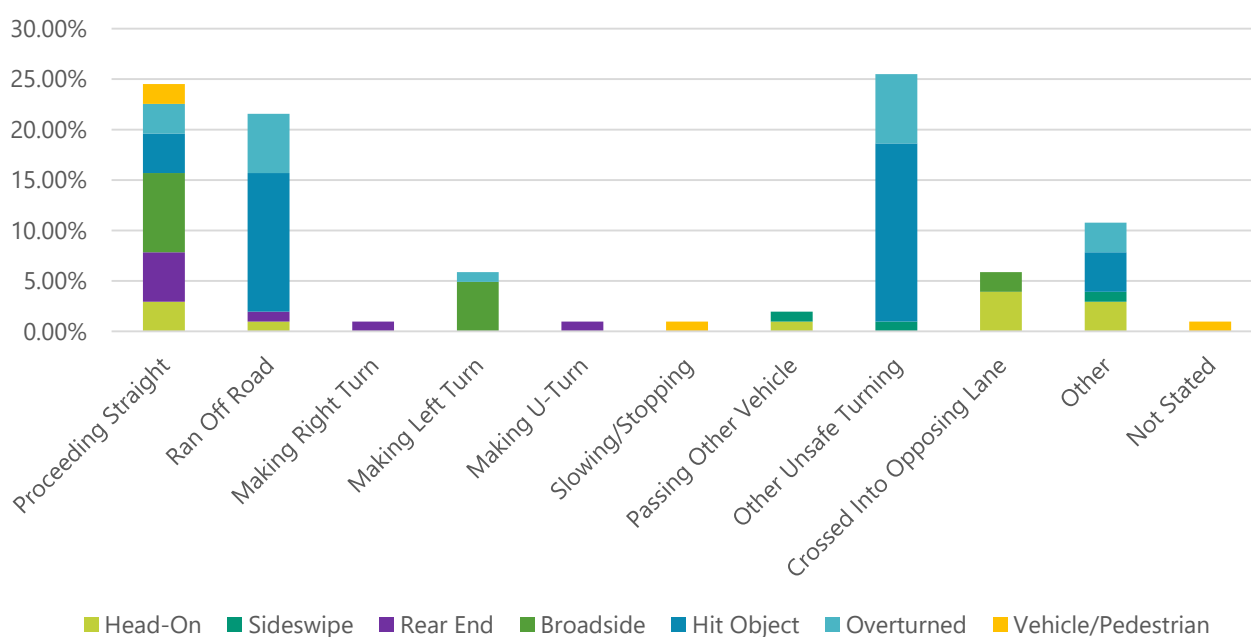
FIGURE 25: F+SI COLLISIONS BY GENDER AND AGE



COLLISION TYPE AND MOVEMENT PRECEDING COLLISION OF PARTY AT FAULT

The most common type of collision for F+SI collisions was hit objects. Of these collisions, other unsafe turning was the most common movement preceding the collision of the party at fault (18%), followed by ran off road (14%). **Figure 26** shows this distribution.

FIGURE 26: F+SI COLLISIONS BY COLLISION TYPE AND MOVEMENT PRECEDING COLLISIONS OF PARTY AT FAULT



GEOGRAPHIC COLLISION ANALYSIS

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

HIT OBJECT COLLISIONS

Hit object collisions represented the highest proportion of both collisions of all injury (36%), and F+SI collisions (39%). **Figure 27** shows the distribution of hit object injury collisions throughout unincorporated Solano County between 2018 and 2022. Pleasants Valley Road, Suisun Valley Road, Gibson Canyon Road, and Mankas Corner Road, Lopes Road have a higher frequency of hit object collisions, compared to other unincorporated Solano County roads.

IMPROPER TURNING COLLISIONS

For F+SI collisions in unincorporated Solano County, 28% of collisions were improper turning collisions. It was the most common violation type among all injury collisions (30%). **Figure 28** shows the distribution of improper turning collisions throughout unincorporated Solano County between 2018 and 2022. Pleasants Valley Road, Suisun Valley Road, Lopes Road and Gibson Canyon Road have a higher concentration of improper turning collisions, compared to other unincorporated Solano County roads.

BROADSIDE COLLISIONS

For all injury collisions in unincorporated Solano County, 24% were broadside collisions. The share of F+SI broadside collisions is 14%. A majority (83%) of broadside collisions occurred at intersection. **Figure 29** shows the distribution of broadside collisions throughout unincorporated Solano County between 2018 and 2022. Midway Road, Lewis Road, S A St, and Hawkins Road have a higher concentration of broadside collisions, compared to other unincorporated Solano County roads.

NIGHTTIME COLLISIONS

Nighttime collisions accounted for 37% of all injury collisions and 51% of F+SI collisions. The majority of these nighttime collisions occurred in areas without street lights, given the unincorporated county's rural nature. **Figure 30** shows the distribution of nighttime collisions throughout unincorporated Solano County between 2018 and 2022. Midway Road, Putah Creek Road, Suisun Valley Road, and Gibson Canyon Road have a higher frequency of nighttime collisions, compared to other unincorporated Solano County roads.

DUI COLLISIONS

For F+SI collisions in unincorporated Solano County, 38% of collisions were reported as DUI collisions (compared to only 20% of all injury collisions). **Figure 31** shows the distribution of DUI collisions throughout the Unincorporated Solano County between 2018 and 2022. Putah Creek Road, Mankas Corner Road, Meridian Road, and Green Valley Road have a higher frequency of DUI collisions, compared to other unincorporated Solano County roads.



FIGURE 27: SOLANO COUNTY HIT OBJECT COLLISIONS (2018-2022)

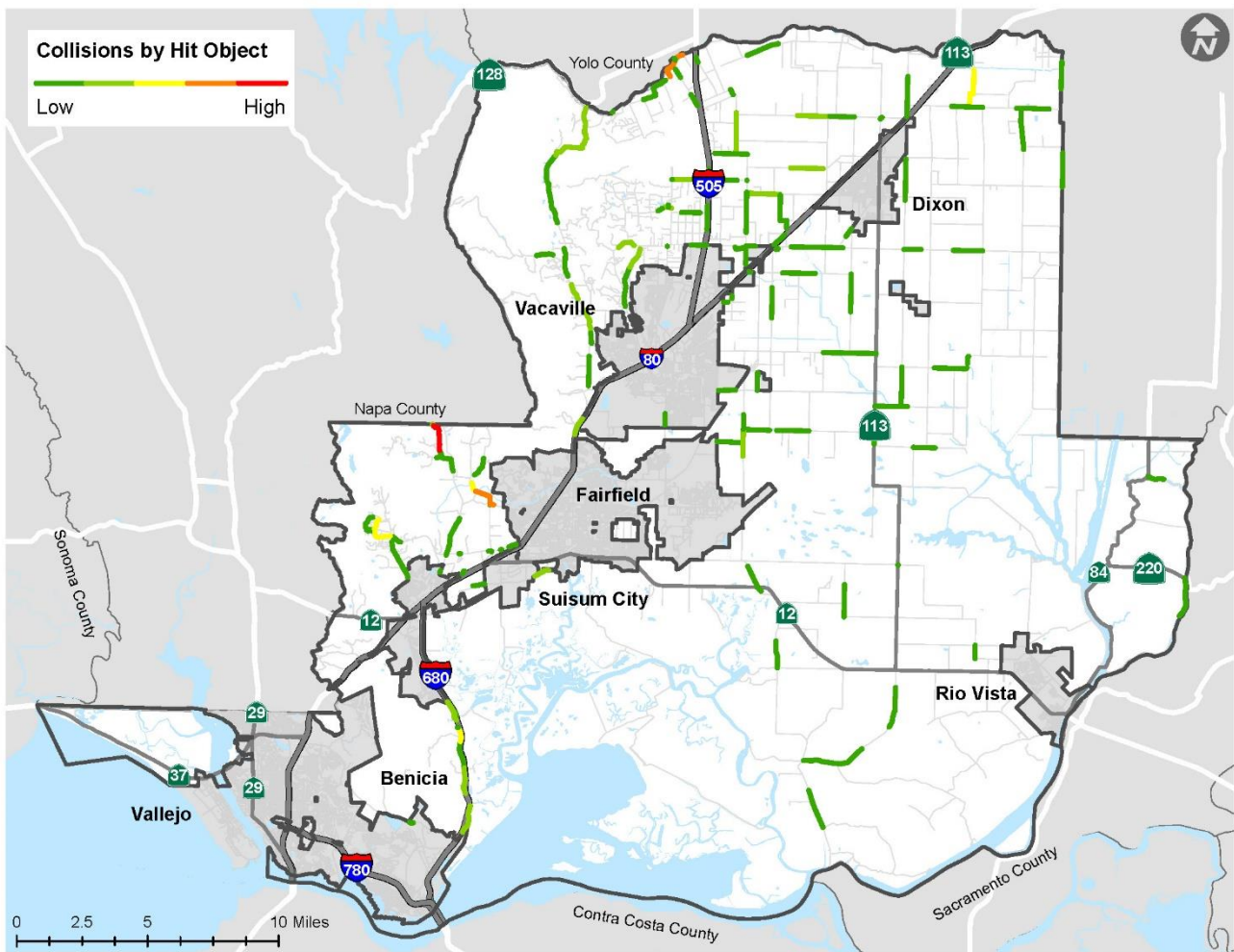


FIGURE 28: SOLANO COUNTY IMPROPER TURNING COLLISIONS (2018-2022)

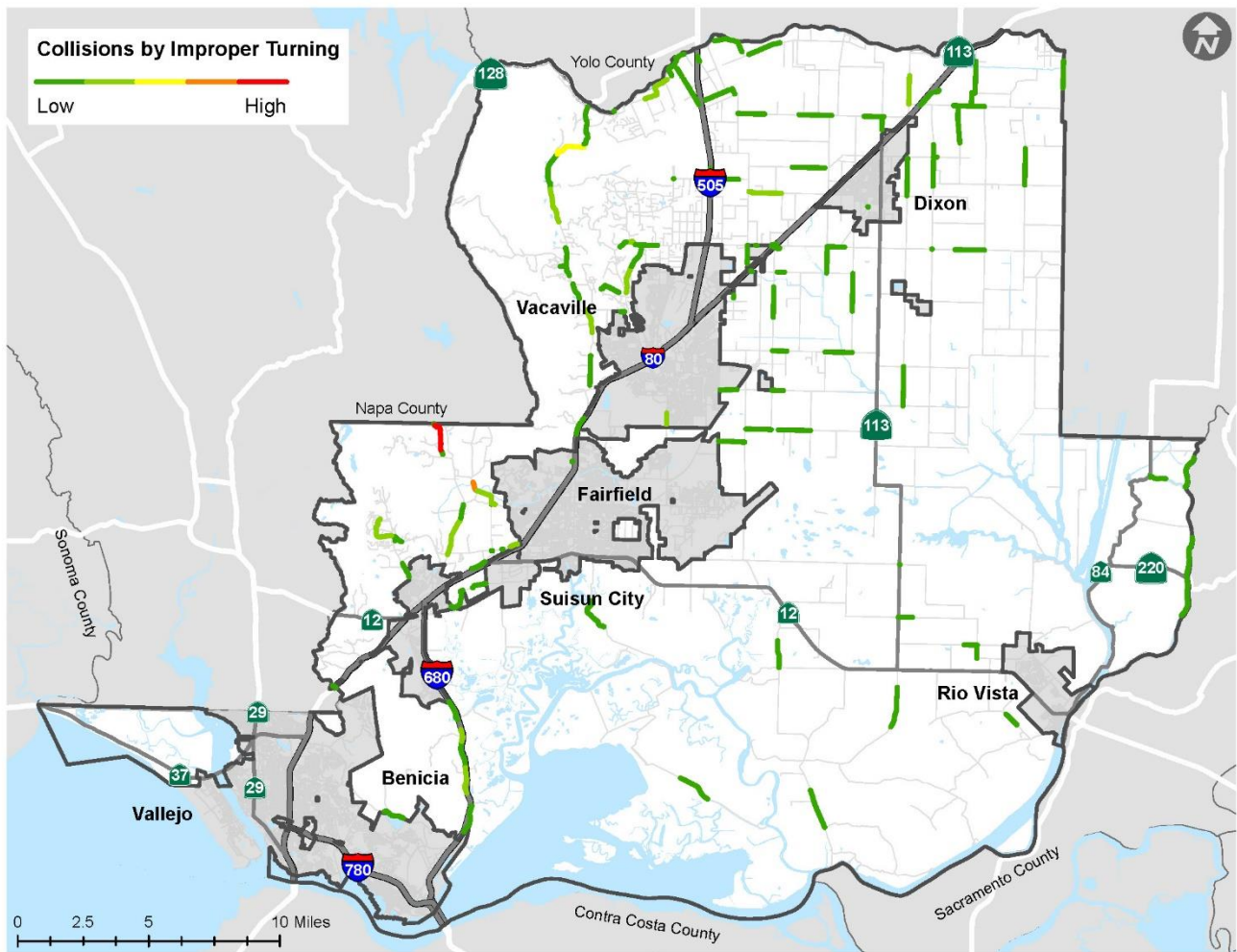


FIGURE 29: SOLANO COUNTY BROADSIDE COLLISIONS (2018-2022)

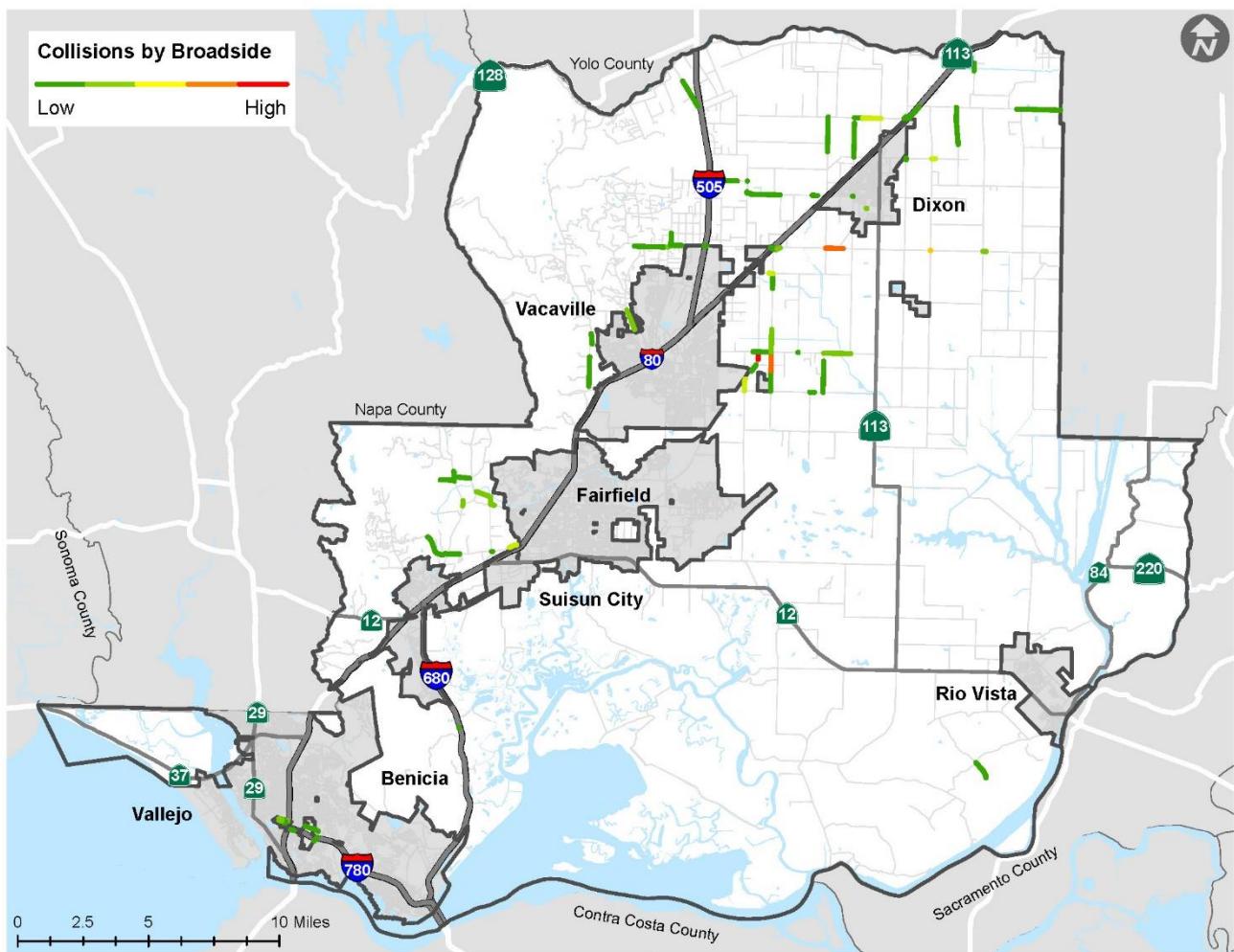


FIGURE 30: SOLANO COUNTY NIGHTTIME COLLISIONS (2018-2022)

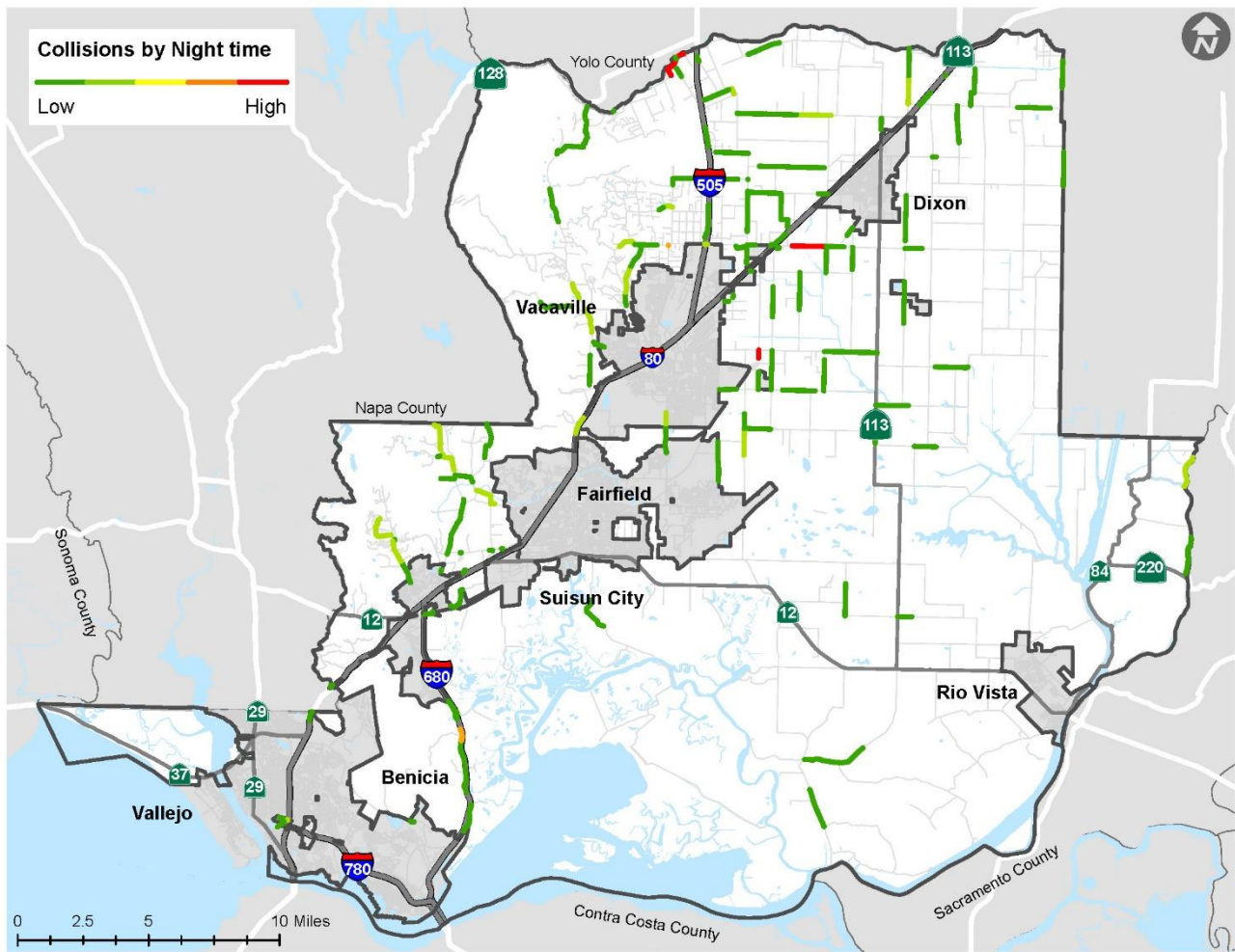
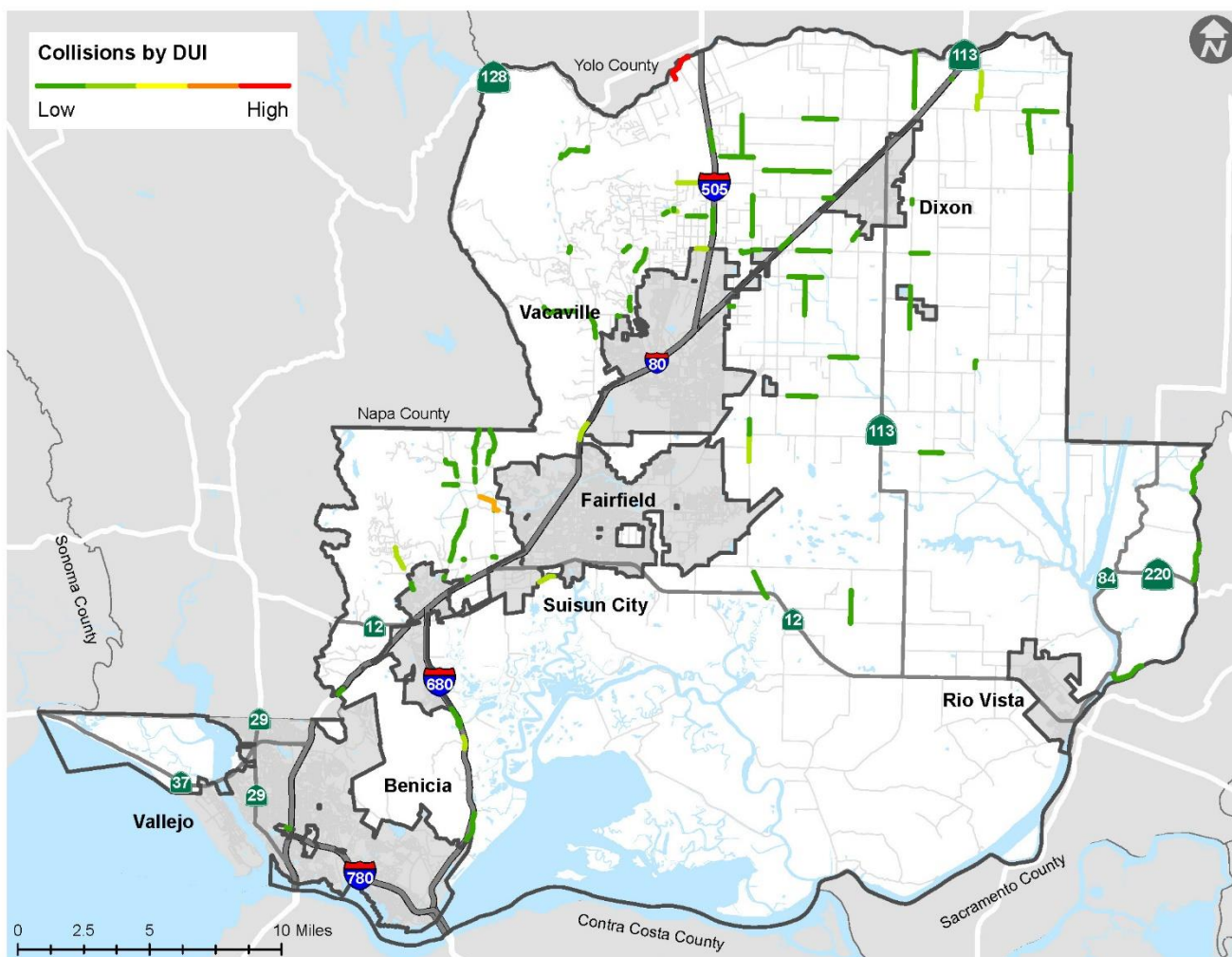


FIGURE 31: SOLANO COUNTY DUI COLLISIONS (2018-2022)



Collision Severity Weight

The California Department of Transportation (Caltrans) uses the cost of a collision as the unit of measurement to compare locations where collisions have occurred. The comparison leads to a prioritized list of roadways and intersections to receive funds for safety improvements. The cost factor is comprehensive in that F+SI collision is weighed with a much higher cost than property damage only collision. A collision severity weight was used to identify the high severity collision network, using the EPDO method. The EPDO method accounts for both the severity and frequency of collisions by converting each collision to an equivalent number of 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 11 application. The weights used in the analysis are shown below in **Table 3**.

TABLE 3: EPDO SCORE USED IN HIGHWAY SAFETY IMPROVEMENT PROGRAM

COLLISION SEVERITY	EPDO SCORE*
Fatal	165
Severe	165
Visible Injury	11
Possible Injury	6
PDO	1

**This is the score used in HSIP Cycle 11 for collisions on roadway segments, to simplify the analysis this study uses the same score for all F+SI collisions, including those at intersections.*

EPDO is used because it provides a methodology for the project team to understand the locations in Solano County that are experiencing the most severe crashes. Because of the high score given to F+SI 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. Identified intersections are scored based on collisions occurring at or within 250 feet of the intersection, while roadway segment locations are identified based on collisions that occur along the segment, except directly at an intersection (0 feet from intersection per the collision data). Identifying the locations with the most severe crashes allows the team to focus recommended solutions and countermeasures at these locations.

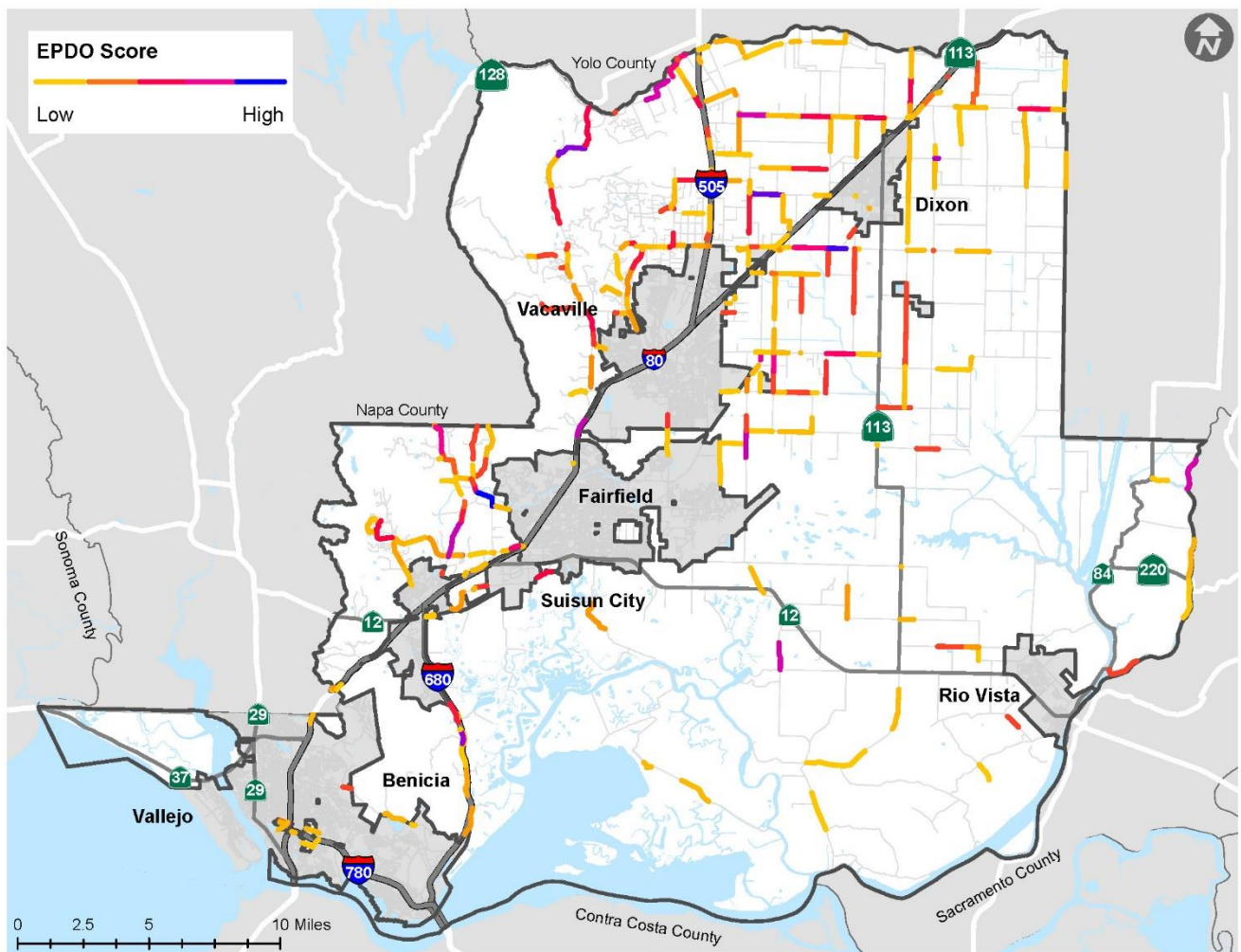
The EPDO scores for all collisions can then be aggregated in a variety of ways to identify collision patterns, such as location hot-spots. The weighted collisions for the Solano County were geolocated onto county's road network. For the purposes of this analysis, PDO collisions were excluded. GIS is then used to calculate the EPDO score for each roadway segment and intersection countywide, which is then ranked according to its score.

The EPDO scores for all collisions are aggregated in a variety of ways to identify collision patterns, such as location hot-spots. The weighted collisions were geo-located on to unincorporated Solano County's road network.

Figure 32 shows the location and geographic concentration of collisions by their EPDO score.



FIGURE 32: SOLANO COUNTY SEVERITY INDEX



High Injury Network

The next step in the process was to identify high-risk roadway segments and intersections in unincorporated Solano County. The methodology for scoring the high injury locations is the EPDO method; that is, the same method used in the severity weight section.

Figures 33 and **Figure 34** show the top 14 high-collision intersections and top 15 high-collision roadway segments.

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 zero value in intersection distance column in the SWITRS dataset.



FIGURE 33: SOLANO COUNTY HIGH INJURY INTERSECTIONS

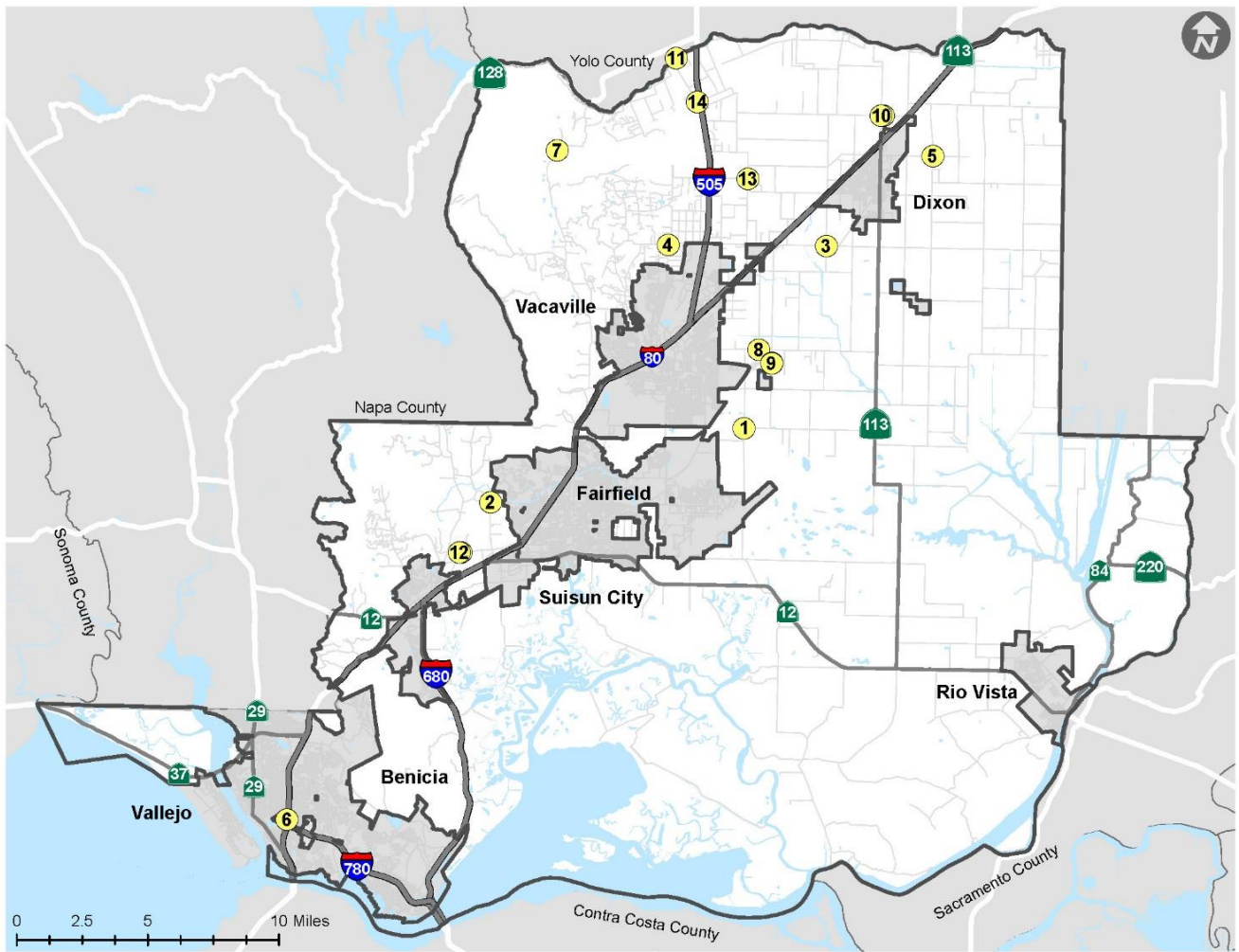
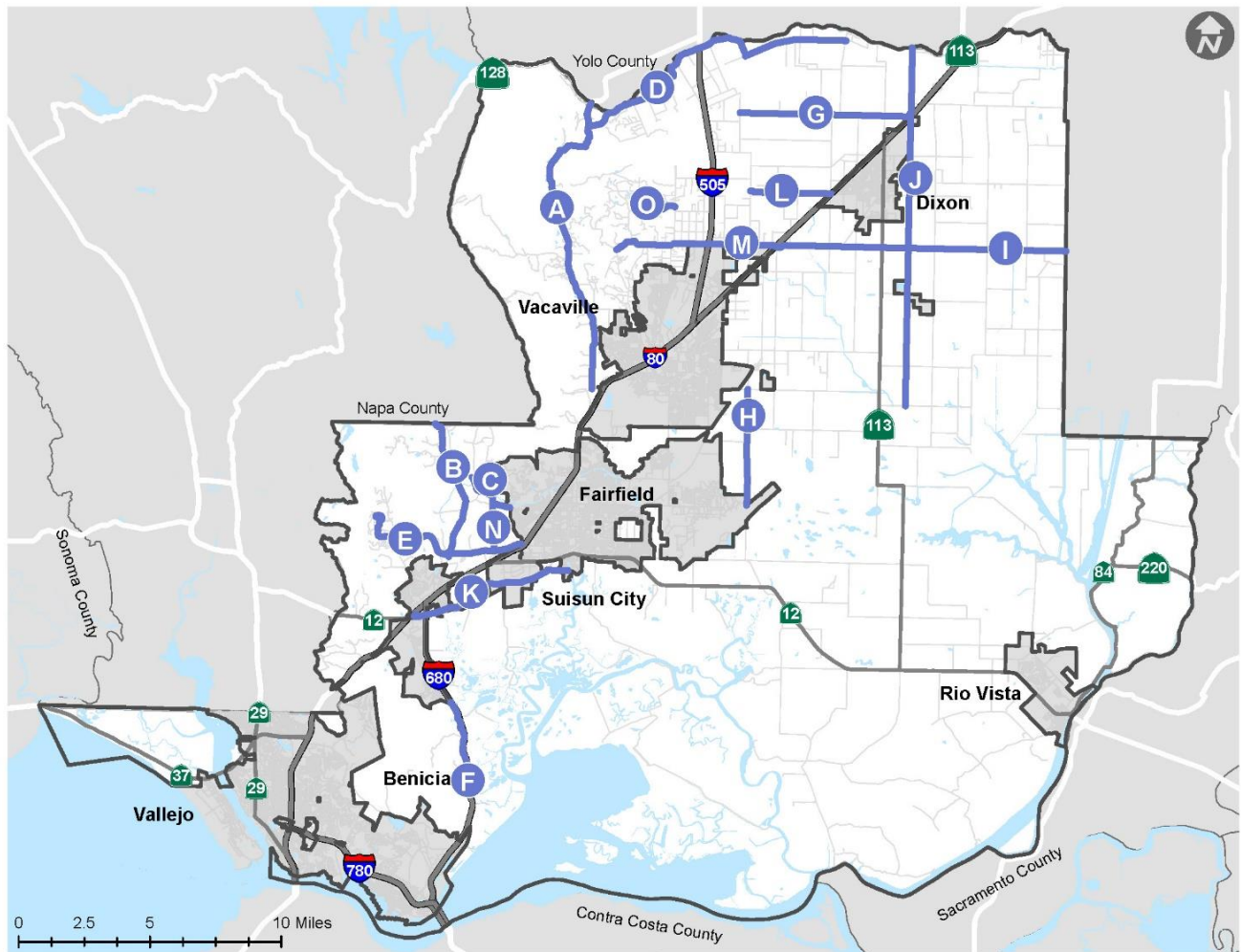


FIGURE 34: SOLANO COUNTY HIGH INJURY ROADWAY SEGMENTS



INTERSECTION RANKING

A total of 14 intersections were identified as high injury intersections. There were a total of 22 F+SI collisions that occurred at these intersections. The intersection of Hay Road and Meridian Road has the highest EPDO score, indicating the suggested highest priority location for improvement.

Table 4 lists the EPDO score of the top 14 identified high-collision intersections along with the types of collisions that were occurred at these locations.

TABLE 4: HIGH INJURY INTERSECTIONS

ID	Intersection	Total	F+SI	HIT OBJECT	IMPROPER TURNING	BROAD -SIDE	NIGHT-TIME	DUI	EPDO Score
1	Hay Road and Meridian Road	3	3	2	0	0	3	3	495
2	Abernathy Road and Mankas Corner Road	5	2	1	1	1	2	1	353
3	Batavia Road and Midway Road	4	2	1	1	3	0	0	342
4	Browns Valley Road and Cantelow Road/ Timm Road	4	2	1	0	2	3	0	342
5	Robben Road and Vaughn Road	3	2	0	1	3	1	0	341
6	Benicia Road and Lemon Street/ Lincoln Road	3	2	0	0	2	2	1	336
7	Quail Canyon Road and Pleasants Valley Road	2	2	0	1	0	0	0	330
8	Byrnes Road and Hawkins Road	11	1	0	0	10	4	0	240
9	Holdener Road and Lewis Road	6	1	0	0	6	1	0	210
10	Sievers Road and Currey Road	3	1	0	1	3	0	0	182
11	Railroad Avenue and Putah Creek Road	2	1	2	0	0	2	2	176
12	Rockville Road and Willotta Drive	2	1	1	0	1	1	1	176
13	Meridian Road and Allendale Road	2	1	1	0	1	1	0	171
14	Winters Road and Wolfskill Road	2	1	1	1	1	0	0	171



ROADWAY SEGMENT RANKING

A total of 15 corridors were identified as high injury corridors. There were 49 F+SI collisions on these corridors. The corridor with the highest number of F+SI collisions is Pleasants Valley Road with seven F+SI collisions.

Table 5 lists the EPDO score of the top 15 identified high-collision corridors along with the number of F+SI collisions, total collisions, and length of corridor.

TABLE 5: HIGH INJURY CORRIDORS

ID	Corridors	Total	F + SI	HIT OBJECT	IMPROPER TURNING	BROAD -SIDE	NIGHT- TIME	DUI	Length (miles)	EPDO Score
		Collisions								
A	Pleasants Valley Road: Yolo County Line to Cherry Glen Road	24	7	14	13	1	8	3	12.5	1302
B	Suisun Valley Road: 650 ft. south of Rockville Road to Napa County Line	23	5	10	11	2	6	3	5.7	963
C	Mankas Corner Road: Fairfield City Limit to Clayton Road	14	3	7	6	2	3	3	2.1	921
D	Putah Creek Road: Pleasants Valley Road to Stevenson Bridge Road	13	3	6	6	0	5	3	12.0	745
E	Rockville Road: Fairfield City Limit to Tartan way	21	4	8	7	5	5	2	7.1	637
F	Lopes Road: 5600 ft. north of Marshview Road to 1500 ft. south of Parish Road	9	3	8	6	0	6	3	3.5	546
G	Sievers Road: Halley Road to Pedrick Road	9	4	2	3	2	4	1	6.5	535
H	Meridian Road: Fry Road to Fairfield City Limit	4	3	3	0	0	3	3	4.4	501
I	Midway Road: Leeve Road to Timm Road	20	3	6	4	3	8	5	14.9	477
J	Pedrick Road: Yolo County Line to Maine Prairie Road	13	2	5	4	0	5	3	13.6	441
K	Cordelia Road: I-80 to Park Lane	9	2	3	3	0	1	2	7.0	387
L	Dixon Avenue: I-80 to Meridian Road	7	2	2	2	2	2	1	3.0	375
M	Cantelow Road: Browns Valley Road to Steiger Hill Road	7	3	4	3	1	4	1	2.2	364
N	Abernathy Road: Mankas Corner Road to Rockville Road	4	3	1	1	0	2	1	1.8	341
O	Peaceful Glen Road: Timm Road to Acacia Lane	3	2	3	0	0	3	3	0.9	336



Cut-Through Traffic

Solano County experiences a high volume of inter-regional traffic between the Bay Area, Sacramento, and other regions due to its location on I-80 between regions. During peak periods and on peak weekend times, motorists on I-80 can experience heavy congestion at locations in Fairfield, Vacaville, and Dixon. As a result, many drivers exit the freeway and travel on unincorporated County roads to avoid the I-80 congestion, which can in turn cause congestion and safety issues on rural roads that, in many cases, were not designed to handle inter-regional traffic. As part of the LRSP process, County staff included seven additional corridors where large amounts of cut through traffic diverted from I-80 is experienced to receive countermeasures that could help address safety concerns. The corridors are as follows:

- Suisun Valley Road (traffic to and from Napa)
- Tremont Road between Dixon and Davis
- Midway Road between Vacaville and Dixon
- Lyon Road between Vacaville and Fairfield
- Sievers Road between Dixon and Davis
- Cherry Glen Road/Pleasants Valley Road
- Weber Road between Vacaville and Dixon



Chapter 3 Summary

During the study period of 2018-2022, a total of 481 injury collisions occurred on unincorporated Solano County roads, of which 102 resulted in either a fatality or severe injury. The number of collisions occurring each year has been slightly increasing except for a dip in 2019 and 2020. Based on the collision data, five prominent trends emerged: hit object collisions, improper turning collisions, broadside collisions, nighttime collisions, and DUI collisions. Each of these became the focus of analysis because they were prominent factors in causing F+SI collisions on Solano County roadways. A more detailed geographic analysis was conducted for each of the five identified trends.

Hit Object Collisions: This type of collision represented the highest proportion of F+SI collisions (39%), and all injury collisions (36%). They are most concentrated on Pleasants Valley Road, Suisun Valley Road, Gibson Canyon Road, and Mankas Corner Road, Lopes Road.

Improper Turning Collisions: This type of violation caused 28% of all F+SI collisions and was the most common violation type among all injury collisions (30%). They were observed to be more concentrated along Pleasants Valley Road, Suisun Valley Road, Lopes Road and Gibson Canyon Road.

Broadside Collisions: 24% of all injury collisions were broadside collisions, higher than its share of F+SI collisions (14%). They were more concentrated on Midway Road, Lewis Road, S A St, and Hawkins Road.

Nighttime Collisions: 37% of all injury collisions and 51% of all F+SI collisions occurred during low light conditions. The majority of these nighttime collisions occurred in areas without street lights, given the rural nature of unincorporated Solano County. Higher concentrations of nighttime collisions were observed on Midway Road, Putah Creek Road, Suisun Valley Road, and Gibson Canyon Road.

DUI Collisions: 38% of F+SI collisions occurred as a result of motorists driving under the influence (compared to only 20% of all injury collisions). They were observed to be more concentrated along Putah Creek Road, Mankas Corner Road, Meridian Road, and Green Valley Road.

Once a geographic analysis was conducted of prominent collision trends, a collision severity weight was used to identify the high-risk network. 14 intersections and 15 roadway segments across the unincorporated County were identified as high-risk based on their EPDO score, which takes into account the severity of collisions occurring at a particular intersection or on a roadway segment. Pleasants Valley Road from Yolo County Line to Cherry Glen Road was identified as the highest ranking roadway segment, while Hay Road and Meridian Road was the highest ranking intersection and the only intersection with three F+SI collisions.

COMPARISON OF COLLISION TRENDS: 2016-2020 VS. 2018-2022

The 2023 Local Roadway Safety Plan (LRSP) analyzed collision data for the period of January 1, 2016, to December 31, 2020, in unincorporated Solano County. While there is an overlap of three years (2018, 2019, and 2020) with the current LRSP update covering the period from 2018 to 2022, it is essential to compare the notable collision trends observed in both study periods. This comparison can provide insights into the evolving traffic safety landscape and inform strategies for targeted interventions.

