CITY OF GRIDLEY

LOCAL ROAD SAFETY PLAN

FINAL REPORT
November 2023

TJKM

GRIDLEY
CALIFORNIA

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Glossary

5 E's – Abbreviation for Education, Enforcement, Engineering, Equity, and Emergency Medical Services (EMS): 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.

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.

KSI – Abbreviation for fatal and severe injury collisions.

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

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 City of Gridley's Local Road Safety Plan (LRSP) is a comprehensive plan that creates a framework to systematically identify and address safety issues prevalent to the City of Gridley's jurisdiction. The analysis of crash history through the City's transportation network allows for opportunities to improve safety and develop safety measures aligning with the five E's of safety.

The LRSP takes a proactive approach to learn and reduce traffic accident fatalities and severe injury (KSI) on public roads. It will be a living document, one that is routinely reviewed and updated by City staff and their safety partners to reflect evolving collision trends and community needs and priorities. With the LRSP as a guide, the City will be able to apply for grant funds, such as the Federal Highway Safety Improvement Program (HSIP). The process and analysis performed in development of the City's LRSP, including an analysis of collisions that occurred in Gridley, high-injury locations, and recommended countermeasures at each of these high-risk locations, are summarized in this LRSP.

GOALS OF THE LRSP

The goals are summarized as follows:

- Systematically identify and analyze active transportation problems and recommend improvements.
- Improve the safety of all road users by using proven effective countermeasures.
- Ensure Coordination of key stakeholders to implement roadway safety improvements and response within Gridley.
- Continually seek funding for safety improvements
- Ensure that safety improvements are made in a manner that is fair and equitable for all Gridley residents

PROCESS

The guidelines on the LRSP process is provided at both FHWA (Federal Highway Administration) and Caltrans (California Department of Transportation) level. The systemic approach in preparing the LRSP involves the following steps:

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

COLLISION DATA

Collision data for a five year period spanning from January 1, 2018 through December 30, 2022 was collected from the University of California at Berkeley SafeTREC's Transportation Injury Mapping Service (TIMS) and the California Highway Patrol's Statewide Integrated Traffic Records System (SWITRS). For the purpose of this report the data was analyzed to identify top collision trends such as collision severity, time of collisions, collision type, traffic violations, mode of transportation, lighting and weather conditions etc.

COLLISION TREND

Below is the summarization of key findings on collision patterns and trends. The detailed information is provided in the Chapter 4.

- Overall, from 2018-2022 there were a total of 257 citywide collisions of which 175 (68 percent) were property damage only collisions (PDO) and 83 (32 percent) were injury collisions. Of total collisions, 19 (7 percent) resulted in fatal and severe injury collisions (KSI collisions).
- A total of 83 injury collisions that resulted in 109 people being injured. Of those injured, 43 suffered possible injuries, 44 had minor injuries, 20 sustained severe injuries, and 2 resulted into fatalities.
- The year 2018 and 2021 had the highest number of total collisions (63 each), and 2019 had the lowest number of total collisions with 33 collisions.
- The month of October have the highest number of total and all injury collisions.
- Collisions peak during typical evening commute hours, 4 - 6 p.m.
- Broadside and rear-end collisions account for 27 percent and 22 percent of total collisions, respectively. 26 percent of broadside collisions and 26 percent of Head-on collisions were KSI collisions, the highest among any type of KSI collisions.
- Automobile right of way violations accounted for 27 percent of total collisions, followed by improper turning (20 percent) and the unsafe speed (14 percent).
- For all injury collisions, 57 percent collisions were motor vehicles involved with other motor vehicles followed by motor vehicles involved with fixed objects (12%) and bicycles (11%).
- Also, 26 percent of total KSI collision involve people within the age group of 40 – 49 years.
- There were a total of 18 bicycle and pedestrian collisions during the study period, of which 11 were bicycle and 7 pedestrian collisions.
- The highest number of KSI collisions occurred within 250 feet of an intersection (89 percent).
- For 47 percent of all injury collision, the movement preceding crash was 'proceeding straight'. 17 percent were making left turn before crash happen.

- Of the total injury collisions, 30 percent of collisions occur during dusk-dawn or nighttime. This percentage increases to 47 percent when considering KSI collisions showing poor lighting condition can be one of the factor leading to KSI collision.

HIGH RISK LOCATIONS

The collision analysis was performed on all City streets and State Route 99. The corridors were ranked to show the top 10 high-collision intersections and the top 9 high-collision roadway segments.

Key findings of identifying high-risk intersections are as follows:

- There were a total of 30 injury collisions that occurred at intersections
- 14 collisions led to KSI
- The intersection of SR 99 and Cherry Street had the highest number of injury collisions overall (10 collisions)

Key findings of identifying high-risk roadway segments are as follows:

- There were a total of 38 injury collisions that occurred on roadway segments
- 12 collisions led to KSI collisions
- SR 99 between City Limits had the highest number of injury collisions with 17

EMPHASIS AREAS

Emphasis areas are focus areas for the LRSP that are identified through the comprehensive collision analysis of the identified high injury locations within the City of Gridley. The six emphasis area identified for the City of Gridley are:

- Improve Intersection safety
- Address Broadside collisions
- Address Rear-end collisions
- Address Nighttime collisions
- Address Pedestrian and Bicycle collisions
- Address collisions on SR 99

VIABLE SAFETY PROJECTS

A set of seven safety projects were created for the high-risk intersections and roadway segments. The countermeasures were based off of approved countermeasures from the Caltrans Local Roadway Safety manual (LRSM) used in HSIP grant calls for projects. These safety projects are:

- **Project 1**: Signalized Intersections: Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number, Improve signal timing (coordination, phases, red, yellow, or operation), Install Raised Pavement Markers and Striping through Intersection
- **Project 2**: Unsignalized Intersections: Convert to all-way STOP control (from 2-way or Yield control) (Warrant Study needed), Install/upgrade larger or additional stop signs or other intersection warning/ regulatory signs
- **Project 3**: Unsignalized Intersections: Install Pedestrian Signal (including Pedestrian Hybrid Beacon (HAWK)), Improve sight distance to intersection (Clear Sight Triangles), and Install raised median on approaches (NS.I.)
- **Project 4**: Citywide Lighting Improvements: Add Segment Lighting
- **Project 5:** Citywide Sign Upgrade: Install/Upgrade signs with new fluorescent sheeting (regulatory or warning), Install delineators, reflectors and/or object markers
- **Project 6**: Roadway Segments: Remove or relocate fixed objects outside of Clear Recovery Zone, Install edge-lines and centerlines
- **Project 7**: Roadway Segment: Install sidewalk/ pathway (to avoid walking along roadway), Install/ upgrade pedestrian crossing (with enhanced safety features)

IMPLEMENTATION AND EVALUATION

The LRSP is a guidance document that is recommended to be updated every two to five years in coordination with the safety partners. The LRSP document provides the 5 E's of safety: Engineering, Education, Enforcement, Equity and Emergency Medical Service-related (EMS) countermeasures that can be implemented throughout the City to reduce KSI collisions. It is recommended that the City of Gridley implement the selected projects in high-collision locations in coordination with other projects proposed for the City's infrastructure development in their future Capital Improvement Plans. After implementing countermeasures, the performance measures for each emphasis area should be evaluated annually. The most important measure of success of the LRSP should be reducing KSI collisions throughout the City. If the number of KSI collisions does not decrease over time, then the emphasis areas and countermeasures should be re-evaluated.

Report Organization

CHAPTER 1 – INTRODUCTION

The Introduction describes what an LRSP is and details the study area. It also summarizes the systemic approach involved in preparing the LRSP and goal and objectives of the plan.

CHAPTER 2 – SAFETY PARTNERS AND PUBLIC OUTREACH

Involvement of safety partners is critical in the success of the LRSP. For the City of Gridley, this included the Gridley Police Department, Fire Department, Gridley Unified School District, City Staff, Butte County Staff, Butte County Association of Governments, B-Line Butte Regional Transit, Caltrans, California Highway Patrol (CHP), and Gridley residents. This chapter summarizes the public outreach involvement of the stakeholders in the LRSP process.

CHAPTER 3 – EXISTING PLANNING EFFORTS

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

CHAPTER 4 – COLLISION DATA AND ANALYSIS

This chapter summarizes the collision data analysis approach and presents preliminary as well as detailed collision analysis and findings in the study area. This chapter also identifies and lists top high-risk intersections and roadway segments within the City of Gridley.

CHAPTER 5 – EMPHASIS AREAS

This chapter identifies the top six emphasis areas for the City and the safety strategies for each.

CHAPTER 6 – COUNTERMEASURE IDENTIFICATION

This chapter identifies the 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 City potential countermeasures for each high-risk location that can be implemented either in future HSIP calls for projects, or using other funding sources, such as the City's Capital Improvement Program. Non-engineering countermeasures were also selected using the 5 E's strategies, and are included with the emphasis areas.

CHAPTER 7 – SAFETY PROJECTS

This chapter summarizes the list of viable safety projects applicable to the high-risk intersections and roadway segments, along with the cost for implementation and their benefit cost ratio.

CHAPTER 8 – IMPLEMENTATION AND EVALUATION

This chapter summarizes the process of implementation, monitoring, evaluation, and future updates.

What is an LRSP?

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

PROCESS

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

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

Goals and Objectives

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 Gridley, (with an emphasis on fatal and severe injury collisions); where, when, and how they are occurring, and implement appropriate and proven countermeasures.

Objective 2: Improve roadway planning, design, operations, and connectivity to enhance safety and mobility for all modes, and for users of all ages and abilities

Objective 3: Implement traffic calming strategies to discourage speeding and other unsafe driving behaviors on residential streets

Objective 4: Ensure that all recommended improvements are consistent with City of Gridley 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: Review existing City policies and recommend improvements to ensure that they meet current best practices in the realm of traffic safety

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

Objective 1: Identify safety issues and locations/hot spots where bicycle and pedestrian collisions occur in Gridley, and treat with appropriate and effective engineering countermeasures.

Objective 2: Provide educational programs for bicyclists, pedestrians, and motorists to inform on how to be safe in the public right-of-way; either through after-school programs, law enforcement programs, or other public/private sponsored programs

Objective 3: Improve sidewalks, walkways, and crossings to be free of hazards and to minimize conflicts with vehicular traffic

Objective 4: Prioritize improvements that promote Safe Routes to School efforts or are located near schools

GOAL 3: ENSURE COORDINATION OF KEY STAKEHOLDERS TO IMPLEMENT ROADWAY SAFETY IMPROVEMENTS & RESPONSE WITHIN GRIDLEY

Objective 1: Coordinate between City Departments, Gridley Police and Fire Departments, and EMS agencies to ensure a coordinated 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 Butte County or Caltrans), to identify and address traffic safety issues and ensure a coordinated response.

GOAL 4: CONTINUALLY SEEK FUNDING FOR SAFETY IMPROVEMENTS

Objective 1: Ensure the LRSP meets Highway Safety Improvement Program (HSIP) guidelines in order to apply for funding for identified countermeasures

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

Objective 3: Identify and prioritize specific types of countermeasures to address identified safety issues, for systemic implementation citywide

Objective 4: Continually seek funding sources to implement engineering, education, enforcement, equity, and emergency response solutions to roadway safety issues in Gridley

GOAL 5: ENSURE THAT SAFETY IMPROVEMENTS ARE MADE IN A MANNER THAT IS FAIR AND EQUITABLE FOR ALL GRIDLEY 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 City staff and officials to respond to such concerns

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

Study Area

The City of Gridley, located in Butte County, California, covers a total area of 2.08 square miles. Gridley is located 56 miles north of Sacramento, California. The City's estimated population is 7,421 (US Census 2020). California State Route (SR) 99, Spruce Street, Sycamore Street, Magnolia Street, Vermont Street, E Gridley Road and W Biggs Gridley Road are major thoroughfares within Gridley. The study area is mapped in **Figure 1** below.

According to the five-year estimates from the American Community Survey (ACS) 2021[1] from the U.S. Census, 83% of Gridley commuters get to work by driving alone, more than both the Butte County and State percentages. The second most common method of commuting to work in the City is carpooling at 14%. The different modes of transportation used by Gridley residents to commute to work are shown in **Table 1** below.

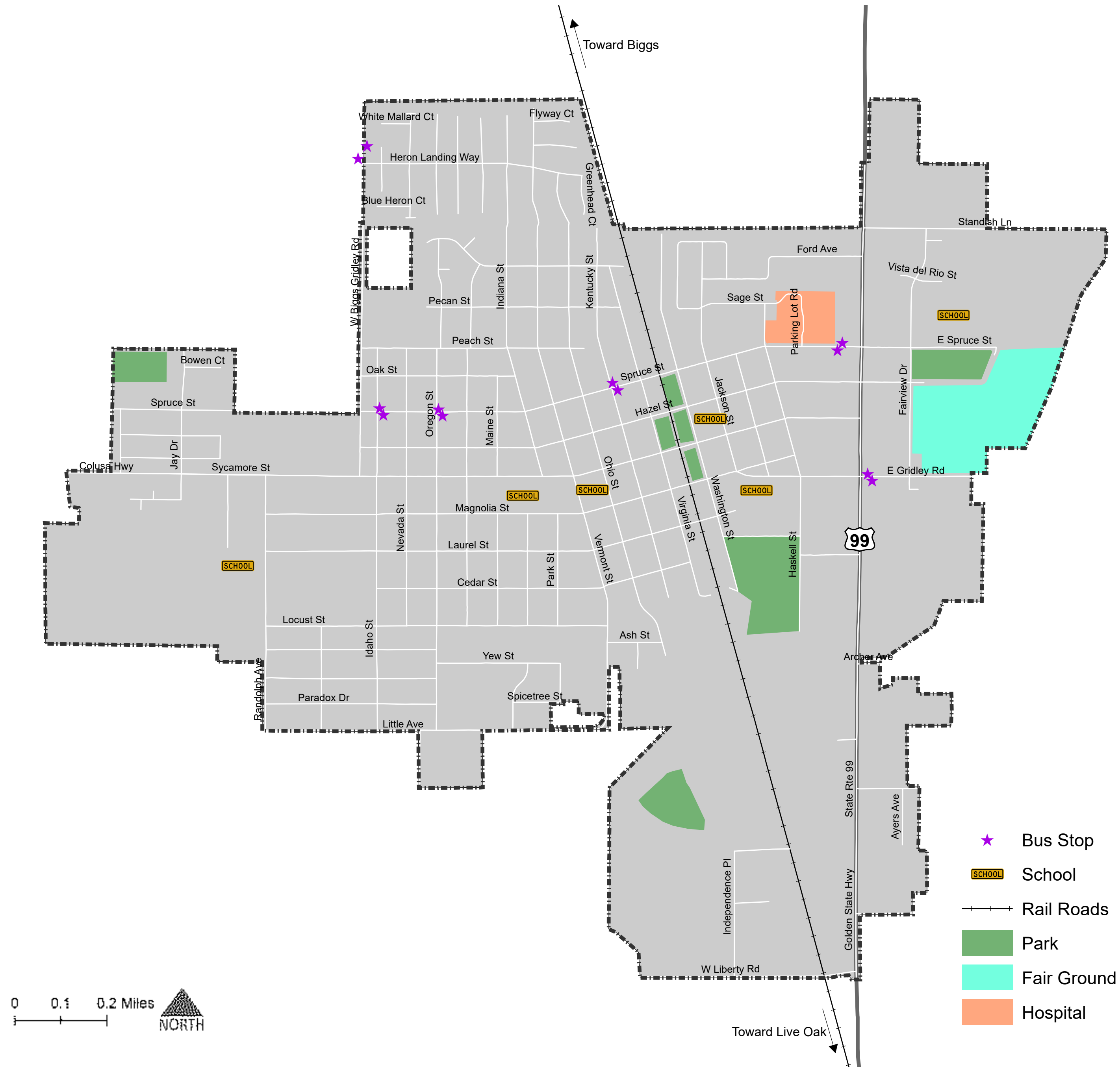
Table 1: Gridley Commute to Work Census Data

Commute to Work	Gridley	Butte County	California
Drive Alone	83%	74%	64%
Carpool	7%	8%	8%
Public Transportation	0%	0.5%	2%
Other (including work from home)	10%	17.5%	26%

Source: Data from the Census Bureau ACS 5-year Estimate 2021

1 https://data.census.gov table?q=Gridley+city,+California&tid=ACSST5Y2021.S0804&tp=true

Figure 1: Study Area



Safety Partners

Safety partners are vital to the development and implementation of an LRSP. For the City of Gridley, these include Gridley Police Department, Fire Department, Gridley Unified School District, Gridley City Staff, Butte County Staff, Butte County Association of Governments, B-Line Butte Regional Transit, Caltrans, California Highway Patrol (CHP), and Gridley residents. These stakeholders attended a virtual stakeholder meetings, held on June 28, 2023 and August 30, 2023 to review project goals, findings, and solicit feedback and comments. **Figure 2** illustrates the power point presentation for the virtual Stakeholder Meeting.

Figure 2. Zoom Meeting from Stakeholder Meeting

This stakeholder outreach was supplemented by a project website with an interactive platform. The interactive map was used to solicit input from City of Gridley residents and stakeholders outside the confines of traditional meetings. **Figure 3** illustrates the landing page of the Gridley LSRP Project Website.

Figure 3. Gridley LRSP Project Website

In total, 75 comments were received through the project website and interactive map platform for Gridley. The most comments were received about Sycamore Street, Spruce Street, and SR 99, with the most common concerns being disregarding traffic signals or stop signs and insufficient sight distance at intersections. The results of the interactive map are shown below in **Figure 4**, and summarized in **Figure 5**. In **Figure 4**, each dot and line (in blue color) represents a comment provided by a community member.

Figure 4. Interactive Map Comment Responses

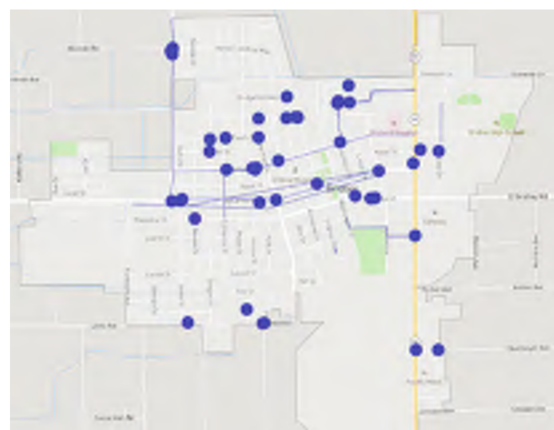
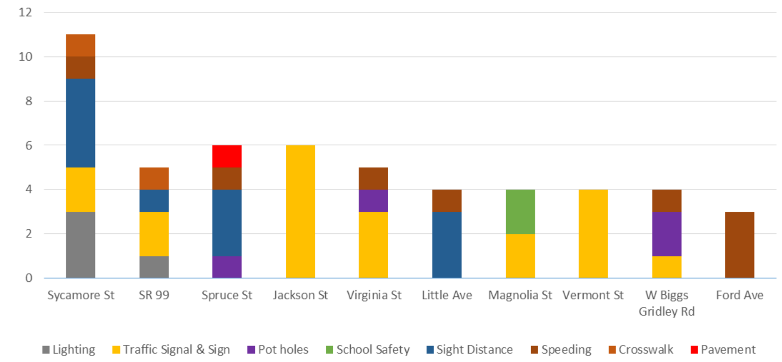


Figure 5. Public Comments on Traffic Safety by Location



Note: This summary does not list corridors with less than three comments. Categories with less than three comments are not included in this graph. The category was chosen based on the primary issue listed in the comment. Each comment was assigned to the major road if at an intersection.

The community comments collected through Interactive map platform is included in **Appendix A**.

Existing Planning Efforts

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

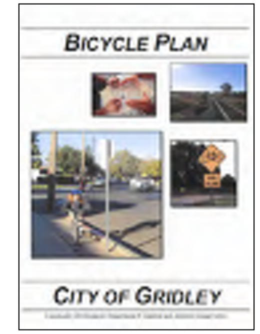
- City of Gridley General Plan | Circulation Element (2030)
- City of Gridley Bicycle Plan (2011)
- City of Gridley Operating Budget and Capital Improvement Plan (FY 2022-2023)
- Butte County Regional Population and Transportation Study (2020)
- Butte County Transit and Non- Motorized Plan (2015)
- SR-99 Road Safety Audit

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

CITY OF GRIDLEY 2030 GENERAL PLAN | CIRCULATION ELEMENT

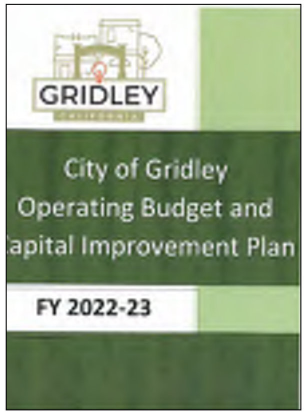
The General Plan mobility element identifies safe, reliable and accessible transportation needs within Gridley and seeks to maintain and improve the city's transportation network through policies and standards. The General Plan also reflects goals to create better and safer communities through a multi-modal circulation system, mix densities, complete streets, transportation options, integrating land use and transportation, regional leadership. The element focuses on detailing the existing conditions of the system and projecting future conditions and needs.

CITY OF GRIDLEY BICYCLE PLAN (2011)



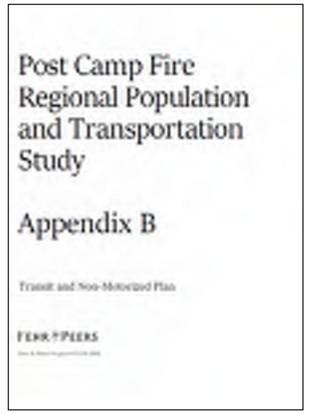
The Bicycle Plan focuses on infrastructure improvments, which are building bike lanes and trails and providing more secure bike parking. The plan sets forth key goals and policy objectives that apply to bicycling facilities directly and seeks to institutionalize the accomodation for these modes throughout City policies and practices. It also recommends developing city wide bicycle routes, safe routes to school, traffic calming strategies, expanding the network of off- street path, and identify priorty safety improvements. It does this by proposing a system of bikeways and pedestrian facilities that connect neighborhoods to key activity centers throughout the City; developing essential support facilities, such as bike parking; suggesting education, encouragement and other programs; and identifying recommendations for improving safety for walkers and cyclists.

CITY OF GRIDLEY | OPERATING BUDGET AND CAPITAL IMPROVEMENT PLAN (FY 2022-23)



The City of Gridley's Capital Improvement Program (CIP) is a multi-year planning document for fiscal sustainability and to support the City's quality of life by providing improved design, construction and renovation of major capital projects. It also identifies infrastructure needs for roadways, drainage system, parks and community facilities. The financial plan is developed by City Staff and is adopted by the City Council as a guide for prioritization of various projects to accomplish community goals.

BUTTE COUNTY REGIONAL POPULATION AND TRANSPORTATION STUDY (2020)



The Butte County Regional Population and Transportation study identifies vision for future transit and non-motorized transportation improvements in the communities of the County. This plan identifies near-term (through 2025) and long-term (through 2045) improvements to transit facilities, biking and walking needs to accommodate planned future growth and to support land use and mobility needs. This plan identifies strategies to improve comfort and convenience of accessing transit by foot or by bike and bicycle and pedestrian safety. The plan prioritizes bicycle and pedestrian improvements identified in local plans based on the extent to which they support transit usage.

BUTTE COUNTY TRANSIT AND NON-MOTORIZED PLAN (2015)

The purpose of this transportation plan is to outline transit service and non-motorized transportation enhancements that can be made in Butte County to expand mobility, improve intermodality, and result in a set of recommended local and intercity public transit services, improved bikeways and bicycle paths, and improved pedestrian access to transit. Through coordination by BCAG and movement toward compliance with the Active Transportation Program, the City of Gridley is working with Caltrans on several bike lanes improvements, Sycamore Street, and State Route 99.

SR-99 ROAD SAFETY AUDIT (2023)

Road Safety Audits (RSAs) aim to proactively improve safety by using evaluation methods and engineering best practices along State Route 99. SR 99 is Gridley's main route through town and also connects it to other cities. This RSA divided the SR-99 study corridor into 5 segments in which Segment 4 covers Gridley. The audit highlighted key traffic safety issues and proposed solutions in Gridley: including few passing opportunities, unsafe speeds, and a lack of U-turn options.

Collision Data and Analysis

This chapter summarizes the results of the countywide collision analysis that occurred in Gridley between January 1, 2018, and December 31, 2022, as part of the Local Road Safety Plan (LRSP). The purpose of the comprehensive collision analysis is to identify the appropriate countermeasures and develop project prioritization for the City.

DATA COLLECTION

Chapter 2 of Caltrans' Local Roadway Safety Manual (LRSM) instructs safety practitioners to "consider a wide range of data sources to get an overall picture of the safety needs." To this end, this Plan is data-driven and synthesizes findings from collision records alongside input from key stakeholders, a technical advisory group, and staff. Collision data helps to understand different factors that might be leading to collisions and influencing collision patterns in a given area. For the purpose of this analysis, five-years of city-wide collision data (2018 to 2022) was retrieved from Transportation Injury Mapping System (TIMS) and Statewide Integrated Traffic Records System (SWITRS). The collision data were analyzed and plotted using ArcMap Geographic Information Systems (GIS) software tool to identify high-risk intersections and roadway segments.

The data-driven process included:

- Examination of Collision Trends: Review of collision statistics to evaluate when, where, and why collisions occur and what modes are involved.
- Development of Emphasis Areas: Combination of collision factors to identify prevalent collision types.
- Development of a Countermeasure Toolbox: Identification of effective, nationally proven countermeasures applicable to different collisions.
- Identification of Priority Safety Project Locations: Identification of priority project locations based on collision density and community verification.

The analysis began with a comparative evaluation of total collisions, all injury collisions, and KSI collisions. Factors examined included collisions within various timeframes, collision type, primary violation, motor vehicle involved with, movement preceding the crash, pedestrian location during a crash, lighting, weather, gender, and age. This was followed by a comprehensive analysis of all injury collisions to identify emphasis areas. The evaluation of injury collisions also identified High Injury Network locations, consisting of intersections and corridors with more frequent injury collisions. Later in the safety plan, location-specific countermeasures is recommended and converted into safety project proposals.

To better understand collision trends, the following collision analysis is separated by trends of various severity. The terminology is explained below:

- **Total Collisions**: This trend includes all countywide collisions (e.g., Fatal, Severe Injury, Visible Injury, Complaint of Pain, and Property Damage only (PDO))
- **All Injury Collisions**: This Trend includes all types of severity excluding PDO (e.g., Fatal, Severe Injury, Visible Injury, Complaint of Pain)
- **KSI**: This trend stands for Killed (Fatal) or Severe Injury collisions

OFFICE OF TRAFFIC SAFETY (OTS) CRASH RANKINGS

The California Office of Traffic Safety (OTS) produces annual collision rankings for all California jurisdictions, enabling cities to benchmark their statistics. The OTS Rankings were developed so that individual cities could compare their city's traffic safety statistics to those of other cities with similar-sized populations. Cities could use these comparisons to see what areas they may have problems in and which they were doing well in.

The rankings are based on the Empirical Bayesian Ranking Method. This method uses population and daily vehicle miles traveled as well as crash records, crash trends and other weighing factors to arrive at a single ranking.

The results helped both cities and OTS identify emerging or on-going traffic safety problem areas in order to help plan how to combat the problems and help with the possibility of facilitating grants. In recent years, media, researchers and the public have taken an interest in the OTS Rankings. It should be noted that OTS rankings are only indicators of potential problems; there are many factors that may either understate or overstate a city/county ranking that must be evaluated based on local circumstances.

The following OTS rankings[1] are for Gridley for the year 2020.

- Motorcycle Collision: 10th Highest out of 74
- Total Fatal and Injury Collisions: 19th Highest out of 74
- Pedestrian Collisions: 24th Highest out of 74

1 https://www.ots.ca.gov/media-and-research/crash-rankings results/?wpv_view_count=1327&wpv-wpcf-year=2020&wpv-wpcf-city_county=Gridley&wpv_filter_submit=Submit

- Bicycle Collisions: 26th Highest out of 74
- Driving under the Influence (DUI) of drug or alcohol: 34th Highest out of 74

COLLISION DATA ANALYSIS FINDINGS

The following section analyzes collision trends and factors in Gridley from 2018-2022. This analysis aims to identify key patterns, risk factors, and emphasis areas to inform the development of targeted countermeasures and safety improvements.

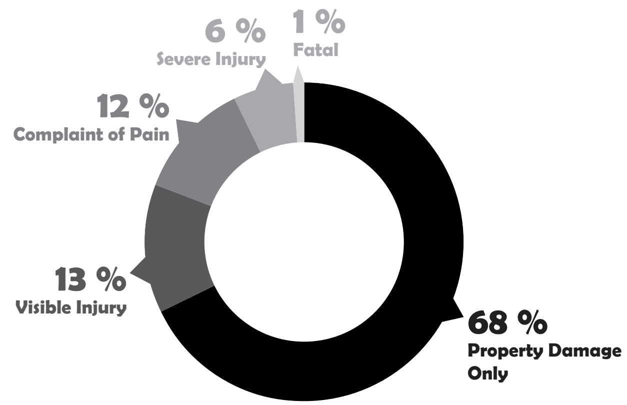
A series of graphs and charts illustrating trends across various dimensions are included in the following pages. **Figures 6, 7 and 8** illustrates collision trends of various severity and **Figure 9** shows the trends with focus on all injury collisions only. These visualizations provide an overview of collision characteristics and contributing factors. Key findings are summarized below.

- Overall, from 2018-2022 there were a total of 257 citywide collisions of which 175 (68 percent) were property damage only collisions (PDO) and 83 (32 percent) were injury collisions. Of total collisions, 19 (7 percent) resulted in fatal and severe injury collisions (KSI collisions).
- A total of 83 injury collisions resulted in 109 people being injured. Of those injured, 43 suffered possible injuries, 44 had minor injuries, 20 sustained severe injuries, and 2 resulted in fatalities.
- The year 2018 and 2021 had the highest number of total collisions (63 each), and 2019 had the lowest number of total collisions with 33 collisions.
- The month of October has the highest number of total (39 collisions) and all injury collisions (13 collisions).
- Collisions peak during typical evening commute hours, 4 - 6 p.m.
- Broadside and rear-end collisions account for 27 percent and 22 percent of total collisions, respectively. 26 percent of broadside collisions and 26 percent of Head-on collisions were KSI collisions, the highest among any type of KSI collisions.
- Automobile right of way violations accounted for 27 percent of total collisions, followed by improper turning (20 percent) and the unsafe speed (14 percent).
- For all injury collisions, 58 percent collisions were motor vehicles involved with other motor vehicles followed by motor vehicles involved with fixed objects (12%) and bicycles (11%).
- Also, 26 percent of total KSI collision involve people within the age group of 40 – 49 years.
- There were a total of 18 bicycle and pedestrian collisions during the study period, of which 11 were bicycle and 7 pedestrian collisions.
- The highest number of KSI collisions occurred within 250 feet of an intersection (89 percent).
- For 47 percent of all injury collision, the movement preceding crash was 'proceeding straight'. 17 percent were making left turn before crash happen.
- Of the total injury collisions, 30 percent of collisions occur during dusk-dawn or nighttime. This percentage increases to 47 percent when considering KSI collisions indicating poor lighting condition can be one of the major factor for KSI collision.

Additional detailed collision stats are summarized in the following pages.