- A 33% increase in the number of F+SI collisions was observed during 2018-2022 period comparing to 2016-2020.
- While the overall trend of type of collisions remained similar comparing with previous LRSP trends, hit object injury collisions decreased by 11%, and the share of broadside injury collisions increased by 8%.
- DUI violation collisions increased by 5% during 2018-2022.



- Motor vehicle collisions with fixed objects decreased by 12% during 2018-2022.
- Motorcycle or scooter collisions increased from 3% to 8%, representing a 5% increase.
- F+SI collisions occurring in dark lighting conditions with no street lights increased from 29% to 41%, a difference of 12%.
- The peak time for F+SI collisions shifted from 12 pm to 3 pm (in the previous LRSP) to 6 pm to 9 pm.

NEXT STEPS

The next steps include identifying strategies corresponding to the 5 E's of safety (Engineering, Enforcement, Education, Equity and EMS) to comprehensively make the roadways of unincorporated Solano County safer for all modes of transportation.



CHAPTER 4 EMPHASIS AREAS

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

This chapter summarizes the top eight emphasis areas identified for unincorporated Solano County. These emphasis areas were derived from the consolidated high injury collision database (**Appendix C**) 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.

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**MS. This approach recognizes that not all locations can be addressed solely by engineering 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, EMS 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 Solano County

The County of Solano and partner agencies have implemented safety strategies corresponding to the 5 E's of traffic safety. The strategies detailed in this section can supplement these existing programs and concentrate ongoing effort on the High Injury Network and crash types. These initiatives are summarized in the following table:



TABLE 6: EXISTING TRAFFIC SAFETY EFFORTS IN SOLANO COUNTY

DOCUMENT/PROGRAM	DESCRIPTION	E'S ADDRESSED
2018 Solano Travel Safety Plan (2018)	This plan identifies the collision trends, such as crash types or violation types which were used to identify specific countermeasures and project lists for each jurisdiction in Solano County, including the unincorporated areas.	Engineering
Regional Traffic Impact Fee (RTIF)	Solano County assesses a Public Facility Fee that is utilized towards roadway and transit improvements throughout the county. 5% of the revenue is utilized for unincorporated County roads, with additional revenue coming from the revenue divided amongst the five RTIF districts. The fee averages \$1.4 million in revenue per year countywide (as of FY 2019-20).	Engineering
Highway Safety Improvement Program (HSIP) Projects	The County has been highly successful in obtaining HSIP funding for safety projects on unincorporated County roads. These include guard rail upgrades, shoulder widening, striping, and pedestrian upgrades. The County has been awarded funding most recently in Cycles 5, 6, 8, and 10.	Engineering
California Highway Patrol (CHP)	CHP Solano provides traffic enforcement on all unincorporated Solano County roads, in addition to state highways throughout the county.	Enforcement, EMS
CHP Start Smart Driver Safety Education	CHP Solano offers driver safety education classes, particularly for teens and their parents to teach safe driving habits and the rules of the road.	Education
Solano Active Transportation Plan – Unincorporated County Chapter (2020)	The chapter of Solano ATP includes a summary of the existing pedestrian and bicycle networks and recommends new engineering projects. The collision analysis section of this chapter summarizes the pedestrian and bicycle-involved collision trends and high-risk locations in Unincorporated Solano County.	Engineering
Solano Safe Routes to School Program	This program is established with the goal of increase the number of children walking and biking to school safely, reduce traffic congestion, and improve air quality around schools, increase daily physical activity levels and reduce obesity and other health risks, and improve academic performance among children.	Engineering Education
Safe Routes for Seniors	STA, utilizing a grant from the California Office of Traffic Safety, is implementing a program to promote pedestrian safety among older adults in Solano County. The goal is to engage the community, share information, and collaborate with city and county stakeholders to make local roadways safer.	Education, Engineering
Solano Mobility Program	The Solano Mobility Program provides mobility services and programs for commuters, employers, seniors, youth, and people with disabilities in Solano County. The variety of services and programs offer ways to get around the local community and beyond without driving.	Education
Mature Driver Improvement Courses	Solano Mobility offers DMV approved, mature driver courses designed for persons 55 years of age or older. The course focuses on an overview of current traffic laws, defensive driving techniques, and safe vehicle operations.	Education



Factors Considered in the Determination of Emphasis Areas

This section presents additional collision data analysis of collision type, collision factors, facility type, roadway geometries, and party level data, 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 F+SI collisions. For the purposes of determining the emphasis areas, only injury collisions on the High Injury Network are presented below. There were a total of 216 collisions occurred on high injury corridors and intersections. Doing so allows the project team to drill further down into the most predominant collision trends and specifically identify their causes at the high-risk locations. Three of the emphasis areas selected were also predominant collision trends in the unincorporated County from the 2018 Solano Travel Safety Plan: roadway departure collisions, DUI collisions, and improper turning collisions.

Each emphasis area is accompanied by comprehensive programs, policies and countermeasures to reduce collisions on County roads in that specific emphasis area. It will provide the basis by which the countermeasure toolbox is developed for each identified high-risk location. Additionally, the emphasis areas will be further refined from stakeholder and public input in subsequent stages of the study.

Solano County experienced 216 collisions on its High Injury Network, which consists of all identified high-risk intersections and roadway segments. All statistics presented below are based on these High Injury Network collisions. The identified emphasis areas are as follows:

- Emphasis Area 1 – Address Roadway Segment Collisions
- Emphasis Area 2 – Reduce Hit Object and Roadway Departure Collisions
- Emphasis Area 3 – Reduce Improper Turning Collisions
- Emphasis Area 4 – Address Driving Under the Influence Collisions
- Emphasis Area 5 – Reduce Broadside Collisions
- Emphasis Area 6 – Reduce Nighttime Collisions
- Emphasis Area 7 - Reduce Motorcycle Collisions
- Emphasis Area 8 - Address Younger Adult Party at Fault Collision



EMPHASIS AREA 1 – ADDRESS ROADWAY SEGMENT COLLISIONS

Of the 216 collisions that occurred on the High Injury Network, 125 (58%) of these collisions occurred on a roadway segment, including 36 F+SI collisions. The following collision data is based on only roadway segment injury collisions in the High Injury Network of the unincorporated Solano County, followed by E's strategies selected to address roadway segment collisions.

50% Hit Object

37% Nighttime

42% Improper Turning

TABLE 7: EMPHASIS AREA 1 STRATEGIES

OBJECTIVE: REDUCE THE NUMBER OF F+SI VEHICLE INJURY COLLISIONS ON ROADWAY SEGMENTS			
	STRATEGY	PERFORMANCE MEASURE	AGENCIES/ ORGANIZATIONS
Education	Conduct public information and education campaign for roadway safety laws regarding speeding, stop signs, and turning left or right.	Number of education campaigns and/or surveys	County/CHP
Enforcement	Targeted enforcement along high-risk roadway segments to monitor traffic law violations right-of-way violations, speed limit laws and other violations that occur along roadway segments.	Number of tickets issued	CHP
Engineering	- R01NT, Add Segment Lighting - R02, Remove or relocate fixed objects outside of Clear Recovery Zone - R04, Install Guardrail - R15, Widen shoulder - 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 - 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 roadways improved	County
EMS	SI04EV, Install emergency vehicle pre-emption systems. Improve resource deployment and clear routes for emergency responses to collision sites.	EMS vehicle response time	Fire districts and EMS response teams



EMPHASIS AREA 2 – REDUCE HIT OBJECT AND ROADWAY DEPARTURE COLLISIONS

Thirty Nine (39%) of the High Injury Network collisions were hit object collisions, including 25 F+SI collisions. Roadway departure collisions are combined due to the strong correlation between roadway departures and hit object collisions. Roadway departure collisions were also identified as a prominent collision trend in the 2018 Solano Travel Safety Plan. The following collision data is based on only hit object injury collisions on the High Injury Network of unincorporated Solano County, followed by E's strategies.

**58% Improper
Turning**

32% DUI Collisions

**52% Nighttime
Collisions**

TABLE 8: EMPHASIS AREA 2 STRATEGIES

OBJECTIVE: REDUCE THE NUMBER OF F+SI HIT OBJECT AND ROADWAY DEPARTURE COLLISIONS			
	STRATEGY	PERFORMANCE MEASURE	AGENCIES/ ORGANIZATIONS
Education	Conduct safety campaigns and outreach to raise awareness of safety needs against roadway departure crashes, such as unsafe speeds, distracted driving, improper turning, and driving under the influence. Continue to utilize existing CHP education campaigns/classes, such as Start Smart.	Number of education campaigns	County/CHP
Enforcement	Targeted enforcement at high-risk rural roadways where hit object/roadway departure collisions are more common.	Number of tickets issued	CHP
Engineering	• NS08, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs • R01NT, Add Segment Lighting • R02, Remove or relocate fixed objects outside of Clear Recovery Zone • R04, Install Guardrail • R06 or R07, Flatten side slopes • 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	County
EMS	SI04EV, Install emergency vehicle pre-emption systems. Improve resource deployment and clear routes for emergency responses to collision sites.	EMS vehicle response time	Fire districts and EMS response teams



EMPHASIS AREA 3 – REDUCE IMPROPER TURNING COLLISIONS

Thirty four (34%) of the collisions on the High Injury Network were improper turning collisions, including 20 F+SI collision. Improper turning collisions accounted for 25% of the total EPDO score in unincorporated Solano County from the 2018 Solano Travel Safety Plan. The following collision data is based on only improper turning caused injury collisions on the High Injury Network of unincorporated Solano County, followed by E's strategies selected to address improper turning collisions.

**67% Hit Object
Collisions**

33% Nighttime

**18% Overturned
Collisions**

TABLE 9: EMPHASIS AREA 3 STRATEGIES

OBJECTIVE: REDUCE THE NUMBER OF F+SI COLLISIONS ON ROADWAY SEGMENTS AND INTERSECTIONS THAT ARE A RESULT OF IMPROPER TURNING			
	STRATEGY	PERFORMANCE MEASURE	AGENCIES/ ORGANIZATIONS
Education	Conduct safety campaigns and outreach to raise their awareness of safety needs against improper turning crashes, such as safe driving habits classes offered by CHP or Solano Mobility (a program of the STA).	Number of education campaigns	County/CHP
Enforcement	Targeted enforcement at high-risk intersections and roadway segments to monitor improper turning violations.	Number of tickets issued	CHP
Engineering	• SI08, Install raised pavement markers and striping (Through Intersection) • SI16RA/NS04RA/NS05RA, Convert intersection to roundabout • NS08, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs • NS09, Upgrade intersection pavement markings (NS.I.) • NS13, Improve sight distance to intersection (Clear Sight Triangles) • NS16, Install raised median on approaches (NS.I.) • R02, Remove or relocate fixed objects outside of Clear Recovery Zone • 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 • R31, Install edge-line rumble strips/stripes	Number of intersections and roadway segments improved	County
EMS	SI04EV, Install emergency vehicle pre-emption systems. Improve resource deployment and clear routes for emergency responses to collision sites.	EMS vehicle response time	Fire districts and EMS response teams



EMPHASIS AREA 4 – ADDRESS DUI COLLISIONS

Eighteen (18%) collisions on the High Injury Network were due to driving under the influence of alcohol or drugs, including 19 F+SI collision. DUI collisions accounted for 25% of the unincorporated County's EPDO score in the 2018 Solano Travel Safety Plan. The following collision data is based on only DUI injury collisions on the High Injury Network of unincorporated Solano County, followed by E's strategies selected to address DUI collisions.

**71% Hit Object
Collisions**

**71% collision
victims has age
range 20-39**

**71% Nighttime
Collisions**

TABLE 10: EMPHASIS AREA 4 STRATEGIES

OBJECTIVE: REDUCE THE NUMBER OF F+SI COLLISIONS THAT OCCUR DUE TO DRIVING UNDER THE INFLUENCE			
	STRATEGY	PERFORMANCE MEASURE	AGENCIES/ ORGANIZATIONS
Education	Conduct safety campaigns and outreach for safety laws regarding driving under the influence, such as existing CHP campaigns to address drunk driving.	Number of education campaigns	County/CHP
Enforcement	Targeted enforcement at high-risk intersections and roadway locations to monitor violations of driving under influence. Establish DUI check points near high-risk locations as appropriate.	Number of tickets issued	CHP
Engineering	• SI02, Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number • SI08, Install raised pavement markers and striping (Through Intersection) • NS08, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs • NS09, Upgrade intersection pavement markings (NS.I.) • NS11, Install flashing beacons as advance warning (NS.I.) • R01NT, 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) • R27, Install delineators, reflectors and/or object markers	Number of locations improved	County
EMS	SI04EV, Install emergency vehicle pre-emption systems. Improve resource deployment and clear routes for emergency responses to collision sites.	EMS vehicle response time	Fire districts and EMS response teams



EMPHASIS AREA 5 – REDUCE BROADSIDE COLLISIONS

Twenty three (23%) of the collisions on the High Injury Network resulted in broadside collision, including 12 F+SI collisions. The following collision data is based on only broadside injury collisions on the High Injury Network of unincorporated Solano County, followed by E's strategies selected to address overturned collisions.

76% At intersection

**49% Auto ROW
Violations**

24% F+SI Collisions

TABLE 11: EMPHASIS AREA 5 STRATEGIES

OBJECTIVE: REDUCE THE NUMBER OF F+SI COLLISIONS THAT OCCUR DUE TO 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	County/CHP
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.	Number of tickets issued	CHP
Engineering	- SI02, Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number - SI03, Improve signal timing (coordination, phases, red, yellow, or operation) - SI05, Install left-turn lane and add turn phase (signal has no left-turn lane or phase before) - SI06, Provide protected left turn phase (left turn lane already exists) - SI07, Convert signal to mast arm (from pedestal-mounted) - SI08, Install raised pavement markers and striping (Through Intersection) - SI16RA/NS04RA/NS05RA, Convert intersection to roundabout - NS02, Convert to all-way STOP control (from 2-way or Yield control) - NS03, Install signals - NS08, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs - NS09, Upgrade intersection pavement markings (NS.I.) - NS10, Install flashing beacons at stop controlled intersections - NS11, Install flashing beacons as advance warning (NS.I.) - NS13, Improve sight distance to intersection (Clear Sight Triangles) - NS15, add splitter-islands on the minor road approaches - SI11/NS16, install raised median on approaches	Number of locations improved	County
EMS	SI04EV, Install emergency vehicle pre-emption systems. Improve resource deployment and clear routes for emergency responses to collision sites.	EMS vehicle response time	Fire districts and EMS response teams



EMPHASIS AREA 6 – REDUCE NIGHTTIME COLLISIONS

Thirty Five (35%) of the collisions on the High Injury Network occurred at night, including 27 F+SI collision. The following collision data is based on only nighttime injury collisions on the High Injury Network of unincorporated Solano County, followed by E's strategies selected to address nighttime collisions.

**36% Collisions due to
DUI**

**32% Improper
Turning**

**58% Hit Object
Collisions**

TABLE 12: EMPHASIS AREA 6 STRATEGIES

OBJECTIVE: REDUCE THE NUMBER OF F+SI COLLISIONS THAT OCCUR DURING NIGHTTIME			
	STRATEGY	PERFORMANCE MEASURE	AGENCIES/ ORGANIZATIONS
Education	Develop awareness program to inform motorists of safe nighttime driving habits, as well as high-risk collision locations and the most common violations/collision types occurring at night. Utilize existing CHP campaigns warning of the dangers of drunk driving.	Number of education campaigns	County/CHP
Enforcement	Targeted enforcement at high-risk intersections and roadway locations where nighttime collisions are more common. Establish DUI check points at night where appropriate.	Number of tickets issued	CHP
Engineering	• SI01NT or NS01NT, Install intersection lighting • SI02, Improve signal hardware • NS08, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs • NS09, Upgrade intersection pavement markings (NS.I.) • NS10, Install Flashing Beacons at Stop-Controlled Intersections • NS11, Install flashing beacons as advance warning (NS.I.) • R01NT, 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) • 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	County
EMS	SI04NT, Install emergency vehicle pre-emption systems. Improve resource deployment and clear routes for emergency responses to collision sites.	EMS vehicle response time	Fire districts and EMS response teams



EMPHASIS AREA 7 – REDUCE MOTORCYCLE COLLISIONS

Twelve (12%) of the collisions on the High Injury Network were motorcycle collisions, including 15 F+SI collisions. Of these motorcycle collisions, six were collisions due to improper passing, seven were overturned, and six factored into non-collision. The following collision data is based on only motorcycle injury collisions on the High Injury Network of unincorporated Solano County, followed by 5 E's strategies selected to address motorcycle collisions.

42% Improper Turning

50% Overturned

58% F+SI Collisions

TABLE 13: EMPHASIS AREA 7 STRATEGIES

OBJECTIVE: REDUCE THE NUMBER OF F+SI MOTORCYCLE COLLISIONS			
	STRATEGY	PERFORMANCE MEASURE	AGENCIES/ ORGANIZATIONS
Education	Conduct public information and education campaign for safety laws regarding motorcycle collisions and motorcyclists' higher risk of F+SI collisions. Utilize existing CHP programs, such as the Motorcycle Safety Program, to encourage safe motorcycle riding habits.	Number of education campaigns	County/CHP
Enforcement	Targeted enforcement at high-risk locations to monitor motorcycle collisions.	Number of tickets issued	CHP
Engineering	• SI16RA/NS04RA/NS05RA, Convert intersection to roundabout • NS08, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs • NS09, Upgrade intersection pavement markings (NS.I.) • R04, Install Guardrail • R15, Widen shoulder • R22, Install/Upgrade signs with new fluorescent sheeting (regulatory or warning) • R26, Install dynamic/variable speed warning signs • R27, Install delineators, reflectors and/or object markers • R28, Install edge-lines and centerlines • R29, Install no-passing line • R31, Install edge-line rumble strips/stripes	Number of locations improved	County
EMS	SI04EV, Install emergency vehicle pre-emption systems. Improve resource deployment and clear routes for emergency responses to collision sites.	EMS vehicle response time	Fire districts and EMS response teams



EMPHASIS AREA 8 – ADDRESS YOUNGER ADULT PARTY AT FAULT COLLISIONS

Of the 216 reported collisions on the High Injury Network of unincorporated Solano County, 37% were caused by a party at fault under the age of 30. The following is a review of the demographic data provided in the party at fault data of the collisions occurring on the High Injury Network, along with educational strategies to address younger adult party at fault collisions.

**24% F+SI Collisions Party at Fault
was Between the Ages of 18-30**

**79% F+SI Collisions Party at
Fault was a Male**

TABLE 14: EMPHASIS AREA 8 STRATEGIES

OBJECTIVE: REDUCE THE NUMBER OF F+SI COLLISIONS CAUSED BY YOUNG ADULTS			
	STRATEGY	PERFORMANCE MEASURE	AGENCIES/ORGANIZATIONS
Education	Target educational programs for young adults. Distribute brochures/fliers with basic red light running, speeding, distracted driving, improper turning, aggressive driving and stop sign violations information at driver training programs. Include statistics of young adult larger risks of fatalities. Involve school districts in such campaigns. Utilize existing CHP programs and classes, such as Start Smart.	Number of education campaigns	County/School Districts/CHP



CHAPTER 5 COUNTERMEASURE IDENTIFICATION

Upon the identification of high-risk locations and Emphasis Areas, the next step was to identify appropriate safety countermeasures. The Caltrans LRSM provides 86 countermeasures, of which 22 are eligible in the current HSIP call for signalized intersections, 25 for un-signalized intersections, and 39 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-risk locations (intersections and roadway segments) using aerial photography and Google Maps Street View software. 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 eight identified Emphasis Areas. The table was refined by selecting up to six 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 LRSM used in HSIP grant calls for projects. The intention is to give the County potential countermeasures for each location that can be funded with federal monies in future HSIP calls for projects, or using other funding sources, such as the County's Capital Improvement Program (CIP). Non-engineering countermeasures were also selected using the 5 E's strategies, and are included with the emphasis areas. The countermeasure toolbox in **Appendix D** 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 County a toolbox for implementing future safety improvements through other means, such as the County's CIP.

Tables 15 and **Table 16** provide a description of each countermeasure along with the CRF, federal funding eligibility, and opportunity for systemic implementation. Each of these factors is weighed in the project team's decision making process to develop the countermeasure toolbox. An excerpt of the LRSM, detailing each available HSIP countermeasure referenced in the recommendations tables, is included as **Appendix E**.



TABLE 15: NON-SIGNALIZED INTERSECTION COUNTERMEASURES

CODE	COUNTERMEASURE NAME	COUNTERMEASURE DESCRIPTION	CRF	HSIP FEDERAL FUNDING	SYSTEMIC APPROACH OPPORTUNITY
NS01NT	Add intersection lighting (NS.I.)	Provision of lighting at the intersection and all its approaches	40%	90%	Medium
NS02	Convert to all-way stop control (from 2-way or yield control)	Conversion of 2-way stop intersection to 4-way stop	50%	90%	High
NS08	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 perceive them	15%	90%	Very High
NS09	Upgrade intersection pavement markings	Increase the visibility of an intersection by upgrading pavement markings where none exist or are faded/ cracked	25%	90%	Very High
NS10	Install flashing beacons at stop-controlled intersections	Reinforce driver awareness of an intersection	15%	90%	High
NS11	Install flashing beacons as advance warning (NS.I.)	Installation of an advance flashing beacons can be used to supplement and call driver attention to intersection control signs	30%	90%	High
NS12	Install transverse rumble strips on approaches	Provide an auditory and tactile sensation for a motorist approaching an intersection	20%	90%	High
NS13	Improve sight distance to intersection (clear sight triangles)	Clearing roadside obstructions to improve sight distance at the intersection	20%	90%	High
NS14	Improve pavement friction (high friction surface treatments)	Improves the friction of the pavement and improves skid resistance	55%	90%	Medium
NS15	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
NS16	Install raised medians on approaches	Channels traffic approaching an intersection	25%	90%	Medium

(Note: CRF = Crash Reduction Factor)



TABLE 16: ROADWAY SEGMENT COUNTERMEASURES

CODE	COUNTERMEASURE NAME	COUNTERMEASURE DESCRIPTION	CRF	HSIP FEDERAL FUNDING	SYSTEMIC APPROACH OPPORTUNITY
R01NT	Add segment lighting	Provision of lighting along roadways	35%	90%	Medium
R02	Remove or relocate fixed objects outside of clear recovery zone	Provisions of a clear zone. 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	35%	90%	Medium
R04	Install guardrail	Reduces the severity of lane departure crashes	25%	90%	Medium
R15	Widen shoulder	provides a greater area to regain control of a vehicle and lateral clearance to roadside objects such as guardrail, signs and poles	30%	90%	Medium
R17	Improve horizontal alignment (flatten curves)	Use on roadways with horizontal curves that have experienced lane departure crashes as a result of a roadway segment having compound curves or a severe radius	50%	90%	Low
R21	Improve pavement friction (high friction surface treatments)	Improves the friction of the pavement and improves skid resistance	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 compliance of roadway signing	15%	90%	Very High
R23	Install chevron signs on horizontal curves	Warns driver of an approaching curve and provides guidance to drivers	40%	90%	Very High
R24	Install curve advance warning signs	Serves as an advance warning of an unexpected or sharp curve	25%	90%	Very High
R25	Install curve advance warning signs (flashing beacon)	Use on roadways that have an unacceptable level of crashes on relatively sharp curves	30%	90%	High
R26	Install dynamic/ variable speed warning signs	Includes the addition of dynamic regulatory signs to warn drivers of speed	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	Provisions of centerlines and edge-lines where none exist or make significant upgrades to existing lines	25%	90%	Very High
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



CODE	COUNTERMEASURE NAME	COUNTERMEASURE DESCRIPTION	CRF	HSIP FEDERAL FUNDING	SYSTEMIC APPROACH OPPORTUNITY
R31	Install edge line rumble strips/ stripes	Provision of edge line rumble strips/strips that create an auditory sound when driven over to mitigate lane departures	15%	90%	High
R32	Speed Safety Cameras	Install speed safety cameras to enforce over speeding	20%	90%	High

(Note: CRF = Crash Reduction Factor)



CHAPTER 6 SAFETY PROJECTS

This chapter summarizes the process of selecting safety projects as part of the analysis for the Solano County's 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 2024 Caltrans LRSM, where:

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

The corresponding number refers to the countermeasure number in the LRSM (2024). 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, County staff input, and stakeholder/community input. The most applicable and appropriate countermeasures are grouped together to form projects that can help make high-risk locations safer.

Table 1 lists the safety projects for high-risk intersections and roadway segments, along with base planning level cost (2024 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 (2024). **Appendix E** lists the HSIP Analyzers for each project.

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

Hit Object Collisions: This type of collision represented the highest proportion of F+SI collisions (39%), and collisions of all severity (36%). To address these collisions, viable safety projects include edge line rumble strips/stripes, widen shoulders, installing delineators, reflectors, and object markers, installing curve warning signs, installing chevron signs at horizontal curves, and installing/upgrading signs with new fluorescent sheeting.

Improper Turning Collisions: This violation category caused 28% of all F+SI collisions and was the most common violation type among collisions of all severity (30%). Viable safety projects to help address these include installing edge line rumble strips/stripes, widening shoulders, installing guard rail, improving pavement friction, improving sight distance, installing/upgrading signs with new fluorescent sheeting, installing flashing curve warning signs, and installing chevrons at horizontal curves.

Broadside Collisions: 14% of all F+SI collisions were broadside collisions, compare to its share of collisions of all severity (24%). Viable safety projects to help address these collisions include adding turn lanes, improving sight distances, installing/upgrading signs with new fluorescent sheeting, adding reflective pavement markers, improve signal timing, install raised median on approaches.



Nighttime Collisions: 37% of all severity collisions and 51% of all F+SI collisions occurred at night or during dusk or dawn. The majority of these nighttime collisions occurred in areas without street lights, given the rural nature of unincorporated Solano County. Viable safety projects to help address these collisions include transverse rumble strips, upgrading intersection pavement markings, installing flashing beacons at stop controlled intersections, installing/upgrading larger or additional stop signs or other intersection regulatory/warning signs, installing flashing beacons as advance warning, installing intersection lighting or upgrade lighting with higher lumens, installing edge line and centerline rumble strips/stripes, installing flashing curve advance warning signs, installing chevron signs on horizontal curves, installing/upgrading signs with new fluorescent sheeting, and installing delineators, reflectors, and object markers.

DUI Collisions: 38% of F+SI collisions occurred as a result of DUI compared to only 20% of collisions of all severity. In addition to educational measures recommended in the emphasis areas section, viable safety projects have been recommended to increase visibility and alert drivers of upcoming intersections or hazards. These are the same as what is listed for nighttime collision recommendations above.

Table 17 lists identified projects for the unincorporated areas of Solano County, with a base planning level cost estimate for each location and the resulting B/C Ratio of the project (the title of each countermeasure is located in **Table 18**).



TABLE 17: LIST OF VIABLE SAFETY PROJECTS

Location	CM1	CM2	CM3	Cost per Location	B/C Ratio
Project 1 - Improve Safety at Non-Signalized Intersections: Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs, Install Flashing Beacons at Stop-Controlled Intersections, Install flashing beacons as advance warning.					
Abernathy Road and Mankas Corner Road		NS10	NS11	\$91,200	60.03
Browns Valley Road and Cantelow Road/ Timm Road	NS08		NS11	\$17,375	
Holdener Road and Lewis Road	NS08	NS10	NS11	\$61,550	
Sievers Road and Currey Road	NS08		NS11	\$32,300	
Railroad Avenue and Putah Creek Road	NS08		NS11	\$20,200	
Rockville Road and Willotta Drive	NS08		NS11	\$16,425	
Meridian Road and Allendale Road	NS08		NS11	\$18,050	
Project 2: Improve Safety at Non-Signalized Intersections: Upgrade intersection pavement markings, Install transverse rumble strips on approaches, Improve sight distance to intersection.					
Abernathy Road and Mankas Corner Road			NS13	\$10,000	691.97
Holdener Road and Lewis Road		NS12		\$2,000	
Rockville Road and Willotta Drive			NS13	\$2,000	
Winters Road and Wolfskill Road		NS12		\$1,500	
Hartley Road and Robinson Road	NS09			\$1,860	
Project 3: Improve Safety on Roadway Segments: Remove or relocate fixed objects outside of Clear Recovery Zone, Install/Upgrade signs with new fluorescent sheeting, Install delineators, reflectors and/or object markers.					
Putah Creek Road: Stevenson Bridge Road to Race Course Ln	R02		R27	\$64,500	82.08
Putah Creek Road: Holmes Rd to Pleasants Valley Road			R27	\$10,750	
Rockville Road: Chadbourne Rd to Tarton Way		R22	R27	\$37,332	
Sievers Road: Halley Road to Pedrick Road		R22	R27	\$34,625	
Meridian Road: Fry Road to Fairfield City Limit			R27	\$15,750	
Midway Road: Leeve Road to Timm Road		R22	R27	\$81,750	
Pedrick Road: Yolo County Line to Sievers Rd		R22	R27	\$21,500	
Pedrick Road: Dixon Ave to Maine Prairie Road		R22	R27	\$45,750	
Cantelow Road: Browns Valley Road to Steiger Hill Road		R22	R27	\$30,150	



Location	CM1	CM2	CM3	Cost per Location	B/C Ratio
Abernathy Road: Mankas Corner Road to Rockville Road		R22	R27	\$20,875	
Peaceful Glen Road: Timm Road to Acacia Lane		R22		\$7,125	
Tremont Road: Sparling Lane to Yolo County Line		R22		\$33,250	
Pitt School Road: Hawkins Road to Midway Road		R22		\$11,400	
Project 4: Improve Safety on Roadway Segments: Install Guardrail, Install chevron signs on horizontal curves, Install dynamic/variable speed warning signs.					
Pleasants Valley Road: Cantelow Rd to Cherry Glen Rd	R04	R23	R26	\$187,600.00	89.81
Suisun Valley Road: Twin Sisters Rd to Rockville Rd		R23	R26	\$174,300.00	
Mankas Corner Road: Fairfield City Limit to Clayton Road	R04	R23	R26	\$185,175.00	
Putah Creek Road: Stevenson Bridge Road to Race Course Ln			R26	\$60,000.00	
Putah Creek Road: Holmes Rd to Pleasants Valley Road			R26	\$30,000.00	
Rockville Road: Chadbourne Rd to Tarton Way			R26	\$30,000.00	
Lopes Road: 5600 ft. north of Marshview Road to 1500 ft. south of Parish Road	R04	R23	R26	\$130,850.00	
Cantelow Road: Browns Valley Road to Steiger Hill Road		R23		\$12,800.00	
Peaceful Glen Road: Timm Road to Acacia Lane		R23	R26	\$36,400.00	
Project 5: Improve Safety on Roadway Segments: Install centerline rumble strips/stripes, Install edgeline rumble strips/stripes, Add segment lighting.					
Pleasants Valley Road: Cantelow Rd to Cherry Glen Rd	R30	R31		\$567,000.00	11.91
Suisun Valley Road: Twin Sisters Rd to Rockville Rd	R30			\$92,400.00	
Mankas Corner Road: Fairfield City Limit to Clayton Road	R30	R31		\$172,200.00	
Putah Creek Road: Stevenson Bridge Road to Race Course Ln		R31		\$434,000.00	
Putah Creek Road: Holmes Rd to Pleasants Valley Road		R31		\$189,000.00	



Location	CM1	CM2	CM3	Cost per Location	B/C Ratio
Rockville Road: Chadbourne Rd to Tarton Way	R30	R31		\$388,500.00	
Lopes Road: 5600 ft. north of Marshview Road to 1500 ft. south of Parish Road	R30	R31		\$420,000.00	
Sievers Road: Halley Road to Pedrick Road	R30	R31		\$672,000.00	
Meridian Road: Fry Road to Fairfield City Limit	R30	R31		\$272,500.00	
Midway Road: Leeve Road to Timm Road	R30	R31		\$1,428,000.00	
Pedrick Road: Yolo County Line to Sievers Rd		R31		\$273,000.00	
Pedrick Road: Dixon Ave to Maine Prairie Road		R31		\$588,000.00	
Cantelow Road: Browns Valley Road to Steiger Hill Road			R01NT	\$237,500.00	
Abernathy Road: Mankas Corner Road to Rockville Road			R01NT	\$281,000.00	
Peaceful Glen Road: Timm Road to Acacia Lane			R01NT	\$163,000.00	
Tremont Road: Sparling Lane to Yolo County Line		R31	R01NT	\$782,000.00	
Pitt School Road: Hawkins Road to Midway Road		R31	R01NT	\$387,000.00	

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



TABLE 18. LIST OF COUNTERMEASURES

COUNTERMEASURE NAME
NS08 = Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs
NS09 = Upgrade intersection pavement markings
NS10 = Install Flashing Beacons at Stop-Controlled Intersections
NS11 = Install flashing beacons as advance warning (NS.I.)
NS12 = Install transverse rumble strips on approaches
NS13 = Improve sight distance to intersection (Clear Sight Triangles)
R01NT = Add Segment Lighting
R02 = Remove or relocate fixed objects outside of Clear Recovery Zone
R04 = Install guardrail
R22 = Install/Upgrade signs with new fluorescent sheeting (regulatory or warning)
R23 = Install chevron signs on horizontal curves
R26 = Install dynamic/variable speed warning signs
R27 = Install delineators, reflectors and/or object markers
R30 = Install centerline rumble strips/strips
R31 = Install edgeline rumble strips/strips



CHAPTER 7 EVALUATION AND IMPLEMENTATION

This chapter describes the steps the County 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 safety partners. This document was developed based on community needs, stakeholder input, and collision analysis conducted to identify priority emphasis areas throughout the County. The implementation of strategies under each emphasis area would aim to reduce F+SI collisions.

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 EMS-related countermeasures that can be implemented throughout the County to reduce F+SI collisions. It is recommended that Solano County implement the selected projects in high-collision locations in coordination with other projects proposed for the County'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 F+SI collisions throughout the City. If the number of F+SI 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 19**).



TABLE 19: 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	~\$223 million per year	2024	Engineering, Education	Can use used for most active transportation related safety projects as well as education programs
Highway Safety Improvement Program	Caltrans	TBD	2024	Engineering	Most common grant source for safety projects
Surface Transportation Block Group Program	FHWA (Administered through MCTC)	Varies by FY	TBD	Engineering	Typically used for roadway projects
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	TBD	Engineering, Education	Must be connected to affordable housing projects; typically focuses on bike/ped infrastructure/ programs
Urban Greening	California Natural Resources Agency	\$23.75 million	TBD	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	TBD	Engineering	Typically used for larger infrastructure projects
Sustainable Transportation Equity Project	California Air Resources Board	~\$19.5 million	TBD; most recent call in 2023	Engineering, Education	Targets projects that will increase transportation equity in disadvantaged communities
Safe Street for All (SS4A)	USDOT	\$200k - \$50 million	2026	Engineering	Two types of SS4A grants available: Action Plan Grants and Implementation Grants
Transformative Climate Communities	Strategic Growth Council	~\$90 million	TBD; most recent call in 2022	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 5 E-strategies continuously. Monitoring and evaluation creates accountability, ensures the effectiveness of the countermeasures for each emphasis area, and helps making decisions on the need for new strategies. Currently, County staff periodically monitor collision data gathered by the CHP. The LRSP process would help the County 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 F+SI collisions
- Number of law enforcement citations
- Number of public comments and concerns

Evaluation should be conducted during similar time periods each year. The most important measure of success of the LRSP should be reductions in F+SI collisions throughout the County. If the number of F+SI collisions doesn't decrease, 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

List of Public Outreach Comments



#	Latitude	Longitude	Intersection?	Street Name	What traffic-related concern do you have at this location?	Mode	Pertinent Issue
1	38.14882	-122.03268	N	Hwy 12	Rio Vista residential neighborhoods. We are getting traffic trying to get around the back ups on hwy 12. The navigation apps route traffic around backups through our residential neighbors hoods. The only way to stop this, According to maps and waze, is to post no thru traffic signs on feeder streets into our residential areas. Please help us I. We need no thru traffic in residential areas.	Motor Vehicle	Traffic Congestion
2	38.14393	-122.06867	N	Hwy 12	Speeding and heavy traffic thru residential areas by commuters avoiding backups on hwy 12 thru Rio Vista. We need no thru traffic signs posted to prevent commuters using residential streets for commuter routes. This suggest came from Waze. They will continue to route traffic down residential streets unless the route is protected by No Thru Traffic signs.	Motor Vehicle	Traffic Congestion
3	38.31346	-122.12973	N	Hwy 12	Vehicles/motorcycles crossing double yellow lines	Motor Vehicle	Unsafe Passing
4	38.21899	-121.71312	N	Liberty Island Rd	Sink hole in middle of northbound lane where canal crosses under the road.	Motor Vehicle	Pot Holes
5	38.21005	-121.7139	N	Liberty Island Rd	Large sinkhole in southbound lane near white house with green trim; appears to be a culvert under the road.	Motor Vehicle	Pot Holes
6	38.15991	-121.69622	N	Hwy 12	We have at times 100 semi-trucks per hour rolling through this small town with 1 traffic light. Numerous accidents on highway/route 12. Have weight limits been explored to make it safer to get to our 1 grocery store and post office? I personally had my car totaled when a semi side swiped me while waiting at a red light at 12 and 160. Numerous accidents in town with traffic often backed up for several miles. We also have a draw bridge which is not designed to support the kind or large truck traffic we are getting. Please consider the safety of residents in this very small town.	Motor Vehicle	Traffic Congestion
7	38.22721	-121.92901	N	Hwy 12	Complete disregard of traffic laws and speed limits. With little exception, Hwy 12 is a race track.	Motor Vehicle	Speeding
8	38.17452	-121.83222	N	Hwy 12	Highway 12 is so unsafe.The road is a mess.Traffic is horrible , Rio vista in a crisis. We have. Approximately five hundred trucks per day crossing the Ria Vista bridge The traffic has gotten, so bad accidents.Constantly people trying to pass where there's no passing lane. I cannot imagine that you are overlooking us because we are a small community in solano county	Motor Vehicle	Traffic Congestion
9	38.17061	-121.70904	Y	Hwy 12	dangerous left turns out of Church road to east bound 12 and dangerous left turns onto Church from east 12. Consider adding left turning lanes or traffic light or stop.	Motor Vehicle	Improper Turning
10	38.16083	-121.68995	Y	Hwy 12	coming from Virginia Way, people still want to turn left onto Hwy 12. A "no left turn" sign was installed this past year or so. Its dangerous to attempt to turn left there. Cars are coming fast, from the East, off of the Rio Vista Bridge	Motor Vehicle	Improper Turning
11	38.1704	-121.70919	Y	Hwy 12	Coming from Church St. its a dangerous intersection to turn Left OR Right onto Hwy 12. And, coming, from either direction on Hwy 12, turning onto Church St, impedes the flow of traffic, especially coming from West Hwy 12, as traffic backs up. Coming from East Hwy 12, people are accelerating as they leave town and head west onto the highway. Its dangerous, to attempt to slow down, and turn right, then.	Motor Vehicle	Improper Turning
12	38.17416	-121.69505	Y	Vieira Way	Vision obstructed at intersection due to several reasons. Needs 4-way stop. Multiple accidents and near misses.	Motor Vehicle	Sight Distance
13	38.41718	-121.95301	Y	Midway Rd	Tree blocking view from cars coming down hill !!	Motor Vehicle	Sight Distance
14	38.21286	-121.71403	N	Liberty Island Rd	Large sinkhole has been there for almost 1 year. What are the plans for repair? I reported a while ago and an orange cone showed up in the sink hole; it is no longer there.	Motor Vehicle	Pot Holes
15	38.21937	-121.71296	N	Liberty Island Rd	Another smaller sink hole over culvert. Have reported already once; reporting again.	Motor Vehicle	Pot Holes
16	LINESTRING (-121.694546 38.181034, -121.6772 38.167649)		N	Airport Rd	Airport Road between Church Road and River Road has several pot hole with shabby/rough asphalt filling in the huge pot holes. One has to drive off the road to avoid the pot holes.	Motor Vehicle	Pot Holes

#	Latitude	Longitude	Intersection?	Street Name	What traffic-related concern do you have at this location?	Mode	Pertinent Issue
17	LINESTRING (-122.21936 38.092697, -122.21936 38.092697, -122.219855 38.091989, -122.21883 38.091705, -122.218598 38.091641, -122.218145 38.092445, -122.219342 38.092712)		Y	Benicia Rd	A stop sign needs to be placed at the intersection of Home Acres Ave and Benicia Road to stop and slow hazardous east-west Benicia traffic, ensure a safe bus stop and pedestrian crossing, and allow Home Acres and parallel streets traffic safer access to Benicia Road. It is an especially good placement since Home Acres Ave has the worst visibility due to vehicles parking into the eastwards bus stop and housing and its grade blocking view, and since Benicia Road is treated as a raceway due to no stop signs between Laurel and Glen. Having worked for law enforcement and traffic control, and having lived along Home Acres for almost ten years, I can guarantee you placing a stop sign for the east-west directions at Benicia and Home Acres benefits both Solano County and the City of Vallejo by decreasing accidents, giving pedestrians safer access there and along Benicia, and generally making that urban area a less violent area due to uninhibited drivers' abuse of the road.	Motor Vehicle	Stop Sign
18	LINESTRING (-121.542378 38.11367, -121.398819 38.115713)		N	Hwy 12	So many accidents! It's very dangerous to drive on Hwy 12 between Fairfield and Lodi. Also, because there is no one patrolling this road, people illegally pass on the right. It's terrifying to drive on Hwy 12 in this area. Please do something to make that road safer. We don't want to keep having horrible accidents on Hwy 12.	Motor Vehicle	Unsafe Passing
19	LINESTRING (-		N	Schroeder Rd	Missing bike considerations	Bicycle	Bicycle Safety
20	LINESTRING (-121.757107 38.502888, -121.744431 38.502741, -121.732227 38.5026)		N	Becker Rd	The height difference of Becker Road compared to the immediate adjacent dirt shoulder is over seven inches in sections. The height difference increases even more a tire's width out from the pavement. My car clearance is less than 5.75 inches. Since the road is too narrow for a car and a truck (let alone any vehicle and a tomato truck!) to pass on the pavement, one must go off of the road. If I drive off of the road, I will have major vehicle damage to the undercarriage. In addition, in several locations, the line indicating the edge of the road is on the vertical or partially on the dirt, not on pavement, and there are no street signs warning drivers to stay on the road or face vehicle damage. Recommendation: Raise the height of the shoulder bordering the road.	Motor Vehicle	No Shoulder
21	LINESTRING (-121.757005 38.517799, -121.757024 38.516745, -121.757062 38.514654, -		N	Old Davis Rd	On Old Davis Road, going either north or south, impatient drivers OFTEN cross the double, yellow line to pass the vehicle in front, but vision is severely limited by the incline (going north) or the dip (going south) and WILL result in a head-on crash with a car, cyclist or equestrian; they rely on pure luck. The victim will have no warning. Recommendation: A long, physical barrier from before the bridge to the first residential driveway, with a gap to allow turning onto and from the southern levee road.	Motor Vehicle	Unsafe Passing
22	Email		N	Hwy 12	Why is there no lights on 12 from Suisun to Interstate 5: I am a senior and avoid highway 12 from Rio Vista to Suisun-Fairfield because of low visibility due to no lights after dark. My question is : Is there a plan to install lights on 12 in the works.	Motor Vehicle	Lighting
23	Email		N	Hwy 12	HWY 12 thru Rio Vista: If HWY 12 is now a major route for trucking, we need to allocate funds to cover the maintenance of this route. It has become unsafe and at times created gridlock for the surrounding area. Close it to trucks or put up the money to make it legitimate.	Motor Vehicle	Traffic Congestion

Appendix B

Matrix of Planning Goals, Policies, and Projects





Appendix B: Relevant Policies and Projects

Document	Relevant Goals, Policies, and Projects
Solano County General Plan Transportation & Circulation Element (2008)	Goals • TC.G-1 Maintain and improve the County's transportation systems to enhance safety, resident access to basic needs, mobility and convenience. • TC.G-2 Promote coordinated approaches to creating, maintaining and improving transportation corridors and facilities by working with other jurisdictions and transportation agencies in funding and implementing projects. • TC.G-3 Encourage land use patterns that maximize access and mobility options for commuting and other types of trips, and minimize traffic congestion, vehicle miles traveled (VMT), and greenhouse gas emissions. • TC.G-4 Encourage the use of alternative forms of transportation such as transit, walking and bicycling to alleviate congestion and promote recreation. • TC.G-5 Encourage and maintain the safe, convenient transfer of goods and services from agricultural lands and industrial locations to regional and interregional transportation facilities. Policies • TC.P-1 Maintain and improve current transportation systems to remedy safety and congestion issues, and establish specific actions to address these issues when they occur. • TC.P-2 In collaboration with other agencies and cities, continue to plan land uses that concentrate major employment and activity centers and services near transportation systems. • TC.P-3 Establish land use patterns that facilitate shorter travel distances and non-auto modes of travel, and limit the extent of additional transportation improvements and maintenance that may be needed with a more dispersed land use pattern.

Document	Relevant Goals, Policies, and Projects
	• TC.P-4 Evaluate proposals for new development for their compatibility with and potential effects on transportation systems. • TC.P-5 Fairly attribute to each development the cost of on- and off-side improvements needed for state and county roads and other transportation systems to accommodate that development, including the potential use of development impact fees to generate revenue. • TC.P-6 Participate in transportation programs that promote technical solutions resulting in more efficient use of energy, reduced greenhouse gas emissions and noise levels, and improved air quality. • TC.P-7 Collaborate with other agencies and cities, continue to seek funding from federal, state, or county agencies for major transportation projects and programs through transportation impact fees, private facilities and/or user tolls. • TC.P-8 Actively participate with the California Department of Transportation, Solano Transportation Authority, cities, and other agencies to plan for any proposed future realignments of current interregional routes. • TC.P-9 Plan, fund, build and improve roadways that support agriculture by providing increased connectivity across Interstate 80, including the intersection at Pedrick Road, for farmers and their equipment, and by grading and paving unimproved rural roads. • TC.P-10 Anticipate increases in vehicular traffic on rural roads that serve agricultural-tourist centers, value-added agricultural uses in the interior valleys, and other unique land uses: complete related roadway improvements that support the viability of such uses. • TC.P-11 Maintain and improve the current roadways and highway system to meet recommended design standards set forth by the County, including streets that also carry transit and nonmotorized traffic. • TC.P-12 Maintain and improve the design of the current roadway system to serve areas where growth is desired and anticipated as identified in the General Plan Land Use Diagram, while minimizing conversion of agricultural and open space areas.

Document	Relevant Goals, Policies, and Projects
	• TC.P-13 Designate and reserve adequate transportation right-of-way to meet projected traffic volumes, anticipating reasonable future demand. • TC.P-14 Encourage the development of transit facilities and operations along major corridors to connect the county with surrounding activity centers and regional destinations. • TC.P-15 Promote the careful location and design of bus stops, transit centers, and complementary roadway projects that maximize the speed and productivity of fixed-route buses. • TC.P-16 Require major employee centers to facilitate the provision of adequate public transportation. • TC.P-17 Ensure that major retail centers and commercial and industrial centers with high levels of employment are served with adequate public transportation opportunities. Implementation Programs • TC.I-2 Promote development review and mitigation (including the use of transportation impact fees) that focuses on upgrading county roads to County design standards if the new development significantly contributes to the need to upgrade these roads, whether the new development occurs inside or outside of a city. • TC.I-3 Support regular monitoring of the transportation system by the California Department of Transportation and the Solano Transportation Authority, with emphasis on studying congested areas to identify the cause, duration, and severity of the congestion, and potential traffic management solutions. • TC.I-5 In cooperation with the Solano Transportation Agency, provide public education about options for reducing motor vehicle-related greenhouse gas emissions. Include information on trip reduction, trips linking, public transit, biking and walking, vehicle performance and efficiency, low- and zero-emissions vehicles, and ridesharing. • TC.I-7 Adopt road construction standards that account for flood hazards for public roads used as evacuation routes. • TC.I-8 Adopt road construction standards that account for the needs of pedestrians, bicyclists, and transit. • TC.I-9 Maintain an inventory of roadway conditions and widths so that an upgrade and replacement program can be developed and implemented for these facilities.

Document	Relevant Goals, Policies, and Projects
	• TC.I-10 Prioritize, secure funding for, design, and build new roadways and complete roadway improvements using the established Capital Improvement Program process to implement the circulation system shown in the General Plan Circulation diagram. Ensure the future roadways meet design specifications and performance criteria for each roadway classification. • TC.I-11 Review roadway widening needs on major county roadways when reviewing proposed new developments to ensure that adequate right-of-way will be available. • TC.I-12 Create a comprehensive plan of roadway improvements that support agricultural needs. The plan should include increased connectivity across Interstate 80 for farmers and their equipment, improvement of roads that serve agricultural-tourist centers in Suisun and other interior valleys, and grading and paving of unimproved rural roads that serve agricultural areas throughout the county. The plan should specifically address the Pedrick Road/Interstate 80 interchange area and additional roadway improvements needed to support the Limited Industrial area northeast of Dixon. • TC.I-14 Respond to transit operators' efforts when they propose changes to bus stop locations to improve rider safety or convenience, or to improve bus travel speeds or paratransit services.
Solano Travel Safety Plan (2018)	Objectives • Providing guidance for staff from STA, Solano County, and City staff for ongoing safety analysis and identification of relevant countermeasures and safety-based projects. • Identifying a list of safety projects to implement based on the data- driven crash analysis and work done for the 2016 Travel Safety Plan, including a subset of projects to be included in HSIP Cycle 9 grant applications. • Meeting the Caltrans SSARP funding requirements. California's Local HSIP focuses on infrastructure projects with nationally recognized crash reduction factors (CRFs). Local HSIP projects must be identified on the basis of crash experience, crash potential, crash rate, or other data-supported means.

Document	Relevant Goals, Policies, and Projects
	Unincorporated County HSIP Eligible Projects: Treatments Along Segments – Widen Shoulders (Paved) • Fry Rd between Leisure Town Rd and Meridian Rd • Solar Hills Dr between Gibson Canyon Rd and Hillsview Dr • Porter Rd between Midway Rd and Pitt School Rd • SR-113 between Fry Rd and Maine Prairie Rd Treatments Along Segments – Pave Existing Shoulder • Fry Rd between Dally Rd and Clark Rd • Meridian Rd between Bryant Rd and Elizabeth Rd • Putah Creek Rd between Boyce Rd and McNeill Ln Treatments at Unsignalized Intersections – Install Additional Signs, Pavement Markings, and Flashing Warning • Porter Rd at Pitt School Rd Treatments at Unsignalized Intersections – Install Warning/Regulatory Signs and Advance Beacons • Meridian Rd at Sweeney Rd • Pitt School Rd at Porter Rd Convert to Mini-Roundabout • Meridian Rd at Elizabeth Rd The plan also recommends non-HSIP eligible projects at locations on SR-12, SR-113, Fry Rd, Gibson Canyon Rd, Hawkins Rd, Meridian Rd, Midway Rd, Pleasants Valley Rd, Porter Rd, and Putah Creek Rd.
Solano Countywide Active Transportation Plan (2020)	Goals: • Access: People of all ages and abilities should be able to walk and bicycle throughout Solano using a comfortable, connected, and well-maintained network to access transit and key destinations. • Equity: All Solano County residents should have equitable access to convenient and safe, low-cost transportation options. • Health and Safety: Solano County’s transportation system should be designed to increase our community’s health and safety by providing opportunities for increased active

Document	Relevant Goals, Policies, and Projects
	transportation, increasing roadway safety, and reducing vehicle emissions. • Quality of Life: Solano communities should be vibrant, active, and promote a good quality of life for all residents. • Environmental Stewardship: Solano County's active transportation system should reduce environmental impacts by promoting the reduction of air pollution, vehicle miles traveled, and greenhouse gas emissions. • Collaboration: Solano County should work collaboratively with local and regional partners to realize shared active transportation values. • Invest in Our Values: Solano County and its seven cities take pride in investing in active transportation as an aspect of our community by funding mobility options for residents in their everyday lives. Top Five Recommendations: • Continue to support and expand the countywide Safe Routes to School program while expanding to include Safe Routes for Seniors • Continue to implement traffic safety education programs • Maintain Pavement Conditions Index (PCI) Program • Encourage jurisdictions to adopt and implement Complete Streets policies • Provide grant assistance to local jurisdictions seeking funding for active transportation projects Backbone Network Objective: Improve walking and bicycling conditions so that people of all ages and abilities feel comfortable traveling using non-motorized transportation options. The Solano Transportation Authority (STA) and local jurisdictions will accomplish this goal through the creation of a countywide backbone network of facilities to link major destinations and residential areas to areas of countywide significance, like transit centers, and provide linkages across jurisdiction lines for cross-county travel. The plan also strives to improve transit speeds and paratransit services, and to support development of transit facilities in strategic locations.

Document	Relevant Goals, Policies, and Projects
Solano ATP Unincorporated County Chapter	Findings • First analysis used gaps along the backbone network, and identified 14.5 miles of sidewalk gaps in Unincorporated Solano. • Second analysis used safety analysis, walk audits, community outreach, or previous transportation plans; or sidewalk gaps located in high-demand areas, such as along arterials in proximity to transit stops or schools. All the projects identified through these two analyses will help improve Unincorporated Solano’s pedestrian network so that it is more comfortable for people of all ages and abilities. • Outreach was conducted from community feedback using an online map to identify areas of concern. • An “action plan corridor” was identified as a priority for improving local access to rural areas. Some areas include multiple corridors that could be developed together. Proposed Projects A total of 117.2 miles of proposed bikeways have been identified at a total cost of \$151.2 million. Near-term priority bicycle projects include: • Benicia Rd and Lemon St Bikeway Gap Closures • Magazine St Bikeway Gap Closure • Fairfield to Benicia Bikeway Route Gap • Rockville and Solano Community College Bikeway Access • Suisun Valley Wine Trail A total of 14.5 miles of pedestrian projects have been identified with a total cost of \$14.3 million. Pedestrian projects in the unincorporated areas are generally centered around activity centers due to the rural nature of the area, with the exception of unincorporated areas of Vallejo. Priority projects have been identified along: Starr Ct, Benicia Rd, Home Acres, Rockville Rd, Mankas Corner Rd, Solano College Rd, E. Tabor Ave, Lemon St, Magazine St, Fulton Ave, Central Wy, Suisun Valley Rd, and Abernathy Rd.

Document	Relevant Goals, Policies, and Projects
Suisun Valley Strategic Plan (2010)	Goals • Accommodate increase in through-traffic and internal traffic over next 20 years, including non-auto traffic, bikes and walking. • Maintain rural character. Allow use of local roads by agricultural vehicles. • Facilitate safe, barrier-free pedestrian access to points of interest. • Discourage high speed vehicular travel. • Improve safety during major storms. Phase I improvements Limited, spot improvements to reduce speed, improve pedestrian crossings, provide new pathways, and provide dedicated left-hand turns. Total cost is \$4.6 million divided among three ATCs, Mankas Corner, Gomer School and Morrison Ln. Phase II improvements Expand right-of-ways, improve utility pole placement, slow traffic, and provide dedicated left-hand turns, consolidate Phase 1 gains. Total cost is \$39.6 million, improvements focus on Suisun Valley Rd, Mankas Corner Rd, Abernathy Rd, and Rockville Rd. Phase III improvements Establish pedestrian crossings, pathways, bicycle and equestrian access. Total cost is \$3.7 million, improvements on Suisun Valley Road, Rockville Rd, Abernathy Rd, and Mankas Corner Rd. Other recommendations Existing shoulders should be widened to meet demand. Address recurring flooding on 100-year flood plain on Abernathy Rd, Mankas Corner Rd, Suisun Valley Rd, Rockville Rd with upstream reservoir or raised roadway. North Connector Project would create new roads between Red Top Road and Business Center drive; major development in the area not included in this plan.

Document	Relevant Goals, Policies, and Projects
Middle Green Valley Specific Plan (2017)	Goals • Maintain the rural legacy of the area, encourage stewardship of the land’s beauty and resources. • Promote agricultural tourism. • Maintain place-based development plan that respects local community’s goals and interests. Policies • Policy NP-3: Provide a series of distinct, compact, walkable, interconnected neighborhoods, each with a recognizable center and guided by the precepts of traditional neighborhood design. • Policy NP-5: Develop a form-based design approach (rather than land use) that emphasizes the concepts of anticipating change, creating human scale environments and ensuring that safe, vibrant streetscapes are realized. • Policy NP-6: Support and develop local opportunities for agricultural tourism uses, related venues, and educational opportunities. • Policy LU.G-4: Encourage land use development patterns and circulation and transportation systems that promote health and wellness and minimize adverse effects on agriculture and natural resources, energy consumption, and air quality. • Policy LU.P-34: Promote patterns of development that encourage physical activity to reduce obesity, cardiovascular disease, asthma, diabetes, or injury, and contribute to a “sense of place” and emotional well-being • Policy LU.P-36: Promote land use decisions that reduce injuries (pedestrian, bicycle, and motor vehicle crashes), and provide access to healthy food choices, including locally grown fresh fruits and vegetables throughout the county. Recommendations • Recommends street design standards for two roundabouts, seven street types, and five general trail types • Pedestrian and bicycle infrastructure is recommended to be included in all street designs • Includes streetscape standards for each street type • Signage guidelines are provided to provide a coordinated aesthetic direction for community and commercial signage Other recommendations include:

Document	Relevant Goals, Policies, and Projects
	• Add 400 new primary residential units. • Encourage local neighborhood retail and community facility uses, form a nonprofit Green Valley Agricultural Conservancy to protect 1,490 acres of agriculture and open space (75% of the study area) as public spaces and conservation areas. • Allow conserving land resources and wildlife to dictate development policy.
Solano 2040 Comprehensive Transportation Plan (2020)	Goals • A primary goal of all transportation system planning is to reduce deaths and serious accidents. • Expand access to HOV lanes to reduce congestion • Expand rail services to provide a multi-modal hub • Expand ferry services to increase water transit and reduce congestion on roads • Add express lanes to I-80, increase multimodal access along I-80 corridor, provide facilities for pedestrians and bicyclists • Elevate SR-37 roadway to address flooding and congestion • Address equitable access to transportation for zero-vehicle households, seniors over 75, people with disabilities, single parents, rent-burdened households, and ESOL community members • Increase economic vitality by reducing commute times and making middle-wage industries more accessible Tier 1 Priority Projects in or affecting the Unincorporated County Arterials, Highways, and Freeways Element • I-80 Express Lanes • I-80/I-680/SR-12 Interchange, including the west end of the North Connector • SR-37 Corridor Improvements Transit and Rideshare Element • I-80 Express Lanes Conversion and Extension • SolanoExpress bus replacement • I-80/I-680/SR-12 Interchange • Solano Mobility Commuter/Employer Program • First/Last Mile Shuttle Pilot Program • Solano Mobility Program • Solano Mobility Call Center • Solano Travel Training Program • Senior Golden Pass Program

Document	Relevant Goals, Policies, and Projects
	• Solano Local and Intercity Taxi Card Program • Non-Profit Vehicle Share Program Active Transportation Element (Priorities) • Safe Routes to School projects and programs • Bicycle and Pedestrian projects that support PDAs or PCAs • Alternative Fuels infrastructure projects that include public access
Solano Priority Conservation Area Assessment and Implementation Plan (2016)	Projects within existing PCAs: • Farm to Market Project – Suisun Valley PCA ◦ Improve public access to Suisun Valley by providing pedestrian and bicycle enhancements, signage, lighting, bike facilities which accommodate higher bike volumes for all skill types, and staging areas. • Rockville Trails Preserve Staging Area and Trail Connections – Western Hills PCA ◦ New Staging Area and Parking Lot at Rockville Trails Preserve. Multiuse trail connections from Rockville Hills Parking across Rockville Rd to Rockville Trails Preserve. • Lynch Canyon Expansion and Trails – Tri-City and County Open Space PCA ◦ Public access plan for expanded Lynch Canyon, construction of staging area and access points • Vallejo Swett Trails and Bay Area Ridge Trail Expansion – Tri-City and County Open Space PCA ◦ Environmental study, trail construction and access points Recommendations of PCAs with potential projects: • Blue Ridge Hills • Vacaville-Fairfield-Solano Greenbelt and Cement Hill • Suisun Valley • Western Hills • Tri-City and County Cooperative Planning Area Potential PCAs: • Putah Creek • Dixon Agricultural Service Area • Mare Island

Document	Relevant Goals, Policies, and Projects
	• Elmira
Solano County Public Works Capital Improvement Plan	Public Works Capital Improvement Plan 2024 • Road Construction ○ Benicia Road Phase 1 ○ HSIP 10 Pedestrian Improvements ○ North Gate Safety Enhancement Project ○ Rockville Hills Park Crossing ○ RTIF Safety Improvement Project 2023 ○ Cantelow-Gibson Intersection Improvements ○ Countywide Striping Project ○ Home Acres Sidewalk Improvement ○ Lewis/Weber Intersection Improvements ○ Liberty Island Road ○ Maple Road ○ Pleasants Valley Culvert Replacement ○ Suisun Valley Road ○ Winters Road Culvert Replacement ○ Olmo Road ○ Creed Road • Right of Way Acquisition ○ Cantelow Road Culvert Improvements ○ Foothill Drive ○ Gibson Canyon Road Safety Improvement ○ Porter - Midway Intersection Improvement ○ Blue Ridge Road ○ Olmo Road ○ Peabody Road ○ Meridian Road North • Paving by contract • Rubberized chip seal with microsurfacing by contract • Microsurfacing by operations • Chip seals by operations • Construction equipment • Corporation yard facilities major maintenance

Appendix C

Consolidated Collision Database



CASE_ID	ACCIDENT_	PROC_DATE	JURIS	COLLISION_D	COLLISION Hour	OFFICER_I	REPORTING
90637211	2018	1/10/2018	9365	1/3/2018	1525	15	21033
90639713	2018	1/15/2018	9365	1/5/2018	1950	19	20281
90642134	2018	1/17/2018	9365	1/10/2018	1720	17	21033
90642910	2018	1/18/2018	9365	1/12/2018	1805	18	19458
90646607	2018	1/24/2018	9365	1/20/2018	1532	15	18702
90658419	2018	2/9/2018	9365	2/3/2018	1055	10	16919
90659612	2018	2/12/2018	9365	2/10/2018	1145	11	17157
90660619	2018	2/13/2018	9365	2/7/2018	130	1	20222
90660650	2018	2/13/2018	9365	2/5/2018	1820	18	20281
90665397	2018	7/9/2018	9365	2/14/2018	852	8	14264
90678280	2018	3/8/2018	9365	3/1/2018	710	7	13706
90692799	2018	3/29/2018	9365	3/28/2018	1520	15	17747
90699729	2018	4/5/2018	9365	4/3/2018	1530	15	17747
90705288	2018	4/13/2018	9365	4/6/2018	415	4	21033
90706441	2018	4/16/2018	9365	4/8/2018	821	8	17654
90716744	2018	4/30/2018	9365	4/26/2018	2110	21	21027
90720815	2018	5/7/2018	9365	4/27/2018	1740	17	20074
90734974	2018	5/25/2018	9365	5/16/2018	1315	13	17747
90735184	2018	5/25/2018	9365	5/20/2018	1230	12	16919
90741512	2018	6/5/2018	9365	5/28/2018	1140	11	14687
90743628	2018	6/7/2018	9365	5/28/2018	1145	11	15416
90744195	2018	6/8/2018	9365	5/31/2018	1855	18	19458
90746386	2018	6/12/2018	9365	6/1/2018	1525	15	21050
90752368	2018	6/20/2018	9365	6/10/2018	2329	23	20074
90771712	2018	7/18/2018	9365	7/11/2018	2235	22	18712
90774764	2018	7/23/2018	9365	7/13/2018	1930	19	20074
90776303	2018	7/25/2018	9365	7/17/2018	2200	22	21127
90780024	2018	7/30/2018	9365	4/13/2018	1930	19	21050
90781204	2018	7/31/2018	9365	7/21/2018	1905	19	20606
90783788	2018	8/3/2018	9365	7/26/2018	1040	10	16887
90786681	2018	8/8/2018	9365	8/1/2018	1449	14	17747
90794272	2018	8/20/2018	9365	8/10/2018	1550	15	19411
90797838	2018	8/27/2018	9365	8/18/2018	1800	18	20566
90809571	2018	9/11/2018	9365	8/25/2018	1300	13	17735
90817462	2018	9/20/2018	9365	9/15/2018	1830	18	19458
90820233	2018	9/24/2018	9365	9/16/2018	2115	21	19086
90826465	2018	10/2/2018	9365	9/21/2018	1738	17	20606
90837704	2018	10/17/2018	9365	10/7/2018	1830	18	19086
90837857	2018	10/17/2018	9365	10/8/2018	1510	15	19086
90841545	2018	10/22/2018	9365	7/5/2018	1453	14	17747
90849784	2018	1/14/2019	9365	10/23/2018	839	8	17654
90853005	2018	11/5/2018	9365	10/27/2018	1930	19	20566
90867475	2018	11/26/2018	9365	11/18/2018	1035	10	17735
90869393	2018	11/28/2018	9365	11/14/2018	1856	18	19299
90875909	2018	12/5/2018	9365	11/28/2018	1832	18	20633
90876952	2018	12/6/2018	9365	12/2/2018	1545	15	20566

CASE_ID	DAY_OF_WEEK	CHP_SHIFT	POPULATION	CNTY_CITY	SPECIAL_C	BEAT_TYPE	CHP_BEAT	CITY_DIVIS	CHP_BEAT
90637211	3	2	9	4800	0	3	5		2
90639713	5	2	9	4800	0	1 A			2
90642134	3	2	9	4800	0	3	5		2
90642910	5	2	9	4800	0	1 A			2
90646607	6	2	9	4800	0	3	5		2
90658419	6	1	9	4800	0	3	5		2
90659612	6	1	9	4800	0	1 A			2
90660619	3	3	9	4800	0	3	5		2
90660650	1	2	9	4800	0	3	5		2
90665397	3	1	9	4800	0	3	5		2
90678280	4	1	9	4800	0	3	5		2
90692799	3	2	9	4800	0	2	4		2
90699729	2	2	9	4800	0	2	4		2
90705288	5	3	9	4800	0	3	5		2
90706441	7	1	9	4800	0	3	5		2
90716744	4	2	9	4800	0	1 A			2
90720815	5	2	9	4800	0	3	5		2
90734974	3	1	9	4800	0	2	4		2
90735184	7	1	9	4800	0	3	5		2
90741512	1	1	9	4800	0	2	4		2
90743628	1	1	9	4800	0	3	5		2
90744195	4	2	9	4800	0	3	5		2
90746386	5	2	9	4800	0	2	4		2
90752368	7	3	9	4800	0	1 A			2
90771712	3	3	9	4800	0	3	5		2
90774764	5	2	9	4800	0	1 A			2
90776303	2	3	9	4800	0	1 A			2
90780024	5	2	9	4800	0	1 A			2
90781204	6	2	9	4800	0	3	5		2
90783788	4	1	9	4800	0	3	5		2
90786681	3	2	9	4800	0	2	4		2
90794272	5	2	9	4800	0	2	4		2
90797838	6	2	9	4800	0	3	5		2
90809571	6	1	9	4800	0	2	4		2
90817462	6	2	9	4800	0	3	5		2
90820233	7	2	9	4800	0	3	5		2
90826465	5	2	9	4800	0	3	5		2
90837704	7	2	9	4800	0	2	4		2
90837857	1	2	9	4800	0	3	5		2
90841545	4	2	9	4800	0	1 A			2
90849784	2	1	9	4800	0	2	4		2
90853005	6	2	9	4800	0	1	1		2
90867475	7	1	9	4800	0	3	5		2
90869393	3	2	9	4800	0	3	5		2
90875909	3	2	9	4800	0	3	5		2
90876952	7	2	9	4800	0	3	5		2

CASE_ID	BEAT_NUM	PRIMARY_RD	SECONDARY_RD	DISTANCE	DIRECTION
90637211	20	ROCKVILLE ROAD	ABERNATHY RD	100	W
90639713	30	MIDWAY RD	I-505 S/B O/C	70	W
90642134	20	ROCKVILLE RD	ABERNATHY RD	480	W
90642910	30	HAWKINS RD.	BYRNES RD.	0	
90646607	40	PUTAH CREEK RD	BOYCE RD	5280	E
90658419	20	SUISUN VALLEY RD	JOYCE LN	3696	N
90659612	30	MCCRORY ROAD	MERIDIAN ROAD	15	E
90660619	20	ROCKVILLE RD	CHADBOURNE RD	200	N
90660650	20	SUISUN VALLEY RD	NAPA COUNTY LINE	1056	S
90665397	40	SIEVERS RD	HALLEY RD	1430	E
90678280	40	DIXON AVENUE WEST	JAHN ROAD	457	W
90692799	202	SUISUN VALLEY ROAD S/B	NAPA COUNTY LINE	300	S
90699729	202	SUISUN VALLEY ROAD	MORRISON LANE	915	S
90705288	40	DIXON AVE W	JAHN RD	900	W
90706441	40	PEDRICK RD	TREMONT RD	1790	N
90716744	30	PLEASANTS VALLEY RD	GATES CANYON RD	355	N
90720815	20	MANKAS CORNER ROAD (270	ABERNATHY RD	589	N
90734974	202	SUISUN VALLEY ROAD	LEDGEWOOD ROAD	2640	N
90735184	20	MANKAS CORNER RD	LEDGEWOOD RD	60	S
90741512	202	SUISUN VALLEY ROAD	TWIN SISTERS RD	3696	N
90743628	20	CORDELIA RD	THOMASSON LN	2112	W
90744195	20	ROCKVILLE RD.	SUISUN VALLEY RD.	340	E
90746386	202	SUISUN VALLEY RD (4200 BL	ROCKVILLE RD	3170	N
90752368	30	PLEASANTS VALLEY ROAD (80	SHALE PEAK LN	840	S
90771712	40	MIDWAY RD	NUNES RD	1650	E
90774764	30	PLEASANTS VALLEY RD	QUAIL CANYON RD	100	S
90776303	30	CANTELOW RD	ENGLISH HILLS RD	1056	W
90780024	30	CORDELIA ROAD (2200 BLOC	PENNSYLVANIA AVE	187	W
90781204	40	SIEVERS ROAD	SPARKS RANCH ROAD	990	E
90783788	40	ROBBEN RD.	VAUGHN RD.	0	
90786681	202	SUISUN VALLEY ROAD	NAPA COUNTY LINE	150	S
90794272	202	SUISUN VALLEY RD	WILLIAMS RD	1056	W
90797838	40	DIXON AVE	MERIDIAN RD	531	E
90809571	301	PLEASANTS VALLEY RD	BREHME LANE	500	S
90817462	40	SIEVERS RD.	SCHROEDER RD.	3	E
90820233	40	SIEVERS RD	SCHROEDER RD	14	E
90826465	10	BENICIA ROAD	LEMON STREET	0	
90837704	402	PEDRICK RD	I-80 E/B	4752	S
90837857	40	MIDWAY RD	GENTILE LN	20	W
90841545	30	BATAVIA ROAD	MIDWAY ROAD	0	
90849784	202	SUISUN VALLEY ROAD	MANKAS CORNER RD	1000	N
90853005	680	LOPES RD	MARSHVIEW RD	2640	N
90867475	20	ROCKVILLE RD	AMARAL COURT	528	W
90869393	40	PEDRICK RD	VINEYARD LN	1450	S
90875909	10	BENICIA RD	LEMON ST	0	
90876952	40	HAWKINS RD	BYRNES RD	0	

CASE_ID	INTERSECT	Intersectio	WEATHER_	WEATHER_ STATE_HW	CALTRANS_ CALTRANS_ STATE_ROI	ROUTE_SU
90637211	N	Y	C	-	N	
90639713	N	Y	C	-	N	
90642134	N	N	B	-	N	
90642910	Y	Y	A	-	N	
90646607	N	N	A	-	N	
90658419	N	N	A	-	N	
90659612	N	Y	A	-	N	
90660619	N	Y	A	-	N	
90660650	N	N	B	-	N	
90665397	N	N	B	-	N	
90678280	N	N	C	-	N	
90692799	N	N	A	-	N	
90699729	N	N	A	-	N	
90705288	N	N	C	-	N	
90706441	N	N	A	-	N	
90716744	N	N	A	-	N	
90720815	N	N	A	-	N	
90734974	N	N	A	-	N	
90735184	N	Y	A	-	N	
90741512	N	N	A	-	N	
90743628	N	N	A	-	N	
90744195	N	N	A	-	N	
90746386	N	N	A	-	N	
90752368	N	N	A	-	N	
90771712	N	N	A	-	N	
90774764	N	Y	A	-	N	
90776303	N	N	A	-	N	
90780024	N	Y	A	-	N	
90781204	N	N	A	-	N	
90783788	Y	Y	A	-	N	
90786681	N	Y	A	-	N	
90794272	N	N	A	-	N	
90797838	N	N	A	-	N	
90809571	N	N	A	-	N	
90817462	N	Y	A	-	N	
90820233	N	Y	A	-	N	
90826465	Y	Y	A	-	N	
90837704	N	N	A	-	N	
90837857	N	Y	A	-	N	
90841545	Y	Y	A	-	N	
90849784	N	N	A	-	N	
90853005	N	N	A	-	N	
90867475	N	N	A	-	N	
90869393	N	N	B	-	N	
90875909	Y	Y	B	-	N	
90876952	Y	Y	A	-	N	

CASE_ID	POSTMILE_ POSTMILE	LOCATION_ RAMP_INT	SIDE_OF_ HTOW_AWA	COLLISION_ NUMBER_I	NUMBER_I	
90637211			Y	3	0	1
90639713			N	4	0	1
90642134			Y	4	0	1
90642910			Y	4	0	1
90646607			N	4	0	1
90658419			Y	3	0	1
90659612			N	4	0	1
90660619			Y	3	0	1
90660650			N	4	0	1
90665397			N	2	0	1
90678280			Y	3	0	1
90692799			Y	3	0	1
90699729			Y	2	0	3
90705288			Y	4	0	1
90706441			Y	3	0	1
90716744			Y	2	0	1
90720815			Y	4	0	2
90734974			N	4	0	1
90735184			Y	3	0	1
90741512			Y	4	0	1
90743628			Y	3	0	1
90744195			Y	4	0	1
90746386			Y	4	0	1
90752368			Y	3	0	1
90771712			Y	3	0	1
90774764			Y	2	0	1
90776303			Y	3	0	1
90780024			Y	1	1	0
90781204			Y	2	0	1
90783788			Y	3	0	2
90786681			Y	4	0	1
90794272			N	4	0	1
90797838			Y	2	0	1
90809571			Y	2	0	1
90817462			Y	4	0	1
90820233			Y	3	0	1
90826465			Y	2	0	2
90837704			Y	3	0	1
90837857			Y	4	0	1
90841545			Y	1	1	1
90849784			Y	4	0	1
90853005			Y	2	0	1
90867475			Y	4	0	3
90869393			Y	3	0	3
90875909			Y	4	0	1
90876952			Y	2	0	2

CASE_ID	PARTY_CO	PRIMARY_	PCF_CODE	PCF_VIOL_	PCF_VIOLA	PCF_VIOL_	HIT_AND_	F	TYPE_OF_	C	M	VIW
90637211	2	A	-	8	22107	N	A	C				
90639713	2	A	-	9	21802	A	N	A	C			
90642134	1	A	-	1	23152	A	N	E	I			
90642910	2	A	-	9	21802	A	N	D	C			
90646607	2	A	-	3	22350	N	C	G				
90658419	2	A	-	17	23114	A	N	B	C			
90659612	1	A	-	3	22350	N	E	I				
90660619	1	A	-	8	22107	N	E	I				
90660650	1	A	-	8	22107	N	F	A				
90665397	2	A	-	6	21760	B	N	C	G			
90678280	1	A	-	8	22107	N	E	I				
90692799	1	A	-	3	22350	N	E	I				
90699729	2	A	-	8	22107	N	A	C				
90705288	1	A	-	8	22107	N	F	A				
90706441	1	A	-	8	22107	N	E	I				
90716744	1	A	-	8	22107	N	E	I				
90720815	1	A	-	1	23152	A	N	E	I			
90734974	2	A	-	6	21750	A	N	C	C			
90735184	2	A	-	3	22350	N	C	C				
90741512	1	A	-	8	22107	N	E	I				
90743628	1	A	-	8	22107	N	F	A				
90744195	2	A	-	3	22350	N	C	C				
90746386	1	A	-	8	22107	N	E	I				
90752368	1	A	-	8	22107	N	E	I				
90771712	1	A	-	1	23152	A	N	E	I			
90774764	1	A	-	8	22107	N	F	A				
90776303	1	A	-	8	22107	N	E	I				
90780024	1	A	-	1	23152	A	N	E	I			
90781204	1	A	-	1	23152	A	N	E	I			
90783788	2	A	-	9	21801	A	N	D	C			
90786681	1	A	-	8	22107	N	E	I				
90794272	2	A	-	3	22350	N	C	C				
90797838	2	A	-	5	21460	A	N	A	C			
90809571	1	A	-	1	23152	A	N	F	A			
90817462	2	A	-	3	22350	N	C	C				
90820233	1	A	-	8	22107	N	E	I				
90826465	2	A	-	1	23152	A	N	A	C			
90837704	2	A	-	6	21750	A	N	B	C			
90837857	2	A	-	3	22350	N	C	C				
90841545	2	A	-	12	22450	A	N	D	C			
90849784	2	A	-	5	21460	A	N	D	C			
90853005	1	A	-	8	22107	N	E	I				
90867475	1	A	-	3	22350	N	E	I				
90869393	2	A	-	1	23152	A	N	A	C			
90875909	2	A	-	12	21453	A	F	D	C			
90876952	2	A	-	9	21802	A	N	D	C			

CASE_ID	PED_ACT	ICROAD_SUR	ROAD_CON	ROAD_CON	LIGHTING	CONTROL_CHP	ROAD PEDESTRIA	BICYCLE_A
90637211	A	B	H	-	A	D	0	
90639713	A	B	H	-	C	A	0	
90642134	A	A	H	-	B	D	0	
90642910	A	A	H	-	D	D	0	
90646607	A	A	H	-	A	A	0	Y
90658419	A	A	H	-	A	D	0	
90659612	A	A	H	-	A	D	0	
90660619	A	A	H	-	D	D	0	
90660650	A	B	H	-	D	D	0	
90665397	A	A	H	-	A	D	0	Y
90678280	A	B	H	-	A	D	0	
90692799	A	A	H	-	A	D	0	
90699729	A	A	H	-	A	D	0	
90705288	A	B	H	-	D	D	0	
90706441	A	A	H	-	A	D	0	
90716744	A	A	H	-	D	D	0	
90720815	A	A	H	-	A	D	0	
90734974	A	A	H	-	A	D	0	
90735184	A	A	H	-	A	D	0	
90741512	A	A	H	-	A	D	0	
90743628	A	A	H	-	A	D	0	
90744195	A	A	H	-	A	D	0	
90746386	A	A	H	-	A	D	0	
90752368	A	A	H	-	D	D	0	
90771712	A	A	H	-	D	D	0	
90774764	A	A	H	-	A	D	0	
90776303	A	A	H	-	D	D	0	
90780024	A	A	H	-	A	D	0	
90781204	A	A	H	-	A	D	0	
90783788	A	A	H	-	A	D	0	
90786681	A	A	H	-	A	D	0	
90794272	A	A	H	-	A	D	0	
90797838	A	A	H	-	A	D	0	
90809571	A	A	H	-	A	D	0	
90817462	A	A	H	-	B	D	0	
90820233	A	A	H	-	D	D	0	
90826465	A	A	H	-	A	A	0	
90837704	A	A	H	-	A	D	0	
90837857	A	A	H	-	A	D	0	
90841545	A	A	H	-	A	A	0	
90849784	A	A	H	-	A	D	0	
90853005	A	A	H	-	D	D	0	
90867475	A	A	H	-	A	D	0	
90869393	A	A	H	-	D	D	0	
90875909	A	B	H	-	C	A	0	
90876952	A	A	H	-	A	D	0	

CASE_ID	MOTORCYC	TRUCK_AC	NOT_PRIV	ALCOHOL	STWD_VEH	CHP_VEH	COUNT_SE	COUNT_VI	COUNT_CC
90637211			Y		A		1	0	1
90639713			Y		A		1	0	0
90642134			Y	Y	A		7	0	0
90642910			Y		A		1	0	0
90646607			Y		L		4	0	0
90658419 Y			Y		E		22	0	1
90659612			Y		A		7	0	0
90660619			Y		A		7	0	1
90660650			Y		A		1	0	0
90665397			Y		D		22	1	0
90678280			Y		A		7	0	1
90692799			Y		A		1	0	1
90699729			Y		A		7	1	2
90705288			Y		D		22	0	0
90706441			Y		A		1	0	1
90716744			Y		A		1	1	0
90720815			Y	Y	A		8	0	0
90734974			Y		D		22	0	0
90735184			Y		A		1	0	1
90741512			Y		A		1	0	0
90743628 Y			Y		C		2	0	1
90744195			Y		A		7	0	0
90746386			Y		A		1	0	0
90752368			Y		A		1	0	1
90771712			Y	Y	A		7	0	1
90774764 Y			Y		C		2	1	0
90776303			Y		A		1	0	1
90780024 Y			Y	Y	C		2	0	0
90781204			Y	Y	D		22	1	0
90783788			Y		E		22	0	1
90786681			Y		A		1	0	0
90794272			Y		D		22	0	0
90797838 Y			Y		C		2	1	0
90809571 Y			Y	Y	C		2	1	0
90817462			Y		A		7	0	0
90820233			Y		A		1	0	1
90826465			Y	Y	A		8	1	0
90837704	Y		Y		A		1	0	1
90837857			Y		A		1	0	0
90841545			Y		A		1	0	1
90849784			Y		A		1	0	0
90853005			Y		A		1	1	0
90867475			Y		A		1	0	0
90869393			Y	Y	A		1	0	1
90875909			Y		A		7	0	0
90876952			Y		A		1	1	0

CASE_ID	COUNT_PE	COUNT_PE	COUNT_BI	COUNT_BI	COUNT_MI	COUNT_MI	PRIMARY_I	SECONDAR	LATITUDE
90637211	0	0	0	0	0	0	-	-	38.246
90639713	0	0	0	0	0	0	-	-	38.41707
90642134	0	0	0	0	0	0	-	-	38.24578
90642910	0	0	0	0	0	0	-	-	38.35895
90646607	0	0	0	1	0	0	-	-	38.53031
90658419	0	0	0	0	0	1	-	-	38.31245
90659612	0	0	0	0	0	0	-	-	38.30827
90660619	0	0	0	0	0	0	-	-	38.24701
90660650	0	0	0	0	0	0	-	-	38.31387
90665397	0	0	0	1	0	0	-	-	38.48966
90678280	0	0	0	0	0	0	-	-	38.2643
90692799	0	0	0	0	0	0	-	-	38.3157
90699729	0	0	0	0	0	0	-	-	38.2638
90705288	0	0	0	0	0	0	-	-	38.44569
90706441	0	0	0	0	0	0	-	-	38.50078
90716744	0	0	0	0	0	0	-	-	38.37706
90720815	0	0	0	0	0	0	-	-	38.2737
90734974	0	0	0	0	0	0	-	-	38.2767
90735184	0	0	0	0	0	0	-	-	38.27877
90741512	0	0	0	0	0	0	-	-	38.30865
90743628	0	0	0	0	0	1	-	-	38.2257
90744195	0	0	0	0	0	0	-	-	38.2442
90746386	0	0	0	0	0	0	-	-	38.25344
90752368	0	0	0	0	0	0	-	-	38.26381
90771712	0	0	0	0	0	0	-	-	38.41693
90774764	0	0	0	0	0	1	-	-	38.36736
90776303	0	0	0	0	0	0	-	-	38.41723
90780024	0	0	0	0	1	0	-	-	38.23518
90781204	0	0	0	0	0	0	-	-	38.48929
90783788	0	0	0	0	0	0	-	-	38.4671
90786681	0	0	0	0	0	0	-	-	38.3155
90794272	0	0	0	0	0	0	-	-	38.297
90797838	0	0	0	0	0	1	-	-	38.4462
90809571	0	0	0	0	0	1	-	-	38.4154
90817462	0	0	0	0	0	0	-	-	38.48935
90820233	0	0	0	0	0	0	-	-	38.48925
90826465	0	0	0	0	0	0	-	-	38.09488
90837704	0	0	0	0	0	0	-	-	38.47667
90837857	0	0	0	0	0	0	-	-	38.41699
90841545	0	0	0	0	0	0	-	-	38.4168
90849784	0	0	0	0	0	0	-	-	38.28989
90853005	0	0	0	0	0	0	-	-	38.15534
90867475	0	0	0	0	0	0	-	-	38.2534
90869393	0	0	0	0	0	0	-	-	38.51785
90875909	0	0	0	0	0	0	-	-	38.09499
90876952	0	0	0	0	0	0	-	-	38.3588

CASE_ID	LONGITUD	COUNTY	CITY	POINT_X	POINT_Y	Age	Gender	MOVE_PRI	Bike_Ped_
90637211	-122.091	SOLANO	UNINCORP	-122.091	38.24597	17	M	M	N
90639713	-121.945	SOLANO	UNINCORP	-121.945	38.41705	31	M	E	N
90642134	-122.093	SOLANO	UNINCORP	-122.093	38.24593	56	M	C	N
90642910	-121.906	SOLANO	UNINCORP	-121.906	38.35891	25	F	H	N
90646607	-121.93	SOLANO	UNINCORP	-121.929	38.53009	63	F	B	Y
90658419	-122.129	SOLANO	UNINCORP	-122.129	38.31203	54	M	B	N
90659612	-121.916	SOLANO	UNINCORP	-121.915	38.3082	26	F	B	N
90660619	-122.084	SOLANO	UNINCORP	-122.084	38.247	61	F	M	N
90660650	-122.131	SOLANO	UNINCORP	-122.131	38.31378	43	M	R	N
90665397	-121.919	SOLANO	UNINCORP	-121.919	38.48965	58	M	B	Y
90678280	-121.535	SOLANO	UNINCORP	-121.898	38.44593	16	F	C	N
90692799	-122.134	SOLANO	UNINCORP	-122.133	38.31508	53	M	I	N
90699729	-122.114	SOLANO	UNINCORP	-122.114	38.26361	26	F	R	N
90705288	-121.9	SOLANO	UNINCORP	-121.9	38.44594	30	M	M	N
90706441	-121.804	SOLANO	UNINCORP	-121.804	38.50108	21	F	C	N
90716744	-122.026	SOLANO	UNINCORP	-122.026	38.37709	36	M	M	N
90720815	-122.092	SOLANO	UNINCORP	-122.093	38.27376	27	F	M	N
90734974	-122.114	SOLANO	UNINCORP	-122.114	38.27819	54	F	I	N
90735184	-122.101	SOLANO	UNINCORP	-122.102	38.27887	37	M	B	N
90741512	-122.129	SOLANO	UNINCORP	-122.129	38.30871	40	F	M	N
90743628	-122.101	SOLANO	UNINCORP	-122.113	38.21939	52	M	B	N
90744195	-122.121	SOLANO	UNINCORP	-122.121	38.24414	31	F	H	N
90746386	-122.12	SOLANO	UNINCORP	-122.12	38.25265	46	F	R	N
90752368	-122.315	SOLANO	UNINCORP	-122.054	38.44391	21	M	C	N
90771712	-121.881	SOLANO	UNINCORP	-121.881	38.41691	38	M	R	N
90774764	-122.05	SOLANO	UNINCORP	-122.05	38.46704	33	M	M	N
90776303	-122.002	SOLANO	UNINCORP	-122.002	38.41718	55	M	R	N
90780024	-122.054	SOLANO	UNINCORP	-122.054	38.23542	41	M	R	N
90781204	-121.864	SOLANO	UNINCORP	-121.864	38.48938	59	M	M	N
90783788	-121.786	SOLANO	UNINCORP	-121.786	38.46709	40	F	E	N
90786681	-122.134	SOLANO	UNINCORP	-122.134	38.31542	18	M	R	N
90794272	-122.124	SOLANO	UNINCORP	-122.124	38.29689	54	M	B	N
90797838	-121.915	SOLANO	UNINCORP	-121.914	38.44655	53	M	I	N
90809571	-122.043	SOLANO	UNINCORP	-122.043	38.41557	30	M	M	N
90817462	-121.859	SOLANO	UNINCORP	-121.859	38.48933	46	M	B	N
90820233	-121.859	SOLANO	UNINCORP	-121.859	38.48933	27	F	C	N
90826465	-122.231	SOLANO	UNINCORP	-122.231	38.09491	22	M	B	N
90837704	-121.804	SOLANO	UNINCORP	-121.804	38.47561	36	F	I	N
90837857	-121.9	SOLANO	UNINCORP	-121.9	38.41698	30	F	B	N
90841545	-121.86	SOLANO	UNINCORP	-121.86	38.41681	23	F	B	N
90849784	-122.119	SOLANO	UNINCORP	-122.119	38.28981	26	F	I	N
90853005	-122.115	SOLANO	UNINCORP	-122.115	38.15485	36	F	M	N
90867475	-122.172	SOLANO	UNINCORP	-122.172	38.25306	18	M	M	N
90869393	-121.803	SOLANO	UNINCORP	-121.803	38.52059	37	M	I	N
90875909	-122.231	SOLANO	UNINCORP	-122.231	38.09491	32	M	B	N
90876952	-121.897	SOLANO	UNINCORP	-121.906	38.35891	23	M	B	N