Figure 6. Collision Trends – Collision Severity, Time of Collision

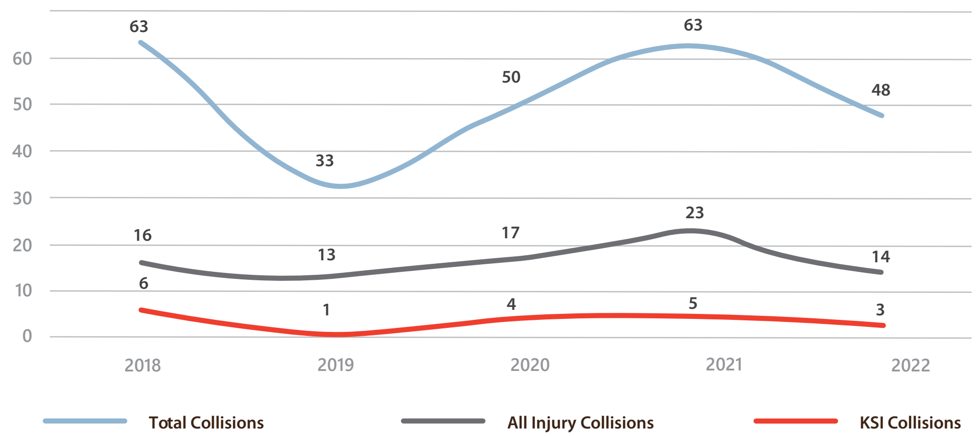
COLLISION SEVERITY



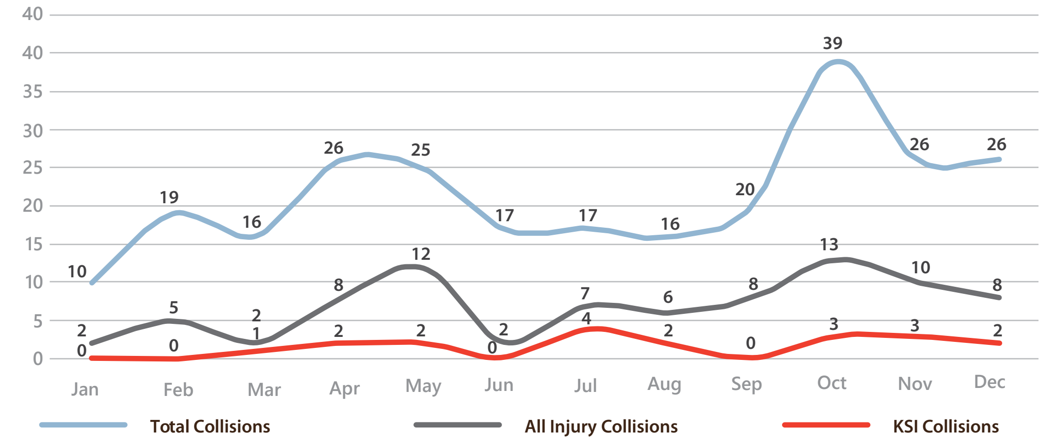
COLLISION SEVERITY

Collision Severity	Intersection	Roadway Segment	Total
Fatal	1	1	2
Severe Injury	1	16	17
Visible Injury	8	26	34
Complaint of Pain	7	23	30
Property Damage Only	33	141	174
Total	**50**	**207**	**257**

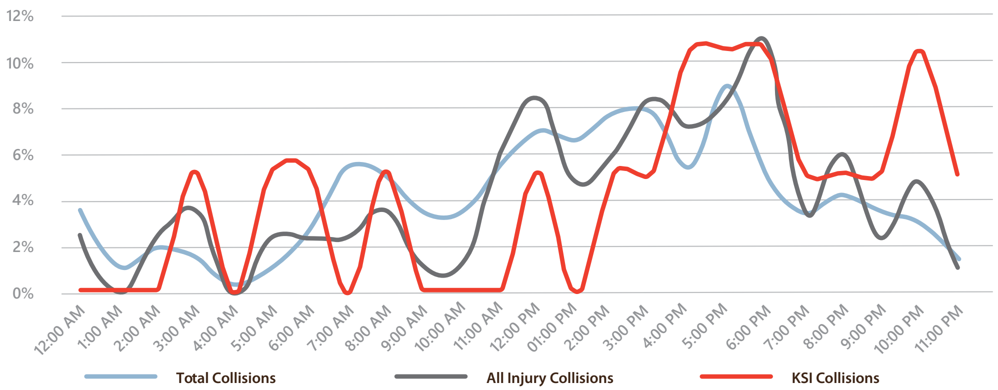
YEARLY COLLISION TREND



MONTHLY COLLISION TREND



HOURLY COLLISION TREND



WEEKLY COLLISION TREND

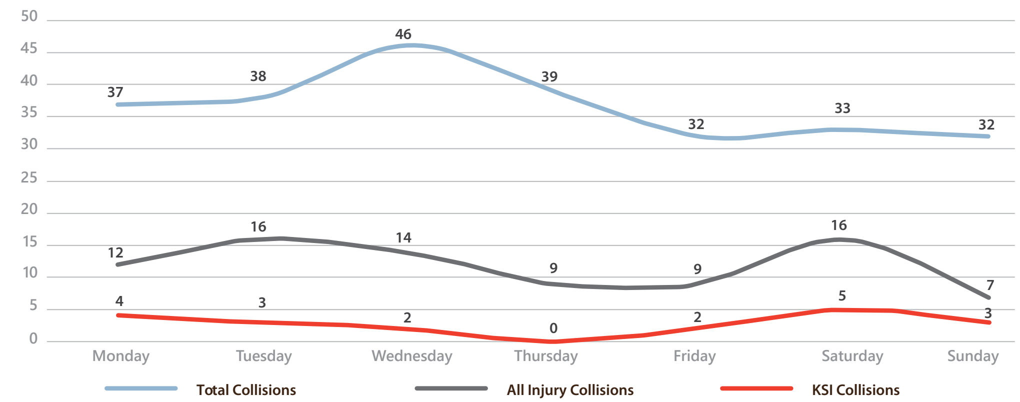


Figure 7. Collision Trends - Collision type, violations and other factors

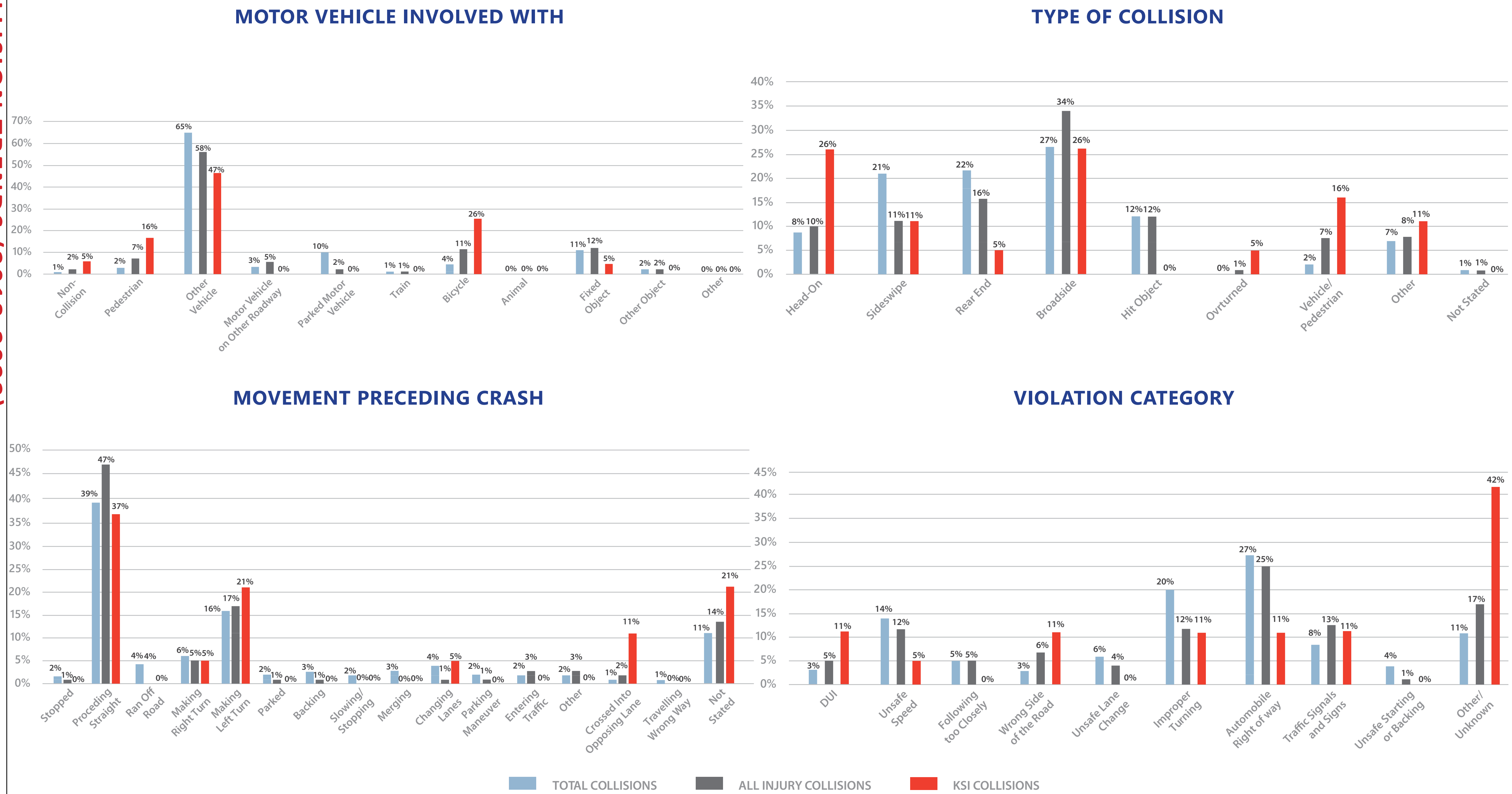
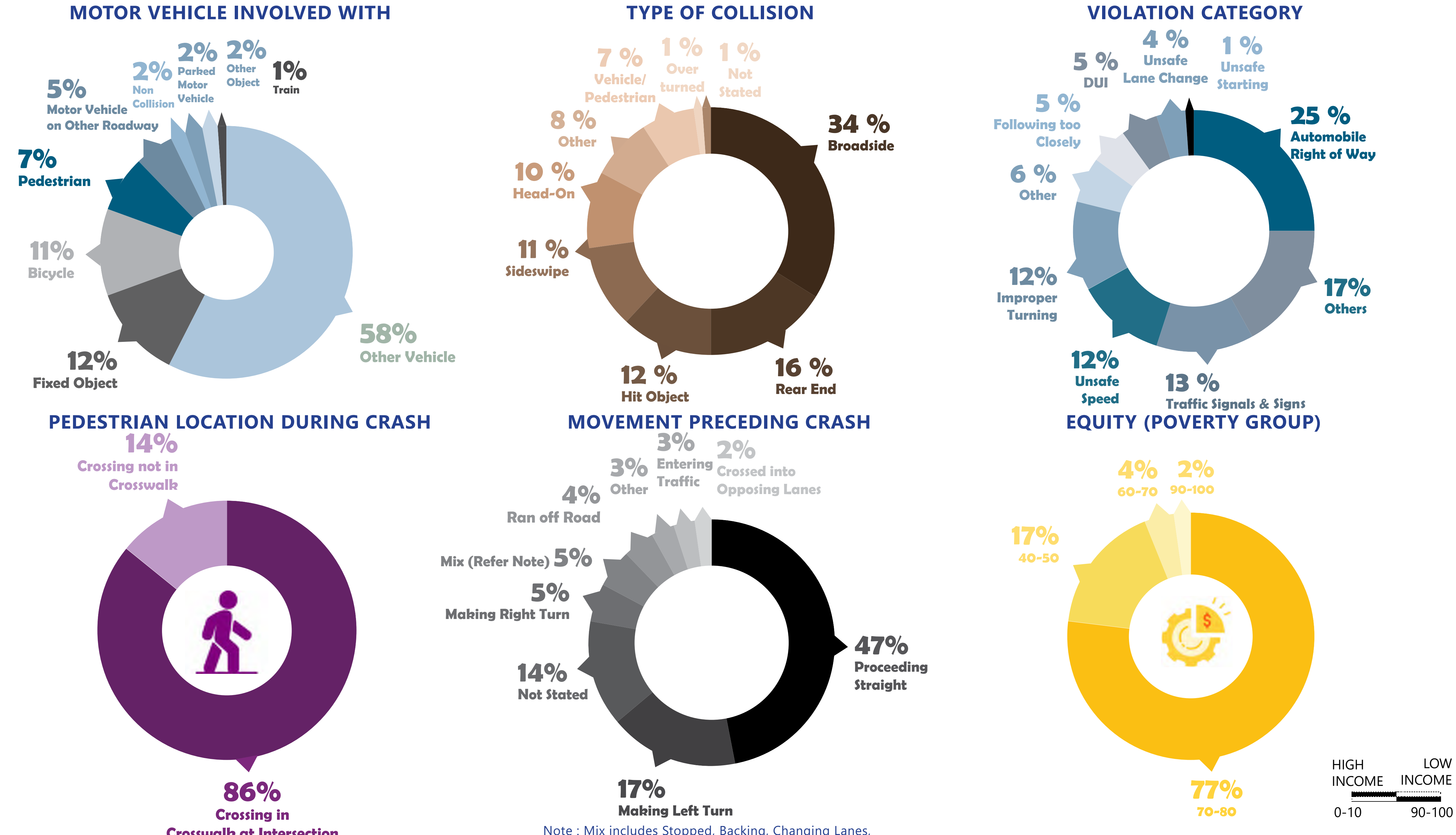


Figure 8. Collision Trends – Location type, lighting, weather, gender and age

	TOTAL COLLISIONS	ALL INJURY COLLISIONS	KSI COLLISIONS
Location	81%	80%	89%
	19%	20%	11%
Lighting Condition	70%	66%	53%
	4%	5%	0%
	20%	25%	47%
	6%	4%	0%
Weather Condition	90%	92%	95%
	4%	5%	0%
	4%	4%	5%
	3%	3%	0%

		TOTAL COLLISIONS	ALL INJURY COLLISIONS	KSI COLLISIONS
Gender		37%	43%	47%
		55%	56%	53%
	NOT STATED	8%	1%	0%
Age	< 15	1%	0%	0%
	15-19	12%	8%	0%
	20-29	22%	19%	21%
	30-39	17%	18%	21%
	40-49	12%	13%	26%
	50-59	11%	14%	16%
	60-69	9%	10%	16%
	> 70	7%	10%	16%
	NOT STATED	8%	1%	0%

Figure 9. All Injury Collision Trends



Note : Mix includes Stopped, Backing, Changing Lanes, Parking Maneuver, Parked (1% each)

COLLISION SEVERITY WEIGHT

Equivalent Property Damage Only (EPDO) method was used to identify the high-severity collision network. The EPDO method accounts for both the severity and frequency of collisions by converting each collision to an equivalent number of property damage only (PDO) collisions. The EPDO method assigns a crash cost and score to each collision according to the severity of the crash weighted by the comprehensive crash cost. These EPDO scores are calculated using a simplified version of the comprehensive crash costs per HSIP Cycle 11 application. The weights used in the analysis are shown below in Table 2.

Table 2. EPDO Score used in HSIP Cycle 11

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

*This is the score used in HSIP Cycle 11 for collisions on roadways segments, to simplify the analysis this study uses the same score for all KSI collisions regardless of location.

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

The EPDO scores for all collisions can then be aggregated in a variety of ways to identify collision patterns, such as location hot spots. The weighted collisions for the City of Gridley were geolocated onto Gridley's road network. GIS is then used to calculate the EPDO score for each roadway segment and intersection citywide, which is then ranked according to its score. **Figure 10** shows the location and geographic concentration of all collisions (those that occurred at intersections and along roadway segments) by their EPDO score.

HIGH INJURY NETWORK

Following the detailed collision analysis, the next step was to identify the high-injury roadway segments and intersections in Gridley. The methodology for scoring the high-injury locations is the same method that used in the collision severity weight section. **Figure 11** and **Figure 12** shows the top high-injury intersections and high-injury roadway segments.

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

Figure 10. City of Gridley EPDO Score

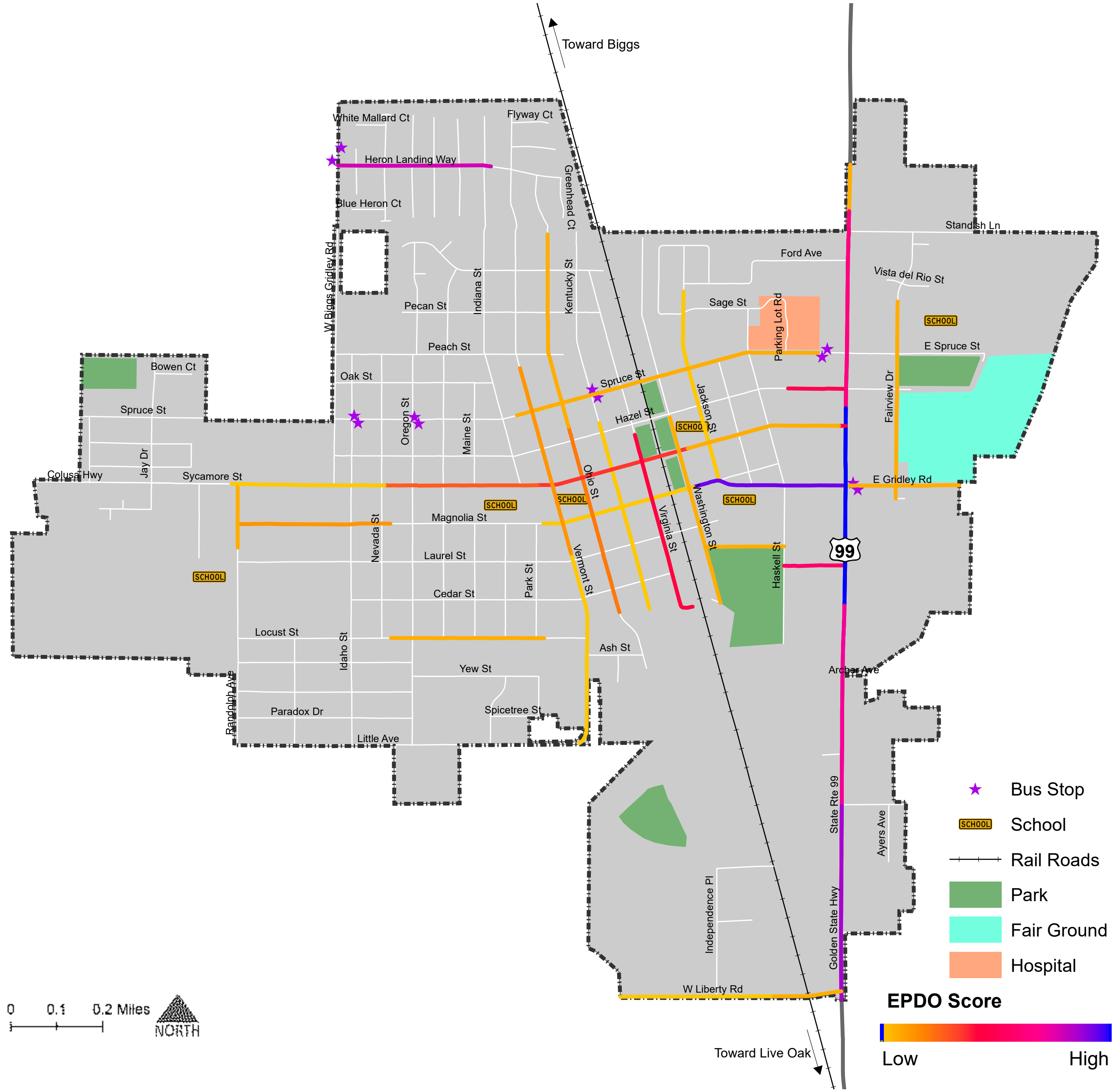
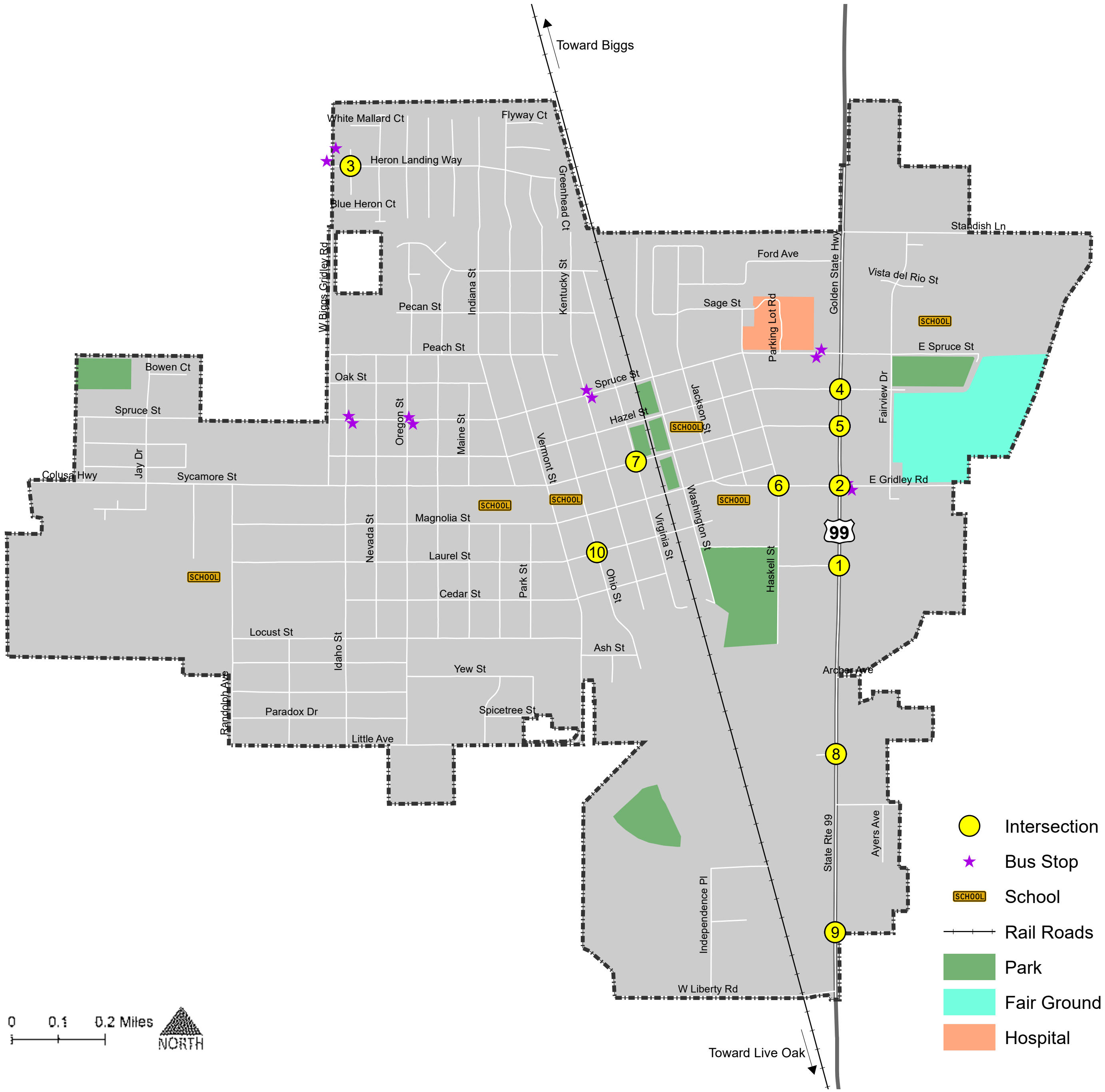


Figure 11. City of Gridley High Injury Intersection Rankings



INTERSECTION RANKINGS

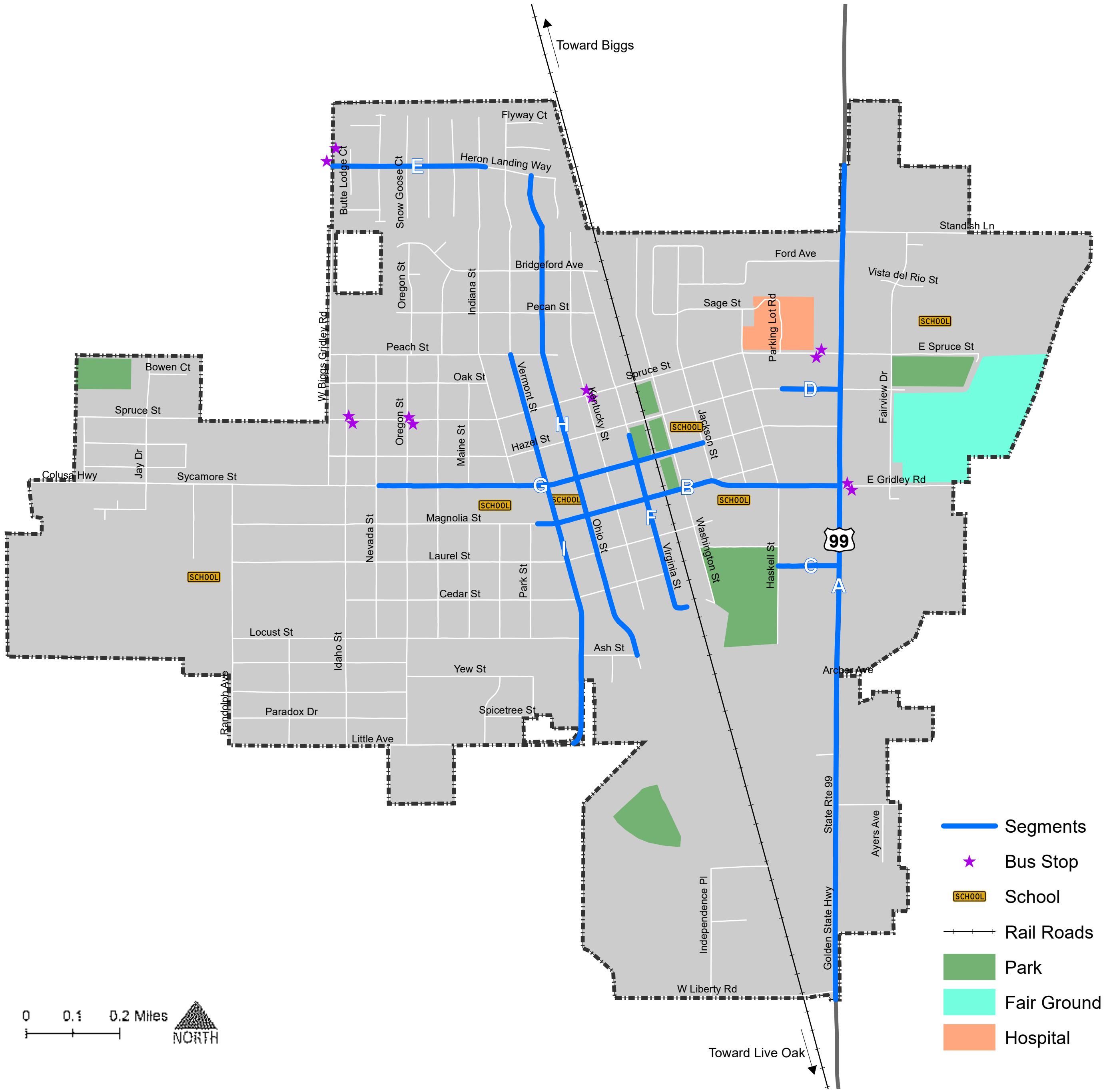
10 intersections were identified as high collision intersections. There were a total of 30 injury collisions and 14 KSI collisions that occurred at these intersections during the five-year study period (2018-2022). The intersection of SR 99 and Cherry St had the highest number of severe collisions.

Table 3 lists the top 10 identified high-risk intersections along with the number of injury collisions, the number of KSI collisions, and the severity weight for each intersection.

Table 3. High Injury Intersections

ID	Intersection	Total Injury	KSI Collisions	Severity Weight
1	SR 99 and Cherry St	10	4	711
2	SR 99 and Magnolia St/E Gridley St	7	2	380
3	Heron Landing Way and W Biggs Gridley Rd	2	2	330
4	SR 99 and Hazel St	3	1	182
5	SR 99 and Sycamore St	2	1	176
6	Magnolia St and Haskell St	1	1	165
7	Sycamore St and Virginia St	1	1	165
8	SR 99 and Evelyn Dr	1	1	165
9	SR 99 and Sheldon Ave	1	1	165
10	Laurel St and Ohio St	2	0	22

Figure 12. City of Gridley High Injury Roadway Segment Rankings



CORRIDOR RANKINGS

Nine corridors were identified as high-injury corridors. There were a total of 38 injury collisions and 12 KSI collisions on these corridors during the five-year study period (2018-2022). SR 99 corridor within city limits had the highest number of KSI collisions and total of 17 injury collisions.

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

Table 4. High Injury Corridors

ID	Corridor	Total Injury	KSI Collisions	Length (miles)	Severity Weight
A	SR 99: Within City Limits	17	7	1.6	1245
B	Magnolia St: SR 99 to Park St	6	1	0.62	210
C	Cherry St: SR 99 to Haskell St	3	1	0.12	182
D	Hazel St: SR 99 to Haskell St	2	1	0.17	171
E	Heron Landing Way: Indiana St to West City Limit	1	1	0.3	165
F	Virginia St: Hazel St to 350 ft. south of Cedar St	1	1	0.45	165
G	Sycamore St: Jackson St to Nevada St	2	0	0.6	22
H	Ohio St: Heron Landing Way to Ash St	3	0	1	33
I	Vermont St: Peach St to South City Limit	3	0	0.8	23

Emphasis Areas

Emphasis Areas are focus areas identified through analyzing the characteristics of collisions that have occurred in the City of Gridley within the last 5 years (2018-2022). Emphasis Areas help in identifying appropriate safety strategies and countermeasures that have the greatest potential to reduce collisions occurring at roadway segments and intersections.

This chapter summarizes six emphasis areas identified for the City of Gridley. These emphasis areas were derived by focusing on the collisions that have occurred on the high-injury network identified in the collision analysis for the City of Gridley.

There are a number of different approaches to traffic safety studies. Some methodologies focus more on a reactive and responsive approach and others focus on a more proactive systemic approach to traffic safety data. A reactive approach to road safety is based on the analysis of existing crash data. Road safety improvements proposed are considered in reaction to identified safety problems brought to light by crashes that have occurred after the road has been designed, and built, and opened. Traditional reactive road safety engineering processes include such activities as information collection and management (crash information systems), identification of problem locations on the road network, analysis, development, and implementation of countermeasures. The Hazard Elimination Program or a jurisdiction's high crash location list are examples of reactive approaches to crash frequency and/or severity reduction.

A proactive approach focuses on the evolving "Science of Safety", that is, what is known about the evolving specific safety implications of highway design and operations decisions. The proactive approach applies this knowledge to the roadway design process or to the implementation of improvement plans on existing roads to diminish the potential of crashes occurring prior to the road being built or reconstructed. The Empirical Bayes method is an example of such proactive traffic safety approach that attempts to predict future crashes based on roadway typologies. Most methodologies use a balance of both reactive and systemic safety approaches.

Based on the systemic safety analysis that helped identified high-injury intersections and roadway segments, the top risk factors and emphasis areas determined for traffic safety in the City of Gridley are as follows –

- Improve Intersection safety
- Address Broadside collisions
- Address Rear-end collisions
- Address Nighttime collisions
- Address Pedestrian and Bicycle collisions
- Address collisions on SR 99

The consolidated high-injury collision database can be found in **Appendix C**.

THE FIVE E'S OF TRAFFIC SAFETY

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

EXISTING TRAFFIC SAFETY EFFORTS IN THE CITY OF GRIDLEY

The City of Gridley already has previously prepared safety strategies corresponding to the 5 E's of traffic safety. The strategies detailed in this chapter can supplement these existing programs and concentrate them on high injury collision locations and crash types. These initiatives are summarized in **Table 5** below:

Table 5. Existing Programs Summary

Document/ Program	Description	E'S Addressed
City of Gridley Bicycle Plan (2011)	Gridley Bicycle Plan's planned implementation measures includes collaborating with schools and businesses to encourage bike to school or work, developing notification method to inform potential bicycle hazards, bicycling events and safety measures (Education programs, helmet laws, share-the-road), coordinating the training of children aged 5-12 on the safe use of bicycles. This plan also propose to improvement for safe conditions on road for pedestrian and bicycles such as class II bike lanes and new bicycle racks.	Engineering, Education
Butte County Safe Routes to School	The Butte County Safe Routes to School program works in schools throughout Butte County educating students on how to safely commute to school. This includes Bike rodeos which educates students on how to properly fit a helmet, maneuver through obstacles, ride in a straight line, use their hand signals, how to be a safe and predictable bicyclist. In-class sessions are also conducted on safe walk and riding to school.	Education

FACTORS CONSIDERED IN THE DETERMINATION OF EMPHASIS AREAS

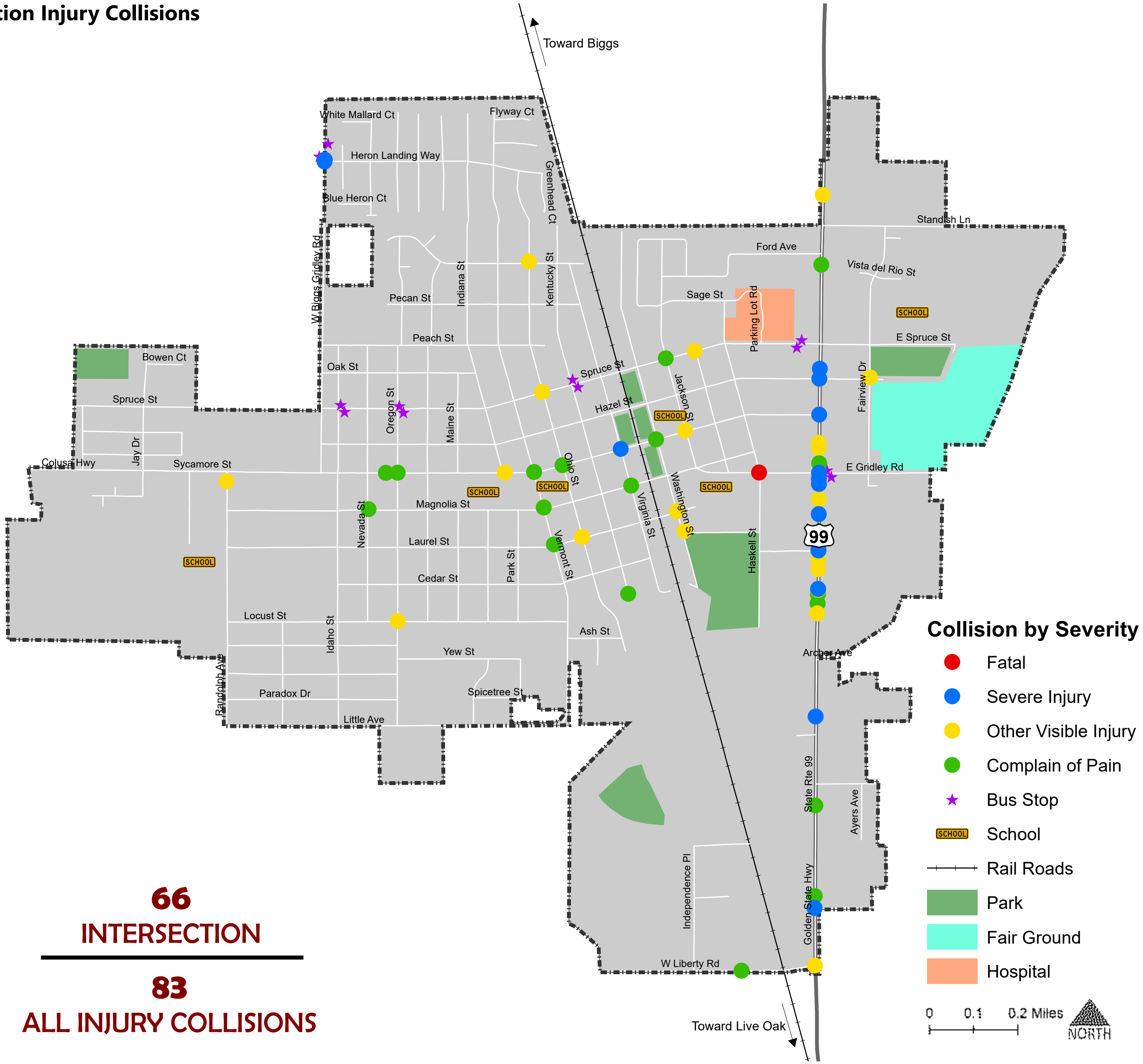
This section presents collision data analysis of collision type, collision factors, facility type, and roadway geometries, analyzed for the various emphasized areas. Emphasis areas were determined by factors that led to the highest amount of injury collisions, with a specific emphasis on killed or severely injured (KSI) collisions. The City of Gridley experienced a total of 66 injury collisions at high injury network locations during the 2018-2022 study period, including 18 killed or severely injured collisions. The data presented in each emphasis area is based on these collisions. This section also presents comprehensive programs, policies, and countermeasures to reduce collisions in specific emphasis areas.