CASE_ID	Age_At Fault_1
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90637211	15-20
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90639713	30-39
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90642134	50-59
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90642910	20-29
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90646607	60-69
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90658419	50-59
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90659612	20-29
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90660619	60-69
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90660650	40-49
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90665397	50-59
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90678280	15-20
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90692799	50-59
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90699729	20-29
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90705288	30-39
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90706441	20-29
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90716744	30-39
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90720815	20-29
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90734974	50-59
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90735184	30-39
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90743628	50-59
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90744195	30-39
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90746386	40-49
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90752368	20-29
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90771712	30-39
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90774764	30-39
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90776303	50-59
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90780024	40-49
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90781204	50-59
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90783788	40-49
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90786681	15-20
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90794272	50-59
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90797838	50-59
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90809571	30-39
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90817462	40-49
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90820233	20-29
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90826465	20-29
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90837704	30-39
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90837857	30-39
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90841545	20-29
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90849784	20-29
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90853005	30-39
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90867475	15-20
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90869393	30-39
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90875909	30-39
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90876952	20-29
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CASE_ID	ACCIDENT_	PROC_DATE	JURIS	COLLISION_D	COLLISION Hour	OFFICER_I	REPORTING
90881857	2018	12/13/2018	9365	12/9/2018	20	0	17805
90888040	2018	12/21/2018	9365	12/12/2018	1558	15	20222
90899051	2018	1/7/2019	9365	12/26/2018	1621	16	18803
90899056	2018	1/7/2019	9365	12/26/2018	1622	16	18803
90941739	2019	3/7/2019	9365	3/2/2019	515	5	17654
90943069	2019	3/11/2019	9365	2/27/2019	825	8	16919
90946363	2019	3/14/2019	9365	3/10/2019	1640	16	20566
90952621	2019	3/25/2019	9365	3/17/2019	1130	11	17735
90967503	2019	4/15/2019	9365	4/4/2019	1730	17	17559
90974603	2019	4/24/2019	9365	4/18/2019	1120	11	16783
90982569	2019	5/6/2019	9365	4/23/2019	1120	11	13706
90984755	2019	5/8/2019	9365	4/29/2019	600	6	14264
90989560	2019	5/15/2019	9365	5/3/2019	1219	12	14687
90991164	2019	5/17/2019	9365	5/4/2019	1434	14	20068
91002220	2019	6/3/2019	9365	6/2/2019	1410	14	17805
91002233	2019	6/3/2019	9365	6/2/2019	1445	14	17805
91006036	2019	6/10/2019	9365	6/3/2019	1205	12	14264
91017156	2019	6/25/2019	9365	6/12/2019	2108	21	18803
91018011	2019	6/26/2019	9365	6/12/2019	1707	17	18803
91028562	2019	7/10/2019	9365	7/6/2019	1840	18	20281
91039258	2019	7/26/2019	9365	7/16/2019	400	4	21116
91052766	2019	8/15/2019	9365	8/9/2019	1435	14	19790
91053461	2019	8/16/2019	9365	8/11/2019	2230	22	21027
91054928	2019	8/19/2019	9365	8/10/2019	1045	10	20068
91056456	2019	8/21/2019	9365	8/16/2019	1150	11	16783
91058586	2019	8/23/2019	9365	8/18/2019	1953	19	20633
91069593	2019	9/6/2019	9365	8/27/2019	1240	12	19051
91078875	2019	9/19/2019	9365	9/14/2019	1325	13	19790
91079834	2019	9/20/2019	9365	9/16/2019	545	5	14264
91081160	2019	9/23/2019	9365	9/17/2019	600	6	16919
91084211	2019	9/26/2019	9365	9/19/2019	1355	13	19790
91109368	2019	10/29/2019	9365	10/20/2019	1217	12	17654
91117407	2019	11/11/2019	9365	10/26/2019	1350	13	19051
91117513	2019	11/11/2019	9365	11/6/2019	750	7	14264
91123715	2019	11/19/2019	9365	11/16/2019	1445	14	20508
91142338	2019	12/12/2019	9365	12/12/2019	710	7	17163
91146516	2019	12/18/2019	9365	12/8/2019	50	0	20565
91159072	2019	1/3/2020	9365	12/28/2019	1510	15	19815
91160450	2019	1/7/2020	9365	12/20/2019	1340	13	17805
91169766	2020	1/22/2020	9365	1/12/2020	30	0	21382
91175403	2020	1/28/2020	9365	1/21/2020	815	8	14264
91183994	2020	2/10/2020	9365	2/5/2020	1430	14	19790
91192541	2020	2/24/2020	9365	2/17/2020	625	6	14264
91193424	2020	2/25/2020	9365	2/15/2020	640	6	17654
91208082	2020	3/13/2020	9365	3/12/2020	600	6	16783
91213110	2020	3/20/2020	9365	3/20/2020	1020	10	16783

CASE_ID	DAY_OF_WEEK	CHP_SHIFT	POPULATION	CNTY_CITY	SPECIAL_C	BEAT_TYPE	CHP_BEAT	CITY_DIVIS	CHP_BEAT
90881857	7	3	9	4800	0	3	5		2
90888040	3	2	9	4800	0	3	5		2
90899051	3	2	9	4800	0	3	5		2
90899056	3	2	9	4800	0	3	5		2
90941739	6	3	9	4800	0	3	5		2
90943069	3	1	9	4800	0	3	5		2
90946363	7	2	9	4800	0	3	5		2
90952621	7	1	9	4800	0	2	4		2
90967503	4	2	9	4800	0	1 A			2
90974603	4	1	9	4800	0	3	5		2
90982569	2	1	9	4800	0	3	5		2
90984755	1	1	9	4800	0	1 A			2
90989560	5	1	9	4800	0	2	4		2
90991164	6	2	9	4800	0	2	4		2
91002220	7	2	9	4800	0	1 A			2
91002233	7	2	9	4800	0	1 A			2
91006036	1	1	9	4800	0	1 A			2
91017156	3	2	9	4800	0	3	5		2
91018011	3	2	9	4800	0	3	5		2
91028562	6	2	9	4800	0	1 A			2
91039258	2	3	9	4800	0	3	5		2
91052766	5	2	9	4800	0	1 A			2
91053461	7	3	9	4800	0	1 A			2
91054928	6	1	9	4800	0	1 A			2
91056456	5	1	9	4800	0	3	5		2
91058586	7	2	9	4800	0	1 A			2
91069593	2	1	9	4800	0	3	5		2
91078875	6	1	9	4800	0	3	5		2
91079834	1	3	9	4800	0	1 A			2
91081160	2	1	9	4800	0	3	5		2
91084211	4	1	9	4800	0	3	5		2
91109368	7	1	9	4800	0	3	5		2
91117407	6	1	9	4800	0	1 A			2
91117513	3	1	9	4800	0	2	4		2
91123715	6	2	9	4800	0	2	4		2
91142338	4	1	9	4800	0	3	5		2
91146516	7	3	9	4800	0	3	5		2
91159072	6	2	9	4800	0	1	1		2
91160450	5	1	9	4800	0	3	5		2
91169766	7	3	9	4800	0	1 A			2
91175403	2	1	9	4800	0	1 A			2
91183994	3	2	9	4800	0	3	5		2
91192541	1	1	9	4800	0	1 A			2
91193424	6	1	9	4800	0	3	5		2
91208082	4	1	9	4800	0	3	5		2
91213110	5	1	9	4800	0	3	5		2

CASE_ID	BEAT_NUM	PRIMARY_RD	SECONDARY_RD	DISTANCE	DIRECTION
90881857	40	PUTAH CREEK RD.	RAILROAD AVE.	122	S
90888040	20	CORDELIA RD	THOMMASON LN	2640	E
90899051	20	MANKAS CORNER RD	ABERNATHY RD	40	N
90899056	20	MANKAS CORNER RD	ABERNATHY RD	250	N
90941739	40	PEDRICK RD	DIXON AVE E	20	N
90943069	20	CORDELIA RD	PENNSYLVANIA AVE	5280	E
90946363	20	MANKAS CORNER RD	CLAYTON RD	1584	S
90952621	201	ROCKVILLE RD	LOZANO LN	710	W
90967503	30	PLEASANTS VALLEY RD	BRINCK TRAIL	219	N
90974603	20	MANKAS CORNER RD	ABERNATHY RD	1584	N
90982569	40	MERIDIAN ROAD	ALLENDAL ROAD	6	S
90984755	30	HAWKINS RD	BYRNES RD	0	
90989560	201	ROCKVILLE ROAD	SUISUN VALLEY RD	2640	W
90991164	202	SUISUN VALLEY RD	JOYCE LN	2975	N
91002220	30	MIDWAY RD.	ELIZABETH RD	100	W
91002233	30	GATES CANYON RD.	PLEASANTS VALLEY RD.	15840	N
91006036	30	PEASANTS VALLEY ROAD	CANTELOW RD	4224	N
91017156	20	SUISUN VALLEY RD	JOYCE LN	1584	N
91018011	20	MANKAS CORNER RD	LEDGEWOOD RD	1042	E
91028562	30	PUTAH CREEK RD	WINTERS RD	315	E
91039258	20	LOPES RD	PARISH RD	528	S
91052766	30	MIDWAY RD	PADDON RD	142	E
91053461	30	MERIDIAN RD	HAY RD	35	N
91054928	30	CORDELIA RD	HALE RANCH RD	2693	W
91056456	40	WINTERS RD	WOLFSKILL RD	100	N
91058586	30	WINTERS RD	WOLFSKILL RD	0	
91069593	20	ROCKVILLE RD	OLIVER RD	3379	W
91078875	20	SUISUN VALLEY RD	LEDGEWOOD RD	75	S
91079834	30	HAWKINS RD	BYRNES RD	0	
91081160	20	ABERNATHY RD	MANKAS CORNER RD	42	S
91084211	40	DIXON AVE W	MERIDIAN RD	792	E
91109368	40	DIXON AVE W	SCHROEDER RD	2075	W
91117407	30	MIDWAY RD	PADDON RD	216	E
91117513	402	MIDWAY RD	NUNES RD	3696	E
91123715	301	PLEASANTS VALLEY RD	BRINICK TRAIL	200	N
91142338	20	LOPES RD	PARISH RD	413	S
91146516	40	PUTAH CREEK RD	WINTERS RD	71	E
91159072	89	SIEVERS ROAD	PEDRICK RD	372	W
91160450	40	PUTAH CREEK RD	BOYCE RD	5808	E
91169766	30	MIDWAY RD	I-505	700	E
91175403	30	LEWIS RD	HOLDENER RD	0	
91183994	20	MANKAS CORNER RD	LEDGEWOOD RD	750	N
91192541	30	LEWIS RD	HOLDENER RD	0	
91193424	40	MIDWAY ROAD	NUNES RD	1650	E
91208082	20	LOPES RD	MARSHVIEW RD	1056	S
91213110	40	PUTAH CREEK RD	CAMBELL ROAD	528	W

CASE_ID	INTERSECT	Intersectio	WEATHER_	WEATHER_ STATE_HW	CALTRANS_ CALTRANS_ STATE_ROI	ROUTE_SU
90881857	N	Y	B	-	N	
90888040	N	N	A	-	N	
90899051	N	Y	A	-	N	
90899056	N	Y	A	-	N	
90941739	N	Y	C	-	N	
90943069	N	N	C	-	N	
90946363	N	N	B	-	N	
90952621	N	N	A	-	N	
90967503	N	Y	A	-	N	
90974603	N	N	A	-	N	
90982569	N	Y	A	-	N	
90984755	Y	Y	A	-	N	
90989560	N	N	A	-	N	
90991164	N	N	A	-	N	
91002220	N	Y	A	-	N	
91002233	N	N	A	-	N	
91006036	N	N	A	-	N	
91017156	N	N	A	-	N	
91018011	N	N	A	-	N	
91028562	N	N	A	-	N	
91039258	N	N	A	-	N	
91052766	N	Y	A	-	N	
91053461	N	Y	A	-	N	
91054928	N	N	A	-	N	
91056456	N	Y	A	-	N	
91058586	Y	Y	A	-	N	
91069593	N	N	A	-	N	
91078875	N	Y	A	-	N	
91079834	Y	Y	A	-	N	
91081160	N	Y	A	-	N	
91084211	N	N	A	-	N	
91109368	N	N	A	-	N	
91117407	N	Y	A	-	N	
91117513	N	N	A	-	N	
91123715	N	Y	A	-	N	
91142338	N	N	B	C	N	
91146516	N	Y	C	-	N	
91159072	N	N	A	-	N	
91160450	N	N	A	-	N	
91169766	N	N	A	-	N	
91175403	Y	Y	B	-	N	
91183994	N	N	A	-	N	
91192541	Y	Y	A	-	N	
91193424	N	N	A	-	N	
91208082	N	N	A	-	N	
91213110	N	N	A	-	N	

CASE_ID	POSTMILE_POSTMILE	LOCATION_RAMP_INT	SIDE_OF_H	TOW_AWA	COLLISION_NUMBER_I	NUMBER_I
90881857			Y		2	0
90888040			Y		4	0
90899051			Y		4	0
90899056			Y		4	0
90941739			Y		3	0
90943069			Y		4	0
90946363			Y		3	0
90952621			Y		2	0
90967503			Y		4	0
90974603			Y		3	0
90982569			Y		4	0
90984755			Y		4	0
90989560			Y		3	0
90991164			Y		2	0
91002220			N		3	0
91002233			Y		4	0
91006036			Y		2	0
91017156			Y		4	0
91018011			Y		2	0
91028562			Y		3	0
91039258			Y		4	0
91052766			Y		3	0
91053461			Y		2	0
91054928			Y		3	0
91056456			Y		4	0
91058586			N		2	0
91069593			Y		4	0
91078875			N		4	0
91079834			Y		3	0
91081160			Y		3	0
91084211			Y		3	0
91109368			Y		4	0
91117407			Y		4	0
91117513			N		4	0
91123715			N		3	0
91142338			Y		3	0
91146516			Y		4	0
91159072			Y		4	0
91160450			N		4	0
91169766			Y		4	0
91175403			Y		3	0
91183994			Y		4	0
91192541			Y		2	0
91193424			Y		3	0
91208082			Y		3	0
91213110			N		3	0

CASE_ID	PARTY_CODE	PRIMARY_CODE	PCF_CODE	PCF_VIOL	PCF_VIOLA	PCF_VIOL_HIT	AND_FTYPE_OF_C	MVIW
90881857	1	A	-	1	23152 A	N	E	I
90888040	2	A	-	5	21460 A	F	B	C
90899051	2	A	-	5	21460 A	N	D	C
90899056	2	A	-	5	21460 A	N	D	C
90941739	1	A	-	1	23152 A	N	E	I
90943069	2	A	-	3	22350	N	B	C
90946363	1	A	-	8	22107	N	F	A
90952621	2	A	-	5	21460 A	N	D	C
90967503	1	A	-	8	22107	N	E	I
90974603	1	A	-	3	22350	N	F	A
90982569	2	A	-	9	21801 A	N	D	C
90984755	2	A	-	9	21802 A	N	D	C
90989560	2	A	-	5	21650	N	A	C
90991164	2	A	-	5	21460 A	N	A	C
91002220	1	A	-	8	22107	N	E	A
91002233	1	A	-	8	22107	N	F	A
91006036	1	A	-	8	22107	N	F	I
91017156	1	A	-	8	22107	N	E	I
91018011	1	A	-	8	22107	N	E	I
91028562	2	A	-	1	23152 G	F	A	C
91039258	1	A	-	8	22107	N	E	I
91052766	1	A	-	1	23152 F	N	E	I
91053461	1	A	-	1	23152 A	F	E	I
91054928	1	A	-	8	22107	N	F	A
91056456	1	A	-	8	22107	N	E	I
91058586	2	A	-	9	21801 A	N	D	G
91069593	2	A	-	3	22350	N	C	C
91078875	2	A	-	9	21804 A	N	D	C
91079834	3	A	-	9	21802 A	N	D	C
91081160	2	A	-	3	22350	N	C	C
91084211	1	A	-	3	22350	N	E	I
91109368	2	A	-	9	21801 A	N	D	C
91117407	1	A	-	1	23152 A	N	F	C
91117513	3	A	-	4	21703	N	C	C
91123715	1	A	-	8	22107	N	F	A
91142338	1	A	-	8	22107	N	E	I
91146516	6	A	-	8	22107	M	E	I
91159072	2	A	-	9	21801 A	N	D	C
91160450	1	A	-	8	22107	N	F	A
91169766	3	A	-	3	22350	N	D	C
91175403	2	A	-	9	21802 A	N	D	C
91183994	1	A	-	8	22107	N	E	I
91192541	2	A	-	12	22450 A	F	D	C
91193424	2	A	-	3	22350	N	C	C
91208082	1	A	-	8	22107	N	E	I
91213110	2	A	-	3	22350	N	C	G

CASE_ID	PED_ACT	ICROAD_SUR	ROAD_CON	ROAD_CON	LIGHTING	CONTROL_CHP	ROAD PEDESTRIA	BICYCLE_A
90881857	A	A	H	-	C	D	0	
90888040	A	A	H	-	A	D	0	
90899051	A	A	H	-	A	D	0	
90899056	A	A	H	-	A	D	0	
90941739	A	B	H	-	D	D	0	
90943069	A	B	H	-	A	D	0	
90946363	A	A	H	-	A	D	0	
90952621	A	A	H	-	A	D	0	
90967503	A	A	H	-	A	D	0	
90974603	A	A	H	-	A	D	0	
90982569	A	A	H	-	A	D	0	
90984755	A	A	H	-	B	D	0	
90989560	A	A	H	-	A	D	0	
90991164	A	A	H	-	A	D	0	
91002220	A	A	H	-	A	D	0	
91002233	A	A	H	-	A	D	0	
91006036	A	A	H	-	A	D	0	
91017156	A	A	H	-	D	D	0	
91018011	A	A	H	-	A	D	0	
91028562	A	A	H	-	A	D	0	
91039258	A	A	H	-	D	D	0	
91052766	A	A	H	-	A	D	0	
91053461	A	A	H	-	C	D	0	
91054928	A	A	H	-	A	D	0	
91056456	A	A	H	-	A	D	0	
91058586	A	A	H	-	A	D	0	Y
91069593	A	A	H	-	A	D	0	
91078875	A	A	H	-	A	D	0	
91079834	A	A	H	-	D	A	0	
91081160	A	A	H	-	D	A	0	
91084211	A	A	H	-	A	D	0	
91109368	A	A	H	-	A	D	0	
91117407	A	A	H	-	A	D	0	
91117513	A	A	H	-	A	D	0	
91123715	A	A	H	-	A	D	0	
91142338	A	B	H	-	A	D	0	
91146516	A	B	H	-	D	D	0	
91159072	A	A	H	-	A	D	0	
91160450	A	A	H	-	A	D	0	
91169766	A	A	H	-	C	D	0	
91175403	A	B	H	-	A	A	0	
91183994	A	A	H	-	A	D	0	
91192541	A	A	H	-	D	A	0	
91193424	A	A	H	-	B	D	0	
91208082	A	A	H	-	C	D	0	
91213110	A	A	H	-	A	D	0	Y

CASE_ID	MOTORCYC	TRUCK_AC	NOT_PRIV	ALCOHOL	STWD_VEH	CHP_VEH	COUNT_SE	COUNT_VI	COUNT_CC	
90881857			Y	Y	A		1	2	0	1
90888040					A		1	0	0	2
90899051					A		1	0	0	1
90899056					A		1	0	0	2
90941739			Y		A		1	0	1	0
90943069					A		7	0	0	1
90946363 Y					C		2	0	1	0
90952621					A		1	1	0	1
90967503					D		22	0	0	1
90974603 Y					C		2	0	1	0
90982569					A		1	0	0	1
90984755					A		1	0	0	1
90989560					A		8	0	1	0
90991164 Y					C		2	1	2	0
91002220					A		1	0	1	0
91002233 Y					C		2	0	0	1
91006036 Y					C		2	1	0	0
91017156			Y		A		1	0	0	1
91018011					A		1	1	0	0
91028562			Y		A		1	0	2	0
91039258					A		1	0	0	1
91052766					A		7	0	1	0
91053461			Y		A		1	1	0	0
91054928					A		7	0	1	1
91056456					D		22	0	0	1
91058586					A		7	1	0	0
91069593					A		1	0	0	1
91078875					A		8	0	0	1
91079834					A		1	0	1	0
91081160					A		8	0	1	2
91084211			Y		D		22	0	1	0
91109368					A		7	0	0	1
91117407			Y		A		1	0	0	1
91117513					A		1	0	0	1
91123715 Y					C		2	0	1	0
91142338					A		1	0	1	0
91146516			Y		A		1	0	0	1
91159072					A		1	0	0	1
91160450 Y					C		2	0	0	1
91169766					A		1	0	0	1
91175403					A		1	0	1	1
91183994					D		22	0	0	1
91192541					D		22	1	0	0
91193424					A		1	0	1	0
91208082					A		1	0	1	0
91213110					L		4	0	1	0

CASE_ID	COUNT_PE	COUNT_PE	COUNT_BI	COUNT_BI	COUNT_MI	COUNT_MI	PRIMARY_I	SECONDAR	LATITUDE
90881857	0	0	0	0	0	0	-	-	38.51907
90888040	0	0	0	0	0	0	-	-	38.2256
90899051	0	0	0	0	0	0	-	-	38.27224
90899056	0	0	0	0	0	0	-	-	38.27286
90941739	0	0	0	0	0	0	-	-	38.44518
90943069	0	0	0	0	0	0	-	-	38.23587
90946363	0	0	0	0	0	1	-	-	38.27638
90952621	0	0	0	0	0	0	-	-	38.2488
90967503	0	0	0	0	0	0	-	-	38.46961
90974603	0	0	0	0	0	1	-	-	38.27662
90982569	0	0	0	0	0	0	-	-	38.4352
90984755	0	0	0	0	0	0	-	-	38.35884
90989560	0	0	0	0	0	0	-	-	38.2438
90991164	0	0	0	0	0	1	-	-	38.31006
91002220	0	0	0	0	0	0	-	-	38.417
91002233	0	0	0	0	0	1	-	-	38.38967
91006036	0	0	0	0	0	1	-	-	38.4373
91017156	0	0	0	0	0	0	-	-	38.30412
91018011	0	0	0	0	0	0	-	-	38.27804
91028562	0	0	0	0	0	0	-	-	38.51697
91039258	0	0	0	0	0	0	-	-	38.11301
91052766	0	0	0	0	0	0	-	-	38.4171
91053461	0	0	0	0	0	0	-	-	38.31561
91054928	0	0	0	0	0	0	-	-	38.2258
91056456	0	0	0	0	0	0	-	-	38.49568
91058586	0	0	0	1	0	0	-	-	38.49508
91069593	0	0	0	0	0	0	-	-	38.1454
91078875	0	0	0	0	0	0	-	-	38.27093
91079834	0	0	0	0	0	0	-	-	38.35892
91081160	0	0	0	0	0	0	-	-	38.27203
91084211	0	0	0	0	0	0	-	-	38.44607
91109368	0	0	0	0	0	0	-	-	38.44586
91117407	0	0	0	0	0	0	-	-	38.41713
91117513	0	0	0	0	0	0	-	-	38.41691
91123715	0	0	0	0	0	1	-	-	38.46964
91142338	0	0	0	0	0	0	-	-	38.11477
91146516	0	0	0	0	0	0	-	-	38.51638
91159072	0	0	0	0	0	0	-	-	38.48998
91160450	0	0	0	0	0	1	-	-	38.5252
91169766	0	0	0	0	0	0	-	-	38.4171
91175403	0	0	0	0	0	0	-	-	38.35161
91183994	0	0	0	0	0	0	-	-	38.27965
91192541	0	0	0	0	0	0	-	-	38.35165
91193424	0	0	0	0	0	0	-	-	38.41691
91208082	0	0	0	0	0	0	-	-	38.13539
91213110	0	0	0	1	0	0	-	-	38.52997

CASE_ID	LONGITUD	COUNTY	CITY	POINT_X	POINT_Y	Age	Gender	MOVE_PRI	Bike_Ped_
90881857	-121.967	SOLANO	UNINCORP	-121.967	38.51901	36	F	M	N
90888040	-122.104	SOLANO	UNINCORP	-122.103	38.2267	998	-	M	N
90899051	-122.093	SOLANO	UNINCORP	-122.093	38.27225	75	M	N	N
90899056	-122.093	SOLANO	UNINCORP	-122.093	38.27283	75	M	N	N
90941739	-121.804	SOLANO	UNINCORP	-121.804	38.44547	25	F	C	N
90943069	-122.051	SOLANO	UNINCORP	-122.054	38.23577	41	F	B	N
90946363	-122.093	SOLANO	UNINCORP	-122.105	38.28225	20	M	C	N
90952621	-122.078	SOLANO	UNINCORP	-122.078	38.24877	45	M	N	N
90967503	-122.032	SOLANO	UNINCORP	-122.032	38.46965	35	F	C	N
90974603	-122.093	SOLANO	UNINCORP	-122.093	38.27639	49	M	C	N
90982569	-121.916	SOLANO	UNINCORP	-121.916	38.45329	18	F	E	N
90984755	-121.906	SOLANO	UNINCORP	-121.906	38.35891	35	F	B	N
90989560	-122.125	SOLANO	UNINCORP	-122.13	38.24529	70	F	N	N
90991164	-122.129	SOLANO	UNINCORP	-122.129	38.31008	32	M	B	N
91002220	-121.011	SOLANO	UNINCORP	-121.909	38.41703	75	F	R	N
91002233	-122.079	SOLANO	UNINCORP	-122.026	38.37622	20	M	H	N
91006036	-122.053	SOLANO	UNINCORP	-122.051	38.43503	63	M	M	N
91017156	-122.129	SOLANO	UNINCORP	-122.129	38.30627	23	M	C	N
91018011	-122.099	SOLANO	UNINCORP	-122.099	38.27805	29	M	C	N
91028562	-121.968	SOLANO	UNINCORP	-121.968	38.51695	32	M	N	N
91039258	-122.107	SOLANO	UNINCORP	-122.107	38.11451	31	F	C	N
91052766	-121.952	SOLANO	UNINCORP	-121.953	38.41707	21	M	C	N
91053461	-121.916	SOLANO	UNINCORP	-121.915	38.31553	27	M	M	N
91054928	-122.104	SOLANO	UNINCORP	-122.104	38.226	27	F	M	N
91056456	-121.952	SOLANO	UNINCORP	-121.952	38.49531	65	M	M	N
91058586	-121.952	SOLANO	UNINCORP	-121.952	38.49507	66	F	E	Y
91069593	-122.044	SOLANO	UNINCORP	-122.082	38.24736	19	F	B	N
91078875	-122.112	SOLANO	UNINCORP	-122.112	38.27127	43	F	L	N
91079834	-121.907	SOLANO	UNINCORP	-121.906	38.35891	19	M	B	N
91081160	-122.093	SOLANO	UNINCORP	-122.093	38.27203	32	M	B	N
91084211	-121.913	SOLANO	UNINCORP	-121.913	38.44611	35	M	C	N
91109368	-121.868	SOLANO	UNINCORP	-121.868	38.44589	36	M	E	N
91117407	-121.953	SOLANO	UNINCORP	-121.953	38.41707	33	M	R	N
91117513	-121.875	SOLANO	UNINCORP	-121.874	38.4169	18	F	B	N
91123715	-122.032	SOLANO	UNINCORP	-122.032	38.46964	25	M	M	N
91142338	-122.107	SOLANO	UNINCORP	-122.108	38.1148	24	M	M	N
91146516	-121.969	SOLANO	UNINCORP	-121.969	38.51634	20	M	C	N
91159072	-121.805	SOLANO	UNINCORP	-121.805	38.49005	45	F	E	N
91160450	-121.922	SOLANO	UNINCORP	-121.927	38.52986	31	M	M	N
91169766	-121.943	SOLANO	UNINCORP	-121.944	38.41706	19	M	B	N
91175403	-121.897	SOLANO	UNINCORP	-121.897	38.35158	19	F	B	N
91183994	-122.104	SOLANO	UNINCORP	-122.104	38.28015	60	M	C	N
91192541	-121.897	SOLANO	UNINCORP	-121.897	38.35158	998	M	B	N
91193424	-121.882	SOLANO	UNINCORP	-121.881	38.41691	23	M	B	N
91208082	-122.11	SOLANO	UNINCORP	-122.111	38.14581	26	F	R	N
91213110	-121.889	SOLANO	UNINCORP	-121.887	38.53028	51	M	B	Y

CASE_ID	Age_At Fault_1
90881857	30-39
90888040	998
90899051	70-79
90899056	70-79
90941739	20-29
90943069	40-49
90946363	15-20
90952621	40-49
90967503	30-39
90974603	40-49
90982569	15-20
90984755	30-39
90989560	70-79
90991164	30-39
91002220	70-79
91002233	15-20
91006036	60-69
91017156	20-29
91018011	20-29
91028562	30-39
91039258	30-39
91052766	20-29
91053461	20-29
91054928	20-29
91056456	60-69
91058586	60-69
91069593	15-20
91078875	40-49
91079834	15-20
91081160	30-39
91084211	30-39
91109368	30-39
91117407	30-39
91117513	15-20
91123715	20-29
91142338	20-29
91146516	15-20
91159072	40-49
91160450	30-39
91169766	15-20
91175403	15-20
91183994	60-69
91192541	998
91193424	20-29
91208082	20-29
91213110	50-59

CASE_ID	ACCIDENT_	PROC_DATE	JURIS	COLLISION_D	COLLISION Hour	OFFICER_I	REPORTING
91216428	2020	7/2/2020	9365	2/19/2020	1700	17	18954
91230099	2020	4/27/2020	9365	4/25/2020	1335	13	17805
91230587	2020	4/28/2020	9365	4/15/2020	1733	17	18634
91230898	2020	4/29/2020	9365	4/27/2020	1625	16	17805
91236894	2020	5/12/2020	9365	4/28/2020	1720	17	19051
91253874	2020	6/18/2020	9365	6/3/2020	1009	10	18803
91256081	2020	6/23/2020	9365	6/20/2020	1210	12	16783
91259358	2019	6/26/2020	9365	10/7/2019	1351	13	19458
91259783	2020	6/29/2020	9365	6/18/2020	1500	15	18192
91261654	2020	7/1/2020	9365	5/8/2020	2500	25	18954
91263145	2020	7/3/2020	9365	6/28/2020	1515	15	21352
91263685	2020	7/6/2020	9365	7/3/2020	1445	14	19790
91267378	2020	7/13/2020	9365	3/25/2020	2110	21	18568
91270408	2020	7/17/2020	9365	7/17/2020	915	9	17805
91270418	2020	7/17/2020	9365	7/8/2020	1738	17	17747
91273892	2020	10/20/2020	9365	7/18/2020	2315	23	18712
91277112	2020	7/30/2020	9365	7/27/2020	1015	10	14948
91283575	2020	8/10/2020	9365	8/3/2020	1435	14	21352
91291732	2020	8/25/2020	9365	8/18/2020	835	8	13706
91314506	2020	9/29/2020	9365	6/5/2020	1245	12	14687
91319219	2020	10/7/2020	9365	9/28/2020	1140	11	14687
91319979	2020	10/8/2020	9365	10/4/2020	1655	16	19299
91321064	2020	10/9/2020	9365	10/4/2020	1905	19	21352
91329703	2020	10/22/2020	9365	10/22/2020	555	5	14264
91330528	2020	10/23/2020	9365	10/20/2020	220	2	20508
91333466	2020	10/28/2020	9365	10/24/2020	1248	12	19195
91340193	2020	11/5/2020	9365	10/28/2020	2002	20	18803
91341733	2020	11/9/2020	9365	10/29/2020	1630	16	19651
91350611	2020	11/20/2020	9365	11/18/2020	2130	21	21432
91353958	2020	11/25/2020	9365	11/19/2020	1545	15	18794
91374782	2020	12/24/2020	9365	12/21/2020	835	8	14264
91377762	2020	12/30/2020	9365	12/21/2020	2340	23	18192
91384376	2020	1/8/2021	9365	12/23/2020	935	9	14687
91422772	2021	5/27/2021	9365	2/19/2021	1700	17	19651
91437158	2021	5/27/2021	9365	3/20/2021	1435	14	20428
91441274	2021	5/27/2021	9365	3/22/2021	557	5	17654
91446974	2021	5/27/2021	9365	4/1/2021	2059	20	18803
91447501	2020	4/9/2021	9365	10/24/2020	2002	20	20566
91451381	2021	5/27/2021	9365	4/10/2021	1200	12	17163
91458197	2021	5/27/2021	9365	4/15/2021	2025	20	19815
91458339	2021	5/27/2021	9365	4/18/2021	830	8	20972
91460527	2021	5/27/2021	9365	4/21/2021	600	6	16783
91460784	2021	5/27/2021	9365	4/21/2021	2355	23	18192
91465107	2021	5/27/2021	9365	4/27/2021	2106	21	18803
91480909	2021	5/27/2021	9365	5/18/2021	1640	16	17747
91481371	2021	5/27/2021	9365	5/20/2021	1555	15	18794

CASE_ID	DAY_OF_WEEK	CHP_SHIFT	POPULATION	CNTY_CITY	SPECIAL_C	BEAT_TYPE	CHP_BEAT	CITY_DIVIS	CHP_BEAT
91216428	3	2	9	4800	0	3	5		2
91230099	6	1	9	4800	0	3	5		2
91230587	3	2	9	4800	0	3	5		2
91230898	1	2	9	4800	0	1 A			2
91236894	2	2	9	4800	0	1 A			2
91253874	3	1	9	4800	0	3	5		2
91256081	6	1	9	4800	0	1 A			2
91259358	1	1	9	4800	0	3	5		2
91259783	4	2	9	4800	0	1 A			2
91261654	5	4	9	4800	0	2	4		2
91263145	7	2	9	4800	0	1 A			2
91263685	5	2	9	4800	0	3	5		2
91267378	3	2	9	4800	0	3	5		2
91270408	5	1	9	4800	0	1 A			2
91270418	3	2	9	4800	0	2	4		2
91273892	6	3	9	4800	0	3	5		2
91277112	1	1	9	4800	0	2	4		2
91283575	1	2	9	4800	0	1 A			2
91291732	2	1	9	4800	0	1 A			2
91314506	5	1	9	4800	0	1 A			2
91319219	1	1	9	4800	0	2	4		2
91319979	7	2	9	4800	0	3	5		2
91321064	7	2	9	4800	0	3	5		2
91329703	4	3	9	4800	0	1 A			2
91330528	2	3	9	4800	0	3	5		2
91333466	6	1	9	4800	0	3	5		2
91340193	3	2	9	4800	0	3	5		2
91341733	4	2	9	4800	0	1 A			2
91350611	3	2	9	4800	0	1 A			2
91353958	4	2	9	4800	0	3	5		2
91374782	1	1	9	4800	0	1 A			2
91377762	1	3	9	4800	0	1 A			2
91384376	3	1	9	4800	0	3	5		2
91422772	5	2	9	4800	0	3	5		2
91437158	6	2	9	4800	0	3	5		2
91441274	1	3	9	4800	0	3	5		2
91446974	4	2	9	4800	0	3	5		2
91447501	6	2	9	4800	0	3	5		2
91451381	6	1	9	4800	0	2	4		2
91458197	4	2	9	4800	0	1 A			2
91458339	7	1	9	4800	0	3	5		2
91460527	3	1	9	4800	0	1 A			2
91460784	3	3	9	4800	0	3	5		2
91465107	2	2	9	4800	0	3	5		2
91480909	2	2	9	4800	0	1 A			2
91481371	4	2	9	4800	0	1 A			2

CASE_ID	BEAT_NUM	PRIMARY_RD	SECONDARY_RD	DISTANCE	DIRECTION
91216428	20	MANKAS CORNER RD	ABERNATHY RD	75	W
91230099	40	PEDRICK RD.	TREMONT RD.	2640	E
91230587	40	PEDRICK RD.	6347 PEDRICK RD.	461	S
91230898	30	PEDRICK RD.	BINGHAMTON RD	4488	S
91236894	30	MIDWAY RD	CLEMENT RD	315	W
91253874	20	ABERNATHY RD	MANKAS CORNER RD	0	
91256081	30	MIDWAY RD	BATAVIA RD	0	
91259358	20	MANKAS CORNER RD	LEDGEWOOD RD	589	N
91259783	30	HAWKINS ROAD (5300 BLOC	BYRNES ROAD	0	
91261654	301	PLEASANTS VALLEY RD	QUAIL CANYON RD	890	S
91263145	30	CANTELOW ROAD	BROWNS VALLEY ROAD	1200	W
91263685	20	ROCKVILLE RD	ROCK LN	30	W
91267378	40	PUTAH CREEK RD	MCNEILL LN	2640	W
91270408	30	SUISUN VALLEY RD	JOYCE LANE	495	S
91270418	301	PLEASANTS VALLEY ROAD	PUTAH CREEK ROAD	3168	S
91273892	40	MIDWAY RD	MERIDIAN RD	1000	E
91277112	201	ROCKVILLE RD	2949 ROCKVILLE RD	141	S
91283575	30	MIDWAY ROAD	BATAVIA ROAD	0	
91291732	30	LEWIS ROAD	HOLDENER ROAD	0	
91314506	30	PUTAH CREEK ROAD	WINTU WAY	360	W
91319219	201	ROCKVILLE ROAD	LOZANO LN	300	W
91319979	40	PEDRICK RD	SIEVERS RD	60	N
91321064	20	LOPES ROAD	MARSHVIEW ROAD	2640	S
91329703	30	PLEASANTS VALLEY RD	SUNNY HILLS LN	528	S
91330528	40	DIXON AVE W	SCHROEDER RD	30	E
91333466	20	ROCKVILLE RD	SUISUN VALLEY RD	90	W
91340193	20	LOPES ROAD	MARSHVIEW RD	5280	S
91341733	30	HAWKINS RD	BYRNES RD	0	
91350611	30	MANKAS CORNER RD	2743 MANKAS CORNER RD.	273	S
91353958	20	ROCKVILLE RD	LOZANO LN	5	E
91374782	30	HAWKINS RD	BYRNES RD	0	
91377762	30	BROWNS VALLEY ROAD	CANTELOW ROAD	7	N
91384376	40	PEDRICK RD	VAUGHN RD	3696	S
91422772	20	MANKAS CORNER RD	ABERNATHY RD	1375	S
91437158	20	CORDELIA ROAD	PENNSYLVANIA AVE	400	W
91441274	40	ALLENDALE ROAD	N. MERIDIAN ROAD	0	
91446974	20	SUISUN VALLEY ROAD	TWIN SISTERS RD	1000	E
91447501	20	MANKAS CORNER RD	LEDGEWOOD RD	2640	W
91451381	201	ROCKVILLE RD	LOZANO LN	703	W
91458197	30	CANTELOW RD	ENGLISH HILLS RD	465	E
91458339	20	SUISUN VALLEY ROAD	JOYCE LANE	1000	N
91460527	30	MIDWAY RD	BATAVIA RD	2025	W
91460784	20	MANKAS CORNER ROAD	ABERNATHY RD	31	W
91465107	20	LOPES RD	MARSHVIEW RD	2640	S
91480909	30	MIDWAY ROAD	I-80	700	S
91481371	30	BYRNES RD.	HAWKINS RD.	0	

CASE_ID	INTERSECT	Intersectio	WEATHER_	WEATHER_	STATE_HW	CALTRANS_	CALTRANS_	STATE_ROI	ROUTE_SU
91216428	N	Y	A	-	N				
91230099	N	N	A	-	N				
91230587	N	N	A	-	N				
91230898	N	N	A	-	N				
91236894	N	N	A	-	N				
91253874	Y	Y	A	-	N				
91256081	Y	Y	A	-	N				
91259358	N	N	A	-	N				
91259783	Y	Y	A	-	N				
91261654	N	N	A	-	N				
91263145	N	N	A	-	N				
91263685	N	Y	A	-	N				
91267378	N	N	B	-	N				
91270408	N	N	A	-	N				
91270418	N	N	A	-	N				
91273892	N	N	A	-	N				
91277112	N	Y	A	-	N				
91283575	Y	Y	A	-	N				
91291732	Y	Y	A	-	N				
91314506	N	N	A	-	N				
91319219	N	N	A	-	N				
91319979	N	Y	A	-	N				
91321064	N	N	A	-	N				
91329703	N	N	A	-	N				
91330528	N	Y	A	-	N				
91333466	N	Y	A	-	N				
91340193	N	N	A	-	N				
91341733	Y	Y	A	-	N				
91350611	N	N	A	-	N				
91353958	N	Y	A	-	N				
91374782	Y	Y	E	-	N				
91377762	N	Y	E	-	N				
91384376	N	N	A	-	N				
91422772	N	N	B	-	N				
91437158	N	N	A	-	N				
91441274	Y	Y	A	-	N				
91446974	N	N	A	-	N				
91447501	N	N	A	-	N				
91451381	N	N	A	-	N				
91458197	N	N	A	-	N				
91458339	N	N	A	-	N				
91460527	N	N	A	-	N				
91460784	N	Y	A	-	N				
91465107	N	N	A	-	N				
91480909	N	N	A	-	N				
91481371	Y	Y	A	-	N				

CASE_ID	POSTMILE_POSTMILE	LOCATION_RAMP_INT	SIDE_OF_H	TOW_AWA	COLLISION_NUMBER_I	NUMBER_I
91216428			Y		2	0
91230099			Y		3	0
91230587			Y		2	0
91230898			Y		3	0
91236894			N		4	0
91253874			Y		4	0
91256081			Y		4	0
91259358			Y		1	1
91259783			Y		4	0
91261654			Y		3	0
91263145			Y		4	0
91263685			Y		4	0
91267378			Y		4	0
91270408			Y		2	0
91270418			Y		3	0
91273892			Y		2	0
91277112			Y		3	0
91283575			Y		2	0
91291732			Y		3	0
91314506			Y		1	1
91319219			N		4	0
91319979			Y		3	0
91321064			Y		2	0
91329703			Y		3	0
91330528			Y		3	0
91333466			Y		4	0
91340193			Y		4	0
91341733			Y		4	0
91350611			Y		3	0
91353958			Y		4	0
91374782			Y		4	0
91377762			Y		4	0
91384376			Y		3	0
91422772			Y		3	0
91437158			Y		4	0
91441274			Y		2	0
91446974			Y		4	0
91447501			Y		1	1
91451381			Y		3	0
91458197			Y		2	0
91458339			Y		3	0
91460527			Y		3	0
91460784			Y		2	0
91465107			Y		4	0
91480909			Y		3	0
91481371			Y		4	0

CASE_ID	PARTY_CODE	PRIMARY_CODE	PCF_CODE	PCF_VIOL	PCF_VIOLA	PCF_VIOL_HIT_AND_F	TYPE_OF_C	MVIW
91216428	2	A	-	8	22107	N	A	C
91230099	2	A	-	16	24002 A	N	E	C
91230587	2	A	-	5	21651 B	N	A	C
91230898	1	A	-	8	22107	N	E	I
91236894	2	A	-	6	21750	N	D	C
91253874	2	C	-	18		N	C	C
91256081	2	A	-	9	21802 A	N	D	C
91259358	1	A	-	8	22107	N	E	I
91259783	2	A	-	9	21802 A	N	D	C
91261654	1	A	-	8	22107	N	E	I
91263145	2	A	-	6	21750 A	N	D	C
91263685	1	A	-	8	22107	N	E	I
91267378	1	A	-	8	22107	N	E	I
91270408	1	A	-	8	22107	N	E	I
91270418	1	A	-	3	22350	N	F	A
91273892	1	A	-	1	23152 A	F	E	I
91277112	1	A	-	8	22107	N	E	I
91283575	2	A	-	12	22450 A	N	D	C
91291732	2	A	-	12	22450 A	N	D	C
91314506	2	A	-	8	22107	N	B	C
91319219	2	A	-	3	22350	N	C	C
91319979	2	A	-	3	22350	N	C	C
91321064	1	A	-	1	23152 A	N	E	I
91329703	1	A	-	8	22107	N	E	I
91330528	1	A	-	1	23152 A	N	F	A
91333466	2	A	-	9	21804 A	N	D	C
91340193	1	A	-	8	22107	N	E	I
91341733	2	A	-	12	22450 A	N	D	C
91350611	1	A	-	1	23152 A	N	E	I
91353958	2	A	-	8	22107	N	D	C
91374782	2	A	-	12	22450 A	N	D	C
91377762	1	A	-	12	22450 A	N	E	I
91384376	1	A	-	8	22107	N	E	I
91422772	1	A	-	3	22350	N	H	I
91437158	1	A	-	1	23152 A	N	E	I
91441274	1	A	-	3	22350	N	E	I
91446974	1	A	-	1	23152 A	N	E	I
91447501	1	A	-	3	22350	N	F	A
91451381	2	A	-	9	21801 A	N	D	C
91458197	1	A	-	8	22107	N	E	I
91458339	2	A	-	5	21460 A	N	A	C
91460527	2	A	-	3	22350	N	C	C
91460784	1	A	-	1	23152 A	N	E	I
91465107	1	A	-	8	22107	N	E	I
91480909	2	A	-	8	22107	N	D	C
91481371	2	A	-	9	21802 A	N	D	C

CASE_ID	PED_ACT	ICROAD_SUR	ROAD_CON	ROAD_CON	LIGHTING	CONTROL_CHP	ROAD PEDESTRIA	BICYCLE_A
91216428	A	A	H	-	A	D	0	
91230099	A	A	H	-	A	D	0	
91230587	A	A	H	-	A	D	0	
91230898	A	A	H	-	A	D	0	
91236894	A	A	H	-	A	D	0	
91253874	A	A	H	-	A	D	0	
91256081	A	A	H	-	A	A	0	
91259358	A	A	H	-	A	D	0	
91259783	A	A	H	-	A	A	0	
91261654	A	A	H	-	A	D	0	
91263145	A	A	H	-	A	D	0	
91263685	A	A	H	-	A	D	0	
91267378	A	B	H	-	D	D	0	
91270408	A	A	H	-	A	D	0	
91270418	A	A	H	-	A	D	0	
91273892	A	A	H	-	D	D	0	
91277112	A	A	H	-	A	D	0	
91283575	A	A	H	-	A	A	0	
91291732	A	A	H	-	A	A	0	
91314506	A	A	H	-	A	D	0	
91319219	A	A	H	-	A	D	0	
91319979	A	A	H	-	A	D	0	
91321064	A	A	H	-	D	D	0	
91329703	A	A	H	-	D	D	0	
91330528	A	A	H	-	D	A	0	
91333466	A	A	H	-	A	D	0	
91340193	A	A	H	-	D	D	0	
91341733	A	A	H	-	A	A	0	
91350611	A	A	H	-	D	D	0	
91353958	A	A	H	-	A	D	0	
91374782	A	A	H	-	A	A	0	
91377762	A	A	H	-	C	A	0	
91384376	A	A	H	-	A	D	0	
91422772	A	A	H	-	A	D	0	
91437158	A	A	H	-	A	D	0	
91441274	A	A	H	-	D	D	0	
91446974	A	A	H	-	D	D	0	
91447501	A	A	H	-	D	D	0	
91451381	A	A	H	-	A	D	0	
91458197	A	A	H	-	D	D	0	
91458339	A	A	H	-	A	D	0	
91460527	A	A	H	-	D	D	0	
91460784	A	A	H	-	D	A	0	
91465107	A	A	H	-	D	D	0	
91480909	A	A	H	-	A	D	0	
91481371	A	A	H	-	A	A	0	