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

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

Figure 13 thru **Figure 18** shows the geographical trends of each emphasis area and its correlation with other trends. **Table 6** thru **Table 11** enlists E strategies for each emphasis area, their performance measures, and applicable agencies. An excerpt of the Caltrans Local Roadway Safety Manual providing additional details on each countermeasure is included in **Appendix D**.

Figure 13. Intersection Injury Collisions



66
INTERSECTION

83
ALL INJURY COLLISIONS

COLLISION SEVERITY

Fatal = 2%
Severe Injury = 24%

COLLISION TYPE

Broadside = 35%
Sideswipe = 12%
Rear End = 12%

VIOLATION CATEGORY

Unsafe Speed = 11%
Auto ROW = 26%
Traffic Signals & Signs = 17%
Improper Turning = 11%

MVIW

Other Motor Vehicle = 56%
Bicycle = 14%

MOVEMENT PRE. CRASH

Making Left Turn = 14%
Proceeding Staright = 47%

VEHICLE AT FAULT

Passenger Car = 70 %
Panel Truck = 8 %
Bicycle = 9%

AGE GROUP

20-29 = 18%
30-39 = 21%
50-59 & 60-69 = 17%

LIGHTING CONDITION

Dark = 30%
Daylight = 70%

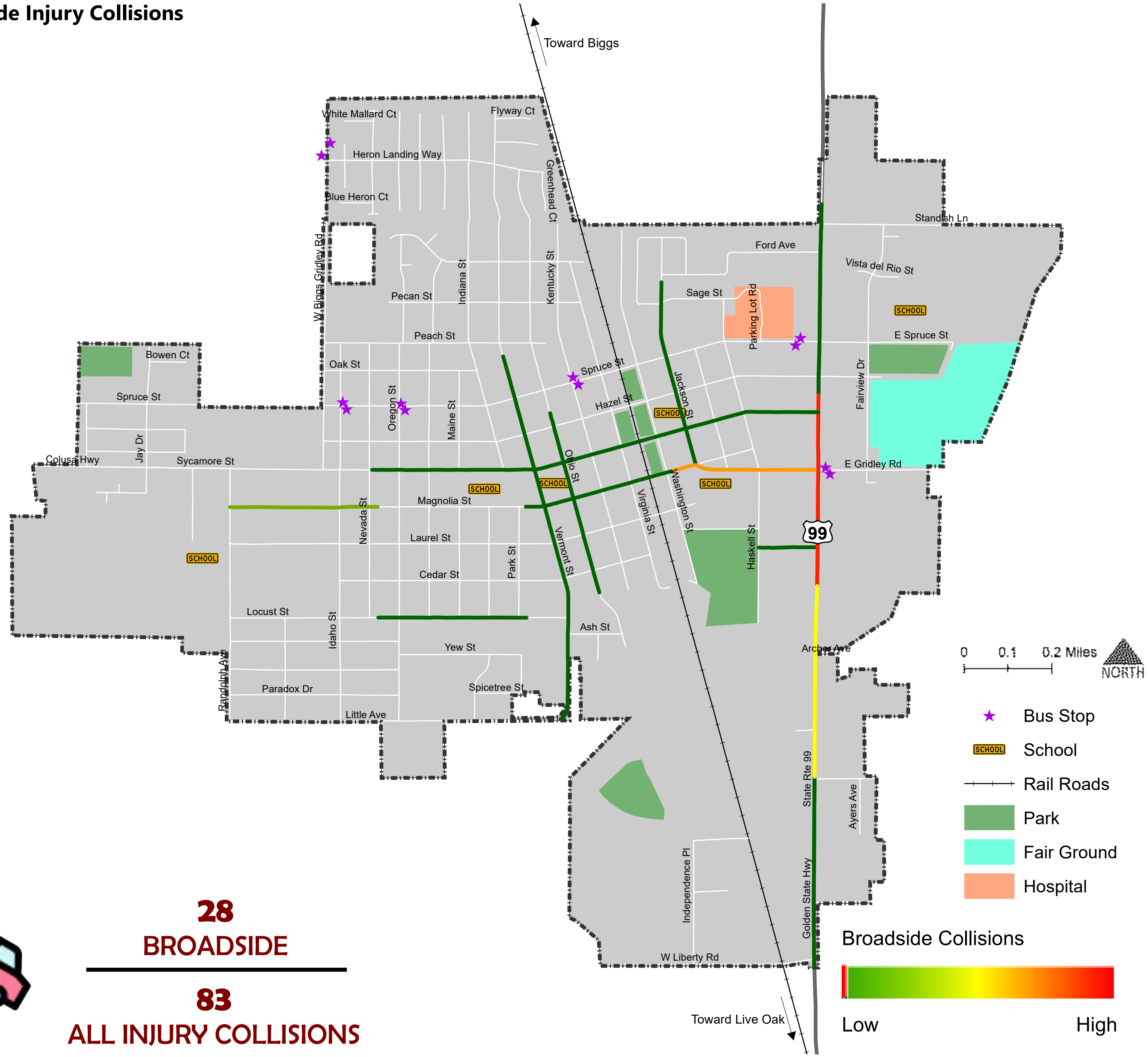
TIME

12:00 PM - 02:00 PM = 14%
02:00 PM - 04:00 PM = 17%

Table 6. Emphasis Area 1 – Improve Intersection Safety

Objective: Reduce the number of KSI collisions at intersections.			
	Strategy	**Performance Measure**	**Agencies/ Organizations**
Education	Conduct public information and education campaign for intersection safety laws regarding traffic signals, stop signs, and turning left or right.	Number of education campaigns or residents reached.	City/Police Department
Enforcement	Targeted enforcement at high-injury intersections to monitor right-of-way violations, traffic signal and sign violations that occur at intersections.	Decrease in number of citations and/or warnings issued over time due to increased driver compliance.	Police Department
Engineering	• S01/NS01, Add lighting • S02, Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number • S03, Improve signal timing • S09, Install raised pavement markers • S16/NS04/NS05, Convert intersection to roundabout • NS06, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs • NS07, Upgrade intersection pavement markings • NS08, Install Flashing Beacons at Stop-Controlled Intersections • NS09, Install flashing beacons as advance warning (Non-Signalized Intersection) (NS.I.) • NS10, Install transverse rumble strips on approaches • NS11, Improve sight distance to intersection (Clear Sight Triangles) • NS13, Install splitter-islands on the minor road approaches • NS14, Install raised median on approaches • NS19PB, Install raised medians (refuge islands) • Automated Red-light Enforcement	Number of locations improved.	City
EMS	S05, Install emergency vehicle pre-emption systems Improve resource of deployment for emergency responses to collision sites. Ensure emergency routes are clear and well defined	EMS vehicle response time.	City/Fire Department & EMS Response Teams

Figure 14. Broadside Injury Collisions



28
BROADSIDE

83
ALL INJURY COLLISIONS

COLLISION SEVERITY

Fatal = 0%
Severe Injury = 18%

VIOLATION TYPE

Auto ROW = 54%
Traffic Signals = 29%

MVIW

Motor Vehicle = 11%
Other Motor Vehicle = 82%

MOVEMENT PRE. CRASH

Making Left Turn = 25%
Proceeding Straight = 54%

LOCATION

Intersection = 82%
Roadway Segment = 18%

VEHICLE AT FAULT

Passenger Car = 86%
Panel Truck = 11%

AGE GROUP

20-29 = 25%
30-39 = 21%
40-49 = 21%

LIGHTING CONDITION

Dark = 36%
Daylight = 64%

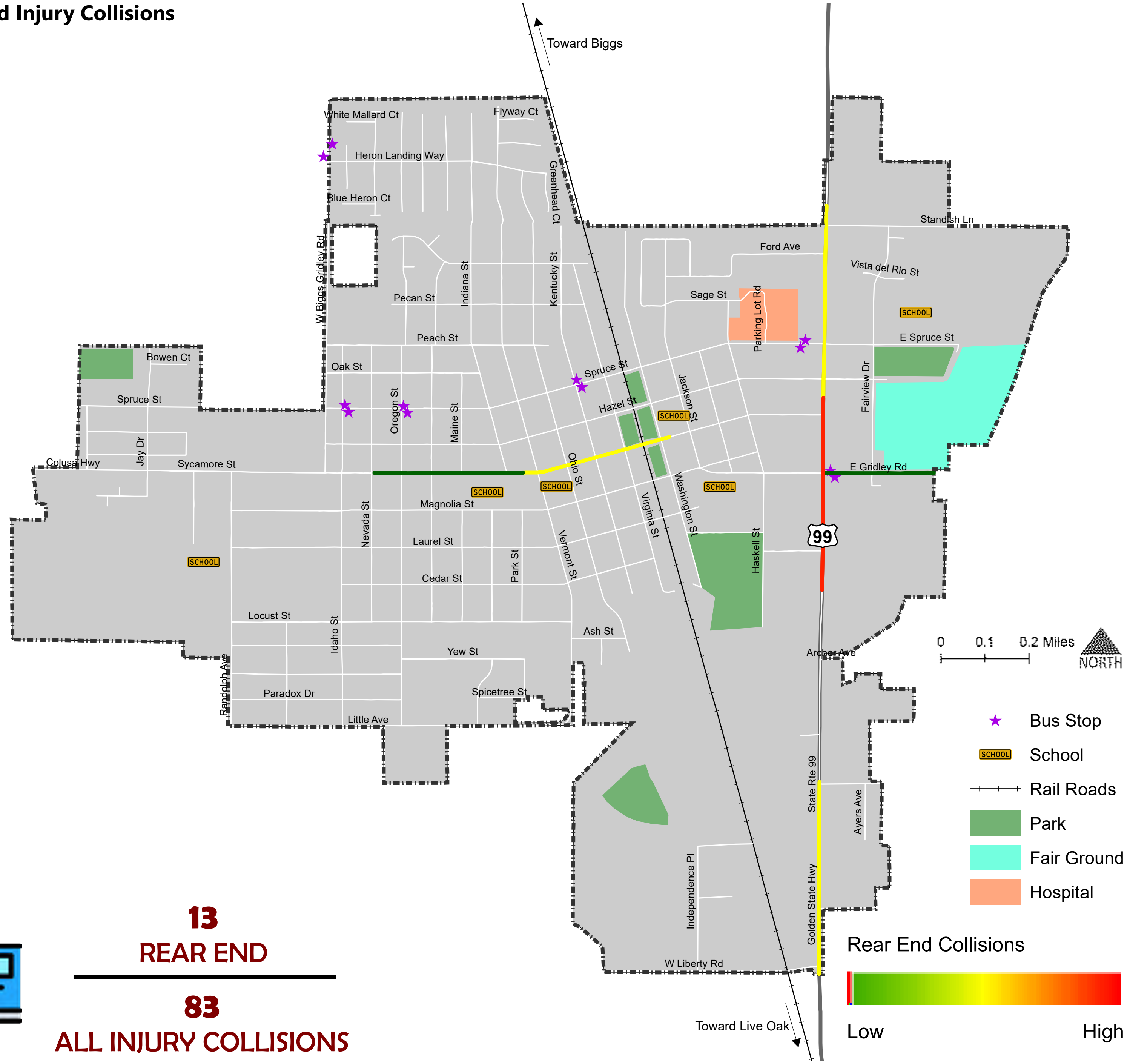
TIME

02:00 PM - 04:00 PM = 18%
04:00 PM - 06:00 PM = 21%

Table 7. Emphasis Area 2 - Address Broadside Collisions

Objective: Reduce the number of KSI broadside collisions.			
	Strategy	**Performance Measure**	**Agencies/ Organizations**
Education	Conduct public information and education campaigns for intersection safety laws regarding traffic lights, stop signs and turning left or right.	Number of education campaigns or residents reached.	City/Police Department
Enforcement	Targeted enforcement at high-injury locations where violations that lead to broadside collisions are more common, such as automobile right of way and traffic signal/stop sign violations.	Decrease in number of citations and/or warnings issued over time due to increased driver compliance.	Police Department
Engineering	• S02, Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number • S03, Improve signal timing (coordination, phases, red, yellow, or operation) • S07, Provide protected left turn phase (left turn lane already exists) • S08, Convert signal to mast arm (from pedestal-mounted) • S09, Install raised pavement markers and striping (Through Intersection) • S16/NS04/NS05, Convert intersection to roundabout • NS02, Convert to all-way STOP control (from 2-way or Yield control) • NS03, Install signals • NS06, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs • NS07, Upgrade intersection pavement markings (NS.I.) • NS08, Install flashing beacons at stop controlled intersections • NS09, Install flashing beacons as advance warning (NS.I.) • NS11, Improve sight distance to intersection (Clear Sight Triangles) • NS13, add splitter-islands on the minor road approaches • NS14, install raised median on approaches	Number of locations improved to mitigate broadside collisions.	City
EMS	S05, Install emergency vehicle pre-emption systems Improve resource of deployment for emergency responses to collision sites. Ensure emergency routes are clear and well defined	EMS vehicle response time.	City/Fire Department & EMS Response Teams

Figure 15. Rear-End Injury Collisions



13
REAR END

83
ALL INJURY COLLISIONS

COLLISION SEVERITY

Fatal = 0%
Severe Injury = 3%

VIOLATION TYPE

Unsafe Speed = 74%
DUI = 9%
Unsafe Starting/ Backing = 5%

MVIW

Bicycle = 20%
Other Motor Vehicle = 65%

MOVEMENT PRE. CRASH

Slowing/ Stopping = 8%
Proceeding Straight = 82%
Other Unsafe Turning = 3%

LOCATION

Intersection = 73%
Roadway Segment = 27%

VEHICLE AT FAULT

Passenger Car = 65%
Panel Truck = 20%

AGE GROUP

20-29 = 22%
30-39 = 16%
40-49 = 15%

LIGHTING CONDITION

Dark = 14%
Daylight = 83%

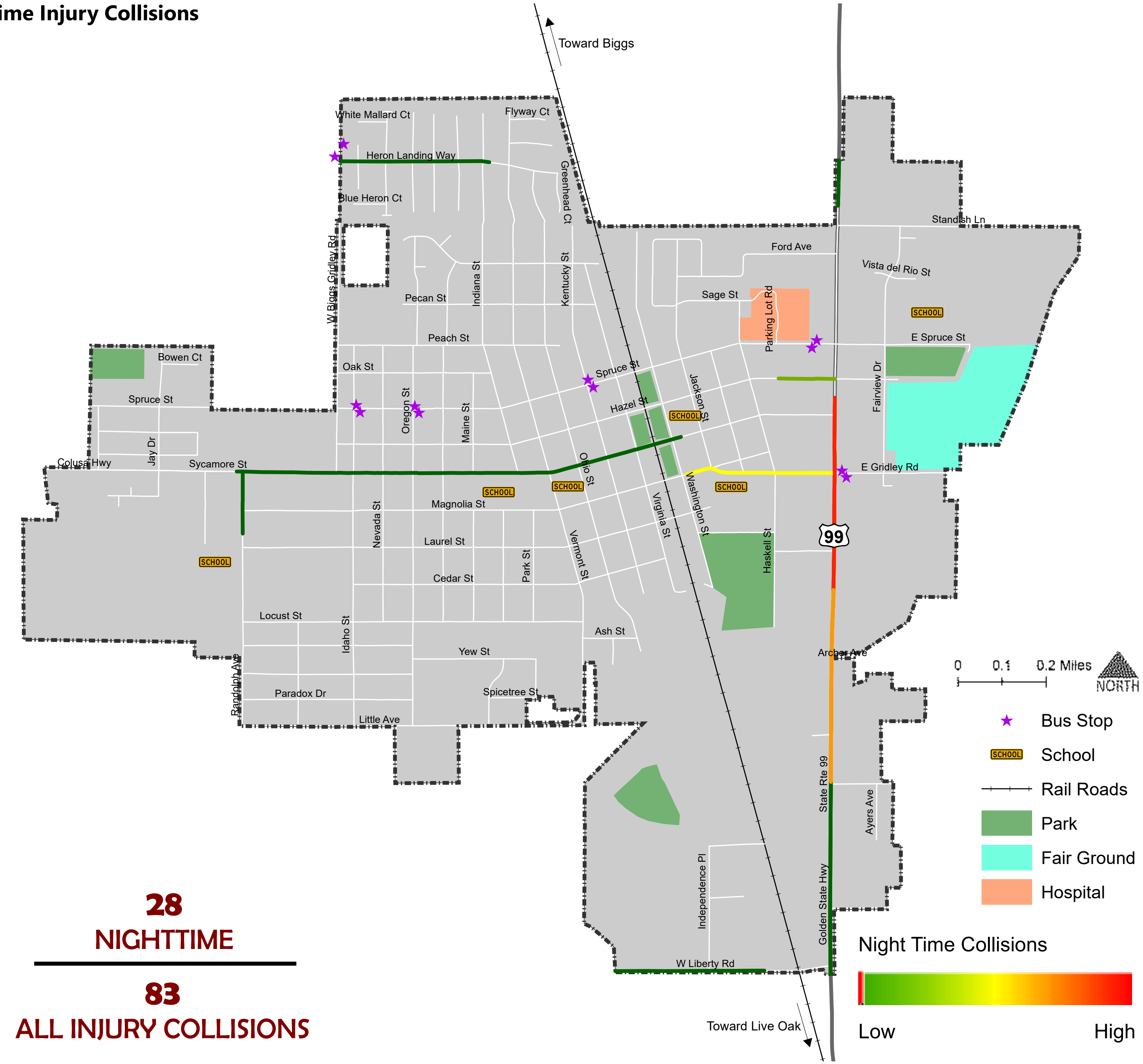
TIME

12:00 PM - 02:00 PM = 18%
02:00 PM - 04:00 PM = 19%
04:00 PM - 06:00 PM = 23%

Table 8. Emphasis Area 3 - Address Rear-End Collisions

Objective: Reduce the number of rear end injury collisions.			
	Strategy	**Performance Measure**	**Agencies/ Organizations**
Education	Conduct public information and education campaign for safety laws regarding unsafe speed, following too closely and improper turning and its dangers.	Number of education campaigns or residents reached.	City/ Police Department
Enforcement	Targeted enforcement at high-injury locations where unsafe speed violations and improper turning are more common. Deploy a radar trailer at locations where instances of unsafe speed is more prevalent	Decrease in number of citations and/or warnings issued over time due to increased driver compliance.	Police Department
Engineering	• S02, Improve signal hardware • S07, Improve pavement friction (High Friction Surface Treatments) • S09, Install raised pavement markers and striping (Through Intersection) • S10, Install flashing beacons as advance warning (S.I.) • S16/NS04/NS05, Convert intersection to roundabout • NS07, Upgrade intersection pavement markings (NS.I.) • NS08, Install Flashing Beacons at Stop-Controlled Intersections • R21, Improve pavement friction (High Friction Surface Treatments) • R22, Install/Upgrade signs with new fluorescent sheeting • R27, Install delineators, reflectors and/or object markers • R26, Install dynamic/variable speed warning signs • R28, Install edge-lines and centerlines • Decrease width of travel lanes. • Simplify turn configurations. • Decrease curb radius of intersections. • Traffic calming strategies where appropriate.	Number of locations improved.	City
EMS	S05, Install emergency vehicle pre-emption systems Improve resource of deployment for emergency responses to collision sites. Ensure emergency routes are clear and well defined	EMS vehicle response time.	City/Fire Department & EMS Response Teams

Figure 16. Nighttime Injury Collisions



28

NIGHTTIME

83

ALL INJURY COLLISIONS

COLLISION SEVERITY

Fatal = 7%
Severe Injury = 25%

VIOLATION CATEGORY

Auto ROW = 18%
Improper Turning = 11%
Unsafe Speed = 14%
Traffic Signals & Signs = 11%

COLLISION TYPE

Hit Object = 21%
Head On = 14%
Broadside = 36%

MVIW

Fixed Object = 21%
Other Motor Vehicle = 61%
Pedestrian = 11%

MOVEMENT PRE. CRASH

Ran off Road = 11%
Proceeding Straight = 39%
Making Left Turn = 25%

LOCATION

Intersection = 71%
Roadway Segment = 29%

VEHICLE AT FAULT

Passenger Car = 75%
Panel Truck = 11%

AGE

20-29 = 36%
40-49 = 14%
50-59 = 18%

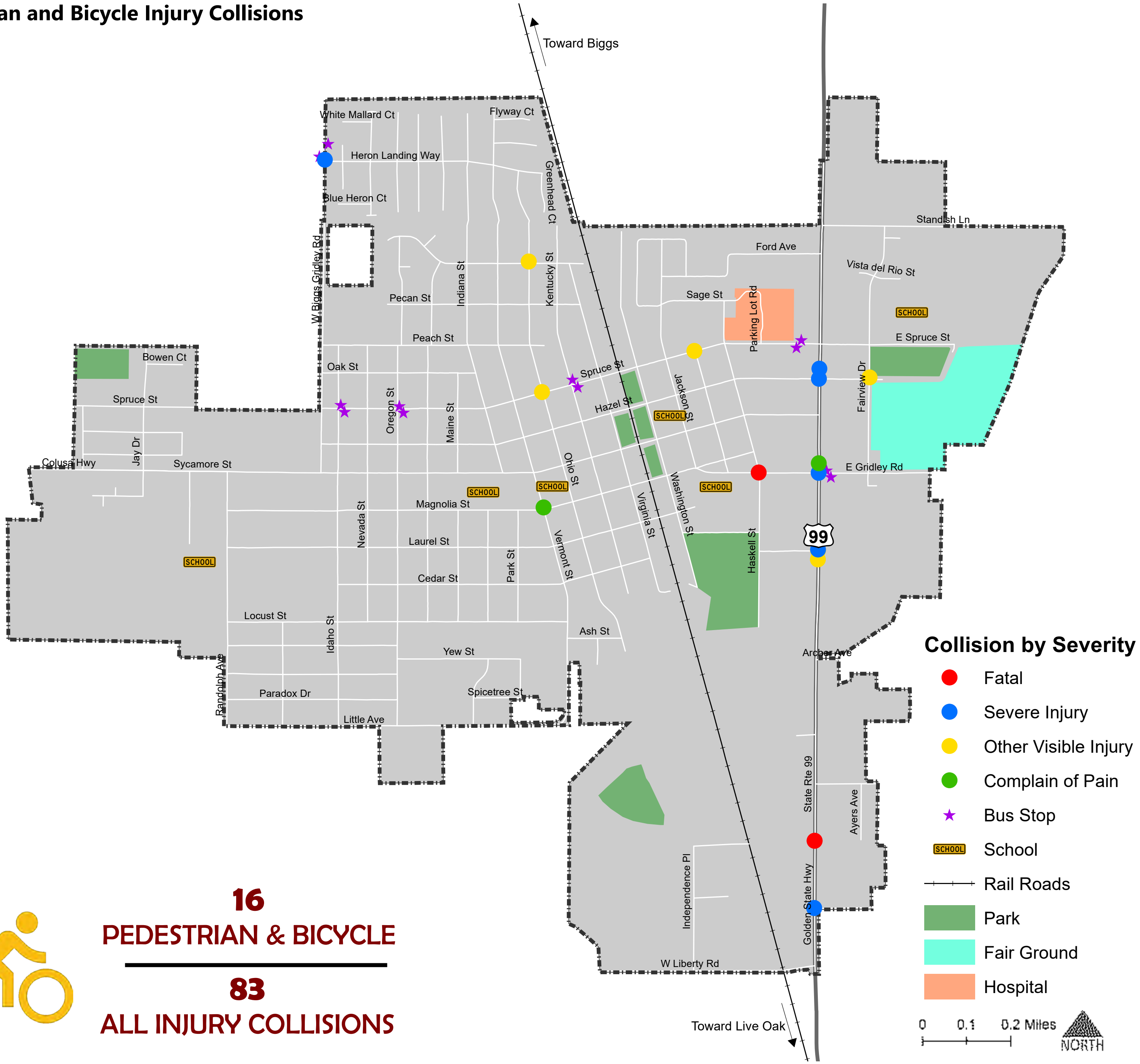
TIME

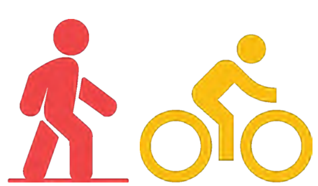
06:00 PM - 08:00 PM = 29%
08:00 PM - 10:00 PM = 25%
10:00 PM - 12:00 PM = 18%

Table 9. Emphasis Area 4 - Address Nighttime Collisions

Objective: Reduce the number of KSI collisions that occur at night or dawn/dusk.			
	Strategy	**Performance Measure**	**Agencies/ Organizations**
Education	Develop an awareness program to inform motorists of safe nighttime driving habits and the dangers of drunk driving, as well as high-injury collision locations and the most common violations/collision types occurring at night.	Number of education campaigns or residents reached.	City/Police Department
Enforcement	Targeted enforcement at high-injury intersections and roadway locations where nighttime collisions are more common. Establish DUI checkpoints at night and enforce over speeding where appropriate.	Decrease in number of citations and/or warnings issued over time due to increased driver compliance.	Police Department
Engineering	• S01/NS01, Add intersection lighting • S02, Improve signal hardware • S10, Install flashing beacons as advance warning (S.I.) • NS06, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs • NS07, Upgrade intersection pavement markings (NS.I.) • NS08, Install Flashing Beacons at Stop-Controlled Intersections • NS09, Install flashing beacons as advance warning (NS.I.) • NS22PB, Install Rectangular Rapid Flashing Beacon (RRFB) • R01, Add Segment Lighting • R02, Remove or relocate fixed objects outside of Clear Recovery Zone • R22, Install/Upgrade signs with new fluorescent sheeting (regulatory or warning) • R23, Install chevron signs on horizontal curves • R25, Install curve advance warning signs (flashing beacon) • 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.	City
EMS	S05, Install emergency vehicle pre-emption systems Improve resource of deployment for emergency responses to collision sites. Ensure emergency routes are clear and well defined	EMS vehicle response time.	City/Fire Department & EMS Response Teams

Figure 17. Pedestrian and Bicycle Injury Collisions





16
PEDESTRIAN & BICYCLE

83
ALL INJURY COLLISIONS

COLLISION SEVERITY

Fatal = 13%
Severe Injury = 38%

VIOLATION TYPE

Pedestrian ROW = 25%

COLLISION TYPE

Vehicle/ Pedestrian = 38%
Other = 38%

MVIW

Bicycle = 56%
Pedestrian = 38%
Train = 6%

MOVEMENT PRE. CRASH

Not Stated = 44%
Proceeding Straight = 31%
Making Left Turn = 19%

LOCATION

Intersection = 94%
Roadway Segment = 6%

VEHICLE AT FAULT

Passenger Car = 44%
Bicycle = 38%

AGE GROUP

30-39 = 25%
50-59 = 25%

LIGHTING CONDITION

Dark = 25%
Daylight = 75%

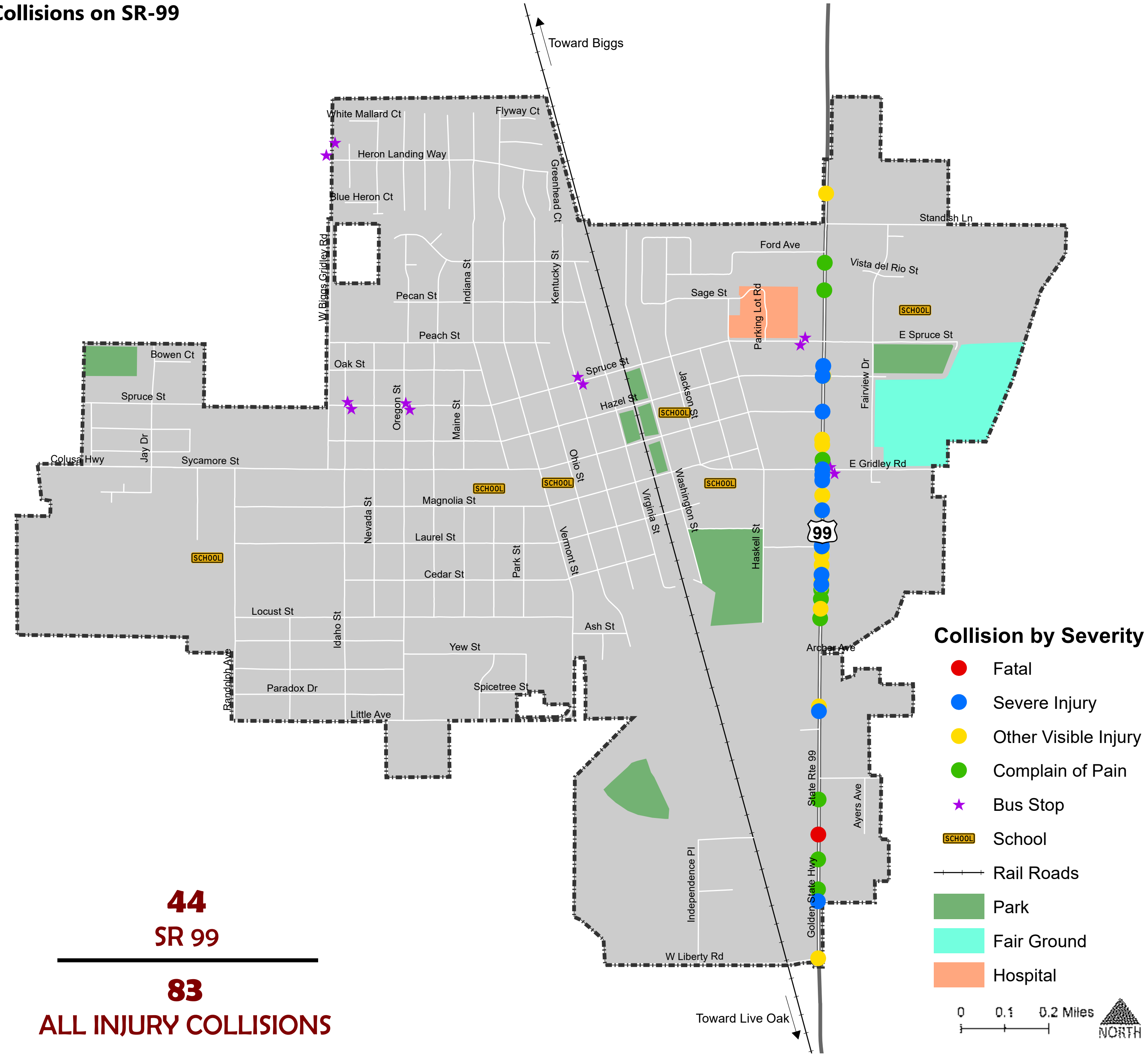
TIME

12:00 PM - 02:00 PM = 25%
02:00 PM - 04:00 PM = 25%
06:00 PM - 08:00 PM = 19%

Table 10. Emphasis Area 5 - Address Pedestrian and Bicycle Collisions

Objective: Reduce the number of KSI pedestrian and bicycle collisions.			
	Strategy	**Performance Measure**	**Agencies/ Organizations**
Education	Conduct pedestrian and bicycle safety campaigns and outreach to raise their awareness of traffic safety needs through media outlets, social media, and public events. Partner with Safe Routes to School to conduct bicycle and pedestrian safety programs in Gridley's schools.	Number of education campaigns or residents reached.	City/Police Department
Enforcement	Targeted enforcement at high-injury locations especially near schools, downtown Gridley, and other areas where pedestrians are more present. Continue to place a high priority on enforcement of motorist and pedestrian violations that most frequently cause injuries and fatalities among pedestrians.	Decrease in number of citations and/or warnings issued over time due to increased driver compliance.	Police Department
Engineering	• S17PB, Install pedestrian countdown signal heads • S18PB, Install pedestrian crossing (S.I.) • S20PB, Install advance stop bar before crosswalk (Bicycle Box) • S21PB, Modify signal phasing to implement a Leading Pedestrian Interval • NS07, Upgrade intersection pavement markings (NS.I.) • NS19PB, Install raised medians (refuge islands) • NS21PB/R35PB, Install/upgrade pedestrian crossing (with enhanced safety • features) • NS22PB, Install Rectangular Rapid Flashing Beacon (RRFB) • NS23PB, Install pedestrian signal (including Pedestrian Hybrid Beacon • (HAWK)) • R32PB, Install bike lanes • R36PB, Install raised pedestrian crossing • R37PB, Install Rectangular Rapid Flashing Beacons (RRFB) • High-visibility ladder crosswalks • Mid-block curb extension • In-road yield sign for pedestrian crossing at crosswalk • Intersection bulb-outs	Number of locations improved.	City
EMS	S05, Install emergency vehicle pre-emption systems Improve resource of deployment for emergency responses to collision sites. Ensure emergency routes are clear and well defined, particularly to areas and times of high pedestrian activity.	EMS vehicle response time.	City/Fire Department & EMS Response Teams