CASE_ID	MOTORCYC	TRUCK_AC	NOT_PRIV	ALCOHOL	STWD_VEH	CHP_VEH	COUNT_SE	COUNT_VI	COUNT_CC
91216428			Y		A		1	2	0
91230099			Y		E		22	0	2
91230587			Y		A		1	1	0
91230898			Y		A		1	0	1
91236894			Y		A		1	0	0
91253874			Y		-	-		0	0
91256081			Y		A		1	0	0
91259358			Y		A		1	0	1
91259783	Y		Y		A		1	0	0
91261654			Y		A		1	0	2
91263145			Y		A		1	0	0
91263685			Y		A		1	0	0
91267378			Y		A		1	0	0
91270408			Y		A		7	1	0
91270418			Y		J		49	0	1
91273892			Y	Y	A		1	3	0
91277112			Y		A		7	0	1
91283575			Y		A		1	1	1
91291732			Y		A		1	0	2
91314506	Y		Y		G		26	0	0
91319219			Y		D		22	0	0
91319979			Y		A		1	0	2
91321064			Y	Y	A		1	1	0
91329703			Y		D		22	0	1
91330528			Y	Y	A		1	0	1
91333466			Y		A		1	0	0
91340193			Y		A		1	0	0
91341733			Y		D		22	0	0
91350611			Y	Y	A		1	0	1
91353958			Y		A		1	0	0
91374782			Y		D		22	0	0
91377762			Y		A		7	0	0
91384376			Y		A		1	0	1
91422772			Y		A		1	0	1
91437158			Y	Y	A		1	0	0
91441274			Y		A		71	1	0
91446974			Y	Y	A		1	0	0
91447501 Y			Y		C		2	0	0
91451381			Y		A		7	0	2
91458197			Y		A		7	1	1
91458339			Y		A		1	0	1
91460527			Y		D		22	0	2
91460784			Y	Y	A		1	1	0
91465107			Y		A		1	0	0
91480909	Y		Y		A		7	0	1
91481371			Y		A		1	0	0

CASE_ID	COUNT_PE	COUNT_PE	COUNT_BI	COUNT_BI	COUNT_MI	COUNT_MI	PRIMARY_I	SECONDAR	LATITUDE
91216428	0	0	0	0	0	0	-	-	38.27219
91230099	0	0	0	0	0	0	-	-	38.59238
91230587	0	0	0	0	0	0	-	-	38.3627
91230898	0	0	0	0	0	0	-	-	38.33854
91236894	0	0	0	0	0	0	-	-	38.41719
91253874	0	0	0	0	0	0	-	-	38.27197
91256081	0	0	0	0	0	0	-	-	38.41694
91259358	0	0	0	0	0	0	-	-	38.27973
91259783	0	0	0	0	0	0	-	-	38.2132
91261654	0	0	0	0	0	0	-	-	38.4655
91263145	0	0	0	0	0	0	-	-	38.41609
91263685	0	0	0	0	0	0	-	-	38.25272
91267378	0	0	0	0	0	0	-	-	38.52779
91270408	0	0	0	0	0	0	-	-	38.30075
91270418	0	0	0	0	0	0	-	-	38.4719
91273892	0	0	0	0	0	0	-	-	38.25139
91277112	0	0	0	0	0	0	-	-	38.249
91283575	0	0	0	0	0	0	-	-	38.41693
91291732	0	0	0	0	0	0	-	-	38.3516
91314506	0	0	0	0	0	0	-	-	38.50658
91319219	0	0	0	0	0	0	-	-	38.2493
91319979	0	0	0	0	0	0	-	-	38.49088
91321064	0	0	0	0	0	0	-	-	38.13922
91329703	0	0	0	0	0	0	-	-	38.219
91330528	0	0	0	0	0	0	-	-	38.4458
91333466	0	0	0	0	0	0	-	-	38.24425
91340193	0	0	0	0	0	0	-	-	38.13442
91341733	0	0	0	0	0	0	-	-	38.35895
91350611	0	0	0	0	0	0	-	-	38.27578
91353958	0	0	0	0	0	0	-	-	38.24953
91374782	0	0	0	0	0	0	-	-	38.35894
91377762	0	0	0	0	0	0	-	-	38.2457
91384376	0	0	0	0	0	0	-	-	38.4563
91422772	0	0	0	0	0	0	-	-	38.27603
91437158	0	0	0	0	0	0	-	-	38.22349
91441274	0	0	0	0	0	0	-	-	38.4533
91446974	0	0	0	0	0	0	-	-	38.297
91447501	0	0	0	0	1	0	-	-	38.27627
91451381	0	0	0	0	0	0	-	-	38.2488
91458197	0	0	0	0	0	0	-	-	38.4181
91458339	0	0	0	0	0	0	-	-	38.31195
91460527	0	0	0	0	0	0	-	-	38.41684
91460784	0	0	0	0	0	0	-	-	38.1619
91465107	0	0	0	0	0	0	-	-	38.13901
91480909	0	0	0	0	0	0	-	-	38.41568
91481371	0	0	0	0	0	0	-	-	38.35885

CASE_ID	LONGITUD	COUNTY	CITY	POINT_X	POINT_Y	Age	Gender	MOVE_PRI	Bike_Ped_
91216428	-122.093	SOLANO	UNINCORP	-122.093	38.27214	50	F	R	N
91230099	-121.804	SOLANO	UNINCORP	-121.804	38.49616	31	M	B	N
91230587	-121.805	SOLANO	UNINCORP	-121.805	38.3627	43	M	N	N
91230898	-121.805	SOLANO	UNINCORP	-121.805	38.33891	18	M	M	N
91236894	-121.966	SOLANO	UNINCORP	-121.965	38.41714	28	F	I	N
91253874	-122.092	SOLANO	UNINCORP	-122.093	38.27214	63	M	B	N
91256081	-121.86	SOLANO	UNINCORP	-121.86	38.41681	59	F	L	N
91259358	-122.104	SOLANO	UNINCORP	-122.104	38.27974	27	M	C	N
91259783	-121.542	SOLANO	UNINCORP	-121.906	38.35891	19	F	E	N
91261654	-122.05	SOLANO	UNINCORP	-122.051	38.46508	24	M	M	N
91263145	-121.975	SOLANO	UNINCORP	-121.975	38.41611	29	M	I	N
91263685	-122.16	SOLANO	UNINCORP	-122.159	38.25268	78	F	C	N
91267378	-121.901	SOLANO	UNINCORP	-121.901	38.52784	30	M	M	N
91270408	-122.128	SOLANO	UNINCORP	-122.128	38.3007	81	M	M	N
91270418	-122.031	SOLANO	UNINCORP	-122.03	38.47282	37	M	B	N
91273892	-121.544	SOLANO	UNINCORP	-121.912	38.41702	21	M	R	N
91277112	-122.077	SOLANO	UNINCORP	-122.077	38.249	24	F	C	N
91283575	-121.86	SOLANO	UNINCORP	-121.86	38.41681	44	M	B	N
91291732	-121.897	SOLANO	UNINCORP	-121.897	38.35158	56	F	B	N
91314506	-121.977	SOLANO	UNINCORP	-121.976	38.50673	34	M	M	N
91319219	-122.076	SOLANO	UNINCORP	-122.076	38.24925	62	M	B	N
91319979	-121.804	SOLANO	UNINCORP	-121.804	38.49076	68	M	B	N
91321064	-122.111	SOLANO	UNINCORP	-122.11	38.14156	33	F	M	N
91329703	-122.013	SOLANO	UNINCORP	-122.025	38.35327	23	F	B	N
91330528	-121.86	SOLANO	UNINCORP	-121.86	38.44586	22	M	M	N
91333466	-122.123	SOLANO	UNINCORP	-122.123	38.24423	24	M	L	N
91340193	-122.11	SOLANO	UNINCORP	-122.11	38.13441	22	F	C	N
91341733	-121.906	SOLANO	UNINCORP	-121.906	38.35891	66	M	B	N
91350611	-122.093	SOLANO	UNINCORP	-122.093	38.27578	30	M	R	N
91353958	-122.075	SOLANO	UNINCORP	-122.076	38.2496	37	M	E	N
91374782	-121.906	SOLANO	UNINCORP	-121.906	38.35891	31	M	B	N
91377762	-121.581	SOLANO	UNINCORP	-121.971	38.41607	41	M	H	N
91384376	-121.804	SOLANO	UNINCORP	-121.804	38.45704	45	F	M	N
91422772	-122.093	SOLANO	UNINCORP	-122.088	38.27129	37	M	C	N
91437158	-122.055	SOLANO	UNINCORP	-122.055	38.23503	30	M	M	N
91441274	-121.916	SOLANO	UNINCORP	-121.916	38.4533	23	M	C	N
91446974	-122.125	SOLANO	UNINCORP	-122.125	38.29699	22	F	C	N
91447501	-122.093	SOLANO	UNINCORP	-122.106	38.28502	57	M	C	N
91451381	-122.078	SOLANO	UNINCORP	-122.078	38.24878	33	F	E	N
91458197	-121.997	SOLANO	UNINCORP	-121.997	38.41804	16	M	M	N
91458339	-122.129	SOLANO	UNINCORP	-122.129	38.30469	37	M	N	N
91460527	-121.866	SOLANO	UNINCORP	-121.867	38.41685	42	M	B	N
91460784	-122.053	SOLANO	UNINCORP	-122.093	38.27214	49	M	C	N
91465107	-122.111	SOLANO	UNINCORP	-122.11	38.14157	22	M	M	N
91480909	-121.895	SOLANO	UNINCORP	-121.897	38.41609	69	M	F	N
91481371	-121.906	SOLANO	UNINCORP	-121.906	38.35891	35	F	E	N

CASE_ID	Age_At Fault_1
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91216428	50-59
91230099	30-39
91230587	40-49
91230898	15-20
91236894	20-29
91253874	60-69
91256081	50-59
91259358	20-29
91259783	15-20
91261654	20-29
91263145	20-29
91263685	70-79
91267378	30-39
91270408	80-110
91270418	30-39
91273892	20-29
91277112	20-29
91283575	40-49
91291732	50-59
91314506	30-39
91319219	60-69
91319979	60-69
91321064	30-39
91329703	20-29
91330528	20-29
91333466	20-29
91340193	20-29
91341733	60-69
91350611	30-39
91353958	30-39
91374782	30-39
91377762	40-49
91384376	40-49
91422772	30-39
91437158	30-39
91441274	20-29
91446974	20-29
91447501	50-59
91451381	30-39
91458197	15-20
91458339	30-39
91460527	40-49
91460784	40-49
91465107	20-29
91480909	60-69
91481371	30-39

CASE_ID	ACCIDENT_	PROC_DATE	JURIS	COLLISION_D	COLLISION Hour	OFFICER_I	REPORTING
91489383	2021	6/4/2021	9365	5/25/2021	1035	10	14687
91494378	2021	6/10/2021	9365	6/6/2021	1405	14	21857
91496319	2021	6/14/2021	9365	6/13/2021	1120	11	17805
91499657	2021	6/17/2021	9365	6/10/2021	2215	22	21116
91518402	2021	7/12/2021	9365	7/1/2021	1751	17	18803
91520145	2021	7/19/2021	9365	7/7/2021	939	9	17705
91520177	2021	7/14/2021	9365	7/2/2021	1340	13	19815
91521892	2021	7/16/2021	9365	7/5/2021	1720	17	20566
91526291	2021	7/22/2021	9365	7/12/2021	1255	12	17654
91531733	2021	7/29/2021	9365	6/19/2021	25	0	21598
91547821	2021	8/18/2021	9365	8/9/2021	1730	17	20566
91557284	2021	1/10/2022	9365	8/26/2021	1045	10	17163
91564257	2021	9/7/2021	9365	8/29/2021	1546	15	22063
91566722	2021	9/9/2021	9365	9/5/2021	1904	19	19299
91570117	2021	9/14/2021	9365	9/11/2021	2000	20	21645
91575900	2021	9/21/2021	9365	9/14/2021	1900	19	18794
91588395	2021	10/5/2021	9365	10/2/2021	1310	13	17805
91589206	2021	10/6/2021	9365	9/25/2021	1	0	22568
91590526	2021	10/7/2021	9365	10/6/2021	755	7	17163
91591462	2021	10/8/2021	9365	9/28/2021	1210	12	14687
91598825	2021	10/18/2021	9365	9/19/2021	155	1	21598
91604133	2021	10/22/2021	9365	10/17/2021	1410	14	20566
91606398	2021	10/26/2021	9365	10/15/2021	1825	18	19815
91606406	2021	10/26/2021	9365	10/16/2021	1310	13	19815
91613693	2021	11/2/2021	9365	10/27/2021	2300	23	21116
91621437	2021	11/10/2021	9365	11/7/2021	1812	18	19299
91628758	2021	11/18/2021	9365	11/11/2021	2015	20	19651
91636680	2021	11/29/2021	9365	11/19/2021	2135	21	21598
91640007	2021	12/1/2021	9365	11/24/2021	1705	17	21466
91641255	2021	12/2/2021	9365	11/25/2021	1800	18	19651
91653020	2021	12/16/2021	9365	12/11/2021	900	9	19086
91667766	2021	12/31/2021	9365	7/26/2021	230	2	18712
91690556	2022	2/1/2022	9365	1/24/2022	1355	13	19458
91692140	2021	2/3/2022	9365	8/21/2021	1050	10	19195
91693889	2022	2/4/2022	9365	1/22/2022	2020	20	20667
91710115	2022	2/25/2022	9365	2/22/2022	550	5	19195
91720718	2022	3/11/2022	9365	3/10/2022	1915	19	19651
91722112	2022	3/14/2022	9365	3/5/2022	228	2	21857
91742509	2022	4/6/2022	9365	4/3/2022	1350	13	20667
91748015	2022	4/14/2022	9365	4/6/2022	1752	17	18794
91771463	2022	5/13/2022	9365	5/7/2022	1340	13	20667
91772771	2022	6/28/2022	9365	5/6/2022	1750	17	17736
91776215	2022	5/19/2022	9365	5/7/2022	2045	20	19815
91779085	2022	8/1/2022	9365	5/2/2022	1205	12	15293
91785962	2022	6/1/2022	9365	5/31/2022	1640	16	20566
91795736	2022	6/15/2022	9365	6/4/2022	115	1	21857

CASE_ID	DAY_OF_WEEK	CHP_SHIFT	POPULATION	CNTY_CITY	SPECIAL_C	BEAT_TYPE	CHP_BEAT	CITY_DIVIS	CHP_BEAT
91489383	2	1	9	4800	0	3	5		2
91494378	7	2	9	4800	0	2	4		2
91496319	7	1	9	4800	0	3	5		2
91499657	4	3	9	4800	0	1 A			2
91518402	4	2	9	4800	0	3	5		2
91520145	3	1	9	4800	0	1 A			2
91520177	5	1	9	4800	0	1 A			2
91521892	1	2	9	4800	0	2	4		2
91526291	1	1	9	4800	0	3	5		2
91531733	6	3	9	4800	0	3	5		2
91547821	1	2	9	4800	0	3	5		2
91557284	4	1	9	4800	0	2	4		2
91564257	7	2	9	4800	0	2	4		2
91566722	7	2	9	4800	0	3	5		2
91570117	6	2	9	4800	0	1 A			2
91575900	2	2	9	4800	0	1	1		2
91588395	6	1	9	4800	0	3	5		2
91589206	6	3	9	4800	0	2	4		2
91590526	3	1	9	4800	0	2	4		2
91591462	2	1	9	4800	0	2	4		2
91598825	7	3	9	4800	0	3	5		2
91604133	7	2	9	4800	0	2	4		2
91606398	5	2	9	4800	0	2	4		2
91606406	6	1	9	4800	0	3	5		2
91613693	3	3	9	4800	0	3	5		2
91621437	7	2	9	4800	0	3	5		2
91628758	4	2	9	4800	0	3	5		2
91636680	5	2	9	4800	0	1 A			2
91640007	3	2	9	4800	0	1 A			2
91641255	4	2	9	4800	0	3	5		2
91653020	6	1	9	4800	0	2	4		2
91667766	1	3	9	4800	0	1 A			2
91690556	1	1	9	4800	0	1 A			2
91692140	6	1	9	4800	0	1 A			2
91693889	6	2	9	4800	0	3	5		2
91710115	2	3	9	4800	0	2	4		2
91720718	4	2	9	4800	0	3	5		2
91722112	6	3	9	4800	0	2	4		2
91742509	7	1	9	4800	0	3	5		2
91748015	3	2	9	4800	0	1 A			2
91771463	6	1	9	4800	0	1 A			2
91772771	5	2	9	4800	0	3	5		2
91776215	6	2	9	4800	0	3	5		2
91779085	1	1	9	4800	0	3	5		2
91785962	2	2	9	4800	0	1	1		2
91795736	6	3	9	4800	0	1 A			2

CASE_ID	BEAT_NUM	PRIMARY_RD	SECONDARY_RD	DISTANCE	DIRECTION
91489383	40	SIEVERS RD	CURREY RD	0	
91494378	202	SUISUN VALLEY ROAD	TWIN SISTERS RD.	4224	N
91496319	40	PUTAH CREEK RD.	BOYCE RD	10560	E
91499657	30	PEACEFUL GLEN RD	TYLER CT	420	E
91518402	20	CORDELIA ROAD	RITCHIE RD	15	W
91520145	30	LEWIS RD	HOLDENER RD	0	
91520177	30	BYRNES RD	HAWKINS RD	0	
91521892	301	PLEASANTS VALLEY RD	WELLS LN	500	N
91526291	40	ROBBEN ROAD	MIDWAY RD	15	N
91531733	20	SUISUN VALLEY RD	MORRISON LN	200	N
91547821	40	MIDWAY RD	ELIZABETH RD	20	S
91557284	402	MIDWAY RD	SIKES RD	4594	W
91564257	301	PLEASANTS VALLEY ROAD	MIX CANYON ROAD	350	S
91566722	40	SIEVER'S ROAD	CURREY ROAD	0	
91570117	30	BROWNS VALLEY RD	CANTELOW ROAD	0	
91575900	87	PLEASANTS VALLEY RD	PUTAH CREEK RD	528	S
91588395	40	SIEVERS RD	NORTHBOUND CURREY RD.	10	E
91589206	301	PLEASANTS VALLEY ROAD N/	QUAIL CANYON ROAD	350	N
91590526	301	PLEASANTS VALLEY RD	CHESTER WAY	415	S
91591462	402	MIDWAY ROAD	PITT SCHOOL RD	80	E
91598825	40	PUTAH CREEK ROAD	WINTERS RD	150	E
91604133	202	SUISUN VALLEY RD	JOYCE LN	400	N
91606398	402	MIDWAY RD.	BATAVIA RD	0	
91606406	40	PUTAH CREEK ROAD	STEVENSON BRIDGE ROAD	4000	W
91613693	40	CANTELOW RD	ENGLISH HILLS RD	1460	E
91621437	40	PEDRICK ROAD	DIXON AVE	5280	S
91628758	20	ROCKVILLE ROAD	AMARAL COURT	200	W
91636680	30	TIMM RD	UDELL ROAD	2640	N
91640007	30	BYRNES RD	HAWKINS RD	0	
91641255	20	SUISUN VALLEY ROAD	WILLIAMS ROAD	60	S
91653020	201	ROCKVILLE RD	ROCKVILLE HEIGHTS	500	W
91667766	30	PEACEFUL GLEN RD	GLOW LN	845	E
91690556	30	PLEASANTS VALLEY ROAD	WHEDBEE DR.	175	N
91692140	30	PLEASANT HILLS RANCH WA\	CHESTER WAY	254	N
91693889	10	LINCOLN ROAD WEST	BENICIA RD	0	
91710115	301	PLEASANTS VALLEY RD	VACA VALLEY RD	2798	N
91720718	20	CORDELIA ROAD	THOMASSON LANE	571	W
91722112	402	MIDWAY RD	PEDRICK RD.	1584	E
91742509	40	PUTAH CREEK RD	I-505	125	E
91748015	30	PEDRICK RD	BINGHAMTON RD	20	N
91771463	30	PLEASANTS VALLEY RD	QUAIL CANYON RD	15	N
91772771	40	HAWKINS ROAD	BYRNES ROAD	0	
91776215	40	PEDRICK RD.	TREMONT RD.	1750	N
91779085	40	ROBBEN ROAD	VAUGHN ROAD	10	N
91785962	83	MANKAS CR	LEDGEWOOD RD	1000	N
91795736	30	MIDWAY ROAD	BATAVIA ROAD	500	W

CASE_ID	INTERSECT	Intersectio	WEATHER_	WEATHER_ STATE_HW	CALTRANS_ CALTRANS_ STATE_ROI	ROUTE_SU
91489383	Y	Y	A	-	N	
91494378	N	N	A	-	N	
91496319	N	N	A	-	N	
91499657	N	N	A	-	N	
91518402	N	Y	A	-	N	
91520145	Y	Y	A	-	N	
91520177	Y	Y	A	-	N	
91521892	N	N	A	-	N	
91526291	N	Y	A	-	N	
91531733	N	Y	A	-	N	
91547821	N	Y	A	-	N	
91557284	N	N	A	-	N	
91564257	N	N	A	-	N	
91566722	Y	Y	B	-	N	
91570117	Y	Y	A	-	N	
91575900	N	N	A	-	N	
91588395	N	Y	A	-	N	
91589206	N	N	A	-	N	
91590526	N	N	B	-	N	
91591462	N	Y	A	-	N	
91598825	N	Y	B	-	N	
91604133	N	N	A	-	N	
91606398	Y	Y	A	-	N	
91606406	N	N	A	-	N	
91613693	N	N	A	-	N	
91621437	N	N	A	-	N	
91628758	N	Y	A	-	N	
91636680	N	N	A	-	N	
91640007	Y	Y	A	-	N	
91641255	N	Y	A	-	N	
91653020	N	N	A	-	N	
91667766	N	N	A	-	N	
91690556	N	Y	A	-	N	
91692140	N	N	A	-	N	
91693889	Y	Y	A	-	N	
91710115	N	N	A	-	N	
91720718	N	N	A	-	N	
91722112	N	N	A	-	N	
91742509	N	Y	A	-	N	
91748015	N	Y	A	-	N	
91771463	N	Y	A	-	N	
91772771	Y	Y	A	-	N	
91776215	N	N	A	-	N	
91779085	N	Y	A	-	N	
91785962	N	N	A	-	N	
91795736	N	N	B	-	N	

CASE_ID	POSTMILE_POSTMILE	LOCATION_RAMP_INT	SIDE_OF_H	TOW_AWA	COLLISION_NUMBER_I	NUMBER_I
91489383			Y	3	0	3
91494378			Y	4	0	2
91496319			N	3	0	1
91499657			Y	2	0	1
91518402			Y	4	0	1
91520145			N	3	0	1
91520177			Y	3	0	3
91521892			N	4	0	2
91526291			N	4	0	1
91531733			Y	2	0	2
91547821			N	3	0	1
91557284			Y	3	0	1
91564257			Y	4	0	1
91566722			N	2	0	2
91570117			Y	4	0	1
91575900			N	4	0	1
91588395			Y	4	0	2
91589206			Y	4	0	1
91590526			Y	3	0	3
91591462			N	4	0	1
91598825			Y	3	0	1
91604133			N	3	0	1
91606398			N	4	0	1
91606406			N	3	0	1
91613693			Y	3	0	1
91621437			N	4	0	1
91628758			Y	4	0	5
91636680			Y	4	0	1
91640007			N	4	0	6
91641255			Y	3	0	1
91653020			Y	3	0	1
91667766			Y	1	1	0
91690556			Y	4	0	1
91692140			N	1	1	0
91693889			Y	2	0	1
91710115			N	3	0	1
91720718			N	3	0	1
91722112			N	3	0	1
91742509			N	4	0	1
91748015			N	4	0	1
91771463			N	2	0	1
91772771			Y	3	0	1
91776215			N	3	0	1
91779085			N	2	0	1
91785962			N	4	0	3
91795736			Y	2	0	1

CASE_ID	PARTY_CODE	PRIMARY_CODE	PCF_CODE	PCF_VIOL	PCF_VIOLA	PCF_VIOL_HIT_AND_F	TYPE_OF_C	MVIW
91489383	2	A	-	12	22450 A	N	D	C
91494378	1	A	-	8	22107	N	E	I
91496319	1	B	-	22		N	F	A
91499657	1	A	-	1	23152 A	N	E	I
91518402	2	A	-	3	22350	N	C	C
91520145	2	A	-	5	21460 A	N	D	C
91520177	2	A	-	9	21802 A	N	-	C
91521892	1	A	-	8	22107	N	E	I
91526291	2	A	-	8	22107	N	B	C
91531733	2	A	-	1	23152 A	N	C	C
91547821	2	A	-	3	22350	N	C	C
91557284	1	A	-	8	22107	N	E	I
91564257	2	A	-	6	21750 A	N	B	C
91566722	2	A	-	9	21802 A	N	D	C
91570117	2	A	-	9	21801 A	N	D	C
91575900	1	C	-	18		N	E	I
91588395	2	A	-	8	22107	N	D	C
91589206	1	A	-	1	23152 A	N	E	I
91590526	1	A	-	8	22107	N	E	I
91591462	2	A	-	3	22350	N	C	C
91598825	1	A	-	1	23152 A	N	E	I
91604133	1	A	-	8	22107	N	E	I
91606398	1	A	-	8	22107	N	E	I
91606406	2	A	-	3	22350	N	C	G
91613693	1	A	-	8	22107	N	E	I
91621437	2	A	-	17	24250	N	C	C
91628758	1	A	-	8	22107	N	E	I
91636680	1	A	-	1	23152 A	N	E	I
91640007	2	A	-	9	21802 A	N	D	C
91641255	1	A	-	3	22350	N	B	I
91653020	3	A	-	9	21801 A	N	D	C
91667766	1	A	-	1	23152 G	N	E	I
91690556	2	A	-	6	21750	N	C	C
91692140	1	A	-	8	22107	N	F	A
91693889	2	A	-	9	21453 C	N	D	C
91710115	1	A	-	8	22107	N	E	I
91720718	1	A	-	3	22350	N	H	I
91722112	1	A	-	1	23152 A	N	E	I
91742509	2	A	-	21	22106	N	G	B
91748015	2	A	-	3	22350	N	C	C
91771463	1	A	-	3	22350	N	F	A
91772771	2	A	-	12	22450 A	N	D	E
91776215	2	A	-	8	22107	N	G	B
91779085	2	A	-	8	22107	N	D	G
91785962	1	A	-	8	22107	N	E	I
91795736	2	A	-	3	22350	F	C	C

CASE_ID	PED_ACT	ICROAD_SUR	ROAD_CON	ROAD_CON	LIGHTING	CONTROL_CHP	ROAD PEDESTRIA	BICYCLE_A
91489383	A	A	H	-	A	A	0	
91494378	A	A	H	-	A	D	0	
91496319	A	A	H	-	A	D	0	Y
91499657	A	A	H	-	D	D	0	
91518402	A	A	H	-	A	A	0	
91520145	A	A	H	-	A	B	0	
91520177	A	A	H	-	A	A	0	
91521892	A	A	H	-	A	D	0	
91526291	A	A	H	-	A	D	0	
91531733	A	A	H	-	D	D	0	
91547821	A	A	H	-	A	D	0	
91557284	A	A	H	-	A	D	0	
91564257	A	A	H	-	A	D	0	
91566722	A	A	H	-	A	A	0	
91570117	A	A	H	-	D	D	0	
91575900	A	A	H	-	B	D	0	
91588395	A	A	H	-	A	A	0	
91589206	A	A	H	-	D	A	0	
91590526	A	A	H	-	A	D	0	
91591462	A	A	H	-	A	A	0	
91598825	A	A	H	-	C	D	0	
91604133	A	A	H	-	A	D	0	
91606398	A	A	H	-	A	A	0	
91606406	A	A	H	-	A	D	0	Y
91613693	A	A	H	-	D	D	0	
91621437	A	A	H	-	D	D	0	
91628758	A	A	H	-	D	D	0	
91636680	A	A	H	-	D	D	0	
91640007	A	A	H	-	D	A	0	
91641255	A	A	H	-	D	D	0	
91653020	A	A	H	-	A	D	0	
91667766	A	A	H	-	D	D	0	
91690556	A	A	H	-	A	D	0	
91692140	A	A	H	-	A	D	0	Y
91693889	A	A	H	-	C	A	0	
91710115	A	A	H	-	D	D	0	
91720718	A	A	H	-	D	D	0	
91722112	A	A	H	-	D	D	0	
91742509	E	A	H	-	A	D	0	Y
91748015	A	A	H	-	A	D	0	
91771463	A	A	H	-	A	D	0	
91772771	A	A	H	-	A	A	0	
91776215	E	A	H	-	D	D	0	Y
91779085	A	A	H	-	A	A	0	Y
91785962	A	A	H	-	A	D	0	
91795736	A	A	H	-	D	D	0	

CASE_ID	MOTORCYC	TRUCK_AC	NOT_PRIV	ALCOHOL	STWD_VEH	CHP_VEH	COUNT_SE	COUNT_VI	COUNT_CC
91489383			Y		A		7	0	3
91494378			Y		A		1	0	0
91496319			Y		L		4	0	1
91499657			Y	Y	D		22	1	0
91518402			Y		A		1	0	0
91520145			Y		A		7	0	1
91520177			Y		A		1	0	1
91521892			Y		A		1	0	0
91526291	Y		Y		F		25	0	0
91531733			Y	Y	A		1	1	1
91547821			Y		D		22	0	1
91557284			Y		A		1	0	1
91564257			Y		D		22	0	0
91566722			Y		A		1	1	1
91570117			Y		D		22	0	0
91575900 Y			Y		-	-		0	0
91588395			Y		A		1	0	0
91589206			Y	Y	A		1	0	0
91590526			Y		D		22	0	3
91591462			Y		A		7	0	0
91598825			Y	Y	A		7	0	1
91604133			Y		A		1	0	1
91606398			Y		A		7	0	0
91606406			Y		L		4	0	1
91613693			Y		A		1	0	1
91621437 Y			Y		C		6	0	0
91628758			Y		A		7	0	0
91636680			Y	Y	D		22	0	0
91640007			Y		A		7	0	0
91641255			Y		A		1	0	1
91653020			Y		A		7	0	1
91667766			Y	Y	A		1	0	0
91690556			Y		-	-		0	0
91692140			Y		L		4	0	0
91693889			Y		A		7	1	0
91710115			Y		D		22	0	1
91720718			Y		A		1	0	1
91722112			Y	Y	A		1	0	1
91742509			Y		A		1	0	0
91748015	Y		Y		F		25	0	0
91771463 Y			Y		C		2	1	0
91772771			Y		A		1	0	1
91776215			Y	Y	A		1	0	1
91779085			Y		L		4	1	0
91785962			Y		A		1	0	0
91795736			Y		A		1	1	0

CASE_ID	COUNT_PE	COUNT_PE	COUNT_BI	COUNT_BI	COUNT_MI	COUNT_MI	PRIMARY_I	SECONDAR	LATITUDE
91489383	0	0	0	0	0	0	-	-	38.4891
91494378	0	0	0	0	0	0	-	-	38.31066
91496319	0	0	0	1	0	0	-	-	38.52551
91499657	0	0	0	0	0	0	-	-	38.436
91518402	0	0	0	0	0	0	-	-	38.21092
91520145	0	0	0	0	0	0	-	-	38.35156
91520177	0	0	0	0	0	0	-	-	38.35897
91521892	0	0	0	0	0	0	-	-	38.41136
91526291	0	0	0	0	0	0	-	-	38.41634
91531733	0	0	0	0	0	0	-	-	38.26663
91547821	0	0	0	0	0	0	-	-	38.8198
91557284	0	0	0	0	0	0	-	-	38.41625
91564257	0	0	0	0	0	0	-	-	38.40392
91566722	0	0	0	0	0	0	-	-	38.48911
91570117	0	0	0	0	0	0	-	-	38.41604
91575900	0	0	0	0	0	1	-	-	38.48
91588395	0	0	0	0	0	0	-	-	38.48909
91589206	0	0	0	0	0	0	-	-	38.46746
91590526	0	0	0	0	0	0	-	-	38.4001
91591462	0	0	0	0	0	0	-	-	38.41675
91598825	0	0	0	0	0	0	-	-	38.51655
91604133	0	0	0	0	0	0	-	-	38.30228
91606398	0	0	0	0	0	0	-	-	38.41682
91606406	0	0	0	1	0	0	-	-	38.53036
91613693	0	0	0	0	0	0	-	-	38.41635
91621437	0	0	0	0	0	1	-	-	38.43496
91628758	0	0	0	0	0	0	-	-	38.25258
91636680	0	0	0	0	0	0	-	-	38.43727
91640007	0	0	0	0	0	0	-	-	38.359
91641255	0	0	0	0	0	0	-	-	38.29649
91653020	0	0	0	0	0	0	-	-	38.24868
91667766	0	0	0	0	0	0	-	-	38.43599
91690556	0	0	0	0	0	0	-	-	38.34356
91692140	0	0	1	0	0	0	-	-	38.40179
91693889	0	0	0	0	0	0	-	-	38.09493
91710115	0	0	0	0	0	0	-	-	38.38672
91720718	0	0	0	0	0	0	-	-	38.22351
91722112	0	0	0	0	0	0	-	-	38.41635
91742509	0	1	0	0	0	0	-	-	38.5253
91748015	0	0	0	0	0	0	-	-	38.35102
91771463	0	0	0	0	0	1	-	-	38.46732
91772771	0	0	0	0	0	0	-	-	38.35895
91776215	0	1	0	0	0	0	-	-	38.51095
91779085	0	0	0	1	0	0	-	-	38.46724
91785962	0	0	0	0	0	0	-	-	38.27968
91795736	0	0	0	0	0	0	-	-	38.4168

CASE_ID	LONGITUD	COUNTY	CITY	POINT_X	POINT_Y	Age	Gender	MOVE_PRI	Bike_Ped_
91489383	-121.822	SOLANO	UNINCORP	-121.822	38.4891	66	F	B	N
91494378	-122.129	SOLANO	UNINCORP	-122.129	38.31017	31	M	M	N
91496319	-121.923	SOLANO	UNINCORP	-121.918	38.52198	52	M	B	Y
91499657	-121.977	SOLANO	UNINCORP	-121.974	38.43724	22	F	C	N
91518402	-122.133	SOLANO	UNINCORP	-122.133	38.21101	24	F	B	N
91520145	-121.897	SOLANO	UNINCORP	-121.897	38.35158	36	M	I	N
91520177	-121.906	SOLANO	UNINCORP	-121.906	38.35891	18	F	B	N
91521892	-122.042	SOLANO	UNINCORP	-122.043	38.41205	18	F	C	N
91526291	-121.786	SOLANO	UNINCORP	-121.786	38.41636	67	M	E	N
91531733	-122.113	SOLANO	UNINCORP	-122.113	38.26664	37	F	B	N
91547821	-121.028	SOLANO	UNINCORP	-121.909	38.41703	23	M	B	N
91557284	-121.765	SOLANO	UNINCORP	-121.765	38.4162	47	F	M	N
91564257	-122.042	SOLANO	UNINCORP	-122.043	38.40391	53	M	I	N
91566722	-121.822	SOLANO	UNINCORP	-121.822	38.4891	43	M	B	N
91570117	-121.971	SOLANO	UNINCORP	-121.971	38.41607	18	M	E	N
91575900	-122.03	SOLANO	UNINCORP	-122.03	38.4795	40	M	B	N
91588395	-121.822	SOLANO	UNINCORP	-121.822	38.48909	20	F	E	N
91589206	-122.049	SOLANO	UNINCORP	-122.049	38.46739	22	F	M	N
91590526	-122.041	SOLANO	UNINCORP	-122.041	38.40012	17	M	M	N
91591462	-121.841	SOLANO	UNINCORP	-121.841	38.41669	47	M	H	N
91598825	-121.969	SOLANO	UNINCORP	-121.967	38.51962	49	M	B	N
91604133	-122.129	SOLANO	UNINCORP	-122.129	38.30304	18	M	C	N
91606398	-121.86	SOLANO	UNINCORP	-121.86	38.41681	39	F	M	N
91606406	-121.862	SOLANO	UNINCORP	-121.864	38.53041	71	M	B	Y
91613693	-122.003	SOLANO	UNINCORP	-121.995	38.41648	37	M	M	N
91621437	-121.804	SOLANO	UNINCORP	-121.804	38.43091	40	M	B	N
91628758	-122.171	SOLANO	UNINCORP	-122.171	38.2526	19	F	C	N
91636680	-121.968	SOLANO	UNINCORP	-121.969	38.43748	35	M	M	N
91640007	-121.906	SOLANO	UNINCORP	-121.906	38.35891	84	F	B	N
91641255	-122.12	SOLANO	UNINCORP	-122.12	38.29631	31	M	C	N
91653020	-122.132	SOLANO	UNINCORP	-122.132	38.24846	62	M	E	N
91667766	-121.977	SOLANO	UNINCORP	-121.977	38.43596	70	M	C	N
91690556	-122.025	SOLANO	UNINCORP	-122.025	38.3435	59	M	I	N
91692140	-122.042	SOLANO	UNINCORP	-122.042	38.40177	33	M	M	Y
91693889	-122.231	SOLANO	UNINCORP	-122.231	38.09491	57	M	E	N
91710115	-122.033	SOLANO	UNINCORP	-122.033	38.3867	67	M	M	N
91720718	-122.113	SOLANO	UNINCORP	-122.113	38.22353	19	M	M	N
91722112	-121.798	SOLANO	UNINCORP	-121.799	38.41639	66	M	M	N
91742509	-121.952	SOLANO	UNINCORP	-121.953	38.52514	14	M	O	Y
91748015	-121.805	SOLANO	UNINCORP	-121.805	38.3513	28	M	B	N
91771463	-122.05	SOLANO	UNINCORP	-122.05	38.46732	64	M	B	N
91772771	-121.906	SOLANO	UNINCORP	-121.906	38.35891	20	M	B	N
91776215	-121.803	SOLANO	UNINCORP	-121.804	38.50097	35	M	M	Y
91779085	-121.786	SOLANO	UNINCORP	-121.786	38.46712	18	F	E	Y
91785962	-122.104	SOLANO	UNINCORP	-122.104	38.27968	20	F	C	N
91795736	-121.861	SOLANO	UNINCORP	-121.861	38.41683	998	-	B	N

CASE_ID	Age_At Fault_1
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91489383	60-69
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91494378	30-39
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91496319	50-59
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91499657	20-29
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91518402	20-29
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91520145	30-39
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91520177	15-20
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91521892	15-20
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91526291	60-69
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91557284	40-49
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91564257	50-59
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91636680	30-39
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91640007	80-110
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91667766	70-79
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91690556	50-59
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91693889	50-59
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91710115	60-69
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91720718	15-20
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91722112	60-69
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91742509	0-14
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91748015	20-29
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91771463	60-69
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91772771	15-20
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91776215	30-39
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91779085	15-20
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91785962	15-20
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91795736	998
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CASE_ID	ACCIDENT_	PROC_DATE	JURIS	COLLISION_D	COLLISION Hour	OFFICER_I	REPORTING
91820779	2022	7/19/2022	9365	7/16/2022	1000	10	16970
91824453	2022	7/25/2022	9365	7/17/2022	1330	13	21185
91830040	2022	8/1/2022	9365	7/25/2022	1838	18	22766
91830205	2022	8/1/2022	9365	7/24/2022	2205	22	22286
91830561	2022	8/1/2022	9365	2/25/2022	1620	16	17736
91835087	2022	8/8/2022	9365	7/29/2022	450	4	21857
91842337	2022	8/17/2022	9365	8/8/2022	550	5	17654
91844353	2022	8/19/2022	9365	8/14/2022	1215	12	20667
91846685	2022	8/23/2022	9365	8/22/2022	1550	15	22286
91854572	2022	8/31/2022	9365	5/13/2022	1625	16	17736
91856501	2022	9/2/2022	9365	6/16/2022	1923	19	19651
91869866	2022	9/21/2022	9365	9/5/2022	1220	12	17820
91886337	2022	10/10/2022	9365	9/21/2022	1903	19	20835
91886625	2022	10/10/2022	9365	10/1/2022	1650	16	22834
91889576	2022	10/13/2022	9365	10/12/2022	610	6	17163
91890489	2022	10/14/2022	9365	10/6/2022	300	3	20565
91891743	2022	10/17/2022	9365	10/15/2022	940	9	17508
91894091	2022	10/19/2022	9365	10/11/2022	1235	12	19458
91900123	2022	10/26/2022	9365	10/15/2022	1445	14	19815
91929603	2022	11/29/2022	9365	11/22/2022	2330	23	18712
91934881	2022	3/2/2023	9365	11/22/2022	1330	13	21185
91935432	2022	12/6/2022	9365	12/6/2022	845	8	17163
91949677	2022	12/22/2022	9365	12/16/2022	939	9	22796
91949704	2022	12/22/2022	9365	12/7/2022	1745	17	21185
91959984	2022	1/4/2023	9365	12/28/2022	1515	15	21645
91964387	2022	1/10/2023	9365	1/30/2022	1930	19	21609
91964578	2022	1/10/2023	9365	10/10/2022	650	6	15293
92077779	2022	5/25/2023	9365	10/7/2022	2320	23	18712
92135558	2022	8/3/2023	9365	10/5/2022	2028	20	19651
92148689	2022	8/21/2023	9365	11/18/2022	1815	18	21996
92152632	2022	8/24/2023	9365	7/3/2022	15	0	21857
91263616	2020	7/6/2020	9365	6/20/2020	1040	10	16970

CASE_ID	DAY_OF_WEEK	CHP_SHIFT	POPULATION	CNTY_CITY	SPECIAL_C	BEAT_TYPE	CHP_BEAT	CITY_DIVIS	CHP_BEAT
91820779	6	1	9	4800	0	2	4		2
91824453	7	1	9	4800	0	2	4		2
91830040	1	2	9	4800	0	3	5		2
91830205	7	3	9	4800	0	1 A			2
91830561	5	2	9	4800	0	1 A			2
91835087	5	3	9	4800	0	1 A			2
91842337	1	3	9	4800	0	1 A			2
91844353	7	1	9	4800	0	1 A			2
91846685	1	2	9	4800	0	3	5		2
91854572	5	2	9	4800	0	2	4		2
91856501	4	2	9	4800	0	3	5		2
91869866	1	1	9	4800	0	3	5		2
91886337	3	2	9	4800	0	2	4		2
91886625	6	2	9	4800	0	1 A			2
91889576	3	1	9	4800	0	3	5		2
91890489	4	3	9	4800	0	3	5		2
91891743	6	1	9	4800	0	3	5		2
91894091	2	1	9	4800	0	2	4		2
91900123	6	2	9	4800	0	2	4		2
91929603	2	3	9	4800	0	2	4		2
91934881	2	1	9	4800	0	2	4		2
91935432	2	1	9	4800	0	2	4		2
91949677	5	1	9	4800	0	1 A			2
91949704	3	2	9	4800	0	2	4		2
91959984	3	2	9	4800	0	3	5		2
91964387	7	2	9	4800	0	1 A			2
91964578	1	1	9	4800	0	3	5		2
92077779	5	3	9	4800	0	3	5		2
92135558	3	2	9	4800	0	3	5		2
92148689	5	2	9	4800	0	2	4		2
92152632	7	3	9	4800	0	1 A			2
91263616	6	1	9	4800	0	1 A			2

CASE_ID	BEAT_NUM	PRIMARY_RD	SECONDARY_RD	DISTANCE	DIRECTION
91820779	301	PLEASANTS VALLEY RD	BRINCK TRAIL	1056	N
91824453	201	ROCKVILLE RD	ABERNATHY RD	20	W
91830040	20	LOPES RD	MARSHVIEW RD	2006	N
91830205	30	HAY RD	MERIDIAN RD	66	W
91830561	30	DIXON AVE WEST	N. MERIDIAN ROAD	711	E
91835087	30	CANTELOW RD	ENGLISH HILLS RD	1584	W
91842337	30	CANTELOW ROAD	BROWNS VALLEY ROAD	0	
91844353	30	LEWIS RD	HOLDENER RD	0	
91846685	20	ROCKVILLE RD	EMERALD RIDGE LANE	20	W
91854572	301	PLEASANTS VALLEY RD	FOOTHILL DR	951	N
91856501	20	LOPES ROAD	LOPES RANCH ROAD	528	S
91869866	20	CORDELIA RD	THOMASSON LN	2682	E
91886337	201	ROCKVILLE ROAD	SCOT COURT	300	S
91886625	30	CANTELOW ROAD	WEST ROADWAY EDGE LINE PRC	147	W
91889576	40	SIEVERS RD	GARNETT LN	2165	E
91890489	40	SIEVERS RD	HALLEY RD	1584	E
91891743	20	MANKAS CORNER RD W/B	LEDGEWOOD RD	3	W
91894091	202	SUISUN VALLEY ROAD	JOYCE LN	5016	N
91900123	301	PLEASANTS VALLEY RD.	CHERRY GLEN ROAD	4100	N
91929603	301	PLEASANTS VALLEY RD	GATES CANYON RD	850	S
91934881	202	SUISUN VALLEY RD	LEDGEWOOD ROAD	210	S
91935432	201	WILLOTTA DR	ROCKVILLE RD	0	
91949677	30	HOLDENER RD	LEWIS RD AND HOLDENER RD	0	
91949704	201	ROCKVILLE ROAD	WILOTTA DRIVE	110	E
91959984	20	MANKAS CORNER ROAD N/B	LEDGEWOOD ROAD	2745	S
91964387	30	HAY ROAD	MERIDIAN ROAD	111	W
91964578	40	VAUGHN ROAD	ROBBEN ROAD	0	
92077779	40	PEDRICK RD	TREMONT RD	3896	N
92135558	20	MANKAS CORNER ROAD	ABERNATHY ROAD	1363	N
92148689	202	SUISUN VALLEY ROAD	MORRISON LANE	1267	S
92152632	30	PUTAH CREEK ROAD	CANAL LANE	2112	W
91263616	30	PUTAH CREEK RD	MARGARET LN	500	S