Figure 18. Injury Collisions on SR-99



44
SR 99

83
ALL INJURY COLLISIONS

COLLISION SEVERITY

Fatal = 2%
Severe Injury = 23%

VIOLATION TYPE

Auto ROW = 25%
Traffic Signals = 16%
Improper Turning = 14%

COLLISION TYPE

Broadside = 34%
Sideswipe = 16%
Rear End = 16%

MVIW

Motor Vehicle = 68%
Bicycle = 11%

MOVEMENT PRE. CRASH

Making Left Turn = 18%
Proceeding Straight = 39%

LOCATION

Intersection = 68%
Roadway Segment = 32%

VEHICLE AT FAULT

Passenger Car = 77%
Panel Truck = 7%

AGE GROUP

20-29 = 23%
30-39 = 14%

LIGHTING CONDITION

Dark = 36%
Daylight = 64%

TIME

04:00 PM - 06:00 PM = 16%
06:00 PM - 08:00 PM = 16%

Table 11. Emphasis Area 6 - Address Collisions on SR-99

Objective: Reduce the number of KSI collisions that occurred on SR-99.			
	Strategy	**Performance Measure**	**Agencies/ Organizations**
Education	Conduct public information and education campaign for safe driving habits, including the dangers of speeding and obeying traffic laws to specifically address broadside and automobile right of way violations on SR-99	Number of education campaigns or residents reached.	City/Police Department
Enforcement	Targeted enforcement at high-injury locations along SR-99 where automobile right of way, traffic signal and sign violations are more common.	Decrease in number of citations and/or warnings issued over time due to increased driver compliance.	Police Department/CHP
Engineering	• NS03, Install signals • NS07, Upgrade intersection pavement markings • NS09, Install flashing beacons as advance warning (NS.I.) • NS10, Install transverse rumble strips on approaches • NS11, Improve sight distance to intersection (Clear Sight Triangles) • NS07, Upgrade intersection pavement markings (NS.I.) • NS19PB, Install raised medians (refuge islands) • NS21PB/R35PB, Install/upgrade pedestrian crossing (with enhanced safety features) • R04, Install Guardrail • R27, Install delineators, reflectors and/or object markers • R31, Install edge line rumble strips/stripes • Traffic calming on SR-99 (e.g. pedestrian crossing enhancements, bulb outs, raised medians)	Number of locations improved.	Caltrans/City
EMS	S05, Install emergency vehicle pre-emption systems Improve resource of deployment for emergency responses to collision sites. Ensure emergency routes are clear and well defined Increase the number of EMS personnel taking Traffic Incident Management Training	EMS vehicle response time.	City/Fire Department & EMS Response Teams

Countermeasure Selection

IDENTIFICATION OF COUNTERMEASURES

Upon the identification of high-risk locations and Emphasis Areas, the next step was to identify appropriate safety countermeasures. The Caltrans LRSM provides 82 countermeasures, of which 21 are eligible in the current HSIP call for signalized intersections, 23 for un-signalized intersections, and 38 for roadway segments. The LRSM provides guidance on where to apply the countermeasures including the crash types each countermeasure would address, and a CRF for each countermeasure. The 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. Countermeasures were confirmed after review by City staff. Crash characteristics of all collisions occurring on the High Injury Network were considered. Additionally, the feedback from the community survey was also considered. After combining the physical and collision characteristics, the project team developed a table of preliminary countermeasures that address each of the identified emphasis areas. The table was refined by selecting up to five 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 City potential countermeasures for each location that can be implemented either in future HSIP calls for projects, or using other funding sources. Non-engineering countermeasures were also selected using the 4 E's strategies, and are included with the emphasis areas. The countermeasure toolbox in **Appendix E** details the 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 City a toolbox for implementing future safety improvements through other means, such as the City's Capital Improvement Program.

Table 12 provides a description of each potential countermeasure along with the crash reduction factor (CRF), federal funding eligibility, and opportunity for systemic implementation. An excerpt of the LRSM, detailing each available HSIP countermeasure referenced in the recommendations tables, is included as **Appendix D**.

Table 12. Potential Countermeasures selected for City of Gridley

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

Includes New LED lighting, signal back plates, retro-reflective tape outlining the back plates, or visors to increase signal visibility, larger signal heads, relocation of the signal heads, or additional signal heads.

Crash Type	All
CRF	15%
Expected Life (Years)	10
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Very High

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

Includes adding phases, lengthening clearance intervals, eliminating or restricting higher-risk movements, and coordinating signals at multiple locations.

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

S09. Install raised pavement markers and striping

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

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

S12. Install raised median on approaches

Raised medians next to left turn lanes at intersections offer a cost effective means for reducing crashes and improving operations at higher volume intersections

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

NS01. Add intersection lighting

Provision of lighting at intersection

Crash Type	All
CRF	15%
Expected Life (Years)	10
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Very High

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

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

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

NS03. Install signals

Installation of traffic signals

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

NS05. Convert intersection to roundabout (from stop or yield control on minor road)

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.

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

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

Additional regulatory and warning signs at or prior to intersections will help enhance the ability of approaching drivers to perceive them

Crash Type	All
CRF	15%
Expected Life (Years)	10
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Very High

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

Effective access management is key to improving safety at, and adjacent to, intersections. The number of intersection access points coupled with the speed differential between vehicles traveling along the roadway often contributes to crashes. Any access points within 250 feet upstream and downstream of an intersection are generally undesirable.

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

R01. Add segment lighting

Provision of lighting along roadways.

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

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

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

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

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

Additional or new signage can address crashes caused by lack of driver awareness or complaince of roadway signing.

Crash Type	All
CRF	15%
Expected Life (Years)	10
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Very High

R26. Install dynamic/variable speed warning signs

Includes the addition of dynamic speed warning signs (also known as Radar Speed Feedback Signs). Curvilinear roadways that have an unacceptable level of crashes due to excessive speeds on relatively sharp curves.

Crash Type	All
CRF	30%
Expected Life (Years)	10
Federal Funding Eligibility	90%
Systemic Approach Opportunity	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.

Crash Type	All
CRF	15%
Expected Life (Years)	10
Federal Funding Eligibility	90%
Systemic Approach Opportunity	Very High

R28. Install edge-lines and centerlines

Any road with a history of run-off-road right, head-on, opposite-direction-sideswipe, or run-off-road-left crashes is a candidate for this treatment -install where the existing lane delineation is not sufficient to assist the motorist in understanding the existing limits of the roadway. Depending on the width of the roadway, various combinations of edge line and/or center line pavement markings may be the most appropriate.

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

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

R31. Install edgeline rumble strips/stripes

Shoulder and edge line milled rumble strips/stripes should be used on roads with a history of roadway departure crashes.

Crash Type	All
CRF	15%
Expected Life (Years)	10
Federal Funding Eligibility	90%
Systemic Approach Opportunity	High

R32PB. Install bike lanes

Roadway segments noted as having crashes between bicycles and vehicles or crashes that may be preventable with a buffer/shoulder.

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

R33PB. Install Separated Bike Lanes

Separated bikeways are most appropriate on streets with high volumes of bike traffic and/or high bike-vehicle collisions, presumably in an urban or suburban area. Separation types range from simple, painted buffers and flexible delineators, to more substantial separation measures including raised curbs, grade separation, bollards, planters, and parking lanes.

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

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

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

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

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

Roadway segments with no controlled crossing for a significant distance in high-use midblock crossing areas and/or multilane roads locations. flashing beacons, curb extensions, medians and pedestrian crossing islands and/or other safety features should be added to complement the standard crossing elements.

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

R36PB. Install raised pedestrian crossing

On lower-speed roadways, where pedestrians are known to be crossing roadways that involve significant vehicular traffic.

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

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

Note: The pictures of countermeasures shown here are for illustration purposes only and does not reflect existing or future conditions.

Viable Safety Projects

This chapter summarizes the process of selecting safety projects as part of the analysis for Gridley's LRSP. The next step after the identification of high-injury 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 2022 LRSM from Caltrans, where:

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

The corresponding number refers to the countermeasure number in the LRSM (2022). The countermeasures were grouped into safety projects for high-risk intersections and roadway segments. A total of seven safety projects were developed. All countermeasures were identified based on the technical teams' assessment of viability that consisted of extensive analysis, observations, City staff input, and stakeholder/community input. The most applicable and appropriate countermeasures as identified have been grouped together to form projects that can help make high-risk locations safer.

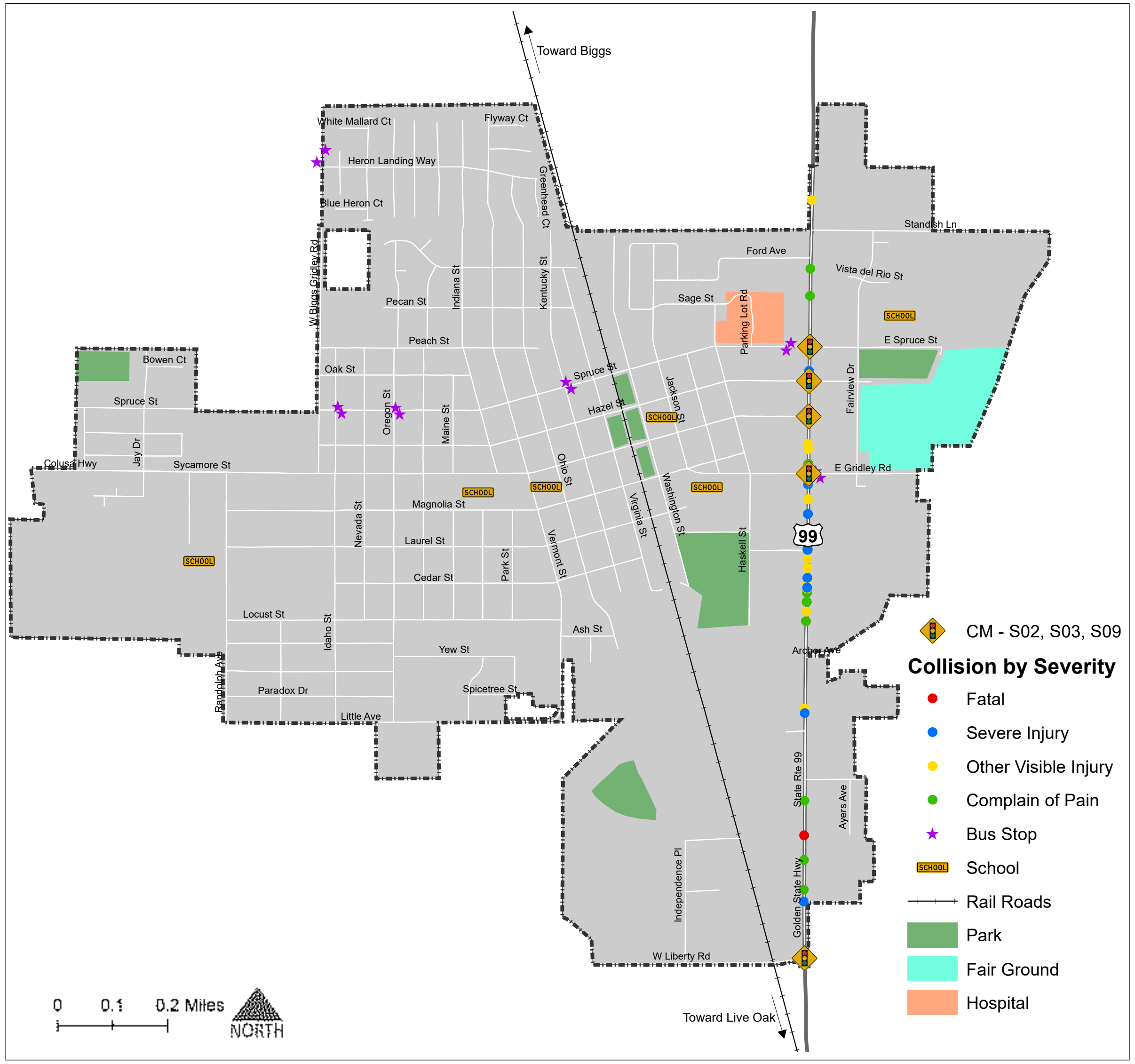
Figure 19 thru 25 shows each of the safety projects for high-risk intersections and roadway segments, along with total base planning level cost estimates (2023 dollar amounts) and the resultant preliminary Benefit-Cost (B/C) Ratio. An example of proposed improvements is also included for one of the intersections or roadway segments listed in the Safety Projects. **Table 13** summarizes all safety projects with proposed improvements, related costs and 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 (2022).

Appendix F includes HSIP analyzer sheets which contains detailed methodology to calculate B/C Ratio for each project, as well as the complete cost, benefit and B/C Ratio calculation. **Appendix G** includes the example of design exhibits for each Safety Project.

These safety projects were chosen based on the previously completed collisions analysis, which was used to identify main collision attributes that were found to be leading factors of fatal and severe collisions in Gridley. In addition to this, several other potential high risk locations were identified from the community survey comments, stakeholder and city staff input and added to safety projects.

The next step in the process will be to secure grant funding for the recommended safety projects. One of the popular grant funding opportunity for safety projects is through the Highway Safety Improvement Program (HSIP). However, it should be noted that while the LRSP projects are based on high-risk locations, HSIP applications can be expanded to include many locations across the city, which is reflected in citywide improvement projects such as Project 1, 4 and 5. TJKM can work with the City to identify additional locations that may be beneficial to add to the HSIP application and calculate the B/C Ratio.

Figure 19. Safety Project 1



Sr. No	Locations	CM1	CM2	CM3
1	SR 99 and Magnolia St	S02	S03	S09
2	SR 99 and Sycamore St	S02	S03	S09
3	SR 99 and Hazel St	S02	S03	S09
4	SR 99 and Spruce St	S02	S03	S09
5	SR 99 and W Liberty Rd	S02	S03	S09

Safety Project 1 : Citywide Signal Update

TOTAL PROJECT COST	TOTAL EXPECTED BENEFIT	BENEFIT COST RATIO (BCR)
$ 391,400	$ 7,231,089	18.47

PROPOSED COUNTERMEASURES

S02

Improve Signal Hardware

S03

Improve signal timing

S09

Install raised pavement markers and striping

MAGNOLIA ST/ E GRIDLEY RD & SR 99

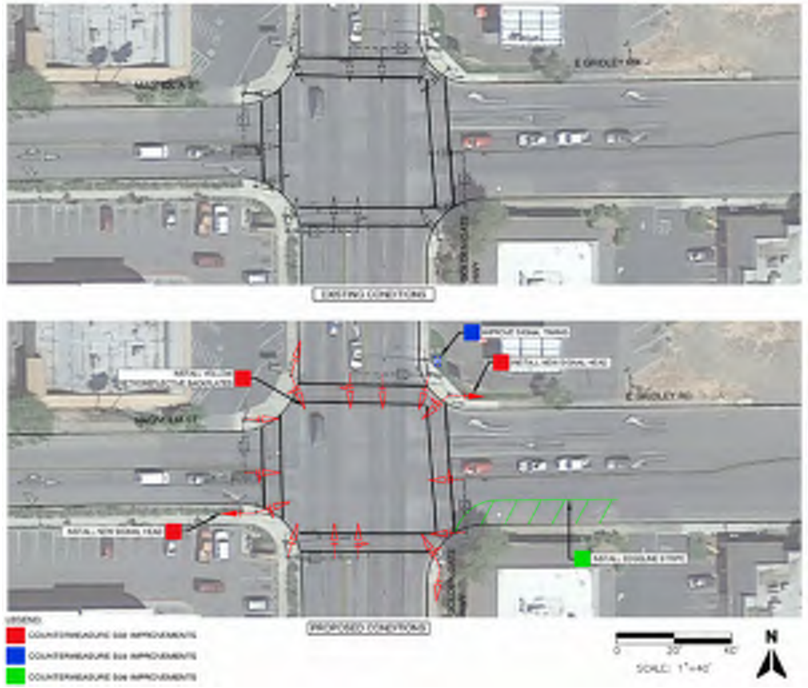
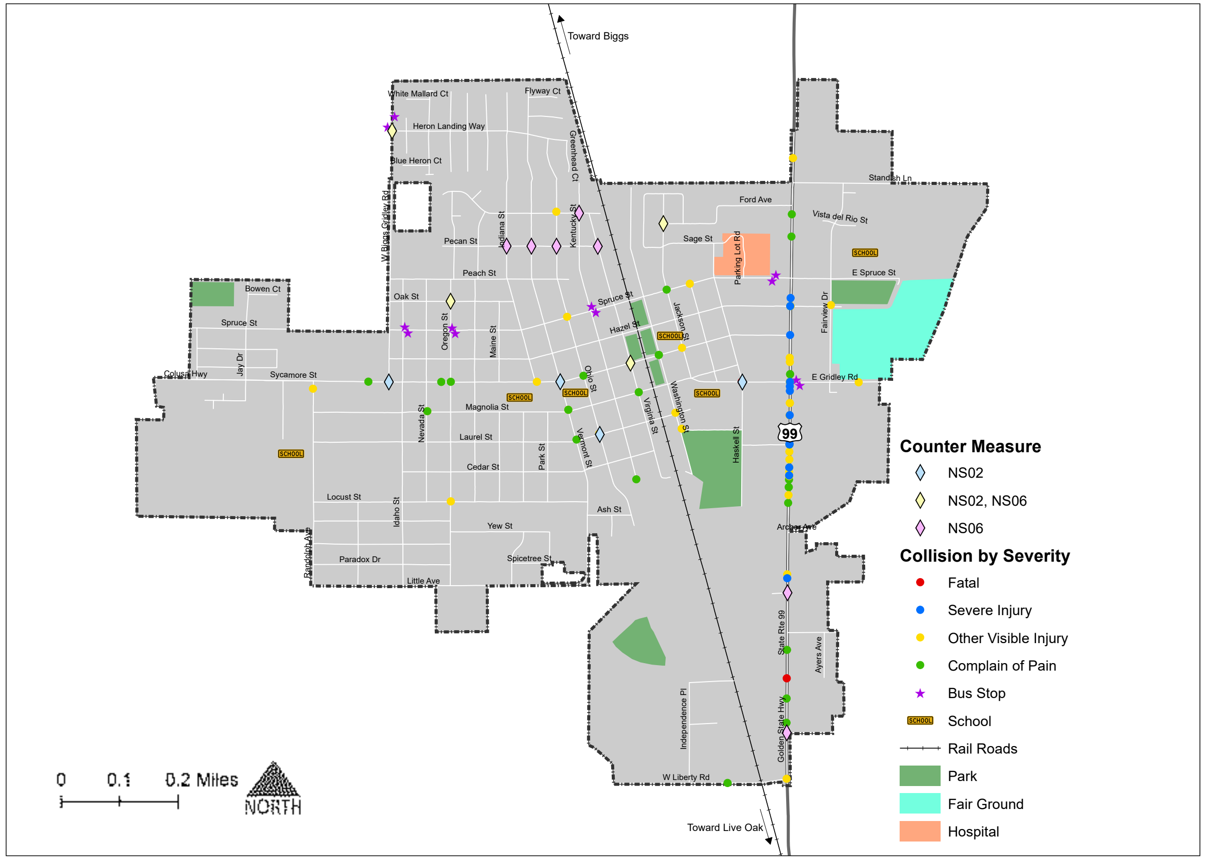


Figure 20. Safety Project 2



Sr. No	Locations	CM1	CM2	CM3
5	Magnolia St and Haskell St	NS02		
6	Sycamore St and Virginia St	NS02	NS06	
7	Heron Landing Way and W Biggs Gridley Rd	NS02	NS06	
8	SR 99 and Evelyn Dr		NS06	
9	SR 99 and Sheldon Ave		NS06	
10	Laurel St and Ohio St	NS02		
11*	Jackson St and Ford Ave	NS02	NS06	
15*	Virginia St and Pecan St		NS06	
16*	Kentucky St and Bridgeford Ave		NS06	
17*	Vermont St and Pecan St		NS06	
18*	Vermont St and Sycamore St	NS02		
22*	Oregon St and Oak St	NS02	NS06	
24*	Sycamore St and W Biggs Gridley Rd	NS02		
25*	Ohio St and Pecan St		NS06	
26*	Indiana St and Pecan St		NS06	

Safety Project 2 : Safety at Unsignalized Intersections

TOTAL PROJECT COST	TOTAL EXPECTED BENEFIT	BENEFIT COST RATIO (BCR)
$ 163,400	$ 11.546,665	70.67

PROPOSED COUNTERMEASURES

NS02

Convert to all-way STOP control

NS06

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

SYCAMORE ST & VIRGINIA ST

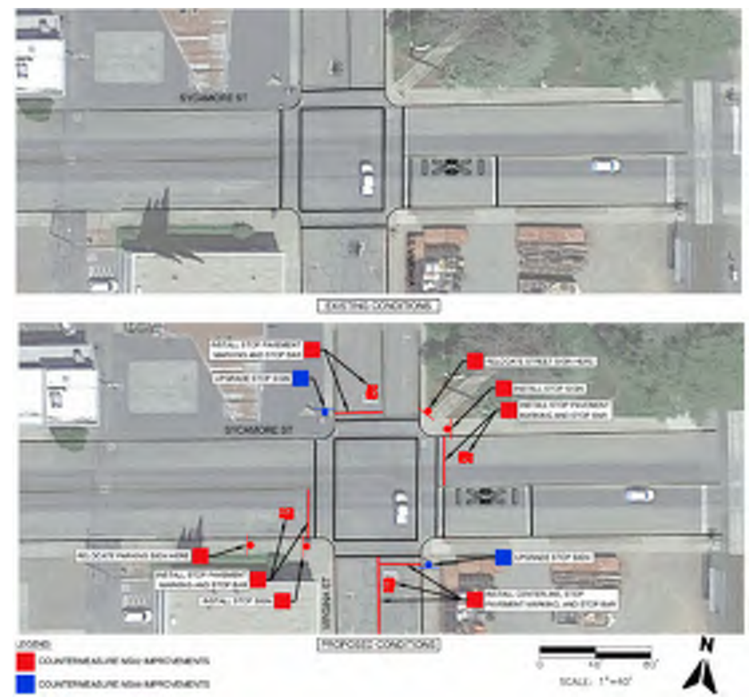
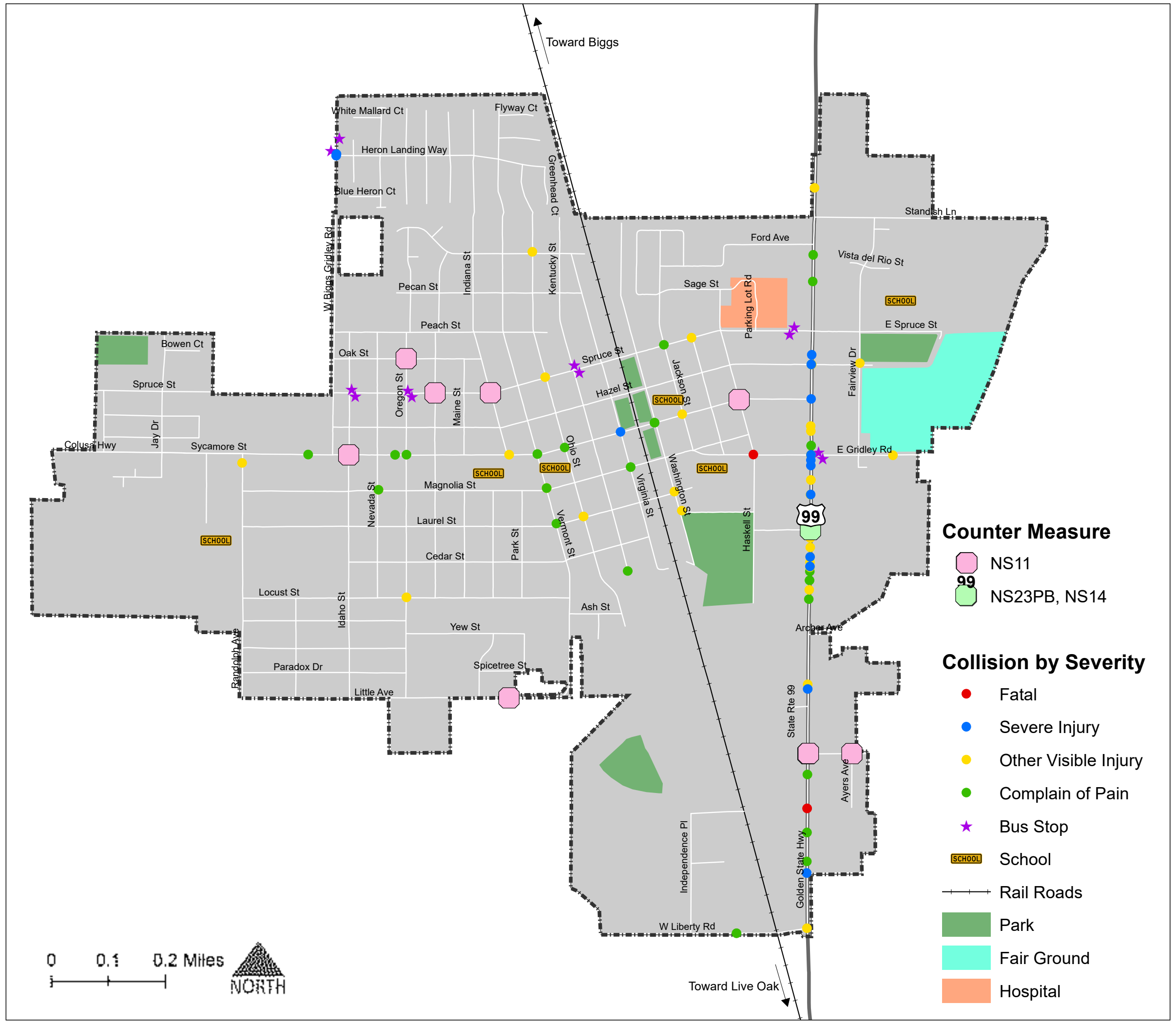


Figure 21. Safety Project 3



Sr. No	Locations	CM1	CM2	CM3
1	SR 99 and Cherry St	NS23PB		NS14
12*	Obermayer Ave and Ayers Ave		NS11	
14*	Sycamore St and Haskell St		NS11	
19*	Little Ave and Losser Ave		NS11	
20*	Indiana St and Spruce St		NS11	
21*	California St and Spruce St		NS11	
23*	Sycamore St and Idaho St		NS11	
22*	Oregon St and Oak St		NS11	

Safety Project 3 : Safety at Unsignalized Intersection

TOTAL PROJECT COST	TOTAL EXPECTED BENEFIT	BENEFIT COST RATIO (BCR)
$ 499,000	$ 14,591,500	29.24

PROPOSED COUNTERMEASURES

NS23PB

Install Pedestrian Signal

NS11

Improve sight distance to intersection

NS14

Install raised median on approaches

CALIFORNIA ST & SPRUCE ST

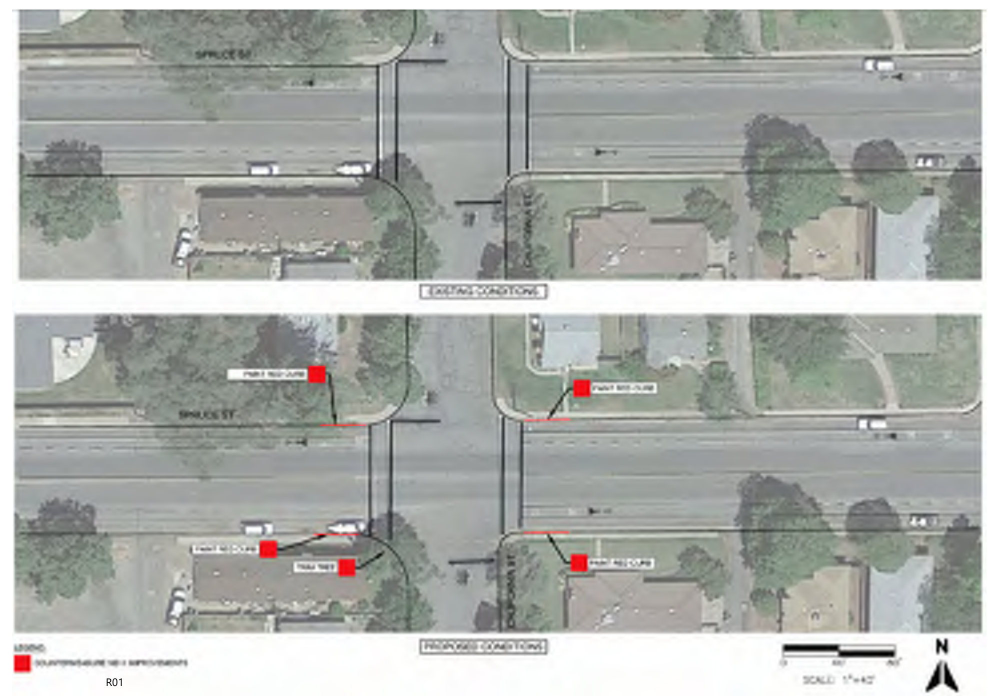
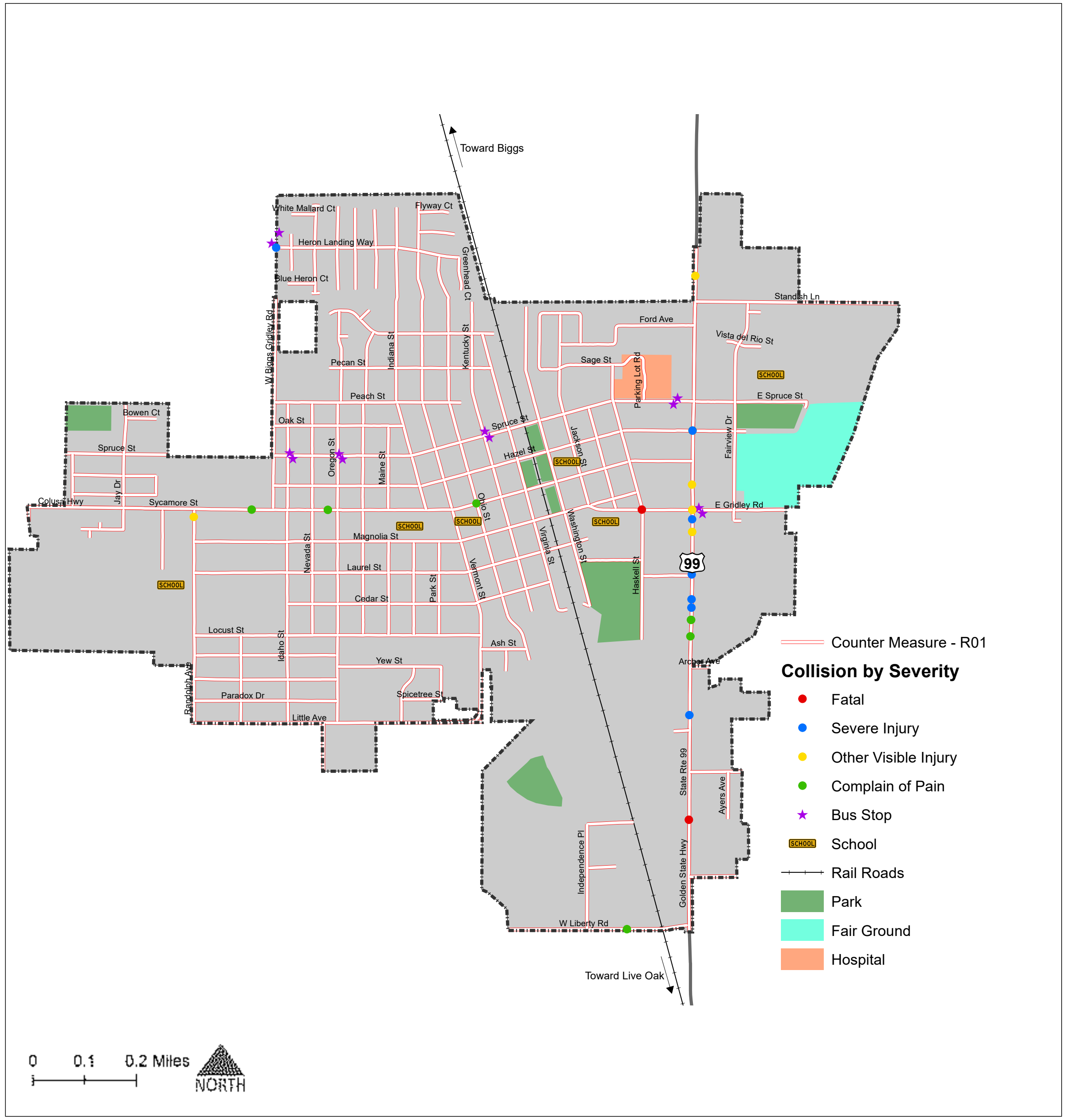


Figure 22. Safety Project 4



Sr. No	Locations	CM1	CM2	CM3
A	Citywide Road Segments	R01		

Safety Project 4 : Citywide Lighting

TOTAL PROJECT COST	TOTAL EXPECTED BENEFIT	BENEFIT COST RATIO (BCR)
$ 1,633,700	$ 35,297,220	21.61

PROPOSED COUNTERMEASURES

R01

Add segment lighting

W BIGGS GRIDLEY RD & HERON LANDING WAY

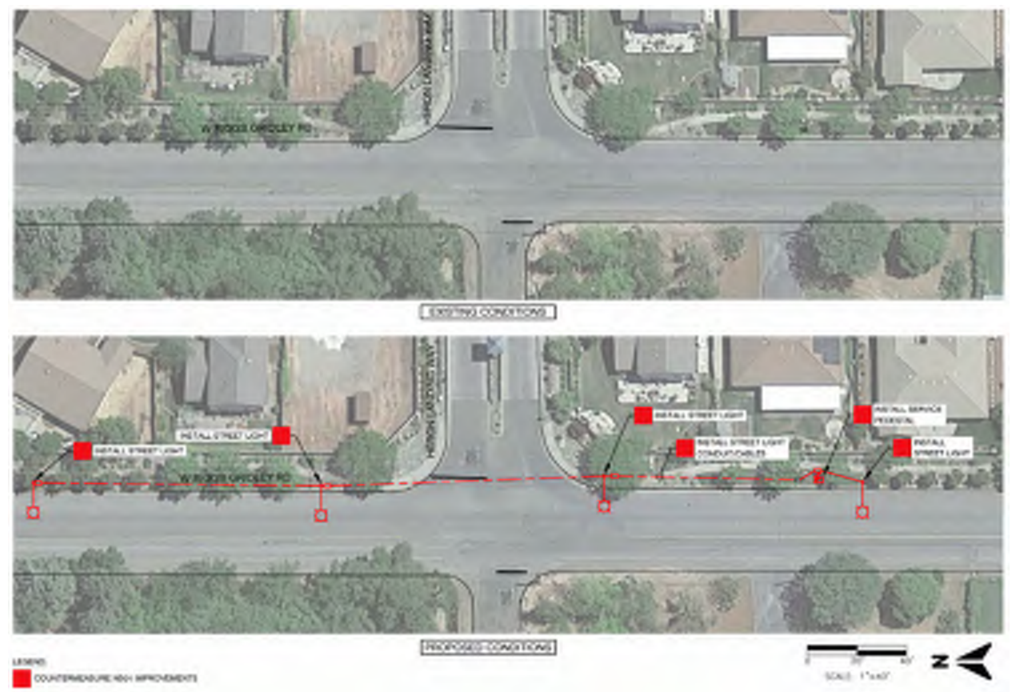
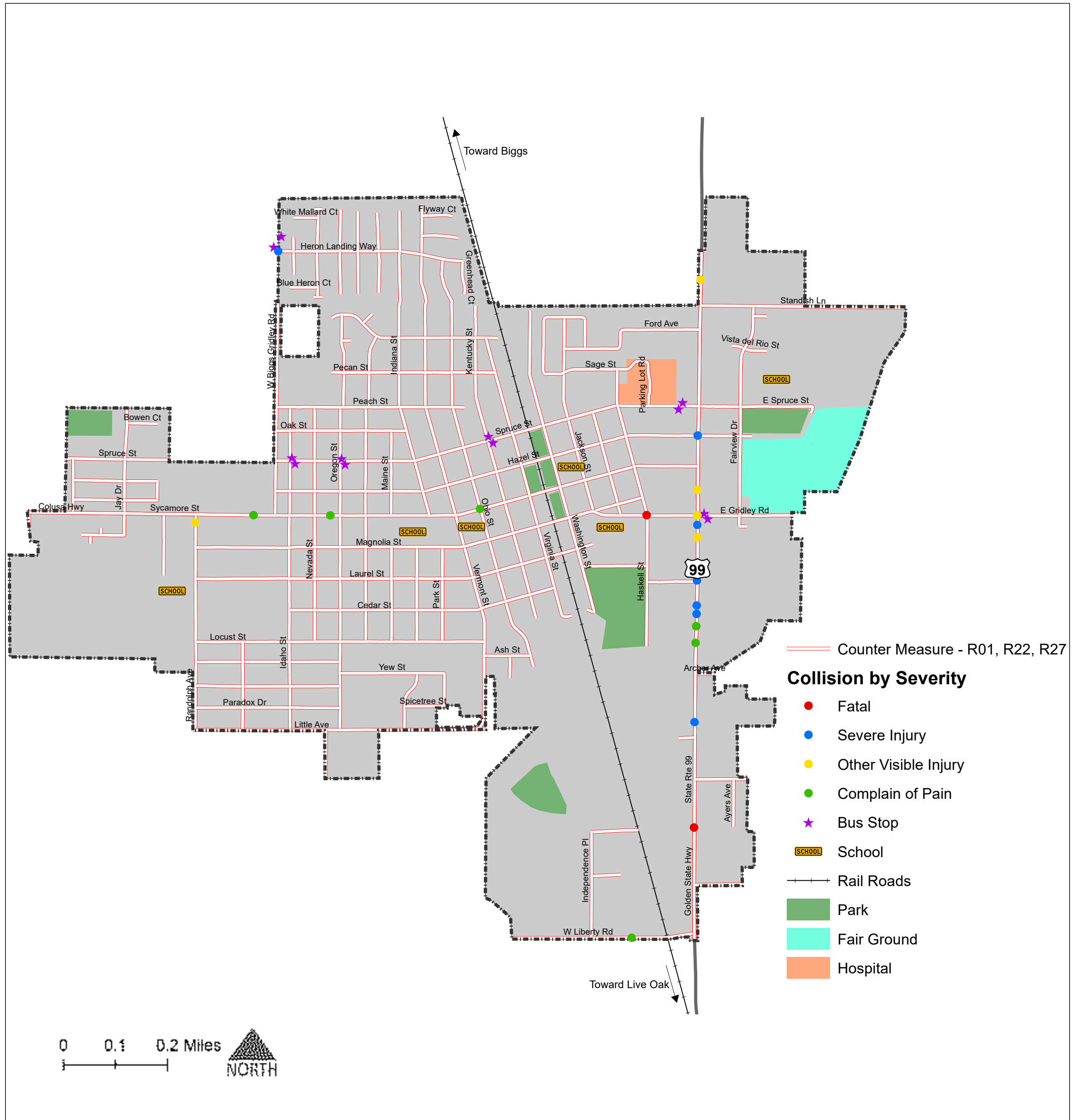


Figure 23. Safety Project 5



Sr. No	Locations	CM1	CM2	CM3
A	Citywide Road Segments	R22	R27	

Safety Project 5 : Citywide Sign Upgrade

TOTAL PROJECT COST	TOTAL EXPECTED BENEFIT	BENEFIT COST RATIO (BCR)
$ 183,500	$ 8,836,156	48.15

PROPOSED COUNTERMEASURES

R22

Install/Upgrade signs with new fluorescent sheeting

R27

Install delineators, reflectors and/or object markers

STATE ROUTE 99

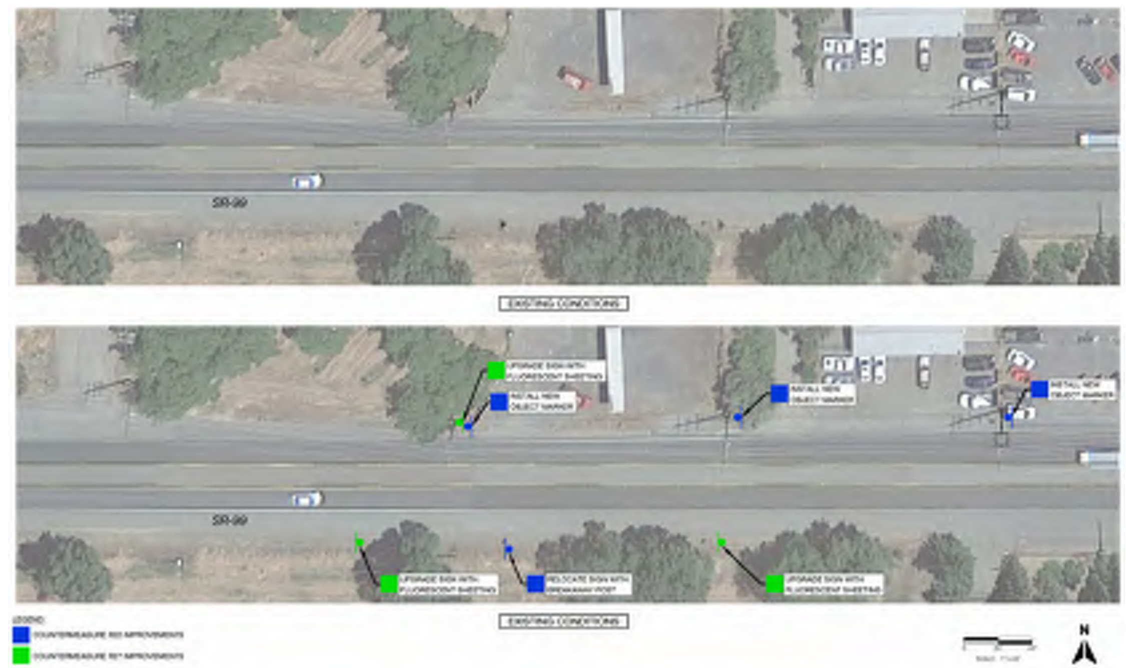
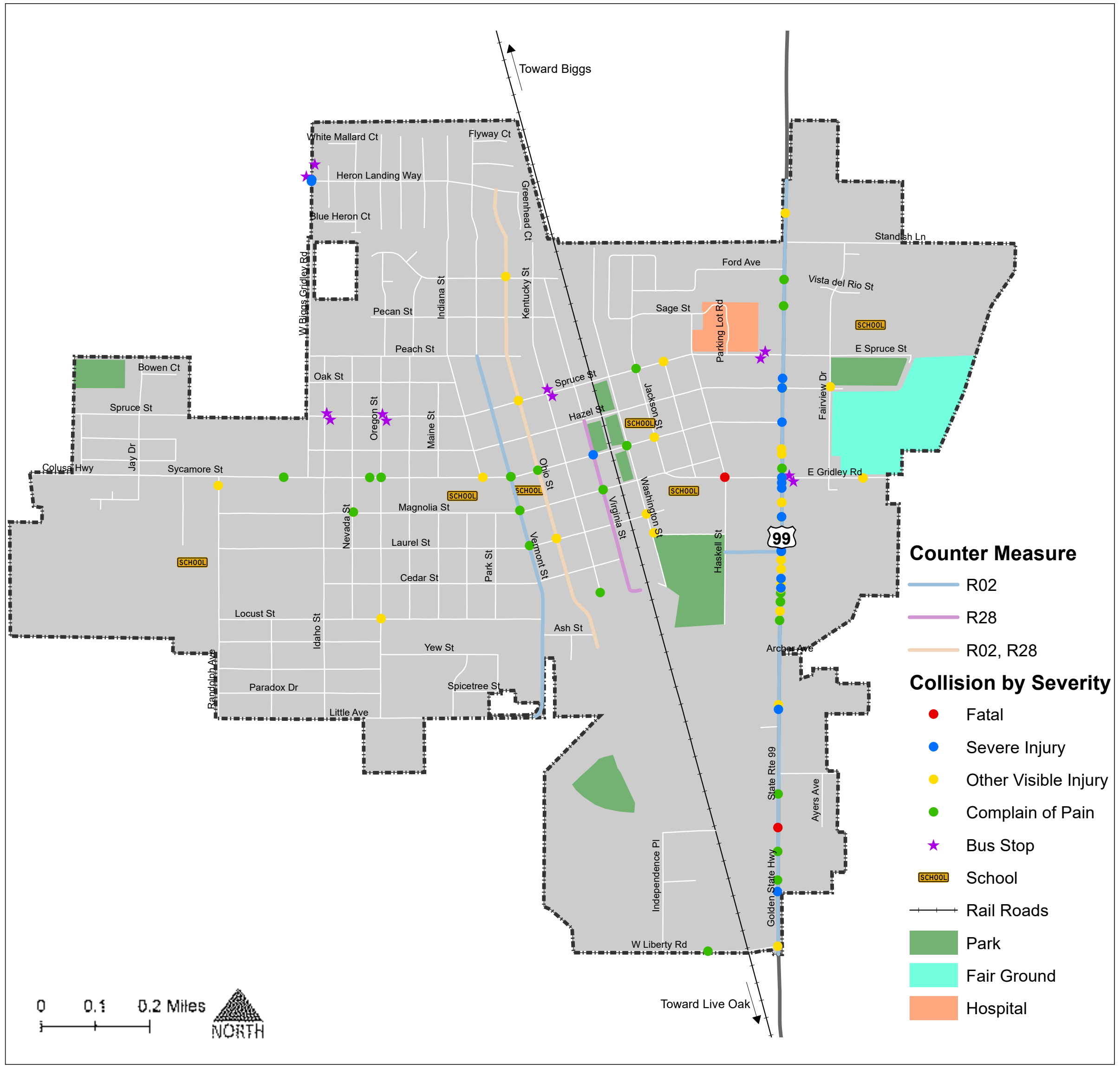


Figure 24. Safety Project 6



Sr. No	Locations	CM1	CM2	CM3
A	SR 99: Within City Limits	R02		
C	Cherry St: SR 99 to Haskell St	R02		
F	Virginia St: Hazel St to 350 ft south of Cedar St		R28	
H	Ohio St: Heron Landing Way to Ash St	R02	R28	
I	Vermont St: Peach St to Little Ave	R02		

Safety Project 6 : Safety on Roadway Segments - Reduce Hit Object, Head-on Collisions

TOTAL PROJECT COST	TOTAL EXPECTED BENEFIT	BENEFIT COST RATIO (BCR)
$ 276,700	$ 17,491,627	63.22

PROPOSED COUNTERMEASURES

R02

Remove or relocate fixed objects outside of Clear Recovery Zone

R28

Install edge-lines and centerlines

OHIO ST (MAGNOLIA ST TO LAUREL ST)

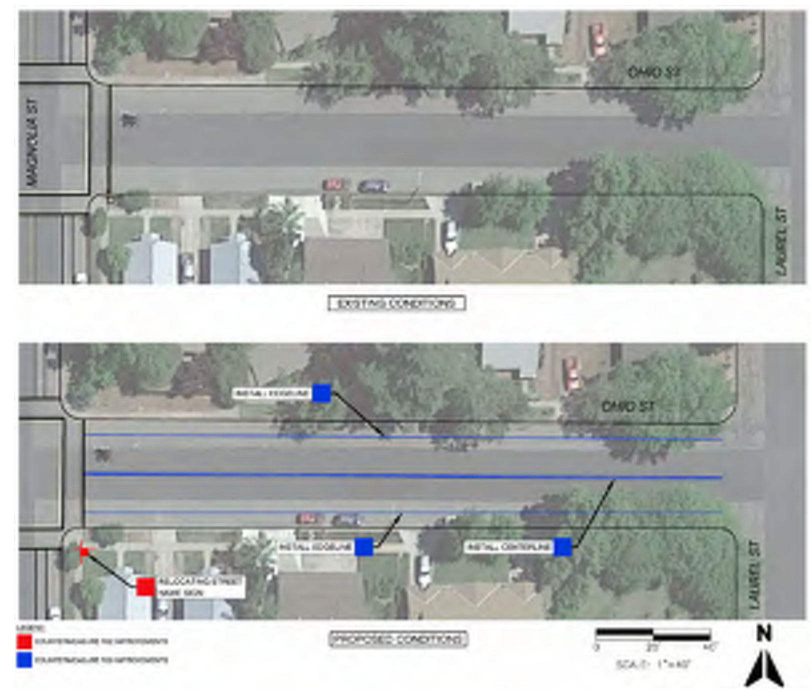
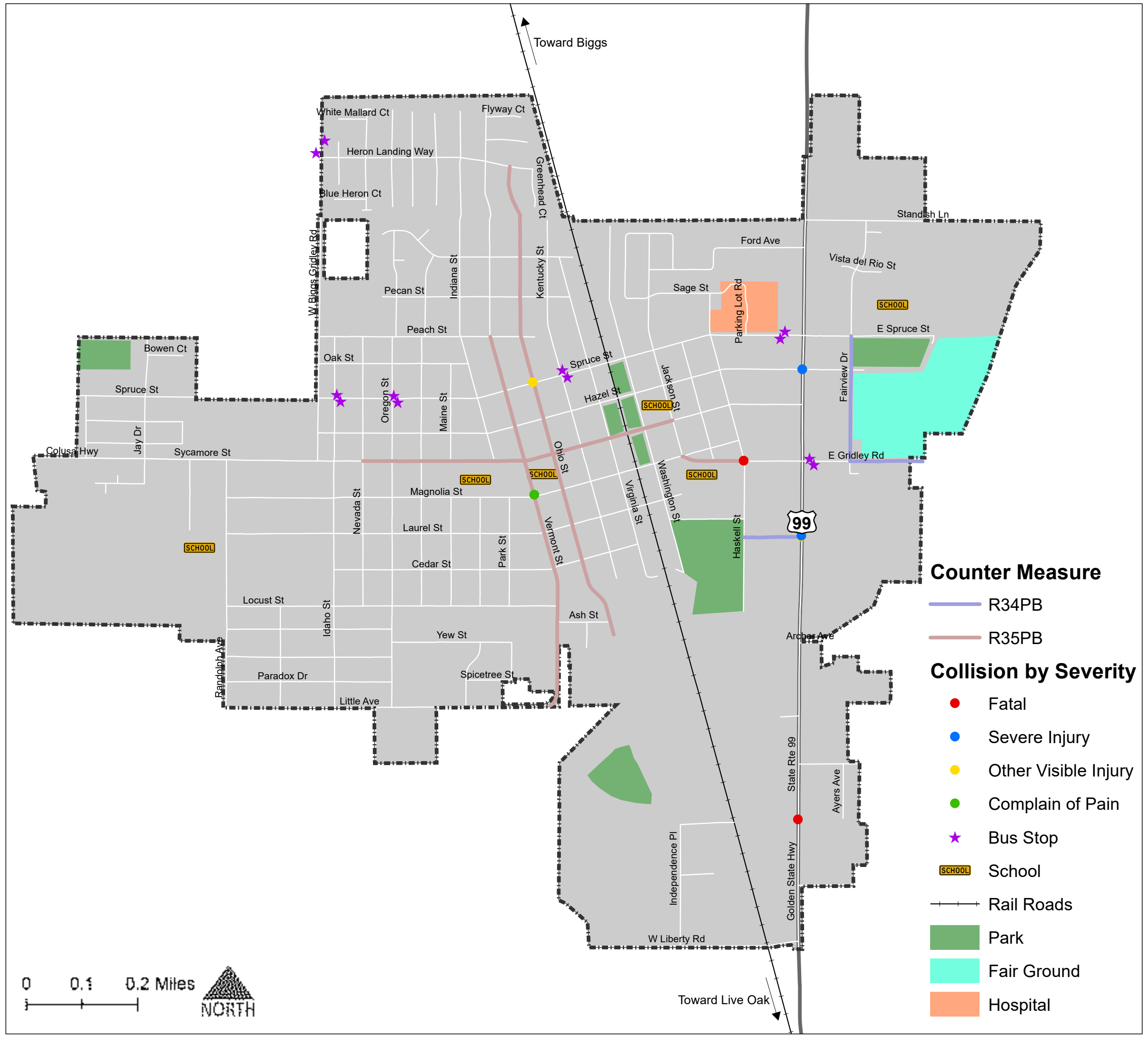


Figure 25. Safety Project 7



Sr. No	Locations	CM1	CM2	CM3
B	Magnolia St: Haskell to Jackson		R35PB	
C	Cherry St: SR 99 to Haskell St	R34PB		
G	Sycamore St: Jackson St to Nevada St		R35PB	
H	Ohio St: Heron Landing Way to Ash St		R35PB	
I	Vermont St: Peach St to Little Ave		R35PB	
J*	E Gridley Road: Fairview Ave and Bonnell Ave	R34PB		
K*	Fairview Dr: E Gridley Rd and E Spruce St	R34PB		

Safety Project 7 : Safety on Roadway Segments - Pedestrian Safety

TOTAL PROJECT COST	TOTAL EXPECTED BENEFIT	BENEFIT COST RATIO (BCR)
$ 2,218,000	$ 4,532,063	2.04

PROPOSED COUNTERMEASURES

R34PB

Install sidewalk/pathway

R35PB

Install/upgrade pedestrian crossing (with enhanced safety features)

CHERRY ST (HASKELL ST TO SR-99)

Table 13. List of Viable Safety Projects

Location	CM1	CM2	CM3	Total Benefit	Total Cost	B/C Ratio
Project 1: Signalized Intersections: Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number, Improve signal timing (coordination, phases, red, yellow, or operation), Install Raised Pavement Markers and Striping Through Intersection						
Citywide Signalized Intersections - 5 intersections	S02	S03	S09	$7,231,089	$391,400	18.47
Project 2: Unsignalized Intersections: Convert to all-way STOP control (from 2-way or Yield control)(Warrant Study needed), Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs						
Magnolia St and Haskell St	NS02			$11,546,665	$163,400	70.67
Sycamore St and Virginia St	NS02	NS06				
Heron Landing Way and W Biggs Gridley Rd	NS02	NS06				
SR 99 and Evelyn Dr		NS06				
SR 99 and Sheldon Ave		NS06				
Laurel St and Ohio St	NS02					
Jackson St and Ford Ave*	NS02	NS06				
Virginia St and Pecan St*		NS06				
Kentucky St and Bridgeford Ave*		NS06				
Vermont St and Pecan St*		NS06				
Vermont St and Sycamore St*	NS02					
Oregon St and Oak St*	NS02	NS06				
Sycamore St and W Biggs Gridley Rd*	NS02					
Ohio St and Pecan St*		NS06				
Indiana St and Pecan St*		NS06				

Location	CM1	CM2	CM3	Total Benefit	Total Cost	B/C Ratio
Project 3: Unsignalized Intersections: Install Pedestrian Signal (including Pedestrian Hybrid Beacon (HAWK)), Improve sight distance to intersection (Clear Sight Triangles), and Install raised median on approaches (NS.I.)						
SR 99 and Cherry St	NS23PB		NS14	$14,591,500	$499,000	29.24
Obermayer Ave and Ayers Ave*		NS11				
Sycamore St and Haskell St*		NS11				
Little Ave and Losser Ave*		NS11				
Indiana St and Spruce St*		NS11				
California St and Spruce St*		NS11				
Sycamore St and Idaho St*		NS11				
Oregon St and Oak St*		NS11				
Project 4: Citywide Lighting Improvements						
Citywide Roadway Segments	R01			$35,297,220	$1,633,700	21.61
Project 5: Citywide Sign Upgrade: Install/Upgrade signs with new fluorescent sheeting (regulatory or warning), Install delineators, reflectors and/or object markers						
Citywide Sign Upgrade	R22	R27		$8,836,156	$183,500	48.15
Project 6: Roadway Segments: Remove or relocate fixed objects outside of Clear Recovery Zone, Install edge-lines and centerlines						
SR 99: Within City Limits	R02			$17,491,627	$276,700	63.22
Cherry St: SR 99 to Haskell St	R02					
Virginia St: Hazel St to 350 ft south of Cedar St		R28				
Ohio St: Heron Landing Way to Ash St	R02	R28				
Vermont St: Peach St to Little Ave	R02					
Project 7: Roadway Segment: Install sidewalk/pathway (to avoid walking along roadway), Install/upgrade pedestrian crossing (with enhanced safety features)						
Magnolia St: Haskell to Jackson		R35PB		$4,532,063	$2,218,000	2.04
Cherry St: SR 99 to Haskell St	R34PB					
Sycamore St: Jackson St to Nevada St		R35PB				
Ohio St: Heron Landing Way to Ash St		R35PB				
Vermont St: Peach St to Little Ave		R35PB				
E Gridley Road: Fairview Ave and Bonnell Ave*	R34PB					
Fairview Dr: E Gridley Rd and E Spruce St*	R34PB					

Note: *Locations are identified from community survey comments and/or Stakeholder input.

Countermeasure Name
S02 - Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number
S03 - Improve signal timing (coordination, phases, red, yellow, or operation)
S09 - Install raised pavement markers and striping (Through Intersection)
NS01 – Add Intersection Lighting
NS02 - Convert to all-way STOP control (from 2-way or Yield control)
NS06 - Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs
NS11 - Improve sight distance to intersection (Clear Sight Triangles)
NS14 - Install raised median on approaches (NS.I.)
NS23PB - Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)
R01 - Add segment lighting
R02 - Remove or relocate fixed objects outside of Clear Recovery Zone
R22 - Install/Upgrade signs with new fluorescent sheeting (regulatory or warning)
R27 - Install delineators, reflectors and/or object markers
R28 - Install edge-lines and centerlines
R34PB – Install sidewalk/pathway (to avoid walking along roadway)
R35PB - Install/upgrade pedestrian crossing (with enhanced safety features)

Table 14 shows additional recommended improvements identified from community survey comments and the city staff inputs.

Table 14. Additional Recommended Improvements

Sr. No	Additional Locations	Recommended Improvements
1	Indiana St (at Spicetree St)	Traffic Calming
2	Sycamore St (near McKinley Primary School and Sycamore	Traffic Calming
3	Little Ave (within city limits)	Traffic Calming
4	W Biggs Gridley Rd (at Heron Landing Way)	Traffic Calming
5	California St (Between Spruce St and Magnolia St)	Pot holes (need repavement)
6	Spruce St (Between SR 99 and W Biggs Gridley Rd)	Repavement
7	Ford Ave (Between SR 99 and Jackson St)	Traffic Calming
8	Fairview Dr (Between E Gridley Rd to E Hazel St)	No on-street parking on east side of roadway, Traffic Calming (speed humps)
9	Cherry St at SR 99	Convert to cul-de-sac/dead end street
10	SR 99 at Obermeyer St	Roundabout (Referenced in the Caltrans SR 99 Safety Audit)

Implementation and Evaluation

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

IMPLEMENTATION

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

Funding is a critical component of implementing any safety project. While the HSIP program is a common source of funding for safety projects, there are numerous other funding sources that could be pursued for such projects. (See Table 15 below).

Table 15. List of Potential Funding Sources

Funding Source	Funding Agency	Amount Available	Next Call for Projects	Applicable E's	Notes
Active Transportation Program	Caltrans, California Transportation Commission, MTC	~$450 million per cycle (every two years)	2024	Engineering, Education	Can use used for most active transportation related safety projects as well as education programs? Funding available through Caltrans or MTC
Highway Safety Improvement Program	Caltrans	Varies	2024	Engineering	Most common grant source for safety 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	~$10-15 million per award	TBD; most recent in 2023	Engineering, Education	Must be connected to affordable housing projects; typically focuses on bike/pedestrian infrastructure/ programs
Urban Greening	California Natural Resources Agency	$28.5 million	TBD; most recent in 2022	Engineering	Focused on bike/pedestrian infrastructure and greening public spaces
Local Streets and Road Maintenance and Rehabilitation	CTC (distributed to local agencies)	$1.5 billion statewide	N/A; distributed by formula	Engineering	Typically pays for road maintenance type projects
RAISE Grant	USDOT	~$1.5 billion	2023	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
Transformative Climate Communities	Strategic Growth Council	~$105 million	TBD; most recent call in 2022	Engineering	Funds community-led projects that achieve major reductions in greenhouse gas emissions in disadvantaged communities
Safe Streets and Roads for All (SS4A)	USDOT	$200k - $50 million	2023	Engineering	Two types of SS4A grants available: Action Plan Grants and Implementation Grants
Clean California Local Grant Program	Caltrans	$100 – 5 million per award	2023	Engineering	Funding for local communities to beautify and improve local streets and roads, tribal lands, parks, pathways, and transit centers

Monitoring and Evaluation

For the success of the LRSP, it is crucial to monitor and evaluate the 5 E-strategies continuously. Monitoring and evaluation help provide accountability, ensures the effectiveness of the countermeasures for each emphasis area, and help making decisions on the need for new strategies. The process would help the City make informed decisions regarding the implementation plan's progress and accordingly, update the goals and objectives of the plan.