CASE_ID	INTERSECT	Intersectio	WEATHER_	WEATHER_ STATE_HW	CALTRANS_ CALTRANS_ STATE_ROI	ROUTE_SU
91820779	N	N	A	-	N	
91824453	N	Y	A	-	N	
91830040	N	N	A	-	N	
91830205	N	Y	A	-	N	
91830561	N	N	A	-	N	
91835087	N	N	A	-	N	
91842337	Y	Y	A	-	N	
91844353	Y	Y	A	-	N	
91846685	N	Y	A	-	N	
91854572	N	N	A	-	N	
91856501	N	N	A	-	N	
91869866	N	N	A	-	N	
91886337	N	N	A	-	N	
91886625	N	Y	A	-	N	
91889576	N	N	A	-	N	
91890489	N	N	A	-	N	
91891743	N	Y	A	-	N	
91894091	N	N	A	-	N	
91900123	N	N	A	-	N	
91929603	N	N	A	-	N	
91934881	N	Y	A	-	N	
91935432	Y	Y	B	-	N	
91949677	Y	Y	A	-	N	
91949704	N	Y	A	-	N	
91959984	N	N	B	-	N	
91964387	N	Y	A	-	N	
91964578	Y	Y	A	-	N	
92077779	N	N	A	-	N	
92135558	N	N	A	-	N	
92148689	N	N	B	-	N	
92152632	N	N	B	-	N	
91263616	N	N	A	-	N	

CASE_ID	POSTMILE_POSTMILE	LOCATION_RAMP_INT	SIDE_OF_H	TOW_AWA	COLLISION_NUMBER_I	NUMBER_I
91820779			Y		2	0
91824453			N		3	0
91830040			Y		3	0
91830205			N		2	0
91830561			Y		1	1
91835087			Y		4	0
91842337			Y		2	0
91844353			Y		4	0
91846685			N		3	0
91854572			Y		1	1
91856501			N		1	1
91869866			Y		2	0
91886337			N		2	0
91886625			N		2	0
91889576			Y		3	0
91890489			N		2	0
91891743			N		3	0
91894091			N		4	0
91900123			Y		4	0
91929603			Y		3	0
91934881			N		3	0
91935432			Y		3	0
91949677			N		4	0
91949704			Y		2	0
91959984			Y		2	0
91964387			Y		1	1
91964578			Y		1	1
92077779			Y		1	1
92135558			N		1	2
92148689			N		1	2
92152632			Y		1	1
91263616			Y		2	0

CASE_ID	PARTY_CO	PRIMARY_	PCF_CODE	PCF_VIOL_	PCF_VIOLA	PCF_VIOL_	HIT_AND_	F	TYPE_OF_	C	MVIW
91820779	1	A	-	8	22107	N	E	I			
91824453	2	A	-	3	22350	F	C	C			
91830040	1	A	-	1	23152 A	N	E	I			
91830205	1	A	-	1	23152 A	N	F	A			
91830561	2	A	-	3	22350	N	D	C			
91835087	1	A	-	1	23152 A	N	E	I			
91842337	2	A	-	5	21460 A	N	D	G			
91844353	2	A	-	9	21802 B	N	D	C			
91846685	2	A	-	3	22350	N	C	C			
91854572	1	A	-	3	22350	N	E	I			
91856501	1	A	-	1	23152 A	N	F	A			
91869866	1	A	-	8	22107	N	E	I			
91886337	1	A	-	8	22107	N	E	I			
91886625	2	A	-	3	22350	N	C	C			
91889576	2	A	-	3	22350	N	C	C			
91890489	1	A	-	8	22107	N	A	I			
91891743	2	A	-	3	22350	N	C	C			
91894091	1	A	-	8	22107	N	E	I			
91900123	2	A	-	9	21804 A	N	D	C			
91929603	1	A	-	1	23152 A	N	E	I			
91934881	1	A	-	8	22107	N	F	A			
91935432	2	A	-	9	21802 A	N	D	C			
91949677	2	A	-	12	22450 A	N	D	D			
91949704	1	A	-	1	23152 A	N	E	I			
91959984	1	A	-	8	22107	N	F	I			
91964387	1	A	-	1	23152 A	N	E	I			
91964578	2	A	-	12	22450 A	N	D	C			
92077779	3	A	-	1	23152 A	N	B	C			
92135558	1	A	-	1	23152 A	N	E	B			
92148689	3	A	-	1	23152 A	N	A	C			
92152632	1	A	-	8	22107	N	E	B			
91263616	1	A	-	8	22107	N	E	I			

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91824453	A	A	H	-	A	A	0	
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91830205	A	A	H	-	C	D	0	
91830561	A	A	H	-	A	D	0	
91835087	A	A	H	-	D	D	0	
91842337	A	A	H	-	B	D	0	Y
91844353	A	A	H	-	A	A	0	
91846685	A	A	H	-	A	D	0	
91854572	A	A	H	-	A	D	0	
91856501	A	A	H	-	A	D	0	
91869866	A	A	H	-	A	A	0	
91886337	A	A	H	-	B	D	0	
91886625	A	A	H	-	A	D	0	
91889576	A	A	H	-	D	D	0	
91890489	A	A	H	-	D	D	0	
91891743	A	A	H	-	A	D	0	
91894091	A	A	H	-	A	D	0	
91900123	A	A	H	-	A	D	0	
91929603	A	A	H	-	D	D	0	
91934881	A	A	H	-	A	A	0	
91935432	A	B	H	-	A	A	0	
91949677	A	A	H	-	A	A	0	
91949704	A	A	H	-	C	A	0	
91959984	A	A	H	-	A	D	0	
91964387	A	A	H	-	D	A	0	
91964578	A	A	H	-	D	A	0	
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92135558	A	A	H	-	D	D	0	
92148689	A	A	H	-	D	D	0	
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91263616	A	A	H	-	A	D	0	

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91846685			Y		D		22	0	1
91854572 Y			Y	Y	C		2	0	0
91856501 Y			Y	Y	C		2	0	0
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91889576			Y		D		22	0	1
91890489			Y		A		1	1	0
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91894091 Y			Y		C		2	0	0
91900123			Y		A		7	0	0
91929603			Y	Y	A		1	0	1
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91935432			Y		A		1	0	1
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91949704			Y	Y	A		1	1	0
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91263616	30-39
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Appendix D

Countermeasure Toolbox



Countermeasures for Intersections

ID	Intersection	Control	Consolidated CMs (HSIP-Eligible - Refer to LRSM* 2024)						Notes/Additional CM (HSIP and non-HSIP)
			CM1	CM2	CM3	CM4	CM5	CM6	
I-1	Hay Road and Meridian Road	One way Stop controlled	NS10	NS14	NS01NT	NS09	NS12	NS08	Guard rail near canal ditches; channelizers if truck turning radius allows; widen shoulder
I-2	Abernathy Road and Mankas Corner Road	All way Stop controlled	NS10	NS12	NS11	NS14	NS13		Remove objects within clear zone; lighted STOP signs; channelizers; widen shoulders
I-3	Batavia Road and Midway Road	Two-way Stop controlled	NS01NT	NS14	NS13	NS05RA	NS15	NS09	Speed feedback signs; consider roundabout if existing CMs do not yield crash reductions
I-4	Browns Valley Road and Cantelow Road/ Tim	One way Stop controlled	NS08	NS13	NS11				
I-5	Robben Road and Vaughn Road	Two-way Stop controlled	NS08	NS11	NS16				Add new barriers to stop drivers from doing donuts at intersection
I-6	Benicia Road and Lemon Street/ Lincoln Road	Signal	SI08	SI10	SI03	SI02	SI09		Adjust west leg ped indication; Apply safe offset to driveway access; improve visibility; high-visibility crosswalks
I-7	Quail Canyon Road and Pleasants Valley Road	One way Stop controlled	NS13	NS14	NS11	NS08	NS09	NS01NT	Flatten horizontal curve on Pleasants Valley; advance warning signs; widen inside shoulder on curve; object markers; STOP sign on Quail Canyon
I-8	Byrnes Road and Hawkins Road	Two-way Stop controlled	NS01NT	NS10*	NS11*	NS02**	NS15	NS08	Channelizers on CL; lighted STOP signs at Byrnes to supplement lighted warning from RTIF 2021; lighted warning signs on Hawkins; add'l lighting
I-9	Holdener Road and Lewis Road	Two-way Stop controlled	NS08	NS10	NS02**	NS12	NS11		Fix offset on Holdener; guard rail around canal; large object markers
I-10	Sievers Road and Currey Road	Two-way Stop controlled	NS08	NS11					
I-11	Railroad Avenue and Putah Creek Road	One way Stop controlled	NS08	NS11	NS13	NS15			
I-12	Rockville Road and Willotta Drive	One way Stop controlled	NS08	NS11	NS13				
I-13	Meridian Road and Allendale Road	One way Stop controlled	NS08	NS11	NS14	NS09			
I-14	Winters Road and Wolfskill Road	One way Stop controlled	NS10	NS09	NS12	NS15	NS01NT		Object markers; channelizers on centerline; widen shoulders at intersection; install bicycle facility; Share the Road sign

*Supplement existing CMs (eg. install on remaining approaches to intersection)

**All-Way stop warrant should be conducted

Recommended HSIP Countermeasures (Refer to LRSM for more details about each countermeasure)

NS01NT = Add intersection lighting

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

NS05RA = Convert intersection to roundabout (from 2-way stop or Yield control)

NS08 = Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs

NS09 = Upgrade intersection pavement markings

NS10 = Install Flashing Beacons at Stop-Controlled Intersections

NS11 = Install flashing beacons as advance warning (NS.I.)

NS12 = Install transverse rumble strips on approaches

NS13 = Improve sight distance to intersection (Clear Sight Triangles)

NS14 = Improve pavement friction (High Friction Surface Treatments)

NS15 = Install splitter-islands on the minor road approaches

NS16 = Install raised median on approaches

NS19 = Install right-turn lane (NS.I.)

SI02 = Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number

SI03 = Improve signal timing (coordination, phases, red, yellow, or operation)

SI08 = Install raised pavement markers and striping (through intersection)

SI09 = Install flashing beacons as advance warning (S.I.)

SI10 = Improve pavement friction (High Friction Surface Treatments)

Countermeasures for Roadway Segments

ID	Roadway Segment	Consolidated CMs (HSIP-Eligible - Refer to LRSM* 2024)						Notes/Additional CM (HSIP and non-HSIP)
		CM1	CM2	CM3	CM4	CM5	CM6	
A	Pleasants Valley Road: Yolo County Line to Cherry Glen Road	R23	R26	R31	R15	R04	R30	Flatten horizontal curves; widen shoulder for clear recovery and bikes; curve advance warning; widen lanes to 12'
B	Suisun Valley Road: 650 ft. south of Rockville Road to Napa Cou	R30	R26	R23	R24	R15	R17	Flatten horizontal curves; widen shoulder for clear recovery and bikes; widen lanes to 12'
C	Mankas Corner Road: Fairfield City Limit to Clayton Road	R23	R26	R31	R04	R30		
D	Putah Creek Road: Pleasants Valley Road to Stevenson Bridge R	R21	R25	R26	R31	R27	R15	NH1 Speed Feedback Sign; Flashing curve warning and/or flashing chevrons at 90 degree curves (to supplement existing signs)
E	Rockville Road: Fairfield City Limit to Tartan way	R22	R26	R31	R30	R21	R27	NH1
F	Lopes Road: 5600 ft. north of Marshview Road to 1500 ft. south of Parish Road	R23	R26	R31	R15	R04	R30	
G	Sievers Road: Halley Road to Pedrick Road	R30	R31	R22	R27	R32		NH2
H	Meridian Road: Fry Road to Fairfield City Limit	R30	R31	R23	R23	R27	R01NT	Curve warning sign at McCrory Rd
I	Midway Road: Leeve Road to Timm Road	R30	R31	R22	R27	R32		
J	Pedrick Road: Yolo County Line to Maine Prairie Road	R31	R26	R27	R22	R02	R15	NH1 Speed Feedback Sign
K	Cordelia Road: I-80 to Park Lane	R04	R23	R26	R27	R30	R31	NH1 Speed Feedback Sign; Guard rail and chevrons at S-curve
L	Dixon Avenue: I-80 to Meridian Road	R25	R26	R30	R06	R27	R15	NH1; Chevrons and advance curve warning on S curve; speed feedback signs; shoulder widening applies to area W of Jahn Rd
M	Cantelow Road: Browns Valley Road to Steiger Hill Road	R01NT	R28	R23	R22	R27		R28: English Hill to Steiger Hill
N	Abernathy Road: Mankas Corner Road to Rockville Road	R01NT	R22	R27				
O	Peaceful Glen Road: Timm Road to Acacia Lane	R01NT	R22	R23	R25	R26		DUI enforcement

**Non-HSIP Eligible CMs	Code
Speed Feedback Signs	NH1
Pave Road	NH2

Recommended HSIP Countermeasures (Refer to LRSM for more details about each countermeasure)

- R01NT = Add Segment Lighting
- R02 = Remove or relocate fixed objects outside of Clear Recovery Zone
- R04 = Install guardrail
- R06 = Flatten side slopes
- R15 = Widen shoulder
- R16 = Curve shoulder widening (Outside Only)
- R17 = Improve horizontal alignment (flatten curves)
- 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
- R24 = Install curve advance warning signs
- 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
- R29 = Install no-passing line
- R30 = Install centerline rumble strips/stripes
- R31 = Install edgeline rumble strips/stripes
- R32 = Speed Safety Cameras

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, improper turning and driving under the influence.	Number of education campaigns	County/ School District/CHP
	Conduct bicycle safety campaigns and outreach to raise their awareness of bicycle safety needs through media outlets, social media and Bike and Walk Mendocino. Create a pamphlet for bicycle safety	Number of education campaigns	County/ School District/CHP
Enforcement	Targeted enforcement at high-risk locations.	Number of tickets issued.	CHP
	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	CHP
Emergency Medical Services (EMS)	SI05, Install emergency vehicle pre-emption systems	EMS vehicle response time.	Fire Districts and EMS Response Teams
	Increase the number of EMS/fire control personnel taking Traffic Incident Management Training	number of EMS/fire control personnel taking Traffic Incident Management Training	Fire Districts and EMS Response Teams

Appendix E

Local Roadway Safety Manual (LRSM) Excerpt



Local Roadway Safety Manual

A Manual for California's Local Road Owners

Version 1.7 April 2024



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



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.

Version 1.6: April 2022

For Cycle 11 Call-for-projects, Countermeasure S04 (Provide Advanced Dilemma Zone Detection for high-speed approaches) was deleted and Countermeasure NS05mr (Convert intersection to mini-roundabout) added. The HSIP Funding Eligibility was changed to 90% except for S03, of which the HSIP Funding Eligibility stays at 50%. The crash costs in Appendix D were updated.

Version 1.7: April 2024

For Cycle 12 Call-for-projects, Countermeasures SI14 (Install right-turn lane (S.I.)) and R32 (Speed Safety Cameras) were added. All countermeasures were re-numbered. The crash costs in Appendix D were updated.

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

1.	Introduction and Purpose.....	1
1.1	California Local Roadway Safety Challenges and Opportunities	2
1.2	Safe System Approach	2
1.3	The State’s Role in Local Roadway Safety.....	3
1.4	The Local Roadway Crash Problem	4
1.5	Reactive vs. Proactive Safety Issue Identification	5
1.6	Implementation Approaches	6
1.7	Our “Safety Challenge” for Local Agencies	9
1.8	Summary of information in this Document	10
2.	Identifying Safety Issues	14
2.1	State and Local Crash Databases	15
2.2	Transportation Injury Mapping System (TIMS).....	17
2.3	Law Enforcement Crash Reports.....	18
2.4	Observational Information.....	18
2.5	Public Notifications	19
2.6	Roadway Data and Devices.....	19
2.7	Exposure Data	20
2.8	Field Assessments and Road Safety Audits.....	21
3.	Safety Data Analysis.....	22
3.1	Quantitative Analysis	22
3.2	Qualitative Analysis.....	24
4.	Countermeasure Selection	27
4.1	Selecting Countermeasures and Crash Modification Factors / Crash Reduction Factors	28
4.2	List of Countermeasures	29
5.	Calculating the B/C Ratio and Comparing Projects	35
5.1	Estimate the Benefit of Implementing Proposed Improvements.....	35
5.2	Estimate the Cost of Implementing Proposed Improvements	37
5.3	Calculate the B/C Ratio	37
5.4	Compare B/C Ratios and Consider the Need to Reevaluate Project Elements	38
6.	Identifying Funding and Construct Improvements.....	39
6.1	Existing Funding for Low-cost Countermeasures.....	39
6.2	HSIP and Other Funding Sources	39
6.3	Project Development and Construction Considerations	40
7.	Evaluation of Improvements	41
	Appendix A: HSIP Call-for-Projects Application Process	42
	Appendix B: Detailed Tables of Countermeasures	43
B.1	Intersection Countermeasures – Signalized	46
	SI01NT, Add intersection lighting (Signalized Intersection => S.I.).....	46
	SI02, Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	46
	SI03, Improve signal timing (coordination, phases, red, yellow, or operation)	47
	SI04EV, Install emergency vehicle pre-emption systems.....	47
	SI05, Install left-turn lane and add turn phase (signal has no left-turn lane or phase before)	48

SI06, Provide protected left turn phase (left turn lane already exists)	49
SI07, Convert signal to mast arm (from pedestal-mounted).....	49
SI08, Install raised pavement markers and striping (Through Intersection)	50
SI09, Install flashing beacons as advance warning (S.I.).....	50
SI10, Improve pavement friction (High Friction Surface Treatments).....	51
SI11, Install raised median on approaches (S.I.)	51
SI12PB, Install pedestrian median fencing on approaches	52
SI13, Create directional median openings to allow (and restrict) left-turns and U-turns (S.I.).....	52
SI14, Install right-turn lane (S.I.).....	53
SI15, Reduced Left-Turn Conflict Intersections (S.I.).....	54
SI16RA, Convert intersection to roundabout (from signal)	55
SI17RA, Convert intersection to compact roundabout (from signal)	56
SI18PB, Install pedestrian countdown signal heads	56
SI19PB, Install pedestrian crossing (S.I.).....	57
SI20PB, Pedestrian Scramble	57
SI21PB, Install advance stop bar before crosswalk (Bicycle Box)	58
SI22PB, Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	58
B.2 Intersection Countermeasures – Non-signalized.....	59
NS01NT, Add intersection lighting (NS.I.)	59
NS02, Convert to all-way STOP control (from 2-way or Yield control)	59
NS03, Install signals	60
NS04RA/NS05RA, Convert intersection to roundabout.....	60
NS06RA/NS07RA, Convert intersection to compact roundabout.....	61
NS08, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs.....	61
NS10, Install Flashing Beacons at Stop-Controlled Intersections	62
NS11, Install flashing beacons as advance warning (NS.I.)	63
NS12, Install transverse rumble strips on approaches.....	63
NS13, Improve sight distance to intersection (Clear Sight Triangles).....	64
NS14, Improve pavement friction (High Friction Surface Treatments)	64
NS15, Install splitter-islands on the minor road approaches.....	65
NS17, Create directional median openings to allow (and restrict) left-turns and u-turns (NS.I.).....	66
NS18, Reduced Left-Turn Conflict Intersections (NS.I.)	67
NS19, Install right-turn lane (NS.I.).....	68
NS20, Install left-turn lane (where no left-turn lane exists)	68
NS21PB, Install raised medians (refuge islands)	69
NS22PB, Install pedestrian crossing at uncontrolled locations (signs and markings only).....	69
NS23PB, Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)	70
NS24PB, Install Rectangular Rapid Flashing Beacon (RRFB).....	70
NS25PB, Install Pedestrian Signal (including Pedestrian Hybrid Beacon (HAWK))	71
B.3 Roadway Countermeasures	72
R01NT, Add Segment Lighting.....	72
R02, Remove or relocate fixed objects outside of Clear Recovery Zone.....	72
R03, Install Median Barrier	73
R04, Install Guardrail	73
R05, Install impact attenuators	74
R06, Flatten side slopes	74
R07, Flatten side slopes and remove guardrail	75
R08, Install raised median	75
R09, Install median (flush)	76
R10PB, Install pedestrian median fencing.....	76
R11, Install acceleration/ deceleration lanes	77

R12, Widen lane (initially less than 10 ft)	77
R13, Add two-way left-turn lane	78
R14, Road Diet (Reduce travel lanes and add a two way left-turn and bike lanes)	78
R15, Widen shoulder	79
R16, Curve Shoulder widening (Outside Only)	79
R17, Improve horizontal alignment (flatten curves)	80
R18, Flatten crest vertical curve	81
R19, Improve curve superelevation	81
R20, Convert from two-way to one-way traffic	82
R21, Improve pavement friction (High Friction Surface Treatments)	82
R22, Install/Upgrade signs with new fluorescent sheeting (regulatory or warning)	83
R23, Install chevron signs on horizontal curves	84
R24, Install curve advance warning signs	84
R25, Install curve advance warning signs (flashing beacon)	85
R26, Install dynamic/variable speed warning signs	85
R27, Install delineators, reflectors and/or object markers	86
R28, Install edge-lines and centerlines	87
R29, Install no-passing line	88
R30, Install centerline rumble strips/stripes	88
R31, Install edgeline rumble strips/stripes	89
R32, Speed Safety Cameras	89
R33PB, Install bike lanes	90
R34PB, Install Separated Bike Lanes	91
R35PB, Install sidewalk/pathway (to avoid walking along roadway)	92
R36PB, Install/upgrade pedestrian crossing (with enhanced safety features)	93
R37PB, Install raised pedestrian crossing	94
R38PB, Install Rectangular Rapid Flashing Beacon (RRFB)	94
R39AL, Install Animal Fencing	95
Appendix C: Summary of “Recommended Actions”	96
Appendix D: Benefit Cost Ratio (BCR) Calculations	100
Appendix E: Examples of Crash Data Collection and Analysis Techniques using TIMS	101
Appendix F: List of Abbreviations	102
Appendix G: References	103

1. Introduction and Purpose

The information in this document is geared towards local road managers and other practitioners with responsibility for operating and maintaining local roads, regardless of safety-specific highway training. The primary goal of this document is to provide an easy-to-use and comprehensive framework of the steps and analysis tools needed to identify locations with roadway safety issues and the appropriate countermeasures. For novice practitioners, the concepts and framework will be new, while experienced safety practitioners may find this manual to be mostly review. In both cases, the manual will provide the practitioners with a good understanding of how to complete a proactive safety analysis and ensure they have the best opportunity to secure HSIP safety funding during Caltrans calls-for-projects.

It's expected that novice and experienced practitioners will utilize this manual to help position their local agency to better compete in future Caltrans' calls-for-projects for safety programs. Inexperienced local roadway practitioners are also a target audience for this manual to gain exposure to the basic concepts that make up a proactive safety analysis of a local agency's roadway network.

The intent of this manual is to focus on key safety activities that every local agency should conduct on an annual basis (or as established by the agency) with the objective of reducing the number and severity of crashes within their jurisdiction. This manual defines this overall process as a "proactive safety analysis" approach to roadway safety. The Highway Safety Manual (HSM), documents a very similar process and refers to it as the "Roadway Safety Management Process." While the process in this document is similar and suggests the same primary elements, the HSM goes into significantly more detail, focuses more on scientific and mathematical equations behind the process, and intends to provide a comprehensive understanding of the overall processes to be applied by individual agencies across the nation. In contrast, this manual attempts to streamline the discussion; and make accommodations for the more novice safety practitioners, provide an adequate understanding of the process to complete an initial safety analysis of their roadway network, and instruct them on how to prepare applications that will compete well in Caltrans' statewide calls-for-projects. In general, this manual is intended to follow the research and methodologies presented in the HSM; however, to support Caltrans' statewide calls-for-projects process, it is important to note this manual deviates from the HSM in areas related to countermeasure selection and benefit / cost calculations. The logic behind these deviations is explained at the specific topic sections.

This manual is not intended to cover many of the day-to-day basics of traffic engineering including: maintain standard signage per the Manual on Uniform Traffic Control Devices (MUTCD); maintain sight distance (cut vegetation, remove parking); maintain a recovery zone; work with local traffic law enforcement; monitor collisions; address complaints; and manage litigation. These activities are understood to be critical elements of a local agency's traffic engineering responsibilities, but are not within the intended scope of this document.

1.1 California Local Roadway Safety Challenges and Opportunities

California's local roads are managed by more than 600 local agencies, including: cities, counties, and tribal governments. These local roads vary from flat multi-lane urban arterials to rural gravel roads in mountainous areas. California local agencies invest extensive resources on roadway safety every year, yet many roadways operate with outdated or insufficient safety features. A portion of these roadways even lack basic signing, pavement markings, alignment, and traffic control devices. Limited funding often prevents agencies from constructing safety projects, which can be expected. At the same time, the lack of safety data, design challenges, and lack of adequate training also hinder local agencies' accurate evaluation of their roadway network safety issues, which is more preventable.

Many small California local agencies are challenged by a lack of crash data. Without data, they have no way to identify High Crash Concentration Locations (HCCLs) or high risk roadway features, which can leave them "flying blind" with respect to the safety of their overall roadway network. Without data and analysis results, local officials may overreact when a tragic crash occurs, resulting in resources being spent in areas that will not maximize the overall application of safety funds. In conjunction with the collision mapping and analysis tools developed by UC Berkeley's SafeTREC, this document helps ensure all California local agencies have direct access to data on fatal and injury crashes within their jurisdictions and the analysis tools to effectively assess and prioritize future safety projects.

1.2 Safe System Approach

The Infrastructure Investment and Jobs Act (IIJA), aka Bipartisan Infrastructure Law (BIL), was signed into law on November 15, 2021. Under IIJA, the Highway Safety Improvement Program (HSIP), codified as Section 148 of Title 23, United States Code (23 U.S.C §148), is a core federal-aid program to States for the purpose of achieving a significant reduction in fatalities and serious injuries on all public roads. The IIJA emphasizes the "safe system approach":

Safe system approach means a roadway design that emphasizes minimizing the risk of injury or fatality to road users; and that (i) takes into consideration the possibility and likelihood of human error; (ii) accommodates human injury tolerance by taking into consideration likely accident types, resulting impact forces, and the ability of the human body to withstand impact forces; and (iii) takes into consideration vulnerable road users. (23 U.S.C. 148(a)(9)).

FHWA recognizes that the funding available through HSIP alone will not achieve the goal of zero fatalities on the Nation's roads. The Safe System approach addresses the safety of all road users, including those who walk, bike, drive, ride transit, and travel by other modes. It involves a paradigm shift to improve safety culture, increase collaboration across all safety stakeholders, and refocus transportation system design and operation on anticipating human mistakes and lessening impact forces

to reduce crash severity and save lives. FHWA encourages States to prioritize safety in all Federal-aid investments and in all appropriate projects, using not only HSIP funding but also other Federal-aid funding.

The IIJA emphasizes the importance of vulnerable road user (non-motorized road user) safety in the HSIP by adding a definition for vulnerable road users, creating a vulnerable road user special rule, and requiring States to develop and update a vulnerable road user safety assessment. All of these provisions address the increasing number of fatalities involving vulnerable road users on U.S. roads. It is imperative that States consider the needs of all road users as part of the HSIP. Investment in highway safety improvement projects that promote and improve safety for all road users, particularly vulnerable road users, aligns with the IIJA and will help Build a Better America. States and other funding recipients should prioritize projects that maximize the existing right-of-way for accommodation of non-motorized modes and transit options that increase safety, equity, accessibility, and connectivity. Projects that separate users in time and space, match vehicle speeds to the built environment, and increase visibility (e.g., lighting) advance implementation of a Safe System approach and improve safety for vulnerable road users.

1.3 The State's Role in Local Roadway Safety

The California Department of Transportation (Caltrans)—Division of Local Assistance is responsible for administering California's HSIP safety funding intended for local roadway safety improvements. This funding primarily comes to the state through two federal programs: Highway Safety Improvement Program (HSIP)—a federal-aid program focused on reducing fatalities and serious injuries on all public roads; and the Active Transportation Program (ATP)—a federal aid and state funded program focused on improving safety and the overall use of non-motorized, active transportation modes of travel. Under SAFETEA-LU, High Risk Rural Roads Program (HR3) was established to focus on addressing rural road safety needs. Under the Infrastructure Investment and Jobs Act (IIJA), it is now a 'special rule' under HSIP that if triggered, directs that a certain amount of HSIP funds will need to be allocated for those rural roads that meet the definition.

Caltrans' administration of these programs encompasses many responsibilities, including: establishing program guidance; reviewing applications for improvements on local roadways; ranking applications/projects on a statewide basis; selecting projects for funding based on the greatest potential for reducing fatalities and injuries; programming the selected projects in the Federal Statewide Transportation Improvement Program (FSTIP); and assisting with programming and delivery issues throughout the delivery of the local agency projects. One goal for developing this document is to improve Caltrans' overall data-driven approach to statewide project selection of safety projects and to maximize the long-term safety improvements across California. To show the relationship between Caltrans' project selection process and this manual, a diagram showing the HSIP Call-for-Projects Process is provided in Appendix A.

Many State Departments are also actively engaged in California's Strategic Highway Safety Plan (SHSP). Caltrans developed the SHSP in a cooperative process with local, State, federal, and private sector safety stakeholders. The SHSP is a data-driven, comprehensive plan that established statewide goals, objectives, integrated the five E's of traffic safety— engineering, enforcement, education, emergency response, and emerging technologies. This manual directly supports many of the emphasis areas of the California SHSP. Local agencies are encouraged to participate in ongoing SHSP update efforts and can find more information on the SHSP at the following website: <https://dot.ca.gov/programs/safety-programs/shsp>.

Local Roadway Safety Plan (LRSP) and Systemic Safety Analysis Report Program (SSARP)

The state-funded Systemic Safety Analysis Report Program (SSARP) was established in 2016. The intent of the SSARP was to assist local agencies in performing a collision analysis, identifying safety issues on their roadway networks, and developing a list of systemic low-cost countermeasures that can be used to prepare future HSIP and other safety program applications. Late 2019, the program was evolved to Local Roadway Safety Plan (LRSP) so that the focus is not just engineering solutions but also include safety improvements in other areas such as enforcement, Education and emergency response.

The state funding for the LRSP/SSARP program is made available by exchanging the local Highway Safety Improvement Program (HSIP) federal funds for State Highway Account (SHA) funds.

For more information, please visit the LRSP/SSARP webpage at <https://dot.ca.gov/programs/local-assistance/fed-and-state-programs/highway-safety-improvement-program/local-roadway-safety-plans>.

1.4 The Local Roadway Crash Problem

Approximately 3,000 people die in California traffic crashes every year, representing nearly 10% of all traffic fatalities in the United States. Fifty-seven percent of these fatalities occur on local roadways, while only forty-three percent occur on the California State Highway System. A comparison of rural and urban roadways shows that local rural roadways have fatality rates 2 to 3 times higher than urban roadways per vehicle miles traveled. Based on these statistics, the total annual cost of local roadway fatal crashes to California is over \$8 billion, while only \$120 million is available annually in HSIP safety funds.

These statistics demonstrate the large and complex safety issues facing California. Through the development of this document, Caltrans is striving to help local agencies proactively identify high risk roadway features, roadway network locations/corridors with the highest safety needs, and encourage them to select effective low-cost improvements, whenever appropriate.

1.5 Reactive vs. Proactive Safety Issue Identification

Safety issues are identified on local roadways through a wide range of approaches. Although no single approach works best for all local agencies, some are far more effective at improving long-term roadway safety. Many agencies, often larger ones, have staff whose full-time job is dedicated to roadway safety; allowing them to focus on safety initiatives, be trained in the latest safety research, and have access to safety analysis data, tools and procedures. These agencies often utilize a 'proactive' approach to analyze their roadway network and identify safety issues.

At the same time many agencies, often the smaller ones, lack the financial ability to dedicate large portions of their staff resources to analyze safety issues and their staff has limited access to roadway safety training, safety expertise, and the latest safety analysis tools and procedures. Unfortunately, this can often result in identifying their safety issues in 'reaction' to tragic events.

The following is a basic outline of the differences in proactive vs. reactive identification approaches used by local agencies:

Reactive Approach

For this document, an agency is considered to be utilizing a reactive approach to roadway safety if they primarily identify safety improvements in reaction to:

- Recent crashes triggering safety investigations
- Specific crash concentrations triggering safety investigations
- Stakeholder identification of locations with safety issues and requests for improvements
- New funding becoming available

Crash concentrations and crash trends may be missed if local agencies rely exclusively on these identifiers for their roadway safety effort. They may also miss many opportunities to effectively utilize low-cost, systemic type improvements. This document encourages local agencies to adopt a more proactive approach to their roadway safety.

Proactive Approach

An agency is considered to be using a proactive approach to roadway safety if they go beyond the elements of a reactive approach and identify safety improvements by analyzing the safety of their entire roadway network, in one of the following ways:

- One-time, network-wide safety analysis of their roadways driven by new source of funding.
- Routine safety analyses of the roadway network (Preferred Approach!)

Agencies with a proactive approach utilize both systemic and spot location improvements (as defined in section 1.5 below). Applying improvements systemically across an entire corridor or network allows an agency to proactively address locations that have not had crash concentrations in the past, but have

similar features as those currently experiencing high levels of crashes. In addition, even though a spot location improvement may be based on ‘past’ crashes, agencies making improvements based on countermeasures with proven crash reduction factors at their highest crash locations often have the best chance of proactively reducing future crashes.

This document encourages safety practitioners to pursue a proactive approach and routinely analyze the safety of their roadway networks to yield the best overall safety results.

1.6 Implementation Approaches

When an agency proactively identifies their safety issues throughout their roadway network, it is likely they will find high crash concentrations at intersections, roadway segments, and corridors. The safety practitioner should consider which implementation approach to utilize. Typical approaches include:

- Systemic Approach
- Spot Location Approach
- Comprehensive Approach incorporating human behavior issues

Each of these approaches has benefits and drawbacks. As Local agency practitioners identify their safety issues and analyze the data for crash patterns, they should be open to implementing a combination of these approaches, as documented in Sections 2 and 3 of this manual.

Systemic Approach

The Systemic Approach is primarily based on application of proven safety countermeasures at multiple crash locations, corridors, or geographic areas. Implementation of the Systemic Approach is generally based on ‘system-wide’ crash data with the estimates of the impacts being made in terms of benefits measured in traffic crash reduction and deployment cost. Identified locations experiencing high levels of crashes and locations with similar geometric features can be treated systemically with low-cost, proven safety countermeasures. *Note: The term “Systemic” used throughout in this manual is often exchanged with the term “Systematic” in many national safety documents and research studies. In general, safety practitioners will find these terms interchangeable. This manual uses “Systemic” to match the new HSM and the FHWA CMF Clearinghouse.*

Benefits of the Systemic Approach may include:

- Widespread effect. The Systemic Approach addresses safety issues at a large number of locations or on an entire local roadway network. It can also generate projects that combine HCCLs and locations with the potential for crashes and still have high Benefit to Cost (B/C) ratios. An example of this type of project could be upgrading pavement delineation and warning signs along a rural corridor: crashes may not have occurred on every curve or segment along the corridor, but all of the corridor’s pavement delineation and warning signs can be upgraded at one time. For urban applications, an example could be protecting the left-turn phase of signalized intersections with

existing left-turn pockets: severe crashes may not have occurred at each of the left-turn movements, but with minor changes to the signal hardware and signing, all or many of a city's unprotected left-turn phases can be protected with one safety project.

- Crash type prevention. By focusing on a predominant crash type, an agency can address locations that have not experienced significant numbers of these types of crashes, but have similar characteristics or conditions as existing HCCLs. The resulting B/C ratios for these types of projects will be less than if only HCCLs are included; but by using low-cost countermeasures and including as many high crash locations as possible, the resulting B/C ratios should still be high enough to allow agencies to proactively address locations that have not experienced high numbers of these types of crashes. For urban areas, projects improving pedestrian crossings can be good examples of the Systemic Approach. By applying the countermeasures systemically, the agency can often justify these projects based on relatively high B/C ratios, even though some of the improvement locations have not experienced enough crashes to yield moderate-to-high B/C ratios on their own.
- Cost-effectiveness. Implementing low-cost solutions across an entire system or corridor can be a more cost-effective approach to addressing system-wide safety issues. Even though this approach does not address all (or total) safety issues for a given location, the deployment of low-cost countermeasures often result in the highest overall safety benefit for an agency with limited safety funding. An example of this would be an agency choosing to install rumble stripes along an entire corridor for equal or less money than realigning a small portion the roadway to fix a single curve.
- Reduced data needs. The Systemic Approach can be used without a detailed crash history for specific locations, thereby reducing data needs. For example, consider a long rural corridor, which includes a section that passes through an Indian Reservation: Even if there is no documented crash data for the portion of the corridor that passes through the reservation, the entire limits can be treated with the same low-cost improvements. As long as there are sufficient past crashes documented for the entire corridor, the project will still have a reasonably high B/C ratio.

Drawbacks of the Systemic Approach may include:

- Justifying improvements can be difficult. Because this approach does not always address locations with a history of crashes and active stakeholders, it can be difficult to justify the improvements. The Systemic Approach will rarely include a recommendation for a large-scale safety improvement at a single location. Since large-scale projects usually garner attention from decision makers, the media, elected officials, and the general public, safety practitioners often need to make additional efforts to explain the Systemic Approach and its benefits to those groups. Safety practitioners can utilize the high B/C ratios of these systemic projects to convey their benefits compared to high-profile, single location projects with lower B/C ratios.

Spot Location Approach

The Spot Location Approach is typically based on an analysis of crash history to identify locations that have significantly higher crashes and treat them accordingly. It is important to practitioners to

understand that for many locations, safety issues can be complicated and sometimes the most appropriate fixes are not quick, easy or cheap.

Benefits of the Spot Location Approach may include:

- Focus on demonstrated needs. The Spot Location Approach focuses directly on locations with a history of crashes and specifically addresses those crashes. Intersection improvements are some of the most common spot location projects. Intersections tend to have higher concentrations of crashes resulting from opposing traffic movements. These high crash concentrations often require stand-alone improvements to adequately resolve the safety issues.
- Justifying improvements can be easy. Because this approach addresses locations with a history of crashes, it is usually easy to justify improvements. For urban areas, reconfiguring/ reconstructing an entire intersection can be a good example of an effective Spot Location Approach. Large urban intersections can have extremely high crash concentrations, making major changes to the intersection the only way to significantly reduce future crashes. With these types of scenarios, even the highest cost countermeasures can be cost effective.
- If low-cost countermeasures are used, this approach can prove very cost effective. The Spot Location Approach does not always have to include moderate or high cost improvements. It is often appropriate for local agencies to make low-cost improvements at one location at a time. Ongoing maintenance and development projects offer great opportunities for these low-cost improvements to be constructed with no additional expense to local agencies.

Drawbacks of the Spot Location Approach may include:

- Assumption that the past equals the future. This approach assumes locations with a history of crashes will continue to experience the same number and type of crashes in the future. When agencies do not account for the random nature of roadway crashes (i.e., Regression to the Mean), moderate to high cost projects can be erroneously justified. Practitioners can mitigate this by using 5 years of crash data when analyzing their roadways. In addition, significant changes to land use or roadway characteristics in or around proposed projects can either increase or decrease the expected number of future crashes.
- Minimal overall benefit to the roadway network. Some local agencies use this approach with medium and high cost improvements at locations which do not represent their worst high crash concentration locations. The result can be projects with low B/C ratios and overall safety benefits that are not as high as if they utilized a Systemic Approach. This drawback can be minimized by safety practitioners who analyze their entire roadway network, propose spot location fixes only at their highest crash locations, and utilize lower cost countermeasures wherever appropriate.

The Spot Location Approach to traffic safety is ideally implemented along with the Systemic Approach to provide the best combination of safety treatments. For instance, the Spot Location Approach can be applied at locations where low-cost countermeasures are not expected to be effective in significantly

reducing future crashes or at those locations that have had low-cost countermeasures previously installed systemically but, after an assessment, continue to show a higher-than-average crash rate.

Comprehensive Approach

The Comprehensive Approach introduces the concept of the “5 E’s of Safety”: Education, Enforcement, Engineering, Emergency Response and Emerging Technologies. This approach recognizes that not all locations can be addressed solely by infrastructure improvements. Incorporating the “5 E’s of Safety” is often required to achieve marked improvement in roadway safety. For instance, some roadway segments will be identified for which targeted enforcement is an appropriate countermeasure. Some of the most common violations are speeding, failure-to-yield, 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 deploy visible targeted enforcement to reduce the potential for future driving violations and related crashes. To improve safety, education and outreach efforts can also be used to supplement enforcement efforts. Enforcement and/or education can also be effectively utilized as short-term ways to address high crash locations, until the recommended infrastructure project can be implemented.

1.7 Our “Safety Challenge” for Local Agencies

Caltrans, FHWA and Safe Transportation Research and Education Center (SafeTREC) “challenge” local agencies to initially commit one or more days to understanding and applying the concepts and tools outlined in this manual. Experienced safety practitioners working in agencies currently using a proactive approach can quickly review the topics in the manual and consider/test some of the new tools (e.g., TIMS) identified within it. In contrast, novice safety practitioners may need several days to better understand the underlying concepts in this manual to be able to complete the basic elements of a proactive safety analysis of their roadway network. In these situations, the room for knowledge growth, internal process improvements, and expected safety benefits will be even greater, which should more than offset the additional time invested.

By utilizing this simple framework for identifying, analyzing and implementing a proactive approach for improving safety on their roadways, practitioners will have a better understanding of their agencies’ unique safety issues, the proven low-cost countermeasures that can reduce crashes, and the existing and future funding to implement the projects. This small investment of time will help local agencies achieve significant reductions in future fatalities, injuries and overall crashes. We believe these local agencies may also gain the added unexpected benefit of improved job satisfaction of those involved, as there are few more rewarding tasks than knowing that your efforts will result in future roadway users arriving safely at their destination instead of becoming statistics.

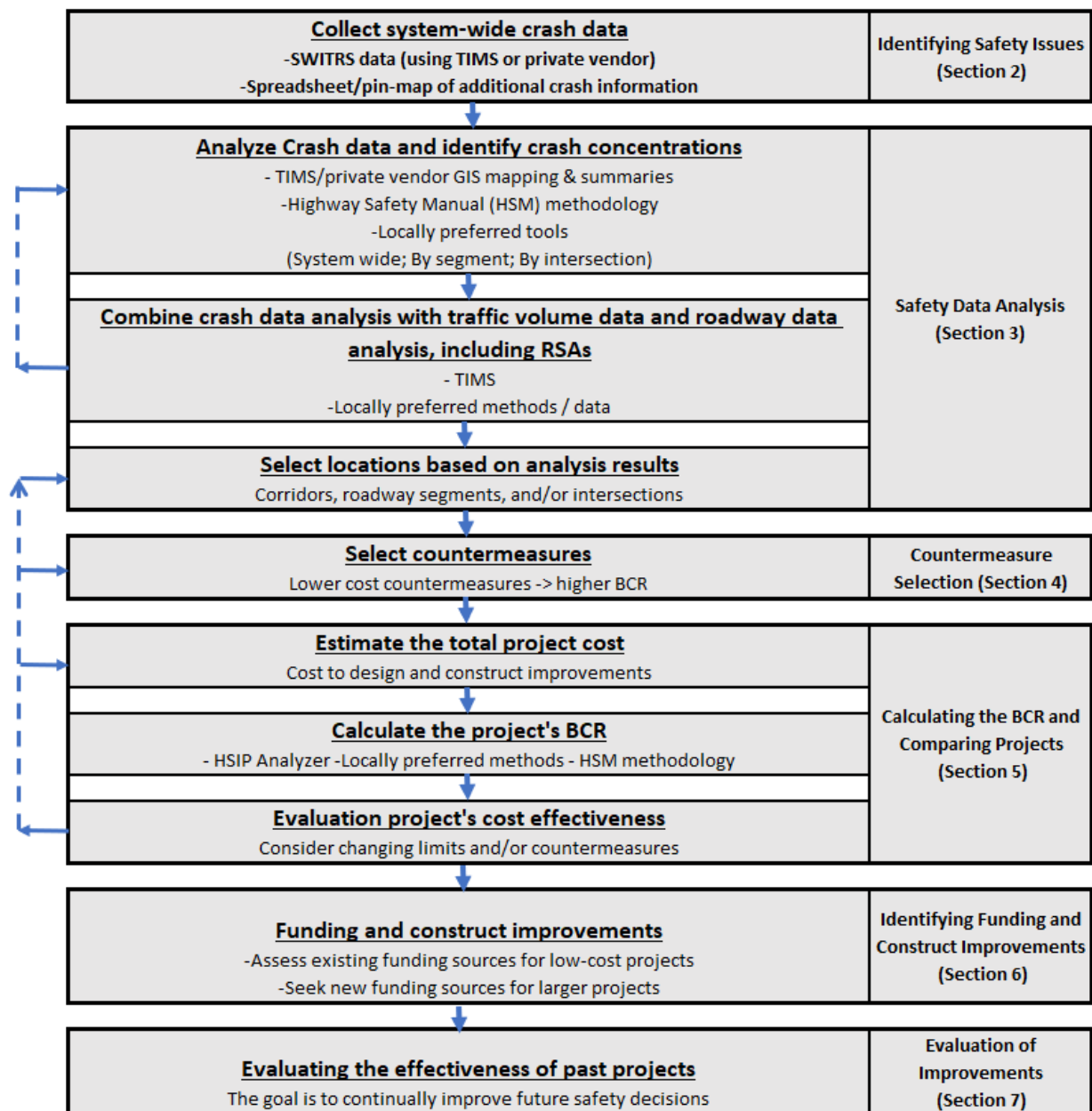
1.8 Summary of information in this Document

This document provides information on effectively identifying California’s local roadway safety issues and the countermeasures that address them, ultimately leading to the effective implementation of safety projects that improve safety on local roadways. The document is not intended to be a comprehensive guide for roadway design and improvement or the only guide local agencies utilize for their safety analysis of their roadways.

Caltrans also expects this document will directly support its efforts in selecting local agency safety projects. The expectation is that as local agencies throughout the state utilize the proactive safety analysis approach outlined in this document, their applications for HSIP and ATP projects will include lower cost improvements at locations with the highest safety needs. This will improve Caltrans’ data-driven approach to statewide project selection of safety projects and maximize the safety benefits across California.

The proactive safety analysis framework incorporated in this document is summarized in Figure 1.

Figure 1: Local Roadway Safety: Proactive Safety Analysis Approach



The above flowchart illustrates how each of the individual sections of this document work together to make up a proactive safety analysis approach. These sections are briefly outlined below:

Section 2 of this manual provides an overview of the types of data to collect for the identification of roadway safety issues. It discusses sources of crash data and how they can be used.

Section 3 summarizes the types of analyses that can be conducted to determine what roadway countermeasures should be implemented. This section is the link between the data (Section 2) and the selection of appropriate countermeasures (Section 4). It provides definitions and examples of the qualitative and quantitative factors that should be considered when evaluating roadway safety issues.

Section 4 provides a description of selected countermeasures that have been shown to improve safety on local roads. It includes a basic set of strategies to implement at locations experiencing a history of crashes and their corresponding crash modification factors (CMF). The interrelationship between CMFs and Crash Reduction Factors (CRFs) are defined and used interchangeably throughout this document.

Section 5 defines a methodology for calculating a B/C ratio for a potential safety project. It includes sources for estimating projected costs and benefits and the specific values/formulas Caltrans uses for its statewide evaluations of HSIP projects. This section also discusses the potential value in reevaluating projects' overall cost effectiveness at this point in the safety analysis, including: refining the project's costs and/or changing the mix of countermeasures and locations.

Section 6 identifies existing and new funding opportunities for safety projects that local agencies should be considering. This section also briefly discusses some unique project development issues and strategies for safety projects as they proceed through design and construction.

Section 7 presents the process to complete an evaluation of installed treatments. After the countermeasures are installed, assessing their effectiveness will provide valuable information and can help determine which countermeasures should continue to be installed on other roadways to make them safer as well as those that should be limited or discontinued.

Appendix A presents a flowchart of the HSIP Call-for-projects application process. This flowchart demonstrates how this document interacts with Caltrans Call-for-projects.

Appendix B contains Detailed Tables of countermeasures discussed in Section 4. This table includes detailed information about each countermeasure, including: where to use, why it works, general qualities (time, cost and effectiveness), crash type(s) addressed, crash reduction factor, and specific values for use in Caltrans HSIP calls-for-projects.

Appendix C includes a summary of "recommended actions" involved in a proactive safety analysis.

Appendix D contains the formulas used to calculate the B/C ratio of safety projects.

Appendix E presents TIMS tutorials that are available to assist local agencies in completing Caltrans call-for-projects application requirements and attachments. The tutorials include examples for Spot Location projects and systemic projects.

Appendix F presents a list of the abbreviations used in this document.

Appendix G presents a list of references.

2. Identifying Safety Issues

This document encourages local agency safety practitioners to proactively analyze their roadway networks with the intention of yielding the best overall safety benefits. When utilizing a proactive safety analysis approach, practitioners need to consider a wide range of data sources to get an overall picture of the safety needs.

There are a number of information sources that can be accessed to get a clearer picture of the roadway safety issues on the roadway network. These can be formal or informal sources, including:

Formal sources:

- State and local crash databases
- SafeTREC's TIMS website (or locally preferred mapping software)
- Law enforcement crash reports and citations
- Field assessments

Informal sources:

- Observational information from road maintenance crews, law enforcement, and first responders
- Citizen notification of safety concerns

Examining crash history will help practitioners identify locations with an existing roadway safety problem, and also identify locations that are susceptible to future roadway crashes. In addition to location identification, this data can provide information regarding crash causation that ultimately provides insight into identifying potentially effective countermeasures.

Emphasis on data-driven decisions is indicative of reliability and efficiency. The more reliable the data, the more likely the decisions regarding safety improvements will be effective. However, detailed, reliable crash data are not available in all areas. Under this circumstance, the practitioner should use the best available information and engineering judgment to make the best decisions. In an effort to mitigate these situations, UC Berkeley SafeTREC has developed the TIMS website, which includes GIS mapping tools to access fatal and injury crashes statewide. This site is now available to all California local agencies. See Section 2.2 for more details on TIMS.

It is generally accepted that at least 3 years, or preferably 5 years, of crash data be used for an analysis; additional years of crash data can provide better information. For low volume roadways and/or when only severe crashes are analyzed, more years of crash data may be necessary for an effective evaluation. Due to the randomness of crashes in a given year, a multi-year average of safety data will smooth outlier years of relatively high or low roadway crash rates. This concept is commonly referred to as "regression to the mean" and is critical in helping safety practitioners avoid making wrong inferences as they analyze their roadway network data. An example of this is an agency making a high-cost improvement at

a location in response to one or two tragic crashes. The Highway Safety Manual (HSM) includes more details on regression to the mean and methods to reduce the random nature of crashes.

There are some circumstances where additional years of crash data may not always be advantageous. First, it's important for practitioners to recognize that as more years of crash data are used, they need to consider changes in traffic patterns, physical infrastructure, land use, and demographics that may affect their projection of future crashes. Second, if practitioners only focus on many years of past crash data, they could miss emerging safety issues and crash trends. For these reasons, if practitioners sense one or more factors affecting crashes have changed or may be changing, they should consider looking at the crash data for the specific area on a yearly or 3-year moving average to expose any changes and crash trends that are occurring.

2.1 State and Local Crash Databases

California has a central repository for storing crash data called SWITRS, which stands for Statewide Integrated Traffic Records System. SWITRS is a comprehensive data source for doing roadway safety analysis that includes almost all public roads in the database except tribal roads which are currently not included. SWITRS information is available to California's local agencies, although many agencies have had difficulty identifying, extracting and utilizing their crash records from SWITRS. All California local agencies, especially those that currently have difficulty accessing and mapping crash data, are encouraged to utilize the SafeTREC TIMS website to access and map SWITRS data.

This document focuses on the SafeTREC TIMS website as a tool to access and map SWITRS data because TIMS is free to local agencies and the general public. At the same time, this document also acknowledges that TIMS currently does not offer some of the features currently available in some of the commercially available crash analysis software packages. For this reason, local agencies are encouraged to try TIMS, but they should not feel obligated to make a switch if they prefer using their vendor supplied crash analysis software. See section 2.2 for more details on TIMS.

Many agencies utilize one of several crash analysis software packages (e.g., Crossroads) to manage and access their crash records. Their use can be costly, but allows local road practitioners to identify locations with multiple roadway crashes, conduct an analysis that can produce predominant crash types, and identify associated roadway features that may have contributed. One drawback to agencies managing and updating their own individual databases is that the statewide database may become outdated and may not include the updated crash details like geo-coded locations. Agencies that manage and update their own individual databases are encouraged to share all updates, including any geo-coding information, with the SWITRS data managers at the California Highway Patrol. This will allow updated geo-coding and other crash features to be available on a statewide basis.

Recommended Action: Obtain at least 5 years of network-wide crash data to identify local roads that have a history of roadway crashes. This data will be used to identify predominant roadway crash locations, crash types and other common characteristics.

As practitioners gather formal and informal information relating to the safety of their roadway network, they are encouraged to develop one or more separate spreadsheets and/or pin-maps to help track and manage this data. (These spreadsheets/pin-maps should capture much of the data gathered in each of Sections 2.1 through 2.8). A spreadsheet and/or pin-map can serve as a database to help an agency identify locations and crash characteristics representing their greatest safety issues and guide them in identifying appropriate countermeasures.

The following spreadsheet is offered as an example, but each agency's spreadsheet should be reformatted to include data to meet their needs. Agencies should consider printing their spreadsheets on 'legal' or '11 x 17' paper for easy review of their data.

	General Information		Crash Information			Evaluation / Action		
Location & Date	Source/Type of information	Safety Issue/Problem	Nature of Crashes	Time of Day	Weather/Traffic Conditions	Staff Evaluation	Recommend Action	Resolution
1) Intersection "X"								
1) Feb 7, 2010	Input from law enforcement	Clearance Intervals need adjustment	V1-WB V2-SB Side-swipe	21:30	Dry, Night, Free-flowing	R. Jones 2/26/10	Increase all-red interval	Completed 2/26/10
1) Mar 9, 2010	Citizen Complaint	Ped Crossing unsafe due to RT turns	N/A	N/A	N/A	R. Jones 3/12/10	No RT on Red (Need study)	
2) Intersection "Y"								
2)								
3) Roadway Segment (PM 5.3 to PM 7.8)								
PM 6.4 to 6.8 Sep 29, 2011	Maintenance data	Extensive skid marks. Speed of Travel?	General WB: ROR	N/A	Dry Free-flowing	J. Smith 10/1/11	High Friction Overlay	Preparing HSIP App.
PM 7.1 Jan 5, 2011	Input from law enforcement	Stop Sign missing	N/A	N/A	N/A	J. Smith 1/5/11	Informed Maintenance	New sign 1/5/11

An example of a pin-map, which could be modified to capture much of the data gathered in Section 2, is shown in the following section as part of the TIMS output.

2.2 Transportation Injury Mapping System (TIMS)

The Safe Transportation Research and Education Center (SafeTREC) at the University of California, Berkeley, has developed a powerful website with tools for California's local agencies to gather data for their safety analyses. Their Transportation Injury Mapping System (TIMS) website provides safety practitioners with California crash data (SWITRS, i.e. Statewide Integrated Traffic Records System) and collision mapping and analysis tools. California local agencies are encouraged to utilize TIMS at: <https://tims.berkeley.edu/>

Site Features:

- Applications to query map and download geo-referenced SWITRS data.
- Summary tables based on data included in SWITRS individual crash reports. These summary tables can be generated based on specified data fields or spatial limits.
- Virtual field review by connecting the crash location to Google maps and Google Street View, allowing the examination of the existing roadway infrastructure and dimensions.
- A 'Help Tab' that provides step-by-step instructions.

Please note that SafeTREC is not able to incorporate all SWITRS crashes into TIMS due to poor crash location descriptions in the crash reports. Currently, TIMS includes the majority of California fatal and injury crashes but does not include Property Damage Only collisions.

Recommended Action: Consider augmenting your local agency's data collection approach with information available using the suite of TIMS tools. The TIMS tools (and/or purchased software applications) can help the safety practitioner complete or assist with each of the actions in Sections 2.1 through 2.8. This website includes several tutorials specifically designed to support the individual sections of this document. Local practitioners may find the TIMS output files as a great starting point to build their tracking spreadsheet discussed in the recommendation of Section 2.1.

2.3 Law Enforcement Crash Reports

Both State and local law enforcement officials can be an important source of roadway crash data. The actual law enforcement crash reports can be valuable in identifying the location and contributing circumstances to roadway crashes (e.g., did the highway hardware and features operate as intended: end treatment worked, no barrier in the passenger compartment, pavement not slippery when wet, signs visible, signal timing, etc.). The following variables can and should be extracted and compiled from the crash reports:

- Location
- Date and time
- Crash type
- Crash severity
- Weather conditions
- Lighting conditions
- Sequence of events and most harmful events
- Contributing circumstances
- Driver Variables: age of driver, DUIs, use of seat belt, etc.

Similar to the crash database, the information in the crash reports can be used to assist in the identification of potential infrastructure and non-infrastructure safety treatments and the deployment approach.

Recommended Action: Develop a working relationship with law enforcement officials responsible for enforcement and crash investigations. This could foster a partnership where sharing crash reports and safety information on problem roadway segments becomes an everyday occurrence. Practitioners with limited access to crash data are encouraged to use TIMS to assess the local crash report data.

2.4 Observational Information

Law enforcement officers, local agency maintenance crews, and Emergency Medical Services personnel can serve as valuable resources to identify problem areas. Since they travel extensively on local roads, they can continuously monitor roads for actual or potential problems (e.g., poor delineation, fixed objects near the roadway, missing signs, signs of vehicles leaving the road). Law enforcement observations of driver behavior and roadway elements can provide valuable information to the local road agency. Additionally, law enforcement officers are sometimes aware of problem areas based on citations written, even if crashes related to the violations have not yet occurred. Road maintenance crews may keep logs of their work, including sign and guardrail replacements, debris removal, and edge drop-off repairs. These logs can provide supplemental information about crashes and HCCLs that may not have been reported to law enforcement. Finally, Emergency Medical Service Crash Reports can provide an entirely different perspectives and set of observations relating to crash occurrences.

Information obtained from road maintenance crews, law enforcement officers, and Emergency Medical Services personnel can help support all three methods of implementation approaches: Spot Location treatments, systemic deployments, and the Comprehensive Approach. Often, traffic violations such as speeding and impaired driving lend themselves to education and enforcement solutions to address these behaviors and supplement the intended infrastructure countermeasures.

Recommended Action: Add information received from law enforcement, road maintenance crew, and Emergency Medical Service observations to the agency's tracking spreadsheet and/or pin-maps. Develop a system for maintenance crews to report and record observed roadway safety issues and a mechanism to address them.

2.5 Public Notifications

Occasionally, when unsafe situations are observed, local citizens may notify the local government by email, letter, telephone, or at a public meeting. Information identifying safety issues on local roads may also come from community or regional newspapers, newsletters, correspondence, and from local homeowner and neighborhood associations. These sources can serve as indicators that a safety issue may exist and may warrant further review and analysis to determine the extent of the issues. Citizen reports can be tracked along with official crash data; however, safety practitioners should not regard these reports as factual, unless proven by other methods. Local safety databases should only contain objective and verifiable data.

Recommended Action: Review and summarize information received from these sources, identifying segments or corridors with multiple notifications and record the locations, dates, and nature of the problem that are cited. Add information received from public notifications to tracking spreadsheets and/or pin-maps once confirmed.

2.6 Roadway Data and Devices

It is also valuable to obtain information about the existing roadway infrastructure. Currently, many local agencies have few of their roadway characteristics in a database. For these agencies, the establishment of a roadway database could be a long-term goal. The following roadway characteristics are often used to assist practitioners in safety analyses of roadway segments:

- Roadway surface (dirt, aggregate, asphalt, concrete)
- Roadway geometry (horizontal, vertical, flat)
- Lane information (number, width)
- Shoulder information (width, type)
- Median (type, width)
- Traffic control devices present (signs, pavement marking, signals, rumble stripes etc.)

- Roadside safety hardware (e.g., guardrail, crash cushions, drainage structures)

The TIMS site, described in Section 2.2, can provide safety practitioners with much of this roadway data virtually by using Google Maps and Google Street View. By utilizing TIMS (and/or private for-profit vendors), safety practitioners can save hours and even days of driving during the initial steps in the safety analysis of their network. Once agencies start to define individual safety projects for funding and future construction, actual field reviews are needed to ensure a complete understanding of the project location and context.

As local practitioners gather information about their existing roadway infrastructure, they need to determine whether it complies with the minimum standards for signs, breakaway supports, signals, pavement markings, protective barriers, etc. Practitioners should use the most current *California - Manual on Uniform Traffic Control Devices (CA-MUTCD)*, which provides the minimum standard requirements for traffic control devices on all public streets, highways, bikeways, and private roads open to public travel.⁶ In addition to ensuring compliance with the MUTCD, geometric standards for sight distance, curve radius, and intersection skew angle and roadway standards for lane width, shoulder width, clear recovery zone, and super-elevation should also be evaluated.

Roadway information can be combined with crash data to help local practitioners identify appropriate locations and treatments to improve safety. For example, if a local rural segment is experiencing a high number of horizontal curve-related crashes, analysis of the inventory of roadway elements could reveal that the roadway does not have sufficient signage installed in advance of many of those curves to give motorists warning of the pending change in roadway geometry.

Recommended Action: Identify and track roadway characteristics for the intersections, roadway segments, and corridors, including compliance with the minimum standards. At a minimum, this should be done for locations being considered for safety improvements, but ideally agencies would establish an extensive database of roadway data to help them proactively identify high risk roadway features.

2.7 Exposure Data

The number of crashes can sometimes provide misleading information about the most appropriate locations for treatment. Introducing exposure data helps to create a more effective comparison of locations. Exposure data provides a common metric to the crash data so roadway segments and intersections can be compared more appropriately, helping local agencies prioritize their potential safety improvements.

The most common type of exposure data used on roadway segments is traffic volume. Ideally, volume would be broken down by pedestrians, bicycles, cars, motorcycles, and large trucks. A count of the number of vehicles and non-motorized users can provide information for comparison. For example, if

two roadway segments have the same number of crashes but different traffic volumes, the segment with fewer vehicles (i.e., less exposure) will have a higher crash rate, meaning that vehicles were more likely to experience a crash along that roadway segment. In situations where traffic volume is not available, segment length or population can serve as an effective exposure element for comparison.

Recommended Action: Consider the availability of exposure data and track it along with the other crash data to help prioritize potential locations for safety improvements.

2.8 Field Assessments and Road Safety Audits

Local road practitioners should always consider conducting field assessments in conjunction with their collection of crash data to help identify problem locations. An assessment can be as informal as driving, walking or virtually viewing the road network looking for evidence of roadway crashes. Ideally, informal field assessments are to be performed by multidisciplinary teams that include a traffic safety expert, law enforcement personnel, and others. The team can visit several sites and document evidence of crashes or deficiencies on the roadway or roadside, including: damaged trees or fences, skid marks, ruts on the shoulder, car parts on the shoulder, and/or pavement drop-offs. This information, along with observations of actual driver-behavior, can be used to develop recommendations for improvement.

Field reviews can also be more formalized such as in conducting a Road Safety Audit (RSA). A RSA is a formal safety performance examination of an existing or future road by an independent, multidisciplinary team. The team examines and reports on existing or potential road safety issues and identifies opportunities for safety improvements for all road users. Agencies considering RSAs for the first time are encouraged to consider requesting support from FHWA. For more information on FHWA's free RSA support, go to their website at: <http://safety.fhwa.dot.gov/rsa/>.

Informal field assessments and more formal RSAs provide an opportunity for local safety practitioners to gather and summarize all of the information sources discussed in Section 2. They can also be used to identify potential project delivery obstacles. The field assessments/RSAs should identify major environmental, right-of-way, infrastructure, and operational issues that need to be considered when applying countermeasures.

Recommended Action: Consider completing formal or informal field assessments and RSAs at certain locations to help ensure all relevant information is collected and available for the safety practitioners to complete their safety analysis and identify the most appropriate countermeasures. It's recommended that local agencies develop simple straightforward criteria on when one of these will be undertaken. The information gathered during the assessments should be added to the agency's tracking spreadsheet, as discussed in section 2.

3. Safety Data Analysis

Proactive safety analysis will assist in making informed decisions on the type, deployment levels, and locations for safety countermeasures. This builds on the previous discussions on information sources that identify safety issues. 'Safety Data Analysis' is one of the most critical steps in an agency's overall proactive safety analysis approach. Ideally, agencies regularly analyze the safety data for their entire roadway networks to identify and prioritize the locations with the most severe safety issues. This step is often skipped by agencies reacting to a recent tragic crash and the corresponding public outcry, which may leave their most critical safety locations undetected.

As agencies analyze their safety data, they will need to select the implementation approach that most effectively address the safety issues identified; Systemic Approach, Spot Location Approach, Comprehensive Approach, or a combination of these approaches. For example, if a high number of crashes are occurring at a particular curve or along a short segment of roadway, a spot treatment may be appropriate. However, systemic treatment of multiple locations experiencing similar crash types may be necessary and most beneficial for reducing overall fatalities and injuries. These implementation approaches were described in Section 1.5. With all of the approaches, safety practitioners should be looking for patterns in the crash data and not just the total number of crashes. These patterns include: types of crashes, severity of crashes, mode of travel, pavement conditions, time of day, etc. Identifying and analyzing the patterns in the crash data will help ensure the most appropriate countermeasure is selected and the safety problems are effectively addressed.

3.1 Quantitative Analysis

Crash data analysis is used to determine the extent of the roadway safety issues, the priority for application of scarce resources, and the selection of appropriate countermeasures. The two main quantitative analysis methods for roadway crashes are crash frequency and crash rate.

Crash Frequency

Crash frequency is defined as the number of crashes occurring within a determined study area. A practitioner can determine crash volumes using methods discussed in Section 2, including: State crash database (SWITRS), TIMS, local agency crash databases, law enforcement crash reports, pin-maps, etc. The practitioner should analyze the data to identify locations and crash characteristics with the highest frequency. There are numerous methods to assist practitioners in this process. Each agency will have their own preferred methods for initially selecting their top priority locations. The following are a few examples of the methods used to determine Crash Frequency:

- Summarize the crashes by attributes such as type, severity and location to identify patterns in the crash data and the most significant problem locations.
 - Top 10 (or 20) lists of intersections and roadway segments. It is common to weight more severe crashes higher in this process.

- Spatially display the sites on a pin-map or a GIS software package.
 - For small or rural agencies with lower volume roadways, network-wide pin-maps may be all that is needed to identify the highest priority locations.
- Develop collision diagrams showing the direction of movement of vehicles, types of crashes, and pedestrians involved in the crashes.

As stated earlier, this manual acknowledges many local agency safety practitioners may have their preferred methods for completing these analyses. For those agencies that do not and for those willing to try something new, Caltrans recommends using the TIMS website along with the processes outlined in this document to complete these analyses.

Once the crash frequency information is collected and displayed, the practitioner can complete a methodical analysis by geographic area, route, or a cluster analysis to determine which locations have experienced a high or moderate level of crashes. The resulting crash information can be further analyzed for recurring patterns or events. As agencies consider their locations with high levels of crashes, they should understand the overall random nature of crashes and the concept of “regression to the mean”, as discussed in Section 2. Otherwise, if the natural variations in crash occurrence are not accounted for, a site might be selected for study when the number of crashes is randomly high, or overlooked when the number of crashes is randomly low.

Crash Rate

Crash rate analysis can be a useful tool to determine how a specific roadway or segment compares with similar roadway types on the network. A simple count of the number of crashes can be inadequate when comparing multiple roadways of varying lengths and/or traffic volume. Local agencies are also encouraged to compare their crashes with those occurring in similar areas around the state; doing so will help in determining just how severe the number and types of crashes are in the local area. When working with limited budgets, Crash Rates are often used to prioritize locations for safety improvements that will achieve the greatest safety benefits with limited resources. Where traffic volume data is unavailable, other information can be used to provide exposure information. One often-used factor is the length of the roadway segment on each route studied. Comparing the number of roadway crashes per mile or per intersection can help an agency identify potential opportunities to improve safety. The FHWA Roadway Departure Safety and Intersection Safety manuals include the following formulas for calculating crash rates on roadway segments and intersections:

The crash rate for crashes on a roadway is calculated as:

$$R = (C \times 100,000,000) / (V \times 365 \times N \times L)$$

Where:

R = Crash rate for the road segment expressed as crashes per 100 million vehicle-miles of travel,

C = Total number of crashes in the study period

V = Traffic volumes using Average Annual Daily Traffic (AADT) volumes

N = Number of years of data

L = Length of the roadway segment in miles

The crash rate for crashes at an intersection is calculated as:

$$R = (1,000,000 \times C) / (365 \times N \times V)$$

Where:

R = Crash rate for the intersection expressed as crashes per million entering vehicles (MEV)

C = Total number of intersection-related crashes in the study period

N = Number of years of data

V = Traffic volumes entering the intersection daily

Similar to Crash Frequency, there are numerous methods for local safety practitioners to utilize Crash Rate in their safety data analysis and each will have their own preferred methods for initially selecting their top priority locations. The following are a few examples:

- Top 10 (or 20) lists of roadway segments with the highest crashes in relationship to roadway length, traffic volumes, and/or population density.
- Top 10 (or 20) lists of intersections, sorted by crash rate.
- Top 10 (or 20) lists of the highest volume intersections, sorted by crash frequency or rate.

Even though crash frequency and crash rate are helpful for local agency safety practitioners to effectively rank their most critical locations for improvements, the lack of reliable statewide traffic volumes for all roadway types precludes Caltrans from using the crash rate methodology in their statewide project scoring and ranking processes for the HSIP (discussed in more detail in Section 5).

Recommended Action: Complete a quantitative analysis of the roadway data using both Crash Frequency and Crash Rate methodologies. Safety practitioners should look for patterns in the crash data, including: types of crashes, severity of crashes, mode of travel, pavement conditions, roadway characteristics, time of day, intersection control, etc.

3.2 Qualitative Analysis

Qualitative analysis considers the physical characteristics of the roadway network, through the examination of maps, photographs, and field assessments. Certain roadway infrastructure characteristics relate to design standard and compliance issues and should continually be identified and upgraded on a network-wide basis (e.g., signing and pavement delineation characteristics relating to CA-MUTCD compliance as discussed in more detail below). Other roadway characteristics are more important as they relate to locations with high crash frequencies and rates (e.g., well defined pedestrian

paths crossing the roadway or a high number of utility poles/fixed objects adjacent to the edge of travel way). All of these characteristics should be accounted for in an agency's proactive safety analysis.

Ensuring Compliance with CA-MUTCD and Design Standards

It is important for local agencies to continually evaluate their roadways for compliance with the minimum safety standards. The CA-MUTCD provides the minimum standard requirements for traffic control devices on all public streets, highways, bikeways, and private roads open to public travel. In addition to ensuring compliance with the CA-MUTCD, geometric standards should be evaluated as they relate to sight distance, curve radius, and intersection skew angle and roadway standards for lane width, shoulder width, clear recovery zone, and super-elevation. Many local agencies have their own specific roadway design standards, while others rely on Caltrans' Highway Design Manual⁷, FHWA's "Green Book" policy manual⁸ and PEDSAFE guide⁹, and AASHTO's Roadside Design Guide¹⁰. If the traffic control devices or roadway geometry are not in compliance, appropriate devices/countermeasures should be installed. Non-compliance is an important consideration that can affect road safety and may have liability implications for a jurisdiction. Using CA-MUTCD compliant devices results in uniformity among California roadways and serves to meet road user expectations.

Field Assessments

While the qualitative analysis of compliance issues should continually occur on a network-wide basis, a qualitative analysis should also occur for each of the locations and corridors identified as a result of a 'Quantitative Analysis'. The consideration of roadway infrastructure characteristics in conjunction with crash frequency or crash rate gives a more complete picture of overall safety and should be used in an agency's identification and prioritization process for locations needing safety improvements. The qualitative assessment of HCCLs can be completed through the examination of maps and photographs, but the importance of in-field assessments by multi-disciplinary teams should not be underestimated. In some cases, field reviews of all potential project locations may not be practical, so safety practitioners are encouraged to utilize internet-mapping tools to view maps and photographs and virtually visit these sites from their offices.

Actual field visits or RSAs can be done at the highest priority locations before or during the countermeasure selection process. In many cases, field assessments are often the only way for practitioners to identify potential countermeasure implementation and project delivery obstacles. Without in-field assessments, right-of-way, infrastructure, and operational constraints can be overlooked, including: sensitive environmental resources (widening may not be feasible next to wetlands), roadway users (rumble strips may not be feasible on roadways with high bicycle volumes and narrow shoulders), or nearby roadway stakeholders (flashing beacons may be problematic for adjacent residents.) Assessments can provide critical information for local practitioners as they prioritize their crash locations and select countermeasures with the greatest potential for cost effective deployment.

Recommended Action: Incorporate qualitative analysis elements into agency's proactive analysis approach. Consider completing field assessments and RSAs to identify locations with roadway

infrastructure characteristics that relate to both compliance issues and high crash frequencies/rates. As part of field assessments, common roadway and crash characteristics should be identified for the potential systemic deployment of countermeasures. Rather than reviewing all crash sites individually, agencies may find the use of Internet mapping tools offers significant time savings. For agencies without a preferred virtual field review method, the SafeTREC TIMS website automatically links the SWITRS crash locations to Google Maps and Google Street View.

Caltrans recommends all agencies complete both quantitative and qualitative analyses before starting their applications for HSIP program funding. The findings from these analyses should be documented in spreadsheets and/or pin-maps similar to the ones discussed in Section 2.

4. Countermeasure Selection

Once locations and crash problems are identified as illustrated in Sections 2 and 3, the safety practitioners will need to select the set of proposed safety improvements to reduce the likelihood of future crashes. Individual elements of standard safety improvements are referred to as countermeasures and most countermeasures have corresponding Crash Modification Factors (CMFs).

When applied correctly, CMFs can help agencies identify the expected safety impacts of installing various countermeasures to reduce crashes. CMFs are multiplicative factors used to estimate the expected number of crashes after implementing a given countermeasure at a specific site (the lower the CMF, the greater the expected reduction in crashes). Crash Reduction Factors (CRFs) are directly connected to the CMFs and are another indication of the effectiveness of a particular treatment, measured by the percentage of crashes the countermeasure is expected to reduce. The CRF for a countermeasure is defined mathematically as $(1 - \text{CMF})$ (the higher the CRF, the greater the expected reduction in crashes). *NOTE: Given that CRF values can be more intuitive when analyzing roadways for potential “reductions” in crashes; this document shows CRF values in the countermeasure tables. The terms CMFs and CRFs are used interchangeably throughout the text of this section and in other sections of this document.*

In an effort to stretch the limited highway safety funding, local transportation agencies are encouraged to identify and implement the optimal combination of countermeasures to achieve the greatest benefits. Combined with crash cost data and project cost information, CRFs can help safety practitioners compare the B/C ratio of multiple countermeasures and then choose the most appropriate application for their proposed safety improvement projects.

As agencies consider the overall scope/cost of their projects, they also need to consider the number of locations to which each countermeasure may be applied in order to maximize the B/C ratio and the overall effectiveness of their limited safety funding. For HCCLs with varying causes, the Spot Location Approach may be the most appropriate. In contrast, the Systemic Approach should be considered where a high proportion of similar crash types tend to occur at locations that share common geometric or operational elements. In these situations, installing the same low-cost safety countermeasure at multiple locations can increase the cost effectiveness of the safety improvement, allowing an increased number of treatments to be applied.

It is important to note that there are many safety issues and corresponding countermeasures that are more “maintenance” in nature (e.g., visibility issues relating to the need for brush clearing and roadway departure issues relating to the need to replace shoulder backing). As these issues are identified when investigating crash locations, it’s expected that the local safety practitioners would take the necessary steps to remedy the situation in the short-term. For this reason, most of the common maintenance-type safety countermeasures are not included in this document.

4.1 Selecting Countermeasures and Crash Modification Factors / Crash Reduction Factors

Selecting an appropriate countermeasure and corresponding CMF is similar to choosing the right tool for a job. In some cases, a countermeasure and CMF may not be perfect, but will still work well enough to get the job done by providing a reasonable estimation of the countermeasure's effect. In other cases, using an improper countermeasure or CMF may do more harm than good. Applying a CMF that does not fit a specific situation may give a false sense of the countermeasure's safety effectiveness and may result in an increased safety problem.

The Federal Highway Administration (FHWA) is leading a concerted effort to develop information on CMFs and makes it available to State and local agencies to assist with highway safety planning. The CMF Clearinghouse, a free online database introduced in 2009 and accessible at <http://www.cmfclearinghouse.org/>, details the varying quality and reliability of CMFs available to transportation professionals.

FHWA has identified three main considerations to assure appropriate selection of CMFs for a given countermeasure: the **availability** of relevant CMFs, the **applicability** of available CMFs, and the **quality** of applicable CMFs. The following sections detail these considerations and describe how Caltrans recommended CRF and service life values meet these criteria.

Availability: The availability of a CMF that applies to a specific situation depends on whether research has been conducted to determine the safety effects of a particular countermeasure or combination of countermeasures, and whether researchers have documented it. The CMF Clearinghouse contains more than 2,900 CMFs and receives quarterly updates to include the latest research.

At this point, Caltrans has established a small subset of 82 countermeasures and a single CRF for each of these countermeasures that must be used when submitting applications for Caltrans statewide calls-for-projects. This methodology allows for a statewide data-driven process that facilitates a fair and accurate comparison of project applications. (The reason for limiting the number of countermeasures is further explained below under “applicability”).

Applicability: In general, once a local safety practitioner determines that one or more CMFs exist for a specific countermeasure, the next step is to determine which CMF is the most applicable. Applicability depends on how closely the CMF represents the situation to which it will be applied. Safety practitioners should evaluate the potentially applicable CMFs, eliminating any that are not appropriate for the situation. Practitioners should only choose the most appropriate CMFs for their specific project based on factors including but not limited to: urban areas vs. rural areas; low vs. high traffic volumes; 2-lane vs. 6-lane roadways; individual vs. combination treatments; signalized vs. non-signalized intersections; and minor crashes vs. fatal crashes. If practitioners choose to use a CMF outside the range of applicability, the safety effect will likely be over or underestimated.

The mix of countermeasures and CRFs included in this document is intended to meet Caltrans' goal for a data-driven award process for local agencies to follow that allows for a fair and accurate comparison of project applications. Where possible and appropriate, the CRF value intended for use in statewide calls-for-projects is based on research studies that specifically established the CRF to be used for 'all' project areas, roadway types, and traffic volumes. Where not all applicability factors have already been established by prior research, Caltrans worked closely with FHWA to approximate CRFs for countermeasures often utilized by local agencies.

Quality: Often a search of the CMF Clearing House results in multiple CMFs for the same countermeasure. A practitioner needs to examine the quality of each CMF. The quality of a CMF can vary greatly depending on several factors associated with the process of developing the CMF. The primary factors that determine the quality of a CMF are the study design, sample size, standard error, potential bias, and data source. The CMF Clearinghouse provides a star rating for each based on a scale of 1 to 5, where 5 indicates the highest quality. The most reliable CMFs in the HSM are indicated with a bold font.

Wherever possible, the CRFs included in this document are based on research that has a CMF Clearinghouse star rating of 3 or more. For countermeasures that do not have corresponding research of a star rating of 3 or more but were deemed important to provide flexibility to local practitioners, Caltrans worked closely with FHWA to establish CRFs based on the best available research.

4.2 List of Countermeasures

The list of countermeasures discussed in this section is not an all-inclusive list, and only includes those available in the Caltrans' HSIP Cycle 12 Call-for-projects. Only thoroughly researched countermeasures with a readiness to be applied by local agencies on a statewide basis are utilized. In addition, the California Local HSIP program places further restrictions on the eligibility of some countermeasures to meet the most critical needs on California local roadways. Practitioners are encouraged to utilize the FHWA CMF Clearinghouse for a more comprehensive list as they establish their local agency specific set of proposed improvements and prioritize their projects.

The countermeasures listed in the following three tables 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, as the consideration of non-motorized travel is important for all roadway classifications and locations. The countermeasures included in these tables are also used in the HSIP Analyzer. When selecting countermeasures and CMFs to apply to their specific safety needs, local agency safety practitioners should consider the **availability**, **applicability**, and **quality** of CMFs, as discussed in section 4.1.

Only Crash Types, CRFs, Expected Lives, and HSIP Funding Eligibility of the countermeasures for use in Caltrans local HSIP program are provided in this section. Fields in the countermeasure tables are:

- **Crash Types** - “All”, “P & B” (Pedestrian and Bicycle), “Night”, “Emergency Vehicle”, or “Animal”.
- **CRF** - Crash Reduction Factor used for HSIP calls-for-projects.
- **Expected Life** - 10 years or 20 years.
- **Funding Eligibility** – the maximum HSIP reimbursement ratio for HSIP Cycle 12 Call-for-projects.
 - Eighty-one (85) countermeasures: 90%
 - One (1) countermeasure: 50% (CM No. SI03: Improve signal timing, as this CM will improve the signal operation rather than merely the safety.)
- **Systemic Approach Opportunity** - Opportunity to Implement Using a Systemic Approach: “Very High”, “High”, “Medium” or “Low”.

The list of countermeasures presented in this section is intended to be a quick-reference summary. Appendix B of this manual provides more details on each of these countermeasures including Where to use, Why it works, General Qualities (Time, Cost and Effectiveness), and information from FHWA CMF Clearinghouse (Crash Types Addressed and range of Crash Reduction Factor).

Recommended Action: At this point, agencies should use all information and results obtained by completing the actions in Sections 2, 3 and 4 to select the appropriate countermeasures for their HCCLs and systemic improvements. As novice safety practitioners select countermeasures, they must realize that a reasonable level of traffic ‘engineering judgment’ is required and that this manual should not be used as a simple cheat-sheet for preparing and submitting applications for funding.

Table 1. Countermeasures for Signalized Intersections

No.	Type	Countermeasure Name	Crash Type	CRF	Expected Life (Years)	HSIP Funding Eligibility	Systemic Approach Opportunity?
SI01NT	Lighting	Add intersection lighting (S.I.)	Night	40%	20	90%	Medium
SI02	Signal Mod.	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	All	15%	10	90%	Very High
SI03	Signal Mod.	Improve signal timing (coordination, phases, red, yellow, or operation)	All	15%	10	50%	Very High
SI04EV	Signal Mod.	Install emergency vehicle pre-emption systems	Emergency Vehicle	70%	10	90%	High
SI05	Signal Mod.	Install left-turn lane and add turn phase (signal has no left-turn lane or phase before)	All	55%	20	90%	Low
SI06	Signal Mod.	Provide protected left turn phase (left turn lane already exists)	All	30%	20	90%	High
SI07	Signal Mod.	Convert signal to mast arm (from pedestal-mounted)	All	30%	20	90%	Medium
SI08	Operation/ Warning	Install raised pavement markers and striping (Through Intersection)	All	10%	10	90%	Very High
SI09	Operation/ Warning	Install flashing beacons as advance warning (S.I.)	All	30%	10	90%	Medium
SI10	Operation/ Warning	Improve pavement friction (High Friction Surface Treatments)	All	55%	10	90%	Medium
SI11	Geometric Mod.	Install raised median on approaches (S.I.)	All	25%	20	90%	Medium
SI12PB	Geometric Mod.	Install pedestrian median fencing on approaches	P & B	35%	20	90%	Low
SI13	Geometric Mod.	Create directional median openings to allow (and restrict) left-turns and u-turns (S.I.)	All	50%	20	90%	Medium
SI14	Geometric Mod.	Install right - turn lane (S.I.)	All	15%	20	90%	Medium
SI15	Geometric Mod.	Reduced Left-Turn Conflict Intersections (S.I.)	All	50%	20	90%	Medium
SI16RA	Geometric Mod.	Convert intersection to roundabout (from signal)	All	Varies	20	90%	Low
SI17RA	Geometric Mod.	Convert intersection to compact roundabout (from signal)	All	Varies	20	90%	Low
SI18PB	Ped and Bike	Install pedestrian countdown signal heads	P & B	25%	20	90%	Very High
SI19PB	Ped and Bike	Install pedestrian crossing (S.I.)	P & B	25%	20	90%	High
SI20PB	Ped and Bike	Pedestrian Scramble	P & B	40%	20	90%	High
SI21PB	Ped and Bike	Install advance stop bar before crosswalk (Bicycle Box)	P & B	15%	10	90%	Very High
SI22PB	Ped and Bike	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	P & B	60%	10	90%	Very High

Table 2. Countermeasures for Non-Signalized Intersections

No.	Type	Countermeasure Name	Crash Type	CRF	Expected Life (Years)	HSIP Funding Eligibility	Systemic Approach Opportunity?
NS01NT	Lighting	Add intersection lighting (NS.I.)	Night	40%	20	90%	Medium
NS02	Control	Convert to all-way STOP control (from 2-way or Yield control)	All	50%	10	90%	High
NS03	Control	Install signals	All	30%	20	90%	Low
NS04RA	Control	Convert intersection to roundabout (from all way stop)	All	Varies	20	90%	Low
NS05RA	Control	Convert intersection to roundabout (from stop or yield control on minor road)	All	Varies	20	90%	Low
NS06RA	Control	Convert intersection to compact roundabout (from all way stop)	All	Varies	20	90%	Medium
NS07RA	Control	Convert intersection to compact roundabout (from stop or yield control on minor road)	All	Varies	20	90%	Medium
NS08	Operation/ Warning	Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs	All	15%	10	90%	Very High
NS09	Operation/ Warning	Upgrade intersection pavement markings (NS.I.)	All	25%	10	90%	Very High
NS10	Operation/ Warning	Install Flashing Beacons at Stop-Controlled Intersections	All	15%	10	90%	High
NS11	Operation/ Warning	Install flashing beacons as advance warning (NS.I.)	All	30%	10	90%	High
NS12	Operation/ Warning	Install transverse rumble strips on approaches	All	20%	10	90%	High
NS13	Operation/ Warning	Improve sight distance to intersection (Clear Sight Triangles)	All	20%	10	90%	High
NS14	Operation/ Warning	Improve pavement friction (High Friction Surface Treatments)	All	55%	10	90%	Medium
NS15	Geometric Mod.	Install splitter-islands on the minor road approaches	All	40%	20	90%	Medium
NS16	Geometric Mod.	Install raised median on approaches (NS.I.)	All	25%	20	90%	Medium
NS17	Geometric Mod.	Create directional median openings to allow (and restrict) left-turns and u-turns (NS.I.)	All	50%	20	90%	Medium
NS18	Geometric Mod.	Reduced Left-Turn Conflict Intersections (NS.I.)	All	50%	20	90%	Medium
NS19	Geometric Mod.	Install right-turn lane (NS.I.)	All	20%	20	90%	Low
NS20	Geometric Mod.	Install left-turn lane (where no left-turn lane exists)	All	35%	20	90%	Low
NS21PB	Ped and Bike	Install raised medians / refuge islands (NS.I.)	P & B	45%	20	90%	Medium
NS22PB	Ped and Bike	Install pedestrian crossing at uncontrolled locations (new signs and markings only)	P & B	25%	10	90%	High
NS23PB	Ped and Bike	Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)	P & B	35%	20	90%	Medium
NS24PB	Ped and Bike	Install Rectangular Rapid Flashing Beacon (RRFB)	P & B	35%	20	90%	Medium
NS25PB	Ped and Bike	Install Pedestrian Signal (including Pedestrian Hybrid Beacon (HAWK))	P & B	55%	20	90%	Low

Table 3. Countermeasures for Roadways

No.	Type	Countermeasure Name	Crash Type	CRF	Expected Life (Years)	HSIP Funding Eligibility	Systemic Approach Opportunity?
R01NT	Lighting	Add segment lighting	Night	35%	20	90%	Medium
R02	Remove/ Shield Obstacles	Remove or relocate fixed objects outside of Clear Recovery Zone	All	35%	20	90%	High
R03	Remove/ Shield Obstacles	Install Median Barrier	All	25%	20	90%	Medium
R04	Remove/ Shield Obstacles	Install Guardrail	All	25%	20	90%	High
R05	Remove/ Shield Obstacles	Install impact attenuators	All	25%	10	90%	High
R06	Remove/ Shield Obstacles	Flatten side slopes	All	30%	20	90%	Medium
R07	Remove/ Shield Obstacles	Flatten side slopes and remove guardrail	All	40%	20	90%	Medium
R08	Geometric Mod.	Install raised median	All	25%	20	90%	Medium
R09	Geometric Mod.	Install median (flush)	All	15%	20	90%	Medium
R10PB	Geometric Mod.	Install pedestrian median fencing on approaches	P & B	35%	20	90%	Low
R11	Geometric Mod.	Install acceleration/ deceleration lanes	All	25%	20	90%	Low
R12	Geometric Mod.	Widen lane (initially less than 10 ft)	All	25%	20	90%	Medium
R13	Geometric Mod.	Add two-way left-turn lane	All	30%	20	90%	Medium
R14	Geometric Mod.	Road Diet (Reduce travel lanes and add a two way left-turn and bike lanes)	All	35%	20	90%	Medium
R15	Geometric Mod.	Widen shoulder	All	30%	20	90%	Medium
R16	Geometric Mod.	Curve Shoulder widening (Outside Only)	All	45%	20	90%	Medium
R17	Geometric Mod.	Improve horizontal alignment (flatten curves)	All	50%	20	90%	Low
R18	Geometric Mod.	Flatten crest vertical curve	All	25%	20	90%	Low
R19	Geometric Mod.	Improve curve superelevation	All	45%	20	90%	Medium
R20	Geometric Mod.	Convert from two-way to one-way traffic	All	35%	20	90%	Medium
R21	Geometric Mod.	Improve pavement friction (High Friction Surface Treatments)	All	55%	10	90%	High

Table 3. Countermeasures for Roadways (Continued)

No.	Type	Countermeasure Name	Crash Type	CRF	Expected Life (Years)	HSIP Funding Eligibility	Systemic Approach Opportunity?
R22	Operation/ Warning	Install/Upgrade signs with new fluorescent sheeting (regulatory or warning)	All	15%	10	90%	Very High
R23	Operation/ Warning	Install chevron signs on horizontal curves	All	40%	10	90%	Very High
R24	Operation/ Warning	Install curve advance warning signs	All	25%	10	90%	Very High
R25	Operation/ Warning	Install curve advance warning signs (flashing beacon)	All	30%	10	90%	High
R26	Operation/ Warning	Install dynamic/variable speed warning signs	All	30%	10	90%	High
R27	Operation/ Warning	Install delineators, reflectors and/or object markers	All	15%	10	90%	Very High
R28	Operation/ Warning	Install edge-lines and centerlines	All	25%	10	90%	Very High
R29	Operation/ Warning	Install no-passing line	All	45%	10	90%	Very High
R30	Operation/ Warning	Install centerline rumble strips/strips	All	20%	10	90%	High
R31	Operation/ Warning	Install edgeline rumble strips/strips	All	15%	10	90%	High
R32	Operation/ Warning	Speed Safety Cameras	All	20%	10	90%	High
R33PB	Ped and Bike	Install bike lanes	P & B	35%	20	90%	High
R34PB	Ped and Bike	Install Separated Bike Lanes	P & B	45%	20	90%	High
R35PB	Ped and Bike	Install sidewalk/pathway (to avoid walking along roadway)	P & B	80%	20	90%	Medium
R36PB	Ped and Bike	Install/upgrade pedestrian crossing (with enhanced safety features)	P & B	35%	20	90%	Medium
R37PB	Ped and Bike	Install raised pedestrian crossing	P & B	35%	20	90%	Medium
R38PB	Ped and Bike	Install Rectangular Rapid Flashing Beacon (RRFB)	P & B	35%	20	90%	Medium
R39AL	Animal	Install animal fencing	Animal	80%	20	90%	Medium

5. Calculating the B/C Ratio and Comparing Projects

Practitioners need to consider the expected B/C ratio of their proposed projects. This is an important step in a proactive safety analysis process because it provides two key pieces of information: First, it defines the cost effectiveness of the proposed projects; and second, it gives the safety practitioner a means to help prioritize their safety projects both inside the agency's traffic safety section and against other proposed operational and maintenance projects competing for funding.