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

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

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

LRSP Update

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

Appendix A - Summary of Community Comments

Respondent ID	#	Coordinates	Intersection?	Street Name	What traffic-related concern do you have at this location?	Mode	Pertinent Issue
2kdl4nev3h44	1	39.372126,-121.706633	Y	W Biggs Gridley Rd	Cars and motorcycles speed down this area. We need a stop sign at Heron Landing and W. Biggs	Motor Vehicle	Traffic Signal & Sign
2kdl4nev3h44	2	39.371754,-121.706642	N	W Biggs Gridley Rd	The whole road needs to be re-paved. Cars will veer to avoid the pot holes and come close to hitting others cars.	Motor Vehicle	Pot holes
2kdl4nev3h44	3	39.363189,-121.691352	Y	Magnolia St	Stop signs needed. This is a major safety concern area during drop off and pick up times during the school year. The kids and crossing guard need more saftey.	Motor Vehicle	Traffic Signal & Sign
2kdl4nev3h45	4	39.363189,-121.691353	Y	Magnolia St	Stop signs needed. This is a major safety concern area during drop off and pick up times during the school year. The kids and crossing guard need more saftey.	Motor Vehicle	School Safety
2kdl4nev3h44	5	39.363093,-121.698666	Y	Sycamore St	Stop signs needed for crossing safety for kids, parents, and teachers/staff.	Motor Vehicle	Traffic Signal & Sign
2kdl4nev3h44	6	39.363015,-121.706703	Y	Sycamore St	Stop signs needed. The big rigs coming out of this street need the other cars to stop and give them the right of way and time to turn. Also causes a lot of congestion on W. Biggs if cars have to wait for traffic to go by during the rush hours. It's also not an easy road to see oncoming traffic when cars are parked on the street. You have to inch out to see around them.	Motor Vehicle	Traffic Signal & Sign
2kdl4nev3h45	7	39.363015,-121.706704	Y	Sycamore St	Stop signs needed. The big rigs coming out of this street need the other cars to stop and give them the right of way and time to turn. Also causes a lot of congestion on W. Biggs if cars have to wait for traffic to go by during the rush hours. It's also not an easy road to see oncoming traffic when cars are parked on the street. You have to inch out to see around them.	Motor Vehicle	Sight Distance
3b7gjn7c2j66	8	39.355803,-121.705473	N	Little Ave	Little Ave has constant speed concerns, racing, etc. Adding speed bumps as it is not patrolled would be great. We have kids and pets all along this road and more to come with the new construction, and I am concerned for the safety of residents.	Pedestrian	Speeding
3ss7l8f263pa	9	39.368877,-121.693865	Y	Jackson St	Cars race by straight down Jackson since there are no stop signs. The 1 stop sign there is people either don't stop or just slow down and go. My house is right across the stop sign (1053 Jackson) and I feel like one day someone is going to crash into my house. So either 2 more stop signs or speed bumps	Motor Vehicle	Traffic Signal & Sign
7ef24oh6x7s3	10	39.363224,-121.69101	Y	Magnolia St	Needs speed bumps and better drop off zone for Wilson school	Motor Vehicle	School Safety
3m8lpw7vko77	11	39.367931,-121.700005	Y	Vermont St	There are no stop or yield signs at this intersection	Motor Vehicle	Traffic Signal & Sign

Respondent ID	#	Coordinates	Intersection?	Street Name	What traffic-related concern do you have at this location?	Mode	Pertinent Issue
3m8lpw7vko77	12	39.366819,-121.699994	Y	Vermont St	There are no stop or yield signs at this intersection	Motor Vehicle	Traffic Signal & Sign
3m8lpw7vko77	13	39.367964,-121.697851	Y	Kentucky St	There are no stop or yield signs at this intersection	Motor Vehicle	Traffic Signal & Sign
3p4biy88u2t7	14	39.368881,-121.693917	Y	Jackson St	Cars race down Jackson St and don't stop at the 1 stop sign. Needs to be another stop sign or bumps	Motor Vehicle	Traffic Signal & Sign
4ggm2wop6hb6	15	39.367984,-121.696969	Y	Virginia St	There is no stop sign down Virginia St. This is the only street without a stop sign in this area therefore it is a high traffic area and cars travel at very high and very dangerous speeds. This makes is highly unsafe for the children who reside on the street as well as the foot traffic during before and after school hours. A stop sign or speed bump at the area of the pin (Virginia St. And Pecan St.) would make this street a safer environment for all.	Motor Vehicle	Traffic Signal & Sign
8f8psw3xbo39	16	39.36501,-121.700185	Y	Spruce St	Visibility from Indiana pulling out on to spruce going south truck parked on spruce blocking view and deep pot holes on that corner too.	Motor Vehicle	Sight Distance
8f8psw3xbo40	17	39.36501,-121.700186	Y	Spruce St	Visibility from Indiana pulling out on to spruce going south truck parked on spruce blocking view and deep pot holes on that corner too.	Motor Vehicle	Pot holes
8f8psw3xbo39	18	39.364974,-121.700471	Y	Spruce St	Visibility pulling on to spruce from Indiana heading south is limited due to truck parked on spruce blocking view and deep pit hole a are present too	Motor Vehicle	Sight Distance
6us3p73jhk29	19	39.368884,-121.693879	Y	Jackson St	High traffic.	Motor Vehicle	Traffic Signal & Sign
6us3p73jhk29	20	39.368978,-121.693845	Y	Jackson St	New high school route. Need speed bumps or something. A lot young children in this neighborhood playing and riding bikes. Not safe peoples speeding and not making that stop.	Motor Vehicle	Traffic Signal & Sign
3xpo8ty24up9	21	39.37195,-121.706775	Y	W Biggs Gridley Rd	Frequent extremely high speed vehicles. Multiple collisions in the last 3 years.	Motor Vehicle	Speeding
3xpo8ty24up9	22	39.361979,-121.704899	Y	Magnolia St	No stop sign, frequent near collisions here.	Motor Vehicle	Traffic Signal & Sign
3x29hv24ktg3	23	39.368037,-121.697132	Y	Virginia St	This street does not have a stop sign and the high speeding vehicles are a major safety issue to all foot traffic in the morning and afternoon before and after school hours.	Motor Vehicle	Traffic Signal & Sign
3x29hv24ktg3	24	39.368037,-121.697029	Y	Virginia St	Virginia Street needs a stop sign to prevent the high speed vehicles.	Motor Vehicle	Traffic Signal & Sign
2ozi6zjf7fw7	25	39.364826,-121.690712	Y	Sycamore St	Northbound on Haskell, the westbound traffic on sycamore visibility is blocked by the sign. The eastbound traffic visibility is difficuly as the ROW changes angle, and parked cars on the southside of sycamore and the west side of Haskell block visibility.	Motor Vehicle	Sight Distance

Respondent ID	#	Coordinates	Intersection?	Street Name	What traffic-related concern do you have at this location?	Mode	Pertinent Issue
7ah3fs4ffc77	26	39.366086,-121.687525	Y	SR 99	Starbucks traffic creates log jam during morning school hours. Drivers driving on side of traffic to get their way. Reported to PD; no response. Also traffic coming into 99S from rt side very unpredictable. While I have your attention, please address street and sidewalks. Safety hazard and not ADA compliant	Motor Vehicle	Traffic Congestion
7ah3fs4ffc78	27	39.366086,-121.687526	Y	SR 99	Starbucks traffic creates log jam during morning school hours. Drivers driving on side of traffic to get their way. Reported to PD; no response. Also traffic coming into 99S from rt side very unpredictable. While I have your attention, please address street and sidewalks. Safety hazard and not ADA compliant	Pedestrian	ADA
4gx7axy6tsv4	28	39.355758,-121.699549	Y	Little Ave	Blind corner with bushes on Little Ave where Losser and Little Ave meet.	Motor Vehicle	Sight Distance
4gx7axy6tsv4	29	39.363141,-121.705888	Y	Sycamore St	The corner of Idaho Street and Syacamore Street has a house with bushes that block people coming into town at 35 MPH from Sycamore (turns into Gridley Colusa Hwy). If your pulling out from Idaho Street it's very dangerous.	Motor Vehicle	Sight Distance
7mvk4ibp2cf7	30	39.36597,-121.703799	Y	Oak St	Have almost collided with vehicles twice now. Needs a 4 way stop sign.	Motor Vehicle	Traffic Signal & Sign
3lp6xwp8grn9	31	39.365986,-121.686094	Y	Hazel St	No crosswalks at intersection	Pedestrian	Crosswalk
8of4f46nku37	32	39.364071,-121.695484	Y	Sycamore St	Curbing sticks out and is frequently hit by vehicles	Motor Vehicle	Curb
94ikd4838l39	33	39.354149,-121.687864	Y	SR 99	Too dark. Cannot see pedestrians on hwy 99 or Obermeyer. Overgrown yard on corner of Obermeyer and Ayers blocks visibility of cars, pedestrians, and pets. Very unsafe area for driving day or night.	Motor Vehicle	Lighting
94ikd4838l40	34	39.354149,-121.687865	Y	SR 99	Too dark. Cannot see pedestrians on hwy 99 or Obermeyer. Overgrown yard on corner of Obermeyer and Ayers blocks visibility of cars, pedestrians, and pets. Very unsafe area for driving day or night.	Motor Vehicle	Sight Distance
94ikd4838l39	35	39.354168,-121.686131	Y	Obermayer Ave	Overgrown yard blocks visibility of cars, children, all pedestrians, and pets.	Motor Vehicle	Sight Distance
4oz74fp37f87	36	39.363047,-121.706043	Y	Sycamore St	cars on the side make it hard to see incoming traffic	Motor Vehicle	Sight Distance
4oz74fp37f87	37	39.355728,-121.699662	Y	Little Ave	property landscape make it hard to see incoming traffic. When your turning onto Losser Ave its a blind spot.	Motor Vehicle	Sight Distance
4oz74fp37f87	38	39.360969,-121.687907	Y	SR 99	Traffic doesnt stop immediatly after pedestrian lights turn on	Motor Vehicle	Traffic Signal & Sign
37c6pcr2bbg3	39	39.368929,-121.69382	Y	Jackson St	HS students not making complete stop at stop sign. Speeding from hwy 99 through Ford Ave to Spruce St. It’s the new route they take after school.	Motor Vehicle	Traffic Signal & Sign

Respondent ID	#	Coordinates	Intersection?	Street Name	What traffic-related concern do you have at this location?	Mode	Pertinent Issue
37c6pcr2bbg3	40	39.366538,-121.693694	Y	Spruce St	I've seen many close accidents almost happen.	Motor Vehicle	Speeding
7nv4e2mvj9mu	41	39.35659,-121.700892	N	Indiana St	Drivers going too fast	Motor Vehicle	Speeding
3uj67pzv73c7	42	39.369235,-121.697835	Y	Kentucky St	no stop signs on either corner.	Motor Vehicle	Traffic Signal & Sign
2kz4odi4tbi6	43	39.362945,-121.699926	N	Sycamore St	Speeders around the schools	Motor Vehicle	Speeding
4r83zxf432da	44	39.364898,-121.702456	Y	Spruce St	Southbound California making a left hand turn onto Spruce. View frequently blocked by parked vehicle on NE corner.	Motor Vehicle	Sight Distance
4r83zxf432da	45	39.3667,-121.703729	Y	Peach St	Off set street.	Motor Vehicle	Intersection Geometry
4r83zxf432da	46	39.36678,-121.702533	Y	Peach St	Offset street	Motor Vehicle	Intersection Geometry
2kdl4nev3h44	47	121.702636","39.364951,-	N	California St	Pot holes! Cars will veer to avoid them .	Motor Vehicle	Pot holes
3ss7l8f263pa	48	121.693767","39.368922,-	N	Ford Ave	Cars race down especially after school	Motor Vehicle	Speeding
9hc4z7vul3l9	49	'39.368904,-121.692271","	N	Ford Ave	My concern is that high schoolers are avoiding going through Spruce St. and this is their new route. They speed through here and don't do the stop on corner of Ford and Jackson St. There's many young kids in this neighborhood it's very concerning. Thank you hopefully something can be done.	Motor Vehicle	Speeding
93wat3olm833	50	"39.364846,-121.691025"	N	Sycamore St	Sycamore street is very dark. Hard to see pedestrians.	Motor Vehicle	Lighting
6p4sxo22efh7	51	"39.362567,-121.699318"	N	Sycamore St	Sycamore St is very dark from hwy 99 to Biggs Gridley rd. Hard to see pedestrians.	Motor Vehicle	Lighting
8mo7jbj9ano6	52	,-121.687877","39.360709	N	Archer Ave	Roadway on Archer Avenue just east of 99 is in horrible disrepair. It has been complained about before and still not fixed. This area is within the city limits and is commonly used by the city police department to divert traffic around collisions in between Archer Ave and East Gridley. Rd	Motor Vehicle	Pavement
4gx7axy6tsv4	53	121.699714","39.355567,-	Y	Little Ave	Blind Corners	Motor Vehicle	Sight Distance
6mtb8yzo2ok8	54	121.700474","39.366959,-	N	Spruce St	Rough road and high number of school/hospital related road crossings.	Motor Vehicle	Pavement
46psf7n7n8vn	55	-121.68593","39.368925,-	N	Fairview Dr	During school hours and especially before and after school there is a lot of traffic and especially pedestrian traffic in this area. With students parking on both sides of the street making the street narrow only one car can pass the area at a time and frequently walking with traffic then quickly turning into the road without looking for cars. I am concerned about the safety of pedestrians. Possibly getting more off the street parking or addressing the jaywalking without looking for cars would be helpful.	Pedestrian	School Safety

Respondent ID	#	Coordinates	Intersection?	Street Name	What traffic-related concern do you have at this location?	Mode	Pertinent Issue
76cyc8fx4k47	56	'39.361456,-121.690137",	N	Norman St	I am a long-time resident on the east side of Norman Street. My concern relates to the (1) amount and (2) speed of traffic that comes off of HWY 99 and on to Cherry Street and then Norman St. Drivers are really attempting to avoid the traffic light at HWY 99 and Magnolia Street, perhaps even traffic dealys around Wilson School. Drivers often use this path to connect to the west side of town. Norman Street is a small street that is really not designed for so much traffic. Vehicles speed, often making "rolling" stops at the corners of Cherry & Haskell Streets; Haskell and Norman Streets; and Norman and Washington Streets. Given the proximity of these areas to Wilson School and the Gridley Park, I am concerned for the safety of pedestrians, nearby children, and area residents. There is so much traffic at times that I sometimes have to wait to even pull out of my drive way. Norman Street only permits street parking on one side, we need more signage and enforcement, too.	Pedestrian	School Safety
3lp6xwp8grn9	57	121.706819","39.363178,-	N	Sycamore St	lighting is poor at nighttime	Motor Vehicle	Lighting
8of4f46nku37	58	,-121.69013","39.360942,-	N	Cherry St	This path is heavily used by pedestrians going to highway business corridor. Pedestrians frequently walk on roadway because sidewalks are non-existent or incomplete. Cherry Street is unusually narrow making it hard for two cars to pass each other especially when cars are parked on both sides of the street. or non	Pedestrian	Sidewalk
8of4f46nku37	59	121.694061","39.359968,-	N	Virginia St	Huge potholes at edge of street due to lack of storm drains	Motor Vehicle	Pot holes
2e3r9hyd7t64	60	),-121.706653","39.36856	N	W Biggs Gridley Rd	There are many pot holes on west biggs gridley road	Motor Vehicle	Pot holes
37c6pcr2bbg3	61	-121.692953","39.368908	N	Ford Ave	Speeding not doing complete stop!	Motor Vehicle	Speeding
37c6pcr2bbg4	62	-121.692953","39.368908	Y	Jackson St	Speeding not doing complete stop!	Motor Vehicle	Traffic Signal & Sign
Email	63		Y	Ohio St	Corner of Ohio and Laurel St. Just had another accident 7/7/23. This is also a bus route E/W on Laurel St. It's a short block, but constant speeding and failure to yield.	Motor Vehicle	Traffic Signal & Sign

Respondent ID	#	Coordinates	Intersection?	Street Name	What traffic-related concern do you have at this location?	Mode	Pertinent Issue
Email	64		Y	Spruce St	As a caregiver for a wheelchair bound resident if Gridley, one of our main concerns is the safely of those in wheelchair and walkers. 1. There are streets where there is corner ada access from street to sidewalk, only to get to the other end of the block and find that there is only a curb and no decline to exit into the street. As solution, wheelchair or scooter needs to be riden along the roadside where road is even. This is also unsafe during dark hours. Example are the corners of Washington Street and Spruce. 2. The are many roads that don't even have sidewalk accessibility..	Pedestrian	ADA
Email	65		N	Archer Ave	Archer Avenue just east of State Route 99 is in horrible disrepair. It has been complained about before and is still not fixed. This area is within the city limits and commonly used to divert traffic when there’s a collision on 99 between Archer Avenue and E. Gridley Rd.	Motor Vehicle	Pavement
Email	66		Y	Ohio St	We need stop signs put in at Ohio and pecan and Vermont and pecan and Indiana and pecan. Pecan street has NO stop signs from Virginia to Oregon.the three streets above need stop signs for sure. People drive about 40mph sometimes through these streets and I have two 8yr kids. These streets are dangerous	Motor Vehicle	Traffic Signal & Sign

Appendix B - Summary of Planning Documents

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

Document	Highlights
Gridley 2030 General Plan | Circulation Element	Gridley's goals, policies, and implementation strategies related to circulation. These are organized according to key circulation issues: complete streets; transit service; connectivity; mobility for all ages; parking; and, local economy. This Element supports goals and policies in other elements of the General Plan related to land use, public health and safety, community character and design, and local economy by reducing the reliance on cars for better air quality and reduced household transportation costs; assuring that essential goods and services are provided to Gridley residents; and supporting a growing local economy. **Circulation Goals:** To ensure that new development accommodates safe and pleasant routes for pedestrians, bicyclists, and drivers. ○ **Policy 1:** The City's bicycle network will be safe, accessible, attractive, and convenient. ○ **Policy 2:** In areas where high pedestrian traffic is anticipated, such as Neighborhood Centers and commercial areas, new developments should have relatively lower curb radii at street intersections to slow traffic, per City standards. ○ **Policy 3:** In areas with high pedestrian traffic, new developments will install and dedicate streets with lane widths that encourage slower traffic speeds to increase pedestrian safety, per City standards. ○ **Policy 4:** In areas with high pedestrian traffic, new developments will install and dedicate relatively wide sidewalks that encourage pedestrian use, per City standards. ○ **Policy 5:** New development shall construct and dedicate, and/or participate in fair-share funding of, an integrated system of streets, sidewalks, and on- and off-street bicycle/pedestrian facilities, in compliance with City standards. ○ **Policy 6**: Off-street bicycle and pedestrian pathways will be designed to promote visibility and a feeling of security for users. ○ **Policy 7:** New development shall provide secure bicycle storage facilities in appropriate locations. ○ **Policy 8:** New developments will fund their fair-share of area-wide and citywide transportation facilities. ○ **Policy 9:** A City-approved transportation impact study is required for proposed multi-family residential developments of

Document	Highlights
	more than 150 dwelling units, proposed single-family residential developments of more than 100 dwelling units, and nonresidential developments proposing to add more than 10,000 square feet of building space. The City may, as appropriate, exclude infill and affordable housing projects from this requirement. ○ **Policy 10:** Traffic studies prepared for Gridley projects will be sensitive to the trip-reducing characteristics of higher-density housing development, affordable housing, and mixed-use development. **Circulation Goal 2:** To retrofit existing development for increased pedestrian, bicycle, and transit access. ○ **Policy 1:** The City will explore opportunities to install traffic circles, landscaped medians, and extended curbs (bulb-outs) on wider existing City streets within the existing City to calm traffic and provide a more pleasant pedestrian environment. Streets wider than 45 feet, curb-to-curb, could accommodate these improvements. ○ **Policy 2:** As funding is available, the City will invest in pedestrian, bicycle, and transit facilities Downtown, such as bus stops, shade trees, textured crosswalks, street furniture, pedestrian lighting, water features, and pedestrian-oriented signage. ○ **Policy 3:** The City will enhance pedestrian and bicycle access to and from Downtown, as feasible. ○ **Policy 4:** The City will seek funding for pedestrian and bicycle improvement projects in developed areas within current City limits and will incorporate these projects into the City's Capital Improvement Programming. ○ **Policy 5:** Development adjacent to Highway 99 between West Liberty Road and Ord Ranch Road shall include wide, separated sidewalks, and shade trees, per City standards. **Circulation Goal 3:** To provide Gridley residents and employees with convenient and predictable transit access. ○ **Policy 1:** The City will consult with BCAG and other local transit operators to provide more convenient and predictable service throughout Gridley, including the design and location of transit stops and other facilities along transit routes.

Document	Highlights
	○ **Policy 2:** The City will consult with BCAG to prioritize transit access serving retail, service, and employment centers along Highway 99, Downtown destinations, and Neighborhood Centers in the Planned Growth Area. ○ **Policy 3:** The City will support transit access to and from locations within Gridley and better connections for Gridley residents and workers to destinations elsewhere in the County and beyond. ○ **Policy 4:** New development shall construct and dedicate or otherwise accommodate transit facilities consistent with transit agency planning and standards. ○ **Policy 5:** The City will encourage and provide incentives to encourage local businesses to support transit and create their own travel demand management programs. ○ **Policy 6:** The City will consult with BCAG regarding possible sponsorship of bus routes for future large employers. **Circulation Goal 4: To improve connectivity in existing developed parts of Gridley.** ○ **Policy 1:** The City will seek ways to better connect existing neighborhoods with Downtown. ○ **Policy 2:** The City will increase connectivity in the Highway 99 corridor by requiring new east-west and north-south connections in new developments, to the maximum extent feasible. ○ **Policy 3:** To reduce congestion and increase safety, new development adjacent to Highway 99 should have multiple access to local streets rather than direct access to the Highway. ○ **Policy 4:** Infill and redevelopment projects should accommodate safe and convenient transit, pedestrian, and bicycle connections to existing ○ employment areas, such as Downtown and the Gridley Industrial ○ Park, to the maximum extent feasible. **Circulation Goal 5: To provide highly connected new neighborhoods and employment areas** **Circulation Goal 6: To provide healthy, safe, and convenient transportation choices for our entire population, including our youth and seniors.**

Document	Highlights
	○ **Policy 1:** The City will consult with Caltrans to ensure frequent, safe, and convenient multi-modal crossing of Highway 99 in areas with existing schools. ○ **Policy 2:** The City will consult with the School District to improve safety and pedestrian/bicycle access to and from existing school sites. This could involve the installation of traffic calming devices, bike lanes, sidewalk improvements, pedestrian crossing improvements at intersections, and other improvements. ○ **Policy 3:** New developments will be required to accommodate new school sites in the Planned Growth Area, per School District requirements, that ensure safe routes for new school sites to and from the surrounding neighborhood. ○ **Policy 4:** The City will consider the transportation needs of seniors in implementing transportation improvements. Areas of the City with existing or proposed senior housing should be in proximity to, and/or have non-vehicular transportation options to health care and other needed services. **Circulation Goal 7: To plan and design parking for safe and convenient bicycling, walking, transit use, and vehicular access.** ○ **Policy 1:** Projects located in Neighborhood Centers and Downtown will have reduced or eliminated off-street parking requirements, as appropriate. ○ **Policy 2:** New development should use shared parking to meet the City's off street parking requirements, where appropriate. ○ **Policy 3:** New development will provide on-street parking to meet parking needs, reducing or avoiding the need for off-street parking, where feasible. ○ **Policy 4:** The City will discourage large, single-use surface parking lots, particularly in Neighborhood Centers and Downtown. ○ **Policy 5:** Where surface parking is proposed, it should be broken up and distributed around different sides of the project site. Any surface parking should be behind, or on the side of any proposed buildings. ○ **Policy 6:** Shade trees shall be provided in any proposed surface parking lot that, at maturity, will provide a minimum of 50% canopy coverage. A ratio of at least one tree for every six parking

Document	Highlights
	spaces is recommended, although 50% canopy coverage will require more of some tree species and fewer of other species. **Circulation Goal 8**: To provide effective freight systems that serve Gridley's business, while avoiding negative impacts to residents. ○ **Policy 1:** The City will consult with Caltrans, Butte County, the California Highway Patrol, the California Public Utilities Commission, and the Union Pacific Railroad to appropriately regulate the safe movement of truck traffic and hazardous materials throughout the City. ○ **Policy 2:** The City will restrict truck traffic to Highway 99, Magnolia Avenue, West Biggs-Gridley Road, Ord Ranch Road, South Avenue, East Gridley Road, West Liberty Road, and streets in areas designated for Industrial and Agricultural Industrial development (see Exhibit Circulation-7). Trucks may go by direct route to and from restricted streets, where required for the purpose of making pickups and deliveries of goods, but are otherwise restricted to truck routes. ○ **Policy 3:** The City will consult with the Public Utilities Commission and Union Pacific Railroad regarding local rail spurs and the use of rail for materials delivery and/or product shipping for Gridley industries. ○ **Policy 4:** The City will work to improve access between Highway 99 and the Gridley Industrial Park.
City of Gridley Bicycle Plan (2011)	**Goals and Objectives:** **Goal:** A safe, effective, and efficient bicycle circulation system. **Objective 1:** A continuous bicycle system that is part of the multi-modal transportation network in Gridley. **Implementation Measure 1:** Develop, approve, and update the bicycle transportation plan that identifies local bikeway routes in Gridley, every five years. **Implementation Measure 2:** Coordinate with local and regional transit providers to integrate bicycle facilities with their services. **Objective 2:** Promote bicycling and information about bicycle safety programs. **Implementation Measure 1:** Work with local schools and businesses to encourage participation in statewide bike to work and bike to school days.

Document	Highlights
	Implementation Measure 2: Develop a feature on the City's web site to compile information on bicycling events and safety. **Implementation Measure 3:** Develop a notification method through the City web site to inform the City about new bicycle hazards. **Implementation Measure 4:** Place advertisements in the newspaper to promote bicycling and bicycle safety (Education programs, helmet laws, share-the-road). **Implementation Measure 5:** As requested by the school district and other public groups, coordinate the training of children aged 5-12 on the safe use of bicycles. **Objective 3:** Continuous regional routes surrounding the City of Gridley. **Implementation Measure 1:** Participate and comment on the Butte County Bicycle Plan update as it relates to Gridley-area routes, namely access to Feather River along East Gridley Road, and bikeways to Biggs and Gray Lodge Wildlife Area. **Implementation Measure 2:** Work with Butte County representatives to maintain the Union Pacific Railroad route between the Cities of Gridley and Biggs as identified in the Butte County Regional Bikeways Plan. **Implementation Measure 3:** Continue the coordination and communication between relevant jurisdictions in Butte County, including the Butte County Association of Governments, City of Biggs, and Caltrans. **Implementation Measure 4:** Hold and/ or participate in regional bicycle planning meetings. **Implementation Measure 5:** Develop a Class II bike lane between Gridley and Biggs, along the proposed new road extension of Washington Street to Sixth Street in Biggs. **Implementation Measure 6**: Coordinate and cooperate with the City of Biggs to develop a continuous bikeway between the cities. **Implementation Measure 7:** Explore trail way easement opportunities and linear parkways during Gridley-Biggs "Area of Concern" meetings. **Objective 4:** Increase bicycle and pedestrian safety and access to all points in the City. **Implementation Measure 1:** Improve safety conditions on select streets in the City with Class II bicycle facilities. **Implementation Measure 2:** Require the establishment of Class II Bike Lanes whenever roads are repaved along existing bike routes, as available funding permits.

Document	Highlights
	Implementation Measure 3: Require that, as conditions of project approval, bicycle lanes, access points, and safety enhancement measures be integrated into new development proposals, as appropriate. **Implementation Measure 4:** Review local California Department of Transportation projects for their "bicycle friendliness". Where possible, make modifications to project plans in order to provide safe access for bicyclists. **Implementation Measure 5:** Amend zoning codes for multi-family, commercial, and planned developments to require secure bicycle parking. **Implementation Measure 6:** Purchase and place bicycle racks at public buildings, parks, and key downtown locations. **Implementation Measure 7:** Replace hazardous grates along identified bike routes. **Implementation Measure 8:** Ensure that new railroad crossings that intersect routes, lanes, or corridors identified in this plan are designed to accommodate pedestrian and bicycle traffic. **Implementation Measure 9:** Develop a program to provide area destinations with discounted bicycle parking racks. **Implementation Measure 10:** Require, as conditions of project approval, bicycle parking facilities to be integrated into new development proposals, as appropriate. **Objective 5:** Integrate bicycling into existing recreational and tourism opportunities. **Implementation Measure 1:** Support local organized (recreational and/ or competitive) bicycle rides. **Implementation Measure 2:** Support the development of bicycle facilities that provide connections to local and regional recreational destinations.
City of Gridley Operating Budget and Capital Improvements Plan (FFY 2022-2023)	**Capital improvement program** Each year the City prepares a Capital Improvement Program (CIP), which serves as the City's basic tool to plan, organize, and document various projects needed to meet the many infrastructure and capital investment needs of the community. In its revised formant, this document will provide more information on the projected needs, as well as the challenges and opportunities the City faces in the coming years. Staff is continuously working to integrate the CIP with other City documents, as prepared or updated. This includes the City's General Plan, other relevant

Document	Highlights
	Master Plans, and Regional Transportation Planning efforts. The CIP is seen as a living document that will grow and change from year to year as community needs, priorities, and funding opportunities change. The first year of the CIP coincides with the capital budgets in each Department. The funds have been incorporated into the City operating budget in this manner. Projects slated for subsequent years in the program are approved on a planning basis and do not receive expenditure authority until they are eventually incorporated into the capital budget and a subsequent operating budget. As such, Council endorsement of the overall five-year program is desirable for effective implementation of overall City goals and objectives. **Governmental Funds:** **Streets:** • Pavement Management Plan: $5,000 • Street Pavement Reserve Program: $ 25,000 • Bicycle & Pedestrian ADA Improvements: $20,000 • CGPC & Equal Access Project: $20,000 • GB & SR 99 Corridor Project: $20,000 • FY 22-23 Street Repair/Improvements: $146,000 • FY 22-23 Street Repair/ Improvements: $154,000 • Local Roadway Safety Plan: $40,000 • ADA Audit and Transition Plan: $50,000 **Street Maintenance costs are funded by both the General Fund and Gas Tax Funds**. o The largest revenue sources for Streets come from the State and from special property tax assessments. o The use of these revenues is restricted to special purposes. The State of California imposes excise taxes on various transportation fuels. California motor vehicle fuel taxes include the gasoline tax, diesel fuel tax, and the use fuel tax. o These funds are apportioned pursuant to regulations found in the California Streets and Highways Code. Section 2105 allocates 11.5% of the tax revenues in excess of 9 cents per gallon (i.e. the Proposition 111 rate).

Document	Highlights
	○ The City uses this portion of Gas taxes for maintenance associated with streets, alleys, traffic signs, street name signs, street striping, pavement markings, sidewalks, curbs/gutters and traffic signals. Section 2107 provides monthly allocations of 1.315 cents per gallon of gasoline, 1.8 cents per gallon of diesel, and 2.59 cents per liquefied petroleum gas (LPG). ○ These revenues are used for the maintenance of streetlights, which is the City's responsibility, including maintaining the light standards and light bulbs, the cost of City provided electrical service and the cost of Electric Utility Department labor and benefits used in maintaining the lights.
Butte County Regional Population and Transportation Study (2020)	The Butte County Association of Governments (BCAG) *Transit & Non-Motorized Plan* establishes a vision for future transit and non-motorized transportation improvements in communities throughout Butte County. Investments in transit services and facilities and bicycling and walking infrastructure near transit will be necessary to accommodate planned future growth and to support the land use, mobility, and climate goals set forth in the BCAG *2020 Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS)*. As the operator of B-Line fixed route bus and complementary ADA paratransit service throughout Butte County, BCAG has a unique role in implementing this vision. Accordingly, this plan envisions new and expanded local and intercity public transit services, improved bikeways and bicycle paths, and improved pedestrian access to transit. **Bike and Walking Opportunities:** The most suitable area for non-motorized modes is in northwest Gridley in the commercial zone along Washington Street and the residential neighborhood to the northwest. Two areas score moderate-high: the eastern area between the railroad and Hwy 99; and in west Gridley, the area bound by Sycamore, Randolph, Little, and Oregon Streets. **Transit Access Improvements:** In Gridley, the stops on Spruce Street near Downtown Gridley have a moderately high transit access score. The areas near the Spruce Street/Biggs Gridley Road intersection and State Route 99/Spruce Street intersection have a relatively low transit access score. However, relative to transit access in the community, these two locations are good candidates for bicycle and pedestrian improvements.

TJKM

Document	Highlights
	Non- Motorized Transportation Network Improvements: **Existing:** An east-west bike path traverses the south side of Heron Landing between Biggs Gridley Road and Kentucky Street. Bike lanes exist on Spruce Street between Biggs Gridley Road and State Route 99, on Hazel Street between Virginia Street and the street's eastern terminus, on Magnolia Street between Vermont Street and Jackson Street, and on Washington Street north of Magnolia Street. **Proposed:** The City of Gridley Bicycle Plan (January 2011) identifies planned bicycle facilities throughout the City. The City of Gridley has proposed to add bike lanes to several north-south and east-west streets within its roadway grid. Additionally, the regional bike path between Biggs and Gridley will be accessible in Gridley near the Washington Street/Spruce Street intersection. **Regional Routes: Additional Recommendations:** Route 32 will remain in service in the short-term timeframe, serving Gridley and Biggs via Durham. o In the mid-term timeframe and if applicable given employment demographics, it may make more sense to implement vanpools between these locations. o Regardless of the service type, BCAG could work with Gridley to install a Park & Ride using shared parking spaces at the Butte County Fairgrounds. o This Park & Ride lot could support either fixed route or vanpool services, or a combination of both. o In the long-term, BCAG may choose to implement a Butte County-to-Sacramento commute service, possibly using Park & Rides as major stops within the County. **Proposed Bikeways in Gridley:** The City of Gridley does not currently have any bike paths or designated streets as bike routes. However, the City has proposed to add bike lanes to several north-south and east-west streets within its roadway grid. This Plan also proposes to add bike paths along the railroad tracks and bike lanes on Sycamore Street, State Route 99, and on either side of Sycamore Middle School.