5.1 Estimate the Benefit of Implementing Proposed Improvements

Sections 2 through 4 provide the practitioner all the information needed to calculate the expected 'Benefit' of the proposed safety projects. The resulting expected benefit value is derived by applying the proposed countermeasures and corresponding CMFs to the expected crashes. It is of critical importance for the practitioner to understand that misapplication of a CMF will lead to misinformed decisions. Four main factors need to be considered when applying countermeasures and CMFs to calculate the expected benefit value: (1) how to estimate the number of expected crashes without treatment, (2) how to apply CMFs by type and severity, (3) how to apply multiple CMFs if multiple treatments are to be included in the same project, and (4) how to apply a benefit value by crash severity. The following text explains how these factors affect the expected benefit value in more detail.

Estimating expected crashes without treatment: Before applying CMFs, local safety practitioners first need to select countermeasures and CMFs. The CMF is applied to the expected safety performance (expected crashes) without any treatment in order to estimate the expected crashes with the treatment. The reduction in expected crashes multiplied by the expected costs per each crash gives the practitioner the expected benefit.

As mentioned earlier in this manual, the random nature of roadway crashes suggests that over time the number of crashes at any particular locations will change. This concept is known as "regression to the mean" and it gives rise to the concern that a site might be selected for study when the crashes are at a randomly high fluctuation, or overlooked from study when the site is at a randomly low fluctuation. The HSM presents several methods for estimating the expected safety performance of a roadway or intersection including the Empirical Bayes method, which combines observed information from the site of interest with information from similar sites to estimate the expected crashes without treatment. Another common way to minimize the impact of regression to the mean is to increase the number of years of crash data being analyzed.

For statewide calls-for-projects, Caltrans strives to ensure that all projects are fairly ranked based on a consistent statewide approach. Given this, Caltrans has avoided using methodology requiring agencies to mathematically adjust their crash data (e.g., Empirical Bayes) and instead has opted to use 3 to 5 years of "observed crashes" in estimating "expected crashes."

Applying CMFs by type and severity: Section 4.1 of this manual discusses the application of CMFs and the need for them to represent the situation to which they will be applied. It also stresses the need for

practitioners to choose the most appropriate CMFs for their specific project. In many circumstances, estimating the change in crashes by type and severity is useful; however, local safety practitioners only can use this approach when CMFs exist for the specific crash types and severities in question. If practitioners choose to use a CMF outside the range of applicability, the safety effect may be over- or underestimated. (For example: past research relating to installing a channelized left turn lane, has estimated CMFs as high as 68% for Right-Angle crashes of all severities and as low as 11% for Rear-End crashes with severities of only fatal and injury).

Applying multiple CMFs: In real-world scenarios, transportation agencies commonly install more than one countermeasure per project as part of their safety improvement program. This leads to the question, "What is the safety effect of the combined countermeasures?" The calculation methods that Transportation agencies use include: applying the CMF for the single countermeasure expected to achieve the greatest reduction, applying CMFs separately by crash type and summing them to get a project-level effect, and applying CMFs based on a review of crash patterns, etc. Regardless of the specific method employed, "engineering judgment" is required when combining multiple CMFs and it is important for local agencies to apply their method consistently throughout their analysis to ensure a fair comparison of projects.

One common practice is to assume that CMFs are multiplicative when they are applied to the same set of crash data. In other words, each successive countermeasure will achieve an additional benefit when implemented in combination with other countermeasures. The multiplicative method is a common, generally accepted method and is presented in the HSM and in the CMF Clearinghouse. This method is also used in the HSIP calls-for-projects.

To allow agencies maximum flexibility in combining countermeasures and locations into a single project while ensuring all projects can be consistently ranked on a statewide basis, Caltrans only allows up to three (3) individual countermeasures can be utilized in the B/C ratio for a project location site. The CMFs are multiplicative if there are multiple countermeasures, i.e. each successive countermeasure will achieve an additional benefit based on the remainder of the crashes after the effect of the prior countermeasures, not the original number of the crashes.

More information on these requirements and procedures are provided in the documents (Application Form Instructions, etc.) for each call-for-projects.

Applying benefit value by crash severity: The last step in estimating the overall benefit of a proposed improvement project is to multiply the expected reduction in crashes by a generally accepted value for the "cost" of crashes. In other words, the expected "benefit" value for a project is actually the expected "reduction in costs" value from reducing future crashes. There are many sources for the costs of crashes (e.g., HSM, FHWA & National Safety Council) and some of the sources vary widely depending on how they account for the economic value of a life and when the numbers were last updated.

When calculating the “benefit” to be used in calculating an improvement’s B/C ratio, it is important for the practitioner to consider whether a total benefit value for the “life” of the improvement is needed or if the benefit value should be annualized (i.e., benefit per year). Whichever method is used to calculate the overall cost of the improvements must also be used for calculating the benefit.

Caltrans has currently chosen to use published Cost-of-Crash values from the first edition of the HSM and increase the values by 4% annually. These values may be updated in the future, when updated cost-of-crash values are published by FHWA or another national source. The specific values for each of the crash severities and the formulas used to calculate the total benefit are shown in Appendix D.

Recommended Action: Prepare Total Benefit estimates for the proposed projects being evaluated in the proactive safety analysis.

5.2 Estimate the Cost of Implementing Proposed Improvements

After calculating the expected benefit of the proposed safety projects, the next step for the practitioner is to develop an estimate of the Total Project Costs. These costs need to include both the construction costs and the project development and administration costs. The most common approach to estimating construction costs is through an “Engineer’s Cost Estimate.” A Template for Detailed Engineer’s Estimate and Cost Breakdown by Countermeasures is included in the HSIP Analyzer. When calculating the administration costs for a project, the complexity of the improvements must be accounted for: Low-cost countermeasures, typically used in the Systemic Approach, often have minimal environmental and right-of-way impacts and require minimal design effort. In contrast, many medium to high cost improvements tend to have greater impacts to the environment and right-of-way and require significant design efforts. It’s crucial to account for these differences to accurately determine the true B/C ratio of the projects and prioritize them correctly.

When an agency is initially evaluating several potential locations and countermeasures as part of their proactive safety analysis or in preparing for Caltrans call-for-projects, they should consider first using rough ‘ballpark’ cost estimates using previous projects that had similar scope, if possible. Ballpark cost estimates can allow the practitioner to quickly establish B/C ratios for all of their potential projects and identify the projects with high cost effectiveness and with a reasonable chance of receiving HSIP funding in a Caltrans call-for-projects.

Recommended Action: Prepare ‘Total Project Cost’ estimates for the proposed projects being evaluated in the proactive safety analysis.

5.3 Calculate the B/C Ratio

In general, the B/C ratio is calculated by taking a project’s overall benefit (as calculated in Section 5.1) and dividing it by the project’s overall cost (as calculated in Section 5.2). There are, however, several

methods and input-factors available for calculating a project's B/C ratio and practitioners may want to consider other methods as defined in the HSM.

Based on Caltrans' need for a fair, data-driven, statewide project selection process for HSIP call-for-projects, Caltrans requires the B/C ratio for all applications to be completed using the same process. Applicants must utilize the HSIP Analyzer to calculate the B/C ratio of the project. Additional details and formulas included in the calculation are included in this document as Appendix D.

Recommended Action: Calculate the B/C ratio for each of the proposed projects being evaluated in the proactive safety analysis.

5.4 Compare B/C Ratios and Consider the Need to Reevaluate Project Elements

By implementing a comprehensive proactive safety analysis approach, agencies will likely identify more potential safety projects than they can fund and deliver. It will be important for an agency to prioritize their projects internally before funding is sought. It is not uncommon for projects to have a B/C ratio as low as 0.1 or as high as 100. Once the relative cost effectiveness of an agency's potential projects has been established, the projects with low to mid-ranged B/C ratios should be reassessed. Projects with very low initial B/C ratios may be dropped while projects with low to mid ranged B/C ratios may be redefined by changing the limits of the proposed improvements to focus on higher crash locations or incorporating lower-cost countermeasures. This reiterative process is illustrated in Figure 1 in Section 1 of this document.

At the conclusion of this step, the local agency should have several potential safety projects ready to move into the project development and construction phases. Ideally, there will be a variety of low cost safety projects and potentially a few higher cost roadway reconstruction projects. How each local agency prioritizes their list of safety improvements will vary, but projects with the highest B/C ratios should generally have a high overall priority. It should be understood that available funding will play a key role in local agency prioritization (e.g., higher-cost projects may have to wait for funding to become available while low-cost improvements with lower B/C ratios can be constructed with in-house maintenance crews), but in the goal of maximizing overall safety benefits, the role of politics and public influence should be minimized.

Recommended Action: Compare, reevaluate, and prioritize the potential safety projects. Consider changing the project limits to maximize the number of fatal and injury crashes addressed within the limits. Consider lower cost countermeasures in areas where high and medium cost countermeasures resulted in low B/C ratios.

6. Identifying Funding and Construct Improvements

Funding strategies for implementing safety projects need to vary as widely as local agency's roadway types, project costs, and proposed improvements. At this point in the proactive safety analysis process, local agencies should have several potential safety projects ready to move into the project development and construction phases. There are likely a wide range of 'approaches' to fund each of these projects. This section of the document discusses some of the most common approaches.

6.1 Existing Funding for Low-cost Countermeasures

For projects utilizing low-cost countermeasures, the total project cost may be low enough that the agency can construct the project using its existing roadway funding by utilizing the ongoing activities of their roadway maintenance staff and equipment. Other low-cost projects (e.g., overlays, sealcoats, drainage, signing, and striping projects) may be more important to incorporate into larger maintenance projects. It is common for agencies to have 1-, 5-, and 10-year plans for making these standard maintenance improvements. With upfront planning and coordination between agency staff, the low-cost safety projects identified through the proactive safety analysis can be incorporated with minimal costs to an agency's maintenance program. Maximizing the cost effectiveness of the program may even allow the transportation managers to justify increasing the funding for their overall roadway maintenance program.

In addition to their maintenance program, transportation managers should also strategically seek out planned capital improvement and development projects that can incorporate low and medium cost countermeasures identified in their safety analysis. Local agencies may also find opportunities to partner with private enterprises and insurance companies to fund special safety projects that further both organizations' strategic goals.

Recommended Action: Survey planned maintenance, developer and capital projects to determine whether they overlap any of the proposed safety projects. Where projects overlap, leverage the existing funding sources to include safety countermeasures.

6.2 HSIP and Other Funding Sources

In addition to the HSIP Program, the Division of Local Assistance's web site includes several other Caltrans administered funding programs:

<https://dot.ca.gov/programs/local-assistance>

Recommended Action: Consider all potential funding opportunities to incorporate the identified safety countermeasures.

6.3 Project Development and Construction Considerations

In general, roadway safety projects don't garner the same level of attention from decision makers, media, elected officials, and the general public, that large operational and development-driven projects do. As a result, local safety practitioners and project sponsors often find their projects have difficulty in competing for the agencies' limited project delivery resources. Establishing and implementing a comprehensive safety analysis process can assist safety practitioners in delivering their safety programs in many ways, including:

- Credibility and awareness to individual projects and delivery schedules.
- Increased stakeholders tracking and delivery of a project when low-cost improvements are incorporated into ongoing maintenance and capital projects.
- An increased focus on low-cost countermeasures typically corresponds to projects with less environmental, right-of-way and other impacts; resulting in projects that have streamlined project delivery processes and short construction schedules.

Recommended Action: Safety practitioners should follow their safety projects all the way through the project delivery and construction process. In addition, they should establish a safety program delivery plan that brings awareness and support to the expedited delivery of safety projects. Where possible, safety practitioners should involve the media and even consider having their own program intended to "toot their own safety-horn."

7. Evaluation of Improvements

Evaluation of the effectiveness of roadway treatments following installation should be used to guide future decisions regarding roadway countermeasures. Field reviews should also be conducted shortly after the project is completed to insure the project is operating as intended.

A record of crash history and countermeasure installation forms the foundation for assessing how well the implemented strategies have performed. An important database to maintain is a current list of installed countermeasures with documented “when/where/why” information. Periodic assessments will provide the necessary information to make informed decisions on whether each countermeasure contributed to an increase in safety, whether the countermeasure could or should be installed at other locations, and which factors may have contributed to each countermeasure’s success.

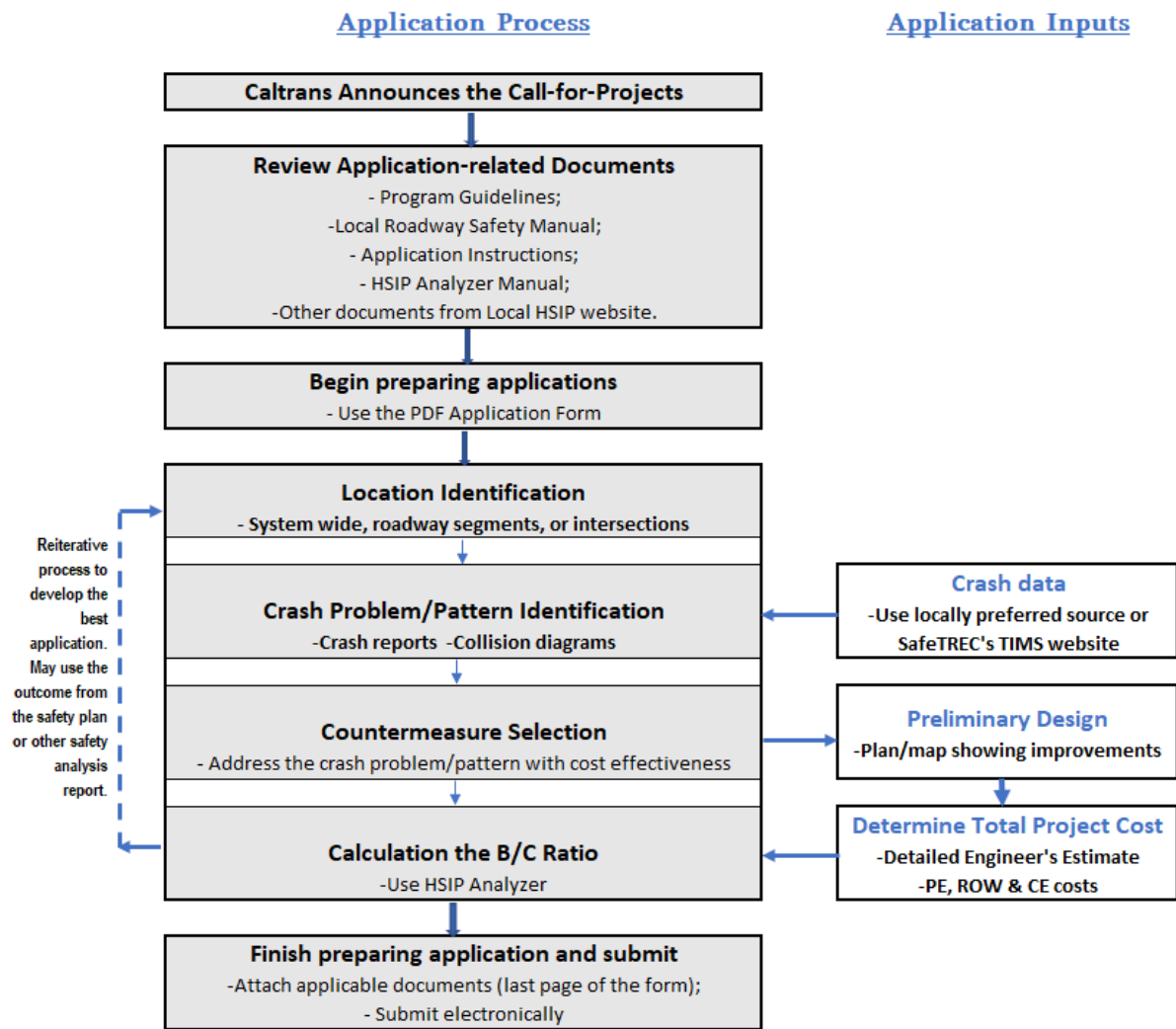
In order to perform the assessment, it is necessary to collect the required information for a certain period after strategies have been deployed at the locations. The time period varies, but whenever possible, 3 to 5 years is recommended to reduce the effects of the random nature of roadway crashes (i.e., Regression to the Mean). The information required may consist of public input and complaints, police reports, observations from maintenance crews, and local and State crash data.

It is important to keep the list of safety installations up-to-date since it will serve as a record of countermeasure deployment history (see table below for an example). By using this type of system, assessment dates can be scheduled to review the crashes and other pertinent information on segments where roadway countermeasures have been installed. Making “after” assessments will inform the practitioner on the effectiveness of past improvements and can provide data to help justify the value of continuing and expanding the local agency’s safety program in the future.

Location	Type of Countermeasure Installed	Date Installed	Crashes Before (Duration and Severity)	Crashes After (Duration and Severity)	Comments

Recommended Action: Develop a spreadsheet or database to track future safety project installations and record 3 or more years of “before” and “after” crash information at those locations. Once safety countermeasures are constructed, schedule and track assessment dates to ensure they happen.

Appendix A: HSIP Call-for-Projects Application Process



Appendix B: Detailed Tables of Countermeasures

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

<https://www.cmfclearinghouse.org/>

NCHRP Report 500 Series: Volumes 4, 5, 6, 7, 10, 12, 13, and others

<https://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
https://safety.fhwa.dot.gov/local_rural/training/

For each countermeasure (CM):

(Title) CM No., CM Name

- CM No. is
 - SI01NT through SI22PB for Intersection Countermeasures – Signalized,
 - NS01NT through NS24PB for Intersection Countermeasures – Unsignalized, or
 - R01NT through R39AL for Roadway Countermeasures.

Some CM Numbers have two letters at the end – this is used to quickly identity the specific feature of the CM. For example, “NT” - reducing night crashes, “PB” – reducing Pedestrian and Bicycle crashes, “EV” – countermeasure toward Emergency Vehicle involved crashes, “AL”- countermeasure toward Animal involved crashes, and “RA” – roundabout.

For HSIP Calls-for-projects:

- **Funding Eligibility** - 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 $1 - \text{CRF}$. 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

SI01NT, Add intersection lighting (Signalized Intersection => S.I.)

For HSIP Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		"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:		CRF:	20-74%
		Night, All			

SI02, Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number

For HSIP Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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%

SI03, Improve signal timing (coordination, phases, red, yellow, or operation)

For HSIP Cycle 12 Call-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%

SI04EV, Install emergency vehicle pre-emption systems

For HSIP Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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%

SI05, Install left-turn lane and add turn phase (signal has no left-turn lane or phase before)

For HSIP Cycle 12 Call-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 %

SI06, Provide protected left turn phase (left turn lane already exists)

For HSIP Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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%

SI07, Convert signal to mast arm (from pedestal-mounted)

For HSIP Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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%

SI08, Install raised pavement markers and striping (Through Intersection)

For HSIP Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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%

SI09, Install flashing beacons as advance warning (S.I.)

For HSIP Cycle 12 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	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%

SI10, Improve pavement friction (High Friction Surface Treatments)

For HSIP Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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 %

SI11, Install raised median on approaches (S.I.)

For HSIP Cycle 12 Call-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 should not include the removal of the existing roadway structural section and should be doweled into the existing roadway surface. This requirement is being implemented to maximize the safety-effectiveness of the limited HSIP funding and to minimize project impacts. Landscaping, if included in the project, is considered non-participating.				
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 %

SI12PB, Install pedestrian median fencing on approaches

For HSIP Cycle 12 Call-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%

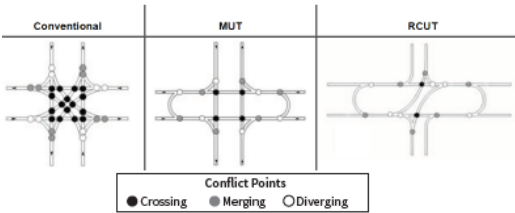
SI13, Create directional median openings to allow (and restrict) left-turns and U-turns (S.I.)

For HSIP Cycle 12 Call-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:		CRF:	51%
		All			

SI14, Install right-turn lane (S.I.)

For HSIP Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		All	15%	20 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new right-turn lanes.			
General information				
Where to use:				
A right-turn lane may be appropriate in situations where there are an unusually high number of rear-end collisions on a single major road approach. The need for right turn lanes should be assessed on an individual approach basis. Many collisions at signalized intersections are related to right-turn maneuvers. It is also important to ensure that the right-turn lanes are of sufficient length to allow vehicles to decelerate and "queue up" before turning, ideally without affecting the flow of through traffic. When considering new right-turn lanes, potential impacts to non-motorized users should be considered and mitigated as appropriate.				
Why it works:				
The provision of right-turn lanes can minimize collisions between vehicles turning right and following vehicles, particularly on high-volume and high-speed major roads. Installation of a right turn lane at a signalized intersection is expected to reduce total crashes and improve overall intersection delay.				
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:	Rear-End	CRF:	14-27%

SI15, Reduced Left-Turn Conflict Intersections (S.I.)

For HSIP Cycle 12 Call-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.				
MUT and RCUT Can Reduce Conflict Points by 50% 				
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%

SI16RA, Convert intersection to roundabout (from signal)

For HSIP Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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 compact roundabouts (SI17RA). 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. 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%

SI17RA, Convert intersection to compact roundabout (from signal)

For HSIP Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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 and the project location (Rural/Urban). The benefit comes from both the reduction in the number and the severity of the crashes.			
General information				
Where to use:				
Compact roundabouts are characterized by a small inscribed circle diameter (80-100 ft). Compact roundabouts offer most of the benefits of regular roundabouts with the added benefit of a smaller footprint. They are best suited to environments where speeds are already low and environmental constraints would preclude the use of a larger roundabout. Compact roundabouts may require minimal additional pavement, and in many cases existing curb or sidewalk can be left in place. As a result, compact roundabouts rarely require the purchase of right of way. Compact roundabouts are similar to single-lane roundabouts regarding design vehicle assumptions, ability to process traffic volumes, and signing. Compact roundabouts are intended to be pedestrian and bicyclist-friendly because their perpendicular approach legs require very low vehicle speeds to make a distinct right turn into and out of the circulatory roadway. Capacity should not be a critical issue for this type of roundabout to be considered.				
Why it works:				
Compact roundabouts may be an optimal solution for a safety or operational issue at an existing intersection where there is insufficient right-of-way for a standard roundabout installation. The benefits of compact roundabouts are the Compact size, operational efficiency, traffic safety improvement and traffic Calming.				
General Qualities (Time, Cost and Effectiveness):				
Construction costs for compact roundabouts vary widely depending upon the extent of sidewalk modifications or other geometric improvements and the types of materials used. In most cases, compact roundabouts have been installed with little or no pavement widening. Construction costs can be moderate for compact roundabouts that include raised islands and pedestrian improvements.				
FHWA CMF Clearinghouse:		Crash Types Addressed:	NA	CRF: NA

SI18PB, Install pedestrian countdown signal heads

For HSIP Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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%

SI19PB, Install pedestrian crossing (S.I.)

For HSIP Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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%

SI20PB, Pedestrian Scramble

For HSIP Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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%

SI21PB, Install advance stop bar before crosswalk (Bicycle Box)

For HSIP Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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%

SI22PB, Modify signal phasing to implement a Leading Pedestrian Interval (LPI)

For HSIP Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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 right or 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

NS01NT, Add intersection lighting (NS.I.)

For HSIP Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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 Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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 Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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%

NS04RA/NS05RA, Convert intersection to roundabout

For HSIP Cycle 12 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	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 stop/yield-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. 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 %

NS06RA/NS07RA, Convert intersection to compact roundabout

For HSIP Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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 and the project location (Rural/Urban). The benefit comes from both the reduction in the number and the severity of the crashes.			
General information				
Where to use:				
Compact roundabouts are characterized by a small inscribed circle diameter (80-100 ft). Compact roundabouts offer most of the benefits of regular roundabouts with the added benefit of a smaller footprint. They are best suited to environments where speeds are already low and environmental constraints would preclude the use of a larger roundabout. Compact roundabouts may require minimal additional pavement, and in many cases existing curb or sidewalk can be left in place. As a result, compact roundabouts rarely require the purchase of right of way. Compact roundabouts are similar to single-lane roundabouts regarding design vehicle assumptions, ability to process traffic volumes, and signing. Compact roundabouts are intended to be pedestrian and bicyclist-friendly because their perpendicular approach legs require very low vehicle speeds to make a distinct right turn into and out of the circulatory roadway. Capacity should not be a critical issue for this type of roundabout to be considered.				
Why it works:				
Compact roundabouts may be an optimal solution for a safety or operational issue at an existing intersection where there is insufficient right-of-way for a standard roundabout installation. The benefits of compact roundabouts are the Compact size, operational efficiency, traffic safety improvement and traffic Calming.				
General Qualities (Time, Cost and Effectiveness):				
Construction costs for compact roundabouts vary widely depending upon the extent of sidewalk modifications or other geometric improvements and the types of materials used. In most cases, compact roundabouts have been installed with little or no pavement widening. Construction costs can be moderate for compact roundabouts that include raised islands and pedestrian improvements.				
FHWA CMF Clearinghouse:		Crash Types Addressed:	NA	CRF: NA

NS08, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs

For HSIP Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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%

NS09, Upgrade intersection pavement markings (NS.I.)

For HSIP Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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%

NS10, Install Flashing Beacons at Stop-Controlled Intersections

For HSIP Cycle 12 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	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%

NS11, Install flashing beacons as advance warning (NS.I.)

For HSIP Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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%

NS12, Install transverse rumble strips on approaches

For HSIP Cycle 12 Call-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%

NS13, Improve sight distance to intersection (Clear Sight Triangles)

For HSIP Cycle 12 Call-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%

NS14, Improve pavement friction (High Friction Surface Treatments)

For HSIP Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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 %

NS15, Install splitter-islands on the minor road approaches

For HSIP Cycle 12 Call-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 <u>the new splitter island on the minor road approaches.</u>			
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 %

NS16, Install raised median on approaches (NS.I.)

For HSIP Cycle 12 Call-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 should not include the removal of the existing roadway structural section and should be doweled into the existing roadway surface. This requirement is being implemented to maximize the safety-effectiveness of the limited HSIP funding and to minimize project impacts. Landscaping, if included in the project, is considered non-participating.		
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 %

NS17, Create directional median openings to allow (and restrict) left-turns and u-turns (NS.I.)

For HSIP Cycle 12 Call-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%

NS18, Reduced Left-Turn Conflict Intersections (NS.I.)

For HSIP Cycle 12 Call-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.					
<i>MUT and RCUT Can Reduce Conflict Points by 50%</i>					
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%

NS19, Install right-turn lane (NS.I.)

For HSIP Cycle 12 Call-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 %

NS20, Install left-turn lane (where no left-turn lane exists)

For HSIP Cycle 12 Call-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 %

NS21PB, Install raised medians (refuge islands)

For HSIP Cycle 12 Call-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 should not include the removal of the existing roadway structural section and should be doweled into the existing roadway surface. This requirement is being implemented to maximize the safety-effectiveness of the limited HSIP funding and to minimize project impacts. Landscaping, if included in the project, is considered non-participating.				
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 %

NS22PB, Install pedestrian crossing at uncontrolled locations (signs and markings only)

For HSIP Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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 %

NS23PB, Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)

For HSIP Cycle 12 Call-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 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%

NS24PB, Install Rectangular Rapid Flashing Beacon (RRFB)

For HSIP Cycle 12 Call-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 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%

NS25PB, Install Pedestrian Signal (including Pedestrian Hybrid Beacon (HAWK))

For HSIP Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		Pedestrian and Bicycle		55%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the intersection/crossing with the new signal. For HAWK or other pedestrian signals, the justification may be Warrant 4, 5 and/or 7, or passing the test in Figure 4F-1/4F-2 in Chapter 4F of CA MUTCD. Please refer to Chapter 4F of CA MUTCD for more details				
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

R01NT, Add Segment Lighting

For HSIP Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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 Cycle 12 Call-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 Cycle 12 Call-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 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 Cycle 12 Call-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 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 Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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 Cycle 12 Call-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 Cycle 12 Call-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 Cycle 12 Call-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 should not include the removal of the existing roadway structural section and should be doweled into the existing roadway surface. This requirement is being implemented to maximize the safety-effectiveness of the limited HSIP funding and to minimize project impacts. Landscaping, if included in the project, is considered non-participating.			
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. <u>Agencies need to consider and document impacts of additional turning movements at nearby intersections.</u>				
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 Cycle 12 Call-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 Cycle 12 Call-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 Cycle 12 Call-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 safely 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 Cycle 12 Call-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

For HSIP Cycle 12 Call-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 two-vehicle-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 and add a two way left-turn and bike lanes)

For HSIP Cycle 12 Call-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 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. if any pavement is planned to be removed for the purpose of adding landscaping, planter-boxes, or other non-roadway user features, the cost should be non-participating.			
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 Cycle 12 Call-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/stripping 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 Cycle 12 Call-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 Cycle 12 Call-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/stripping 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 Cycle 12 Call-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/stripping 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 Cycle 12 Call-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 roadway 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 Cycle 12 Call-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 Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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 Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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. <u>This CM is not eligible unless</u> 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 Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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 Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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 Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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 Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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 Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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 Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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/markings 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 Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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 Cycle 12 Call-for-projects				
Funding Eligibility		Crash Types Addressed	CRF	Expected Life
90%		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/strips

For HSIP Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		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%

R32, Speed Safety Cameras

For HSIP Cycle 12 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		All		20%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the road sections that Speed Safety Cameras are newly installed. Agencies should conduct a legal and policy review to determine if Speed Safety Cameras (SSCs) are authorized within a jurisdiction and how the authorization and other traffic laws will affect an SSC program. Please refer to Speed Safety Camera Program Planning and Operations Guide. FHWA, (2023).				
General information					
Where to use:					
Agencies should conduct a network analysis of speeding-related crashes to identify locations to implement SSCs. The analysis can include scope (e.g., widespread, localized), location types (e.g., urban/suburban/rural, work zones, residential, school zones), roadway types (e.g., expressways, arterials, local streets), times of day, and road users most affected by speed-related crashes (e.g., pedestrians, bicyclists). SSCs can be deployed as: Fixed units—a single, stationary camera targeting one location. Point-to-Point (P2P) units—multiple cameras to capture average speed over a certain distance. Mobile units—a portable camera, generally in a vehicle or trailer.					
Why it works:					
Safe Speeds is a core principle of the Safe System Approach since humans are less likely to survive high-speed crashes. Enforcing safe speeds has been challenging; however, with more information and tools communities can make progress in reducing speeds. Agencies can use speed safety cameras (SSCs) as an effective and reliable technology to supplement more traditional methods of enforcement, engineering measures, and education to alter the social norms of speeding. SSCs use speed measurement devices to detect speeding and capture photographic or video evidence of vehicles that are violating a set speed threshold.					
FHWA CMF Clearinghouse:		Crash Types Addressed:		All	CRF: -46 - 61 %

R33PB, Install bike lanes

For HSIP Cycle 12 Call-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 %

R34PB, Install Separated Bike Lanes

For HSIP Cycle 12 Call-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 %

R35PB, Install sidewalk/pathway (to avoid walking along roadway)

For HSIP Cycle 12 Call-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 %

R36PB, Install/upgrade pedestrian crossing (with enhanced safety features)

For HSIP Cycle 12 Call-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%

R37PB, Install raised pedestrian crossing

For HSIP Cycle 12 Call-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%

R38PB, Install Rectangular Rapid Flashing Beacon (RRFB)

For HSIP Cycle 12 Call-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 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%

R39AL, Install Animal Fencing

For HSIP Cycle 12 Call-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 C: Summary of “Recommended Actions”

The information contained here represent a brief summary of each section of this manual as well as the Summary of “Recommended Actions” from Sections 2 through 7. This is intended to be a quick-reference for local agency practitioners working on a “proactive safety analysis” of their roadway network.

Introduction and Purpose

As safety practitioners consider implementing a ‘proactive safety analysis approach’ they should consider the overall context of the safety issues facing California local agencies and Caltrans primary goals for preparing this manual for California’s local roadway owners. Figure 1 provides a flowchart of the process and Appendices E and F provide examples and lessons learned from recent statewide calls-for-projects.

Identifying Safety Issues

This section provides an overview of the types of data to collect for the identification of roadway safety issues. It discusses sources of crash data and how they can be used. As practitioners gather information they are encouraged to develop one or more separate spreadsheets and/or pin-maps to help track and manage this data.

State and Local Crash Databases

Recommended Action: Obtain at least 3 years of network-wide crash data to identify local roads that have a history of roadway crashes. This will be used to identify predominant roadway crash locations, crash types and other common characteristics.

Transportation Injury Mapping System (TIMS)

Recommended Action: Consider augmenting your local agency’s data collection approach with information available using the suite of TIMS tools. The TIMS tools (and/or tools from private for-profit vendors) can help the safety practitioner access and manage their crash data.

Law Enforcement Crash Reports

Recommended Action: Develop a working relationship with law enforcement officials responsible for enforcement and crash investigations. This could foster a partnership where sharing crash reports and safety information on problem roadway segments becomes an everyday occurrence. Practitioners with limited access to crash data are encouraged to use TIMS to assess the local crash report data.

Observational Information

Recommended Action: Gather information received from law enforcement and road maintenance crew observations. Develop a system for maintenance crews to report and record observed roadway safety issues and a mechanism to address them.

Public Notifications

Recommended Action: Review and summarize information received from these sources, identifying segments or corridors with multiple notifications and record the locations, dates, and nature of the problem that are cited.

Roadway Data and Devices

Recommended Action: Identify and track roadway characteristics for the intersections, roadway segments, and corridors, including compliance with the minimum standards. At a minimum, this should be done for locations being considered for safety improvements, but ideally agencies would establish an extensive database of roadway data to help them proactively identify high risk roadway features.

Exposure Data

Recommended Action: Consider the availability of exposure data and track it along with the other crash data to help prioritize potential locations for safety improvements.

Field Assessments and Road Safety Audits

Recommended Action: Consider completing formal or informal field assessments and RSAs at certain locations to help ensure all relevant information is collected and available for the safety practitioners to complete their safety analysis and identification of the most appropriate countermeasures. Develop simple straightforward criteria on when one of these will be undertaken.

Safety Data Analysis

This section summarizes the types of analyses that can be conducted to determine what roadway countermeasures should be implemented. This section is the link between the data (Section 2) and the selection of appropriate countermeasures (Section 4). It provides definitions and examples of the qualitative and quantitative factors that should be considered when evaluating roadway safety issues.

Quantitative Analysis

Recommended Action: Complete a quantitative analysis of their roadway data using both Crash Frequency and Crash Rate methodologies, including:

Crash Frequency

Top 10 (or 20) lists of intersections and roadway segments.

For lower volume roadways, network wide pin-maps may be more effective.

Develop collision diagrams showing the direction of movement of vehicles and pedestrians.

Crash Rate

Top 10 (or 20) lists of roadway segments in relationship to length, volumes, and/or density.

Top 10 (or 20) lists of intersections, sorted by crash rate.

Top 10 (or 20) lists of the highest volume intersections, sorted by crash frequency or rate.

Qualitative Analysis

Recommended Action: Consider completing field assessments and RSAs to identify roadway infrastructure characteristics relating to both locations with compliance issues and locations with high crash frequencies/rates. As part the field assessments, common roadway and crash characteristics should be identified for the potential systemic deployment of countermeasures.

Caltrans recommends all agencies complete both quantitative and qualitative analyses before starting their applications for HSIP program funding. The findings from these analyses should be documented in spreadsheets and/or pin-maps similar to the ones discussed in Section 2.

Countermeasures

This Section provides a description of selected countermeasures that have been shown in this manual. It includes a basic set of strategies to implement at locations experiencing a history of crashes and their corresponding crash modification factors (CMF). NOTE: Crash Reduction Factors (CRFs) are directly connected to the CMFs and are another indication of the effectiveness of a particular treatment. The CRF for a countermeasure is defined mathematically as $1 - \text{CMF}$. The terms CMFs and CRFs are used interchangeably throughout this document.

Selecting Countermeasures and Crash Modification Factors / Crash Reduction Factors

Countermeasure Details and Characteristics

Recommended Action: Agencies should use all information and results obtained through completing the actions in Sections 2, 3 and 4 to select the appropriate countermeasures for their HCCLs and systemic improvements. As novice safety practitioners select countermeasures, they must realize that a reasonable level of traffic ‘engineering judgment’ is required and that this manual and should not be used as a simple cheat-sheet for preparing and submitting applications for funding.

Calculating the B/C ratio and Comparing Projects

This section defines a methodology for calculating a benefit to cost (B/C) ratio for a potential safety project. It includes sources for estimating projected costs and benefits and the specific values/formulas Caltrans uses for its statewide evaluations of HSIP projects. This section also discusses the potential value in reevaluating projects’ overall cost effectiveness.

Estimating the Benefit of Implementing Proposed Improvements

Recommended Action: Prepare ‘Total Benefit’ estimates for the proposed projects being evaluated in the proactive safety analysis.

Estimating the Cost of Implementing Proposed Improvements

Recommended Action: Prepare ‘Total Project Cost’ estimates for the proposed projects being evaluated in the proactive safety analysis.

Calculating the B/C Ratio

Recommended Action: Calculate the B/C ratio for each of the proposed projects being evaluated in the proactive safety analysis.

Compare B/C Ratios and Consider the Need to Reevaluate Project Elements

Recommended Action: Compare, reevaluate, and prioritize the potential safety projects. Consider changing the project limits or utilizing lower cost countermeasures for projects with low initial B/C ratios.

Identifying Funding and Construct Improvements

This section identifies existing and new funding opportunities for safety projects that local agencies should be considering. This section also briefly discusses some unique project development issues and strategies for safety projects as they proceed through design and construction.

Existing Funding for Low-cost Countermeasures

Recommended Action: Survey planned maintenance, developer and capital projects to determine whether they overlap any of the proposed safety projects. Where projects overlap, leverage the existing funding sources to include safety countermeasures.

Other Funding Sources

Recommended Action: Consider all potential funding opportunities to incorporate the identified safety countermeasures including the HSIP and ATP Programs.

Project Development and Construction Considerations

Recommended Action: Safety practitioners should follow their safety projects all the way through the project delivery and construction process. In addition, they should establish a safety program delivery plan that brings awareness and support to the expedited delivery of safety projects. Where possible, safety practitioners should involve the media and even consider having their own program intended to “toot their own safety-horn.”

Evaluation Improvements

This section presents the process to complete an evaluation of installed treatments. After the countermeasures are installed, assessing their effectiveness will provide valuable information and can help determine which countermeasures should continue to be installed on other roadways to make them safer as well.

Recommended Action: Develop a spreadsheet to track future safety project installations and record 3+ years of “before” and “after” crash information at those locations. Once safety countermeasures are constructed, schedule and track assessment dates to ensure they happen.

Appendix D: Benefit Cost Ratio (BCR) Calculations

This appendix includes the Benefit Cost methodology used in the Caltrans Calls-for-projects in the HSIP programs. The HSM, Part B - Chapter 7, includes more details on conducting Economic Appraisal for roadway safety projects. Local agencies will be required to utilize the HSIP Analyzer to calculate the Benefit Cost Ratio (BCR) as part of their application for HSIP funding.

Starting in Cycle 7 call for projects, the fatality and severe injury costs have been combined for calculating the benefit. Because fatality figures are small and are a matter of randomness, this change is being made to reduce the possibility of selecting an improvement project on the basis of randomness.

- 1) Combined Crash Reduction Factor (CRF) of multiple countermeasures (CMs):
Assume there are 3 CMs with CRF_1 , CRF_2 and CRF_3 as their individual CRFs:

$$CRF_{combined} = 1 - (1 - CRF_1)(1 - CRF_2)(1 - CRF_3).$$

- 2) Annual benefit of project = $\sum_{s=0}^3 \frac{CRF_{combined} \times N_s \times CC_s}{Y}$
 - $CRF_{combined}$: Combined CRF of multiple CMs.
 - S: Crash severity (0/1/2/3. See the below table.
 - N_s : Number of crashes in each severity level.
 - CC_s : Crash cost of each severity level.
 - Y: Crash data time period (year).

Severity (S)	Crash Severity *	Location Type	Crash Cost ***
3	** Fatality and Severe Injury Combined (KA)	Signalized Intersection	\$2,162,000
3		Non-Signalized Intersection	\$3,440,000
3		Roadway	\$2,978,000
2	Evident Injury – Other Visible (B)		\$193,000
1	Possible Injury–Complaint of Pain (C)		\$110,000
0	Property Damage Only (O)		\$18,000

* The letters in parenthesis (K, A, B, C and O) refer to the KABCO scale; it is commonly used by law enforcement agencies in their crash reporting efforts and is further documented in the HSM.

** Figures were calculated based on an average Fatality (K) / Severe Injury (A) ratio for each area type. These costs are used in the HSIP Analyzer.

*** Based on Table 7-1, Highway Safety Manual (HSM), First Edition, 2010. Adjusted to 2024 Dollars.

- 3) Life benefit of project = Annual benefit of project x Service life of project (years)

- 4) Project BCR = $\frac{\text{Life benefit of project}}{\text{Total project cost}}$

Appendix E: Examples of Crash Data Collection and Analysis Techniques using TIMS

As demonstrated throughout the manual, SafeTREC's TIMS website <https://tims.berkeley.edu/> can be used to assist local agencies in completing a proactive safety analysis of their roadway network.

Note: This manual focuses on TIMS as a tool to access and map SWITRS data because TIMS is free to local agencies and the general public. Local agencies are encouraged to try TIMS, but they should not feel obligated to make a switch if they prefer using their vendor-supplied crash analysis software to complete their data collection and analysis process.



SWITRS Query & Map:

The SWITRS Query & Map application is a tool for accessing and mapping fatal and injury crash data from the California Statewide Integrated Traffic Records System (SWITRS).

SWITRS GIS Map:

The SWITRS GIS Map offers an interactive map-centric approach to viewing and querying SWITRS collision data with various tools including crash diagram, rank by intersection, etc.

Crash Diagram Tool:

The Crash Diagram tool allows users to generate an interactive crash diagram. The crash diagram is accessible through SWITRS GIS Map after a set of crashes is selected.

ATP Maps & Summary Data:

The ATP Maps & Summary Data tool utilizes interactive crash maps to allow users to track and document pedestrian and bicycle crashes and generate data summaries within specified project and/or community limits. Though it is designed to support the California Active Transportation Program (ATP), this tool may be useful in developing an HSIP project targeting pedestrian and bicycle safety issues.

Appendix F: List of Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ATP	Active Transportation Program
B/C Ratio; BCR	Benefit Cost Ratio
Caltrans	California Department of Transportation (Division of Local Assistance)
CA-MUTCD	California - Manual on Uniform Traffic Control Devices
CM	Countermeasure
CMF	Crash Modification Factor
CRF	Crash Reduction Factor
“5 E’s of Safety”	Education, Enforcement, Engineering, Emergency Response and Emerging Technologies
EMS	Emergency Medical Services
FHWA	Federal Highway Administration
HCCL	High Crash Concentration Location
HR3, HRRR	High Risk Rural Roads Program
HSIP	Highway Safety Improvement Program
HSM	Highway Safety Manual
RSA	Roadway Safety Audit
SafeTREC	Safe Transportation Research and Education Center (SafeTREC) at the University of California, Berkeley
SHSP	Strategic Highway Safety Plan
SWITRS	Statewide Integrated Traffic Records System
TIMS	Transportation Injury Mapping System (a product of SafeTREC)

Appendix G: References

1. FHWA, Office of Safety website: Local and Rural Road Safety Program
 - https://safety.fhwa.dot.gov/local_rural/
2. Highway Safety Manual (HSM). Product of the American Association of State Highway and Transportation Officials.
 - <http://www.highwaysafetymanual.org/Pages/default.aspx>
3. National Highway Traffic Safety Administration (NHTSA): National Center for Statistics and Analysis (NCSA) Motor Vehicle Traffic Crash Data Resource
 - <https://crashstats.nhtsa.dot.gov/>
4. California - Manual on Uniform Traffic Control Devices (CA-MUTCD)
 - <https://dot.ca.gov/programs/safety-programs/camutcd>
5. Caltrans' website on the Highway Design Manual
 - <https://dot.ca.gov/programs/design/manual-highway-design-manual-hdm>
6. FHWA, Research and Development website for pedestrian & bicyclist safety
 - https://safety.fhwa.dot.gov/ped_bike/tools_solve/
7. AASHTO - A Policy on Geometric Design of Highways and Streets ("Green Book")

AASHTO - the Roadside Design Guide
 - <https://store.transportation.org/>
8. FHWA – Public Roads Magazine:
 - <https://highways.dot.gov/public-roads/home>

Appendix F

HSIP Analyzers (2024)

Important: The HSIP Analyzer PDF is embedded as an attachment within the main report PDF. To access it:

- *Open the report PDF using Adobe Acrobat.*
- *Navigate to the Attachments panel (usually found in the left sidebar or under the "View" menu).*
- *You'll find the HSIP Analyzer PDF files listed there, which you can then open or save separately.*