Document	Highlights
Butte County Transit and Non-Motorized Plan (2015)	The Butte County sets out goals for the transportation system, based on a vision of an efficient and environmentally sound multimodal system to meet the established targets. Key objectives of the 2012 MTP/SCS are to improve accessibility and reduce environmental impacts by promoting bicycling, walking, and expanding transit service where possible to meet ridership demand and increase ridership at a rate faster than the county's population growth. The outcome of this planning process is to provide Butte County with a Long-Range Transit and Non-Motorized Plan focusing on bicycles, pedestrians, and transit for integration into the region's 2016-2040 MTP/SCS. **Goal 1: Maximize service efficiency and reliability.** This is a critical goal for B-Line, to improve and maintain the quality of services it provides. Some objectives include: o Ensure availability of sufficient safe and reliable in-service vehicles to meet the daily pullout requirements for B-Line. o Operate on schedule within adopted on-time performance standards. o Operate consistent headways whenever possible. o Consistently monitor and evaluate services in accordance with adopted service standards. o Build services around a network of intercity and local feeder services, as well as local routes/service in urban areas. o Minimize non-revenue hours operated on all services o Assign vehicles by service type. o Maintain a minimum/maximum fleet size that ensures an optimal spare to in-service fleet ratio. **Goal 2: Maximize the effectiveness of service for B-Line's ridership markets**. A more effective transit service focuses on simplification and ease of use, with minimal one-way loops and convenient transfers. Objectives include: o Minimize service overlap/duplications. o Provide access to major centers of demand from all parts of the B-Line service area. o Ensure routes are easy to understand. o Bi-directional service should be provided by most route segments (except unidirectional commuter services), so that

Document	Highlights
	transit provides an equivalent alternative to for travel in both directions. ○ Transfers should be convenient and fast between routes. ○ Operate most routes directionally, minimizing the amount of off-directional travel. ○ Implement strategies to speed transit service, particularly along congested corridors. ○ Ensure adequate vehicle capacity to maintain passenger loads within the adopted maximum load standards established for fixed-route services. **Goal 3: Improve the usability of B-Line.** Some basic objectives to increase usability and visibility include: ○ Provide effective communications and marketing tools to promote transit use and to advance the vision, mission and goals of BCAG. ○ Improve the passengers' experience through enhanced bus stops and passenger amenities. ○ Provide easy-to-understand signage and passenger information that promotes the ease of use of B-Line's services. ○ Ensure transparency and openness to the public throughout all of the agency activities. ○ Partner with local organizations, CSUC, Butte College, businesses, municipalities and other agencies to enhance B-Line's community outreach and information efforts. **Goals and Objectives:** In addition to goals for transit, three primary goals were established for non-motorized transportation. **Goal 1:** Provide options so people will choose and be able to walk and bicycle as a way to travel, to be healthy and for recreation. ○ Recognize the value of walking and bicycling in Butte County's cities and between communities. ○ Advocate for healthy, sustainable, and efficient communities ○ Develop services and invest in improvements that overcome the obstacles – physical, social and institutional – allowing them to walk and bike. **Goal 2: Focus on urban infrastructure improvements that contribute to interconnectivity and safety for people who choose to walk or bike.** Objectives should ensure local planning and

Document	Highlights
	development policies pursue strategies that will support safe and effective travel by bike or walking: o Improve bicycle facilities on primary commuter routes to major employment locations in Butte County. o Encourage installation of sidewalks along the street at all major commercial developments and in higher density residential neighborhoods. o Link noncontiguous sidewalk segments/close gaps. o Provide the option for bike and pedestrian access to surrounding neighborhood destinations for all new developments. **Goal 3: Facilitate regional links allowing for origin-to destination access to bicycle and pedestrian facilities. Some basic objectives include the following:** o Assist local jurisdictions to seek funding to connect local bike and pedestrian projects to regional trails and bikeways. o Develop projects, programs, and policies to encourage use people to make multimodal trips, linking walking, bicycling and transit. o Develop facilities (e.g., bike lockers, freeway crossings, intermodal centers) that make it easy for people to choose non-motorized modes for longer distance travel. **Improvements to pedestrian connections:** In an environment such as Butte County, most transit passengers walk to and from stops, but outside of the downtown areas, pedestrian infrastructure is often inadequate. Sidewalks may be too narrow, in poor condition, or there may be gaps. Opportunities to cross streets may be limited, and where crosswalks exist, there may not be signals requiring drivers to stop, or there may be signals, but not enough time in the walk cycle for all too safely cross. o The street network itself prevents direct pathways. Wheelchair ramps may also be missing or substandard. These issues are generally beyond the purview of BCAG, but the agency can work with cities and Butte County to identify needs, develop projects, and seek grant funding. **Policies to guide Bicycle & Pedestrian Access Planning:** BCAG can support jurisdictions to promote non-motorized modes by adopting the following policies:

Document	Highlights
	○ Encourage jurisdictions to revise local bikeway plans to become compliant with the Active Transportation Program (ATP) by requiring ATP compliance as a condition for regional funding. ○ Rank project finding request higher for project that are identified in a jurisdiction's active transportation plan or equivalent plan (bicycle and pedestrian plan, etc.) ○ Encourage jurisdictions to modify bicycle parking code according to the 2010 California Green Building Standards Code. **Safe Routes to Transit Plan:** A Safe Routes to Transit Plan (SR2T) is a cost-effective way to increase B-Line ridership and address regional traffic relief by providing safe and accessible walking and bicycling routes to transit stops and stations throughout the region. This plan should be completed on a regional scale, covering the extent of Butte County, to capture the catchment area of the B-Line system. **Recommendations for a SR2T plan include:** ○ Begin with the establishment of a community stakeholder group to provide insight during each stage of the process, represent the needs and interests of various local groups and ensure that recommendations are consistent with local goals and values. ○ More narrowed study areas within Butte County should be defined based on a determined bicycle and walk catchment area from identified transit stops and stations. ○ Extensive data collection of existing conditions within these study areas should include transit stops, stations and services, bicycle and pedestrian facilities (present and missing), bicycle and pedestrian collisions, field observations, vehicle counts, land use characteristics and population characteristics. ○ Based on an existing conditions analysis, national best practices should be applied to make project recommendations that increase the safety and accessibility of biking and walking to transit. Recommendations should be made for each of the study areas identified earlier in the process. ○ The project recommendations previously identified should be prioritized based on a number of criteria determined with the assistance of the community stakeholder team.

Document	Highlights
	○ These may include: gap closures, safety improvements, access to or from key origins and destinations, and end-of -trip facilities. ○ To bring projects to implementation stage, coordination between BCAG, the local jurisdiction, B-Line transit and other agencies (including Caltrans) is required. Once the project is ready for implementation, funding can be acquired through a number of federal or state programs. **Regional Proposed Bike lanes:** 1. Chico-Paradise Bike Path: Skyway, Honey Run Road to Paradise Town limits. 2. Biggs-Gridley Bike Path: Along SPRR tracks from Gridley City limits (Orange Ave) TO Biggs City limits (8th Street) 3. Oroville-Paradise Bike Lanes: Class II Bike Lanes on Cherokee Road from Oroville City limits to SR 70, Class II Bike route on Pentz Rd, Class II Bike lanes and Class III Bike route on Pentz route from SR 70 to Paradise Town limits. 4. Oroville –Biggs Bike Lanes: Class II Bike Lanes on Biggs East from Biggs City limit to Larkin Road and Larkin Road from Biggs East to Oroville City limits. Much of the foundation for non-motorized mode planning has already been established by jurisdictions through past bicycle plans. Through coordination by BCAG and movement toward compliance with the Active Transportation Program by jurisdictions, significant progress will be made towards enhancing opportunities for non-motorized modes. Implementation of the recommendations will require investment in several new capital projects.
Caltrans District 3 SR 99 Road Safety Audit	**Segment 4 Potential Solutions/Projects:** **Short-Term Solutions (0-3 Years)** • Gridley Downtown: Lighting and pavement rehab/restripe (scheduled) • Gridley Downtown: Add retroreflective back plates • Liberty Road/Hollis Lane: Add Double red head and add retroreflective plates • Hollis Lane: Line of sight, maintenance clearing overgrown brush blocking sightline to signal • Senior Housing north of Archer Street: Median converting to RIRO for development

Document	Highlights
	• Cherry Street: Retroreflective Paint on island and botts on pavement, tape on pole, pedestrian • push button on refuge median, advanced connected beacon **Mid-Term Solutions (3-5 Years)** • Gridley General: Add CCTV at all signalized intersections • Gridley Downtown: Lighting and pavement rehab/restripe (scheduled) • Liberty Road/Hollis Lane: Relocate or add intersection warning sign further south before curve • Cherry Street: Median converting to RIRO access at Cherry **Long-Term Solutions (5+ Years)** • Liberty Road/Hollis Lane: Close Hollis and realign access with Liberty Road • Liberty Road/Hollis Lane: Lengthen Northbound Left Turn Lane • Obermeyer Avenue: Conduct ICE to determine suitability of Multilane Roundabout • Ord Ranch Road: Conduct ICE to determine suitability of Single Lane Roundabout

Appendix C - Consolidated High-Injury Collision Database

CASE_ID	ACCIDENT_YEAR	PROC_DATE	JURIS	COLLISION_DATE	COLLISION_TIME	OFFICER_ID
8465627	2018	2/15/2019	403	4/1/2018	2108	P201
8601264	2018	8/20/2018	403	4/24/2018	553	P74
8606096	2018	5/14/2018	403	5/2/2018	710	P206
8607389	2018	8/20/2018	403	4/21/2018	1432	P74
8674199	2018	10/26/2018	403	7/13/2018	1653	P74
8696012	2018	10/26/2018	403	7/29/2018	1909	P207
8696559	2018	9/19/2018	403	8/17/2018	1504	P201
8749584	2018	1/18/2019	403	11/16/2018	1210	P52
8764108	2018	1/29/2019	403	12/15/2018	1841	P204
8826521	2019	6/4/2019	403	2/8/2019	1524	P501
8870131	2019	8/28/2019	403	5/21/2019	1157	P73
8872307	2021	10/18/2021	403	8/20/2021	1722	P211
8942194	2019	6/8/2020	403	9/18/2019	559	P52
8964436	2019	6/8/2020	403	9/10/2019	1605	P74
8983268	2019	12/18/2019	403	5/17/2019	1416	P200
8984370	2018	2/28/2020	403	10/17/2018	1405	P204
8984406	2018	5/27/2020	403	3/24/2018	350	P74
8984587	2018	5/27/2020	403	11/25/2018	1830	P206
8986287	2018	1/31/2020	403	3/5/2018	1851	P74
8996133	2019	12/23/2019	403	10/8/2019	730	P76
8996181	2019	2/13/2020	403	11/25/2019	1650	D6
8996895	2019	6/29/2020	403	11/20/2019	643	P204
8996993	2019	9/14/2020	403	11/20/2019	1454	P204
9004356	2019	2/11/2020	403	11/26/2019	1813	P76
9004360	2019	2/11/2020	403	12/23/2019	1125	P211
9048294	2019	6/15/2020	403	12/31/2019	2233	P211
9071212	2020	9/25/2020	403	5/29/2020	226	P211
9078630	2020	9/25/2020	403	2/24/2020	2031	P207
9093643	2020	12/15/2020	403	4/28/2020	1220	P204
9106834	2020	9/25/2020	403	5/10/2020	1616	P207
9107015	2020	11/24/2020	403	9/2/2020	1108	P204
9108995	2020	10/28/2020	403	5/6/2020	1307	P204
9124028	2020	11/9/2020	403	5/20/2020	1138	P210
9160507	2020	1/14/2021	403	10/6/2020	1833	P204

CASE_ID	REPORTING_DISTRICT	DAY_OF_WEEK	CHP_SHIFT	POPULATION	CNTY_CITY_LOC	SPECIAL_COND
8465627	4	7	5	2	403	0
8601264	4	2	5	2	403	0
8606096	2	3	5	2	403	0
8607389	4	6	5	2	403	0
8674199	4	5	5	2	403	0
8696012	4	7	5	2	403	0
8696559	3	5	5	2	403	0
8749584		5	5	2	403	0
8764108		6	5	2	403	0
8826521		5	5	2	403	0
8870131		2	5	2	403	0
8872307	G	5	5	2	403	0
8942194		3	5	2	403	0
8964436		2	5	2	403	0
8983268	3	5	5	2	403	0
8984370		3	5	2	403	0
8984406	4	6	5	2	403	0
8984587		7	5	2	403	0
8986287	4	1	5	2	403	0
8996133		2	5	2	403	0
8996181		1	5	2	403	0
8996895		3	5	2	403	0
8996993		3	5	2	403	0
9004356		2	5	2	403	0
9004360		1	5	2	403	0
9048294		2	5	2	403	0
9071212	G	5	5	2	403	0
9078630		1	5	2	403	0
9093643	G	2	5	2	403	0
9106834	G	7	5	2	403	0
9107015	G	3	5	2	403	0
9108995		3	5	2	403	0
9124028		3	5	2	403	0
9160507		2	5	2	403	0

CASE_ID	BEAT_TYPE	CHP_BEAT_TYPE	CITY_DIVISION_LAPD	CHP_BEAT_CLASS	BEAT_NUMBER	PRIMARY_RD
8465627	0	0		0	4	MAGNOLIA ST
8601264	0	0		0	4	RT 99
8606096	0	0		0	2	BRIDGEFORD AV
8607389	0	0		0	4	RT 99
8674199	0	0		0	4	RT 99
8696012	0	0		0	4	EAST GRIDLEY RD
8696559	0	0		0	3	SYCAMORE ST
8749584	0	0		0	1	RT 99
8764108	0	0		0		RT 99
8826521	0	0		0		RT 99
8870131	0	0		0		RT 99
8872307	0	0		0		RT 99
8942194	0	0		0		RT 99
8964436	0	0		0		RT 99
8983268	0	0		0	3	MAGNOLIA ST
8984370	0	0		0		RT 99
8984406	0	0		0	4	RT 99
8984587	0	0		0		RT 99
8986287	0	0		0	4	MAGNOLIA ST
8996133	0	0		0		LAUREL ST
8996181	0	0		0		SYCAMORE ST
8996895	0	0		0		RT 99
8996993	0	0		0		RT 99
9004356	0	0		0		RT 99
9004360	0	0		0		RT 99
9048294	0	0		0		RT 99
9071212	0	0		0		RT 99
9078630	0	0		0		RT 99
9093643	0	0		0		RT 99
9106834	0	0		0		RT 99
9107015	0	0		0		RT 99
9108995	0	0		0		OHIO ST
9124028	0	0		0		SYCAMORE ST
9160507	0	0		0		OHIO ST

CASE_ID	SECONDARY_RD	SR-99?	DISTANCE	DIRECTION	INTERSECTION	TJKM_Int
8465627	HASKELL ST	N	0		Y	Y
8601264	MAGNOLIA ST	Y	0		Y	Y
8606096	OHIO ST	N	0		Y	Y
8607389	EAST GRIDLEY RD	Y	0		Y	Y
8674199	CHERRY ST	Y	0		Y	Y
8696012	RT 99	Y	27	W	N	Y
8696559	INDIANA ST	N	30	E	N	Y
8749584	OBERMEYER AV	Y	0	S	N	Y
8764108	RT 99 1503	Y	0		N	Y
8826521	CHERRY ST	Y	323	S	N	N
8870131	EAST GRIDLEY RD	Y	44	N	N	Y
8872307	EAST GRIDLEY RD	Y	0		Y	Y
8942194	EAST GRIDLEY RD	Y	0		Y	Y
8964436	CHERRY ST	Y	350	S	N	N
8983268	VIRGINIA ST	N	0		Y	Y
8984370	CHERRY ST	Y	0		Y	Y
8984406	CHERRY AV	Y	0		-	Y
8984587	CHERRY ST	Y	0		Y	Y
8986287	RT 99	Y	240	W	N	Y
8996133	OHIO ST	N	0		Y	Y
8996181	VERMONT	N	0		Y	Y
8996895	CHERRY ST	Y	0		-	Y
8996993	SHELDON AV	Y	0		-	Y
9004356	HAZEL ST	Y	0		Y	Y
9004360	RT 99 1613	Y	30	E	N	Y
9048294	MAGNOLIA ST	Y	0		Y	Y
9071212	STANDISH LN	Y	197	N	N	Y
9078630	EAST GRIDLEY RD	Y	0		Y	Y
9093643	SHELDON AV	Y	623	N	N	N
9106834	CHERRY ST	Y	0	S	N	Y
9107015	EAST GRIDLEY RD	Y	0		Y	Y
9108995	SPRUCE ST	N	0		Y	Y
9124028	VERMONT ST	N	0		Y	Y
9160507	LAUREL ST	N	0		Y	Y

CASE_ID	WEATHER_1	WEATHER_2	STATE_HWY_IND	CALTRANS_COUNTY	CALTRANS_DISTRICT	STATE_ROUTE
8465627	A	-	N			
8601264	A	-	Y	BUT	3	99
8606096	A	-	N			
8607389	A	-	Y	BUT	3	99
8674199	A	-	Y	BUT	3	99
8696012	A	-	Y	BUT	3	99
8696559	A	-	N			
8749584	A	-	Y	BUT	3	99
8764108	B	-	Y	BUT	3	99
8826521	B	-	Y	BUT	3	99
8870131	A	-	Y	BUT	3	99
8872307	A	-	Y	BUT	3	99
8942194	C	-	Y	BUT	3	99
8964436	A	-	Y	BUT	3	99
8983268	A	-	N			
8984370	A	-	Y	BUT	3	99
8984406	A	-	Y	BUT	3	99
8984587	A	-	Y	BUT	3	99
8986287	A	-	Y	BUT	3	99
8996133	A	-	N			
8996181	A	-	N			
8996895	A	-	Y	BUT	3	99
8996993	A	-	Y	BUT	3	99
9004356	C	-	Y	BUT	3	99
9004360	B	-	Y	BUT	3	99
9048294	A	-	Y	BUT	3	99
9071212	A	-	Y	BUT	3	99
9078630	A	-	Y	BUT	3	99
9093643	A	-	Y	BUT	3	99
9106834	A	-	Y	BUT	3	99
9107015	A	-	Y	BUT	3	99
9108995	A	-	N			
9124028	A	-	N			
9160507	A	-	N			

CASE_ID	ROUTE_SUFFIX	POSTMILE_PREFIX	POSTMILE	LOCATION_TYPE	RAMP_INTERSECTION	SIDE_OF_HWY
8465627						
8601264	-	R	4.04	H	-	N
8606096						
8607389	-	-	4.121	I	5	N
8674199	-	R	3.968	I	5	S
8696012	-	-	4.121	I	5	N
8696559						
8749584	-	R	3.45	H	-	S
8764108	-	R	3.86	H	-	S
8826521	-	R	3.91	H	-	S
8870131	-	-	4.14	H	-	S
8872307	-	-	4.11	H	-	N
8942194	-	-	4.121	I	5	N
8964436	-	-	3.9	H	-	S
8983268						
8984370	-	R	3.968	I	5	S
8984406	-	R	3.89	H	-	S
8984587	-	R	3.97	H	-	S
8986287	-	R	4.07	H	-	S
8996133						
8996181						
8996895	-	R	3.879	H	-	S
8996993	-	R	3.246	I	5	N
9004356	-	-	4.31	I	6	S
9004360	-	-	4.17	H	-	N
9048294	-	R	4.07	H	-	N
9071212	-	-	4.69	H	-	S
9078630	-	-	4.18	H	-	S
9093643	-	R	3.33	H	-	S
9106834	-	-	3.89	H	-	S
9107015	-	-	4.121	I	5	N
9108995						
9124028						
9160507						

CASE_ID	TOW_AWAY	COLLISION_SEVERITY	NUMBER_KILLED	NUMBER_INJURED	PARTY_COUNT	'RIMARY_COLL_FACTO
8465627	N	1	1	0	2	A
8601264	Y	2	0	3	3	A
8606096	N	3	0	1	2	A
8607389	N	3	0	1	2	A
8674199	Y	2	0	3	3	A
8696012	N	2	0	1	2	A
8696559	Y	3	0	1	1	A
8749584	N	4	0	2	3	A
8764108	N	4	0	1	2	A
8826521	Y	3	0	2	2	A
8870131	N	4	0	2	2	A
8872307	N	2	0	2	3	A
8942194	Y	3	0	1	2	A
8964436	Y	3	0	1	1	A
8983268	Y	4	0	2	2	A
8984370	N	3	0	1	2	A
8984406	Y	2	0	1	1	A
8984587	N	2	0	1	2	A
8986287	Y	3	0	1	3	A
8996133	Y	3	0	1	2	A
8996181	Y	4	0	1	3	A
8996895	Y	4	0	1	2	A
8996993	N	2	0	1	2	A
9004356	N	4	0	1	2	A
9004360	N	3	0	1	2	A
9048294	N	3	0	1	2	A
9071212	Y	3	0	1	1	A
9078630	Y	3	0	1	2	A
9093643	N	4	0	2	2	A
9106834	Y	3	0	2	2	A
9107015	Y	4	0	1	2	A
9108995	N	3	0	1	2	A
9124028	N	4	0	1	2	A
9160507	Y	3	0	1	2	A

CASE_ID	PCF_CODE_OF_VIOL	PCF_VIOL_CATEGORY	PCF_VIOLATION	PCF_VIOL_SUBSECTION	HIT_AND_RUN	TYPE_OF_COLLISION
8465627	-	10	21950	A	F	G
8601264	-	5	21650	A	N	A
8606096	-	12	22450		N	H
8607389	-	12	21453	A	N	B
8674199	-	9	21801	A	N	A
8696012	-	12	21453	A	N	D
8696559	-	8	22107		M	C
8749584	-	3	22350		N	C
8764108	-	9	21804	A	N	D
8826521	-	9	21804	A	N	D
8870131	-	8	22107		N	C
8872307	-	0	23103	A	F	B
8942194	-	12	21453	A	N	D
8964436	-	3	22350		N	E
8983268	-	0	21450		N	D
8984370	-	6	21951		N	G
8984406	-	0	23103	A	N	A
8984587	-	0	21905		F	A
8986287	-	4	21703		N	C
8996133	-	9	21800	A	N	B
8996181	-	3	22350		N	C
8996895	-	3	22350		N	A
8996993	-	5	21650	1	N	H
9004356	-	12	21453	A	N	B
9004360	-	9	21804	A	N	B
9048294	-	9	21801	A	N	D
9071212	-	7	21658	A	N	E
9078630	-	4	21703		N	C
9093643	-	3	22350		N	C
9106834	-	8	22107		N	B
9107015	-	12	21453	A	N	D
9108995	-	10	21950	A	N	G
9124028	-	3	22350		M	C
9160507	-	9	21800	B	N	D

CASE_ID	MVIW	PED_ACTION	ROAD_SURFACE	ROAD_COND_1	ROAD_COND_2	LIGHTING
8465627	B	B	A	H	-	C
8601264	C	A	A	H	-	A
8606096	F	A	A	H	-	A
8607389	C	A	A	H	-	A
8674199	C	A	A	H	-	A
8696012	G	A	A	H	-	A
8696559	E	A	A	H	-	A
8749584	C	A	A	H	-	A
8764108	C	A	A	H	-	C
8826521	C	A	A	H	-	A
8870131	C	A	A	H	-	A
8872307	C	A	A	H	-	A
8942194	C	A	B	H	-	C
8964436	I	A	A	H	-	A
8983268	C	A	A	H	-	A
8984370	B	B	A	H	-	A
8984406	I	A	A	H	-	C
8984587	G	B	A	H	-	C
8986287	C	A	A	H	-	C
8996133	C	A	A	H	-	A
8996181	C	A	A	H	-	B
8996895	C	A	A	H	-	B
8996993	G	A	A	H	-	A
9004356	C	A	B	H	-	C
9004360	C	A	B	H	-	A
9048294	C	A	A	H	-	C
9071212	I	A	A	H	-	D
9078630	C	A	A	H	-	C
9093643	C	A	A	H	-	A
9106834	C	A	A	H	-	A
9107015	C	A	A	H	-	A
9108995	B	B	A	H	-	A
9124028	A	A	A	H	-	A
9160507	C	A	A	H	-	A

CASE_ID	CONTROL_DEVICE	CHP_ROAD_TYPE	PEDESTRIAN_ACCIDEN	BICYCLE_ACCIDENT	MOTORCYCLE_ACCIDEN	TRUCK_ACCIDENT
8465627	A	0	Y			
8601264	D	0				
8606096	A	0		Y		
8607389	A	0				
8674199	D	0				
8696012	A	0		Y		
8696559	D	0				
8749584	A	0				
8764108	D	0				
8826521	D	0				
8870131	A	0				
8872307	A	0			Y	
8942194	A	0				
8964436	D	0				
8983268	D	0				
8984370	D	0	Y			
8984406	D	0				
8984587	D	0	Y			
8986287	D	0				Y
8996133	D	0				
8996181	D	0				
8996895	D	0				
8996993	D	0		Y		
9004356	A	0				
9004360	D	0				
9048294	D	0				
9071212	D	0				
9078630	A	0				
9093643	D	0				
9106834	D	0				
9107015	A	0				
9108995	D	0	Y			
9124028	D	0				
9160507	D	0				

CASE_ID	OT_PRIVATE_PROPERT	ALCOHOL_INVOLVED	WD_VEHTYPE_AT_FAU	HP_VEHTYPE_AT_FAU	COUNT_SEVERE_INJ	COUNT_VISIBLE_INJ
8465627	Y	Y	A	1	0	0
8601264	Y		A	7	2	1
8606096	Y		L	4	0	1
8607389	Y		A	1	0	1
8674199	Y		A	1	2	1
8696012	Y		L	4	1	0
8696559	Y		A	1	0	1
8749584	Y		A	1	0	0
8764108	Y		A	1	0	0
8826521	Y		A	1	0	1
8870131	Y		A	1	0	0
8872307	Y		C	2	1	1
8942194	Y		A	1	0	1
8964436	Y		A	1	0	1
8983268	Y		A	1	0	0
8984370	Y		A	7	0	1
8984406	Y	Y	A	1	1	0
8984587	Y		-	99	1	0
8986287	Y		F	86	0	1
8996133	Y		A	1	0	1
8996181	Y		A	1	0	0
8996895	Y		A	7	0	0
8996993	Y		L	4	1	0
9004356	Y		A	1	0	0
9004360	Y		-		0	1
9048294	Y		A	7	0	1
9071212	Y		A	1	0	1
9078630	Y		-		0	1
9093643	Y		A	1	0	0
9106834	Y		A	7	0	1
9107015	Y		A	1	0	0
9108995	Y		A	7	0	1
9124028	Y		A	7	0	0
9160507	Y		A	1	0	1

CASE_ID	OUNT_COMPLAINT_PA	COUNT_PED_KILLED	COUNT_PED_INJURED	OUNT_BICYCLIST_KILLE	UNT_BICYCLIST_INJUR	COUNT_MC_KILLED
8465627	0	1	0	0	0	0
8601264	0	0	0	0	0	0
8606096	0	0	0	0	1	0
8607389	0	0	0	0	0	0
8674199	0	0	0	0	0	0
8696012	0	0	0	0	1	0
8696559	0	0	0	0	0	0
8749584	2	0	0	0	0	0
8764108	1	0	0	0	0	0
8826521	1	0	0	0	0	0
8870131	2	0	0	0	0	0
8872307	0	0	0	0	0	0
8942194	0	0	0	0	0	0
8964436	0	0	0	0	0	0
8983268	2	0	0	0	0	0
8984370	0	0	1	0	0	0
8984406	0	0	0	0	0	0
8984587	0	0	1	0	0	0
8986287	0	0	0	0	0	0
8996133	0	0	0	0	0	0
8996181	1	0	0	0	0	0
8996895	1	0	0	0	0	0
8996993	0	0	0	0	1	0
9004356	1	0	0	0	0	0
9004360	0	0	0	0	0	0
9048294	0	0	0	0	0	0
9071212	0	0	0	0	0	0
9078630	0	0	0	0	0	0
9093643	2	0	0	0	0	0
9106834	1	0	0	0	0	0
9107015	1	0	0	0	0	0
9108995	0	0	1	0	0	0
9124028	1	0	0	0	0	0
9160507	0	0	0	0	0	0

CASE_ID	COUNT_MC_INJURED	PRIMARY_RAMP	SECONDARY_RAMP	LATITUDE	LONGITUDE	COUNTY
8465627	0	-	-	39.36445999	-121.6945724	BUTTE
8601264	0	-	-	39.37453842	-121.6873779	BUTTE
8606096	0	-	-	39.36445999	-121.6945724	BUTTE
8607389	0	-	-	39.35834885	-121.6901779	BUTTE
8674199	0	-	-	39.36088181	-121.6879196	BUTTE
8696012	0	-	-	39.37453842	-121.6873932	BUTTE
8696559	0	-	-	39.37453842	-121.6873932	BUTTE
8749584	0	-	-	39.35345078	-121.6877365	BUTTE
8764108	0	-	-	39.35950851	-121.6882172	BUTTE
8826521	0	-	-	39.35984039	-121.6873322	BUTTE
8870131	0	-	-	39.36299896	-121.6870499	BUTTE
8872307	2	-	-	39.36320877	-121.687912	BUTTE
8942194	0	-	-	39.36333847	-121.6878128	BUTTE
8964436	0	-	-	39.35988998	-121.6883392	BUTTE
8983268	0	-	-			BUTTE
8984370	0	-	-	39.37432098	-121.6876068	BUTTE
8984406	0	-	-			BUTTE
8984587	0	-	-	39.36090851	-121.6878967	BUTTE
8986287	0	-	-			BUTTE
8996133	0	-	-	39.36130142	-121.6966019	BUTTE
8996181	0	-	-	39.36346817	-121.7133789	BUTTE
8996895	0	-	-	39.35935974	-121.6878128	BUTTE
8996993	0	-	-	39.35102081	-121.6876984	BUTTE
9004356	0	-	-	39.36629105	-121.6882095	BUTTE
9004360	0	-	-	39.36465836	-121.6883469	BUTTE
9048294	0	-	-	39.37400055	-121.6873932	BUTTE
9071212	0	-	-	39.37049866	-121.6879272	BUTTE
9078630	0	-	-	39.36386871	-121.6879501	BUTTE
9093643	0	-	-	39.35200119	-121.6878967	BUTTE
9106834	0	-	-	39.35998154	-121.6881485	BUTTE
9107015	0	-	-	39.36365891	-121.6876373	BUTTE
9108995	0	-	-	39.36544037	-121.6983566	BUTTE
9124028	0	-	-	39.36312103	-121.6986465	BUTTE
9160507	0	-	-	39.36098099	-121.6965103	BUTTE

CASE_ID	CITY	POINT_X	POINT_Y
8465627	GRIDLEY	-121.6901703	39.36320114
8601264	GRIDLEY	-121.6879044	39.36200714
8606096	GRIDLEY	-121.6989365	39.36928177
8607389	GRIDLEY	-121.687912	39.36321259
8674199	GRIDLEY	-121.6878967	39.36093903
8696012	GRIDLEY	-121.687912	39.36321259
8696559	GRIDLEY	-121.6997452	39.36310196
8749584	GRIDLEY	-121.6878967	39.35348511
8764108	GRIDLEY	-121.6879044	39.35939026
8826521	GRIDLEY	-121.6878967	39.36010742
8870131	GRIDLEY	-121.687912	39.36349487
8872307	GRIDLEY	-121.687912	39.36304855
8942194	GRIDLEY	-121.687912	39.36321259
8964436	GRIDLEY	-121.6878967	39.35994339
8983268	GRIDLEY	-121.6949768	39.36277008
8984370	GRIDLEY	-121.6878967	39.36093903
8984406	GRIDLEY	-121.6878967	39.3598175
8984587	GRIDLEY	-121.6878967	39.36096954
8986287	GRIDLEY	-121.6879044	39.36244583
8996133	GRIDLEY	-121.6968002	39.36124802
8996181	GRIDLEY	-121.6986389	39.36312866
8996895	GRIDLEY	-121.6878967	39.3596611
8996993	GRIDLEY	-121.6878738	39.35048676
9004356	GRIDLEY	-121.6879425	39.3659668
9004360	GRIDLEY	-121.6879272	39.36393738
9048294	GRIDLEY	-121.6879044	39.36244583
9071212	GRIDLEY	-121.6879044	39.37133789
9078630	GRIDLEY	-121.6879349	39.36408615
9093643	GRIDLEY	-121.6878815	39.35172272
9106834	GRIDLEY	-121.6878967	39.35979462
9107015	GRIDLEY	-121.687912	39.36321259
9108995	GRIDLEY	-121.6983719	39.36547089
9124028	GRIDLEY	-121.6986389	39.36312866
9160507	GRIDLEY	-121.6968002	39.36124802

CASE_ID	ACCIDENT_YEAR	PROC_DATE	JURIS	COLLISION_DATE	COLLISION_TIME	OFFICER_ID
9165457	2020	11/24/2020	403	9/19/2020	2004	P206
9165635	2020	11/30/2020	403	8/27/2020	2050	P207
9180178	2020	12/2/2020	403	10/26/2020	2040	P204
9197172	2020	12/22/2020	403	10/31/2020	1758	P74
9214802	2020	2/3/2021	403	11/30/2020	1546	P207
9222075	2021	3/19/2021	403	2/24/2021	1937	P204
9223163	2020	2/20/2021	403	12/30/2020	1342	P206
9240521	2021	4/23/2021	403	2/25/2021	2500	P74
9256742	2021	6/21/2021	403	5/18/2021	2212	P209
9286187	2021	7/12/2021	403	6/10/2021	1247	P74
9294613	2021	8/23/2021	403	7/3/2021	2302	P74
9298707	2021	8/13/2021	403	7/17/2021	813	P211
9322177	2021	9/16/2021	403	8/14/2021	2224	P209
9322666	2021	10/4/2021	403	9/2/2021	1723	P73
9326760	2021	10/29/2021	403	9/5/2021	309	P209
9357122	2021	12/7/2021	403	10/9/2021	1842	P214
9367144	2021	12/3/2021	403	10/26/2021	1816	P217
9374077	2021	12/28/2021	403	11/8/2021	1014	P211
9376732	2021	1/6/2022	403	12/2/2021	1516	P73
9391867	2021	2/11/2022	403	12/13/2021	1836	P204
9403637	2022	3/23/2022	403	2/19/2022	1549	P73
9405975	2022	2/28/2022	403	1/25/2022	809	P73
9419780	2022	4/22/2022	403	1/31/2022	0	P210
9460418	2022	7/12/2022	403	5/2/2022	942	P207
9480911	2022	7/29/2022	403	7/3/2022	1350	P24
9490190	2022	9/1/2022	403	7/18/2022	1212	P207
9494297	2022	10/4/2022	403	9/16/2022	1843	P218
9511794	2022	1/24/2023	403	12/7/2022	1300	P502
9512785	2022	11/15/2022	403	10/12/2022	858	P204
9512870	2022	11/15/2022	403	10/13/2022	200	P207
9529962	2022	1/12/2023	403	10/19/2022	1438	P76
9546103	2022	2/10/2023	403	12/6/2022	637	D33

CASE_ID	REPORTING_DISTRICT	DAY_OF_WEEK	CHP_SHIFT	POPULATION	CNTY_CITY_LOC	SPECIAL_COND
9165457	G	6	5	2	403	0
9165635	G	4	5	2	403	0
9180178		1	5	2	403	0
9197172		6	5	2	403	0
9214802		1	5	2	403	0
9222075		3	5	2	403	0
9223163		3	5	2	403	0
9240521	G	4	5	2	403	0
9256742	G	2	5	2	403	0
9286187		4	5	2	403	0
9294613		6	5	2	403	0
9298707	G	6	5	2	403	0
9322177	G	6	5	2	403	0
9322666	O	4	5	2	403	0
9326760		7	5	2	403	0
9357122		6	5	2	403	0
9367144	G	2	5	2	403	0
9374077		1	5	2	403	0
9376732		4	5	2	403	0
9391867	G	1	5	2	403	0
9403637		6	5	2	403	0
9405975		2	5	2	403	0
9419780	G	1	5	2	403	0
9460418	O	1	5	2	403	0
9480911		7	5	2	403	0
9490190	G	1	5	2	403	0
9494297	G	5	5	2	403	0
9511794	G	3	5	2	403	0
9512785	G	3	5	2	403	0
9512870		4	5	2	403	0
9529962		3	5	2	403	0
9546103		2	5	2	403	0

CASE_ID	BEAT_TYPE	CHP_BEAT_TYPE	CITY_DIVISION_LAPD	CHP_BEAT_CLASS	BEAT_NUMBER	PRIMARY_RD
9165457	0	0		0		RT 99
9165635	0	0		0		RT 99
9180178	0	0		0		MAGNOLIA ST
9197172	0	0		0		SYCAMORE ST
9214802	0	0		0		HERON LANDING
9222075	0	0		0		RT 99
9223163	0	0		0		WASHINGTON ST
9240521	0	0		0		RT 99
9256742	0	0		0		RT 99
9286187	0	0		0		RT 99
9294613	0	0		0		WEST BIGGS GRIDLEY RI
9298707	0	0		0		RT 99
9322177	0	0		0		RT 99
9322666	0	0		0		RT 99
9326760	0	0		0		SYCAMORE ST
9357122	0	0		0		MAGNOLIA ST
9367144	0	0		0		RT 99
9374077	0	0		0		SYCAMORE ST
9376732	0	0		0		MAGNOLIA ST
9391867	0	0		0		RT 99
9403637	0	0		0		WASHINGTON ST
9405975	0	0		0		VERMONT ST
9419780	0	0		0		RT 99
9460418	0	0		0		RT 99
9480911	0	0		0		OREGON ST
9490190	0	0		0		RT 99
9494297	0	0		0		RT 99
9511794	0	0		0		RT 99
9512785	0	0		0		RT 99
9512870	0	0		0		RT 99
9529962	0	0		0		RT 99
9546103	0	0		0		HAZEL ST

CASE_ID	SECONDARY_RD	SR-99?	DISTANCE	DIRECTION	INTERSECTION	TJKM_Int
9165457	RCHER AV	Y	380	N	N	N
9165635	CHERRY ST	Y	574	S	N	N
9180178	RT 99	Y	0		Y	Y
9197172	VIRGINIA AV	N	0		Y	Y
9214802	W BIGGS GRIDLEY RD	N	5	E	N	Y
9222075	MAGNOLIA ST	Y	0		Y	Y
9223163	SYCAMORE ST	N	0		Y	Y
9240521	CHERRY ST	Y	0		Y	Y
9256742	EVELYN DR	Y	0		Y	Y
9286187	CHERRY ST	Y	0		Y	Y
9294613	HERON LANDING WY	N	0		Y	Y
9298707	GRIDLEY RD	Y	439	S	N	N
9322177	CHERRY ST	Y	307	S	N	N
9322666	SHELDON AV	Y	135	N	N	Y
9326760	OHIO ST	N	0		Y	Y
9357122	VERMONT ST	N	0		Y	Y
9367144	CHERRY ST	Y	236	S	N	Y
9374077	JACKSON ST	N	15	W	N	Y
9376732	VERMONT ST	N	0		Y	Y
9391867	OBERMEYER AV	Y	629	S	N	N
9403637	SYCAMORE ST	N	0		Y	Y
9405975	LAUREL ST	N	0		Y	Y
9419780	RT 99 1487	Y	0		-	Y
9460418	W LIBERTY RD	Y	0		Y	Y
9480911	SYCAMORE ST	N	0		Y	Y
9490190	SPRUCE ST	Y	50	S	N	Y
9494297	ARCHER AV	Y	601	S	N	N
9511794	FORD AV	Y	404	S	N	N
9512785	SYCAMORE ST	Y	0		Y	Y
9512870	EAST GRIDLEY RD	Y	100	N	N	Y
9529962	FORD AV	Y	0		Y	Y
9546103	RT 99	Y	0		Y	Y

CASE_ID	WEATHER_1	WEATHER_2	STATE_HWY_IND	CALTRANS_COUNTY	CALTRANS_DISTRICT	STATE_ROUTE
9165457	A	-	Y	BUT	3	99
9165635	A	-	Y	BUT	3	99
9180178	A	-	Y	BUT	3	99
9197172	A	-	N			
9214802	A	-	N			
9222075	A	-	Y	BUT	3	99
9223163	A	-	N			
9240521	A	-	Y	BUT	3	99
9256742	A	-	Y	BUT	3	99
9286187	A	-	Y	BUT	3	99
9294613	A	-	N			
9298707	A	-	N			
9322177	A	-	Y	BUT	3	99
9322666	A	-	Y	BUT	3	99
9326760	A	-	N			
9357122	A	-	N			
9367144	A	-	Y	BUT	3	99
9374077	A	-	N			
9376732	A	-	N			
9391867	C	-	Y	BUT	3	99
9403637	A	-	N			
9405975	A	-	N			
9419780	A	-	Y	BUT	3	99
9460418	A	-	Y	BUT	3	99
9480911	A	-	N			
9490190	A	-	Y	BUT	3	99
9494297	A	-	Y	BUT	3	99
9511794	A	-	Y	BUT	3	99
9512785	A	-	Y	BUT	3	99
9512870	A	-	Y	BUT	3	99
9529962	A	-	Y	BUT	3	99
9546103	A	-	Y	BUT	3	99

CASE_ID	ROUTE_SUFFIX	POSTMILE_PREFIX	POSTMILE	LOCATION_TYPE	RAMP_INTERSECTION	SIDE_OF_HWY
9165457	-	R	3.82	H	-	S
9165635	-	R	3.86	H	-	S
9180178	-	R	4.1	H	-	S
9197172						
9214802						
9222075	-	-	4.121	I	5	S
9223163						
9240521	-	R	3.95	H	-	N
9256742	-	R	3.63	H	-	N
9286187	-	R	3.968	I	5	S
9294613						
9298707						
9322177	-	R	3.91	H	-	S
9322666	-	R	3.27	H	-	N
9326760						
9357122						
9367144	-	R	3.93	H	-	N
9374077						
9376732						
9391867	-	R	3.38	H	-	N
9403637						
9405975						
9419780	-	R	3.84	H	-	S
9460418	-	R	3.13	I	5	S
9480911						
9490190	-	-	4.33	H	-	S
9494297	-	R	3.64	H	-	S
9511794	-	-	4.49	H	-	N
9512785	-	-	4.236	I	5	S
9512870	-	-	4.14	H	-	N
9529962	-	-	4.55	H	-	S
9546103	-	-	4.31	I	5	S

CASE_ID	TOW_AWAY	COLLISION_SEVERITY	NUMBER_KILLED	NUMBER_INJURED	PARTY_COUNT	'RIMARY_COLL_FACTO
9165457	N	4	0	1	2	A
9165635	Y	4	0	1	2	A
9180178	N	2	0	1	2	A
9197172	N	2	0	1	1	A
9214802	N	2	0	1	2	A
9222075	N	3	0	2	2	A
9223163	N	4	0	1	2	A
9240521	N	3	0	1	2	A
9256742	Y	2	0	1	2	A
9286187	Y	4	0	1	2	A
9294613	Y	2	0	5	2	A
9298707	Y	3	0	1	1	A
9322177	Y	2	0	3	2	A
9322666	N	4	0	1	2	A
9326760	Y	4	0	1	1	A
9357122	Y	3	0	1	2	A
9367144	N	3	0	1	2	A
9374077	Y	3	0	2	2	A
9376732	N	4	0	1	2	A
9391867	Y	1	1	0	2	A
9403637	Y	4	0	1	2	A
9405975	N	4	0	1	3	A
9419780	Y	3	0	1	1	A
9460418	Y	3	0	1	4	A
9480911	Y	4	0	2	2	A
9490190	N	2	0	1	2	A
9494297	Y	3	0	1	1	A
9511794	N	4	0	1	2	A
9512785	Y	2	0	3	2	A
9512870	N	4	0	1	2	A
9529962	N	4	0	1	2	A
9546103	N	2	0	1	2	A

CASE_ID	PCF_CODE_OF_VIOL	PCF_VIOL_CATEGORY	PCF_VIOLATION	PCF_VIOL_SUBSECTION	HIT_AND_RUN	TYPE_OF_COLLISION
9165457	-	8	22107		N	B
9165635	-	9	21801		N	D
9180178	-	9	21453	B	N	D
9197172	-	17	23109	C	N	F
9214802	-	8	22107		N	H
9222075	-	12	21453	A	N	D
9223163	-	9	21802	A	N	A
9240521	-	9	21804		N	D
9256742	-	8	22107		N	D
9286187	-	9	21802	A	N	D
9294613	-	3	22350		N	A
9298707	-	0	23103	B	N	E
9322177	-	1	23153		N	D
9322666	-	9	21801	A	N	D
9326760	-	7	21658		N	E
9357122	-	1	23153	B	N	D
9367144	-	9	21804	A	N	D
9374077	-	9	21804	A	N	D
9376732	-	10	21950	A	N	G
9391867	-	11	21954	A	N	G
9403637	-	9	21802	A	N	D
9405975	-	9	21802	A	N	D
9419780	-	5	21650		N	-
9460418	-	9	21801		F	A
9480911	-	12	22450	A	N	D
9490190	-	-			N	B
9494297	-	1	23152	A	N	E
9511794	-	8	22107		N	C
9512785	-	12	21453	A	N	D
9512870	-	8	22107		N	H
9529962	-	4	21703		N	C
9546103	-	10	21950	A	F	G

CASE_ID	MVIW	PED_ACTION	ROAD_SURFACE	ROAD_COND_1	ROAD_COND_2	LIGHTING
9165457	C	A	A	H	-	C
9165635	C	A	A	H	-	C
9180178	C	A	A	H	-	C
9197172	A	A	A	H	-	A
9214802	G	A	A	H	-	A
9222075	C	A	A	H	-	C
9223163	C	A	A	H	-	A
9240521	G	A	A	H	-	A
9256742	C	A	A	H	-	C
9286187	C	A	A	H	-	A
9294613	C	A	A	H	-	C
9298707	I	A	A	H	-	A
9322177	C	A	A	H	-	C
9322666	C	A	A	H	-	A
9326760	I	A	A	H	-	C
9357122	C	A	A	H	-	B
9367144	C	A	A	H	-	B
9374077	C	A	A	H	-	A
9376732	B	B	A	H	-	A
9391867	B	D	B	H	-	C
9403637	C	A	A	H	-	A
9405975	C	A	A	H	-	A
9419780	J	A	A	H	-	A
9460418	C	A	A	H	-	A
9480911	D	A	A	H	-	A
9490190	G	A	A	H	-	A
9494297	I	A	A	H	-	A
9511794	C	A	A	H	-	A
9512785	C	A	A	H	-	A
9512870	G	A	A	H	-	A
9529962	C	A	A	H	-	A
9546103	B	B	A	H	-	C

CASE_ID	CONTROL_DEVICE	CHP_ROAD_TYPE	PEDESTRIAN_ACCIDENT	BICYCLE_ACCIDENT	MOTORCYCLE_ACCIDENT	TRUCK_ACCIDENT
9165457	D	0				
9165635	D	0				
9180178	A	0			Y	
9197172	D	0			Y	
9214802	D	0		Y		
9222075	A	0				
9223163	A	0				
9240521	D	0		Y		
9256742	D	0				
9286187	D	0				
9294613	D	0				
9298707	D	0				
9322177	D	0				
9322666	D	0				
9326760	D	0				
9357122	A	0				
9367144	D	0				
9374077	A	0				
9376732	D	0	Y			
9391867	D	0	Y			
9403637	D	0				
9405975	D	0				Y
9419780	D	0				
9460418	A	0				Y
9480911	A	0				
9490190	A	0		Y		
9494297	D	0				
9511794	D	0				
9512785	A	0				
9512870	A	0		Y		
9529962	D	0				
9546103	A	0	Y			

CASE_ID	OT_PRIVATE_PROPERT	ALCOHOL_INVOLVED	WD_VEHTYPE_AT_FAU	HP_VEHTYPE_AT_FAU	COUNT_SEVERE_INJ	COUNT_VISIBLE_INJ
9165457	Y		A	1	0	0
9165635	Y		A	1	0	0
9180178	Y		D	22	1	0
9197172	Y		C	2	1	0
9214802	Y	Y	A	7	1	0
9222075	Y		A	1	0	1
9223163	Y		A	8	0	0
9240521	Y		A	1	0	1
9256742	Y		A	71	1	0
9286187	Y		A	1	0	0
9294613	Y		A	1	3	2
9298707	Y		A	7	0	1
9322177	Y	Y	A	1	1	2
9322666	Y		A	1	0	0
9326760	Y		A	1	0	0
9357122	Y	Y	A	1	0	1
9367144	Y		A	1	0	1
9374077	Y		A	1	0	1
9376732	Y		A	1	0	0
9391867	Y		N	60	0	0
9403637	Y	Y	D	72	0	0
9405975	Y		A	1	0	0
9419780	Y		A	1	0	1
9460418	Y		D	22	0	1
9480911	Y		A	7	0	0
9490190	Y	Y	L	4	1	0
9494297	Y	Y	A	1	0	1
9511794	Y		A	7	0	0
9512785	Y		A	7	1	2
9512870	Y		L	4	0	0
9529962	Y		A	1	0	0
9546103	Y		-	99	1	0

CASE_ID	OUNT_COMPLAINT_PA	COUNT_PED_KILLED	COUNT_PED_INJURED	OUNT_BICYCLIST_KILLE	UNT_BICYCLIST_INJUR	COUNT_MC_KILLED
9165457	1	0	0	0	0	0
9165635	1	0	0	0	0	0
9180178	0	0	0	0	0	0
9197172	0	0	0	0	0	0
9214802	0	0	0	0	1	0
9222075	1	0	0	0	0	0
9223163	1	0	0	0	0	0
9240521	0	0	0	0	1	0
9256742	0	0	0	0	0	0
9286187	1	0	0	0	0	0
9294613	0	0	0	0	0	0
9298707	0	0	0	0	0	0
9322177	0	0	0	0	0	0
9322666	1	0	0	0	0	0
9326760	1	0	0	0	0	0
9357122	0	0	0	0	0	0
9367144	0	0	0	0	0	0
9374077	1	0	0	0	0	0
9376732	1	0	1	0	0	0
9391867	0	1	0	0	0	0
9403637	1	0	0	0	0	0
9405975	1	0	0	0	0	0
9419780	0	0	0	0	0	0
9460418	0	0	0	0	0	0
9480911	2	0	0	0	0	0
9490190	0	0	0	0	1	0
9494297	0	0	0	0	0	0
9511794	1	0	0	0	0	0
9512785	0	0	0	0	0	0
9512870	1	0	0	0	1	0
9529962	1	0	0	0	0	0
9546103	0	0	1	0	0	0

CASE_ID	COUNT_MC_INJURED	PRIMARY_RAMP	SECONDARY_RAMP	LATITUDE	LONGITUDE	COUNTY
9165457	0	-	-	39.35829163	-121.6884689	BUTTE
9165635	0	-	-	39.35935974	-121.6883698	BUTTE
9180178	1	-	-	39.36320877	-121.6878967	BUTTE
9197172	1	-	-	39.3645401	-121.6956863	BUTTE
9214802	0	-	-	39.37453842	-121.6873932	BUTTE
9222075	0	-	-	39.36354828	-121.6883163	BUTTE
9223163	0	-	-	39.36413956	-121.6940231	BUTTE
9240521	0	-	-	39.3610611	-121.6874237	BUTTE
9256742	0	-	-	39.3560791	-121.687973	BUTTE
9286187	0	-	-	39.36083984	-121.6878433	BUTTE
9294613	0	-	-	39.37213135	-121.7066727	BUTTE
9298707	0	-	-	39.36199951	-121.6865463	BUTTE
9322177	0	-	-	39.35960007	-121.6885834	BUTTE
9322666	0	-	-	39.35047913	-121.6878662	BUTTE
9326760	0	-	-	39.36351013	-121.6979523	BUTTE
9357122	0	-	-	39.36203003	-121.6982498	BUTTE
9367144	0	-	-	39.36066055	-121.6883774	BUTTE
9374077	0	-	-	39.36437988	-121.6929169	BUTTE
9376732	0	-	-	39.37453842	-121.6873932	BUTTE
9391867	0	-	-	39.35224152	-121.6878815	BUTTE
9403637	0	-	-	39.36413956	-121.6940079	BUTTE
9405975	0	-	-	39.36098099	-121.6978836	BUTTE
9419780	0	-	-	39.35887146	-121.6884308	BUTTE
9460418	0	-	-	39.34880829	-121.3878403	BUTTE
9480911	0	-	-	39.36285019	-121.7040024	BUTTE
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9294613	GRIDLEY	-121.7066803	39.37218094
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9322177	GRIDLEY	-121.6878967	39.36010742
9322666	GRIDLEY	-121.6878738	39.35083771
9326760	GRIDLEY	-121.6975708	39.36333847
9357122	GRIDLEY	-121.6982574	39.36209869
9367144	GRIDLEY	-121.6878967	39.36039352
9374077	GRIDLEY	-121.6929779	39.36439514
9376732	GRIDLEY	-121.6982574	39.36209869
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9405975	GRIDLEY	-121.6978607	39.36101913
9419780	GRIDLEY	-121.687912	39.35910416
9460418	GRIDLEY	-121.6878357	39.34880447
9480911	GRIDLEY	-121.7037735	39.36306
9490190	GRIDLEY	-121.6879349	39.36625671
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9529962	GRIDLEY	-121.6879272	39.36930084
9546103	GRIDLEY	-121.6879425	39.3659668

Appendix D - LRSM Excerpt

Local Roadway Safety

A Manual for California's Local Road Owners

Version 1.6
April 2022

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

Caltrans

U. S. Department of Transportation
Federal Highway Administration

Safe Transportation
Research & Education Center
SafeTREC

Document History

Version 1.0: 4/20/2012

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

Version 1.1: 4/26/2013

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

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

Version 1.2: 03/10/2015

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

Version 1.3: 04/29/2016

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

Version 1.4: 06/08/2018

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

Version 1.5: April 2020

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

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.

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.

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Foreword

Why was this manual developed?

The California Department of Transportation - Division of Local Assistance's goal in developing this manual is to maximize the safety benefits for local roadways by encouraging all local agencies to proactively identify and analyze their safety issues and to position themselves to compete effectively in Caltrans' statewide, data-driven call-for-projects.

This goal is complicated by California's wide variety of local agencies, roadway types, and project types, including: rural vs. urban, low-volume vs. high-volume, and intersection vs. roadway segment vs. network-wide. This variety makes it difficult to administer a single program and provide one set of guidelines that meets the needs of all California's local roadway owners and users. Many of California's local agencies are also challenged by the lack of a basic safety analysis framework and analysis tools specifically designed for local roadway managers with widely varying responsibilities and safety training. Currently, there is a vast range of safety documents, program guidance, and analysis tools with a wide variety of complexity and applications. Without clear and simple safety guidance for locals, many agencies take a 'reactive' approach to safety, even when research has shown 'proactive' safety analysis of roadways is more effective in making system-wide safety improvements.

The Federal Highway Administration (FHWA) Office of Safety provides national leadership in identifying, developing, and delivering safety programs and products to local governments to improve highway safety on local and rural roads.[1] In 2010, FHWA published a set of three manuals designed specifically for rural road owners; Roadway Departure Safety, Intersection Safety, and Road Safety Information Analysis.[2] These manuals present a simple, data driven safety analysis framework for rural agencies across the nation. These manuals, in conjunction with Caltrans' ongoing short-term research and development contract with the Safe Transportation Research and Education Center (SafeTREC) at the University of California, Berkeley, provided a unique opportunity for Caltrans to pursue development of this document as a mirror of FHWA's new Manuals for Local Rural Road Owners. Much of the wording, formatting and references from these FHWA manuals have been directly incorporated into this manual for California's local road owners. Individual references to the FHWA manuals have not been included; instead these documents are intended to be referenced on a wholesale basis.

With FHWA's and SafeTREC's support and expertise, Caltrans was able to expedite the completion of this manual and can now offer California's local agencies a new tool intended to provide focused roadway safety information in one manual.

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; 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 but in MAP-21 and FAST, 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 $6 billion, while only $100 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:

- <u>Widespread effect.</u> 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

<u>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.</u> 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

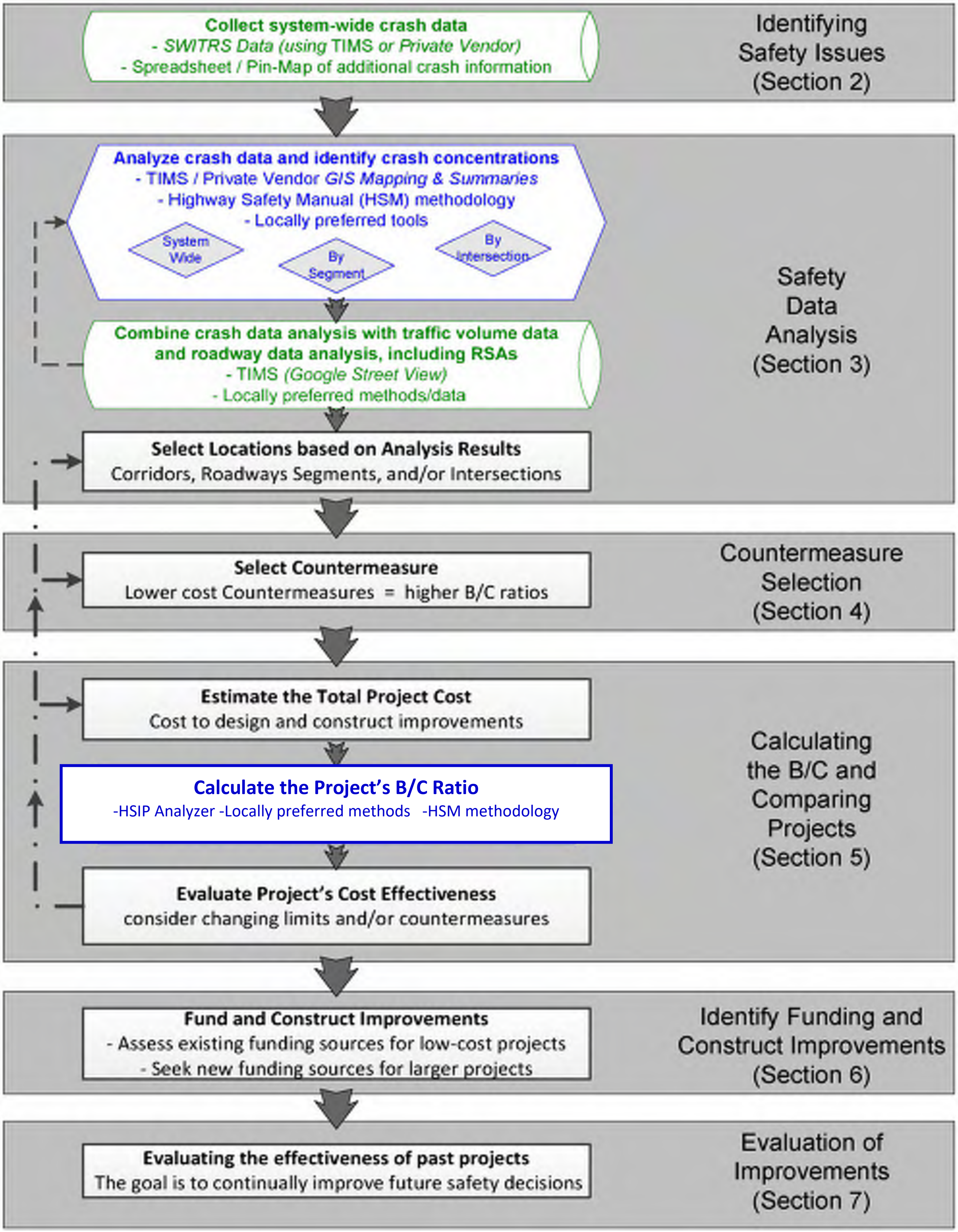
This document provides information on effectively identifying California's local roadway safety issues and the countermeasures that address them, ultimately leading to the effective implementation of safety projects that improve safety on local roadways. The document is not intended to be a comprehensive 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 process. This flowchart demonstrates how this document interacts with these Caltrans calls-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 x 100,000,000) / (V x 365 x N x 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 x C) / (365 x N x 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 to 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 Manual[7], FHWA's "Green Book" policy manual[8] and PEDSAFE guide[9], and AASHTO's Roadside Design Guide[10]. 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 – 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 11 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 11 Call-for-projects.
    - Eighty-one (81) countermeasures: 90%
    - One (1) countermeasure: 50% (CM No. S03: 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 2. Countermeasures for Non-Signalized Intersections

No.	Type	Countermeasure Name	Crash Type	CRF	Expected Life (Years)	HSIP Funding Eligibility	Systemic Approach Opportunity?
NS01	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
NS04	Control	Convert intersection to roundabout (from all way stop)	All	Varies	20	90%	Low
NS05	Control	Convert intersection to roundabout (from stop or yield control on minor road)	All	Varies	20	90%	Low
NS05mr*	Control	Convert intersection to mini-roundabout	All	30%	20	90%	Medium
NS06	Operation/ Warning	Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs	All	15%	10	90%	Very High
NS07	Operation/ Warning	Upgrade intersection pavement markings (NS.I.)	All	25%	10	90%	Very High
NS08	Operation/ Warning	Install Flashing Beacons at Stop-Controlled Intersections	All	15%	10	90%	High
NS09	Operation/ Warning	Install flashing beacons as advance warning (NS.I.)	All	30%	10	90%	High
NS10	Operation/ Warning	Install transverse rumble strips on approaches	All	20%	10	90%	High
NS11	Operation/ Warning	Improve sight distance to intersection (Clear Sight Triangles)	All	20%	10	90%	High
NS12	Operation/ Warning	Improve pavement friction (High Friction Surface Treatments)	All	55%	10	90%	Medium
NS13	Geometric Mod.	Install splitter-islands on the minor road approaches	All	40%	20	90%	Medium
NS14	Geometric Mod.	Install raised median on approaches (NS.I.)	All	25%	20	90%	Medium
NS15	Geometric Mod.	Create directional median openings to allow (and restrict) left-turns and u-turns (NS.I.)	All	50%	20	90%	Medium
NS16	Geometric Mod.	Reduced Left-Turn Conflict Intersections (NS.I.)	All	50%	20	90%	Medium
NS17	Geometric Mod.	Install right-turn lane (NS.I.)	All	20%	20	90%	Low
NS18	Geometric Mod.	Install left-turn lane (where no left-turn lane exists)	All	35%	20	90%	Low
NS19PB	Ped and Bike	Install raised medians / refuge islands (NS.I.)	P & B	45%	20	90%	Medium
NS20PB	Ped and Bike	Install pedestrian crossing at uncontrolled locations (new signs and markings only)	P & B	25%	10	90%	High
NS21PB	Ped and Bike	Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)	P & B	35%	20	90%	Medium
NS22PB	Ped and Bike	Install Rectangular Rapid Flashing Beacon (RRFB)	P & B	35%	20	90%	Medium
NS23PB	Ped and Bike	Install Pedestrian Signal (including Pedestrian Hybrid Beacon (HAWK))	P & B	55%	20	90%	Low

*CM NS05mr is a new countermeasure added for HSIP Cycle 11 Call-for-projects.

Table 1. Countermeasures for Signalized Intersections

No.	Type	Countermeasure Name	Crash Type	CRF	Expected Life (Years)	HSIP Funding Eligibility	Systemic Approach Opportunity?
S01	Lighting	Add intersection lighting (S.I.)	Night	40%	20	90%	Medium
S02	Signal Mod.	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	All	15%	10	90%	Very High
S03	Signal Mod.	Improve signal timing (coordination, phases, red, yellow, or operation)	All	15%	10	50%	Very High
~~S04*~~	~~Signal Mod.~~	~~Provide Advanced Dilemma Zone Detection for high speed approaches~~	~~All~~	~~40%~~	~~10~~	~~90%~~	~~High~~
S05	Signal Mod.	Install emergency vehicle pre-emption systems	Emergency Vehicle	70%	10	90%	High
S06	Signal Mod.	Install left-turn lane and add turn phase (signal has no left-turn lane or phase before)	All	55%	20	90%	Low
S07	Signal Mod.	Provide protected left turn phase (left turn lane already exists)	All	30%	20	90%	High
S08	Signal Mod.	Convert signal to mast arm (from pedestal-mounted)	All	30%	20	90%	Medium
S09	Operation/ Warning	Install raised pavement markers and striping (Through Intersection)	All	10%	10	90%	Very High
S10	Operation/ Warning	Install flashing beacons as advance warning (S.I.)	All	30%	10	90%	Medium
S11	Operation/ Warning	Improve pavement friction (High Friction Surface Treatments)	All	55%	10	90%	Medium
S12	Geometric Mod.	Install raised median on approaches (S.I.)	All	25%	20	90%	Medium
S13PB	Geometric Mod.	Install pedestrian median fencing on approaches	P & B	35%	20	90%	Low
S14	Geometric Mod.	Create directional median openings to allow (and restrict) left-turns and u-turns (S.I.)	All	50%	20	90%	Medium
S15	Geometric Mod.	Reduced Left-Turn Conflict Intersections (S.I.)	All	50%	20	90%	Medium
S16	Geometric Mod.	Convert intersection to roundabout (from signal)	All	Varies	20	90%	Low
S17PB	Ped and Bike	Install pedestrian countdown signal heads	P & B	25%	20	90%	Very High
S18PB	Ped and Bike	Install pedestrian crossing (S.I.)	P & B	25%	20	90%	High
S19PB	Ped and Bike	Pedestrian Scramble	P & B	40%	20	90%	High
S20PB	Ped and Bike	Install advance stop bar before crosswalk (Bicycle Box)	P & B	15%	10	90%	Very High
S21PB	Ped and Bike	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	P & B	60%	10	90%	Very High

*CM S04 has been deleted in HSIP Cycle 11 Call-for-projects.

Table 3. Countermeasures for Roadways

No.	Type	Countermeasure Name	Crash Type	CRF	Expected Life (Years)	HSIP Funding Eligibility	Systemic Approach Opportunity?
R01	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/stripes	All	20%	10	90%	High
R31	Operation/ Warning	Install edgeline rumble strips/stripes	All	15%	10	90%	High
R32PB	Ped and Bike	Install bike lanes	P & B	35%	20	90%	High
R33PB	Ped and Bike	Install Separated Bike Lanes	P & B	45%	20	90%	High
R34PB	Ped and Bike	Install sidewalk/pathway (to avoid walking along roadway)	P & B	80%	20	90%	Medium
R35PB	Ped and Bike	Install/upgrade pedestrian crossing (with enhanced safety features)	P & B	35%	20	90%	Medium
R36PB	Ped and Bike	Install raised pedestrian crossing	P & B	35%	20	90%	Medium
R37PB	Ped and Bike	Install Rectangular Rapid Flashing Beacon (RRFB)	P & B	35%	20	90%	Medium
R38	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 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 uses 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 funding application website. 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.

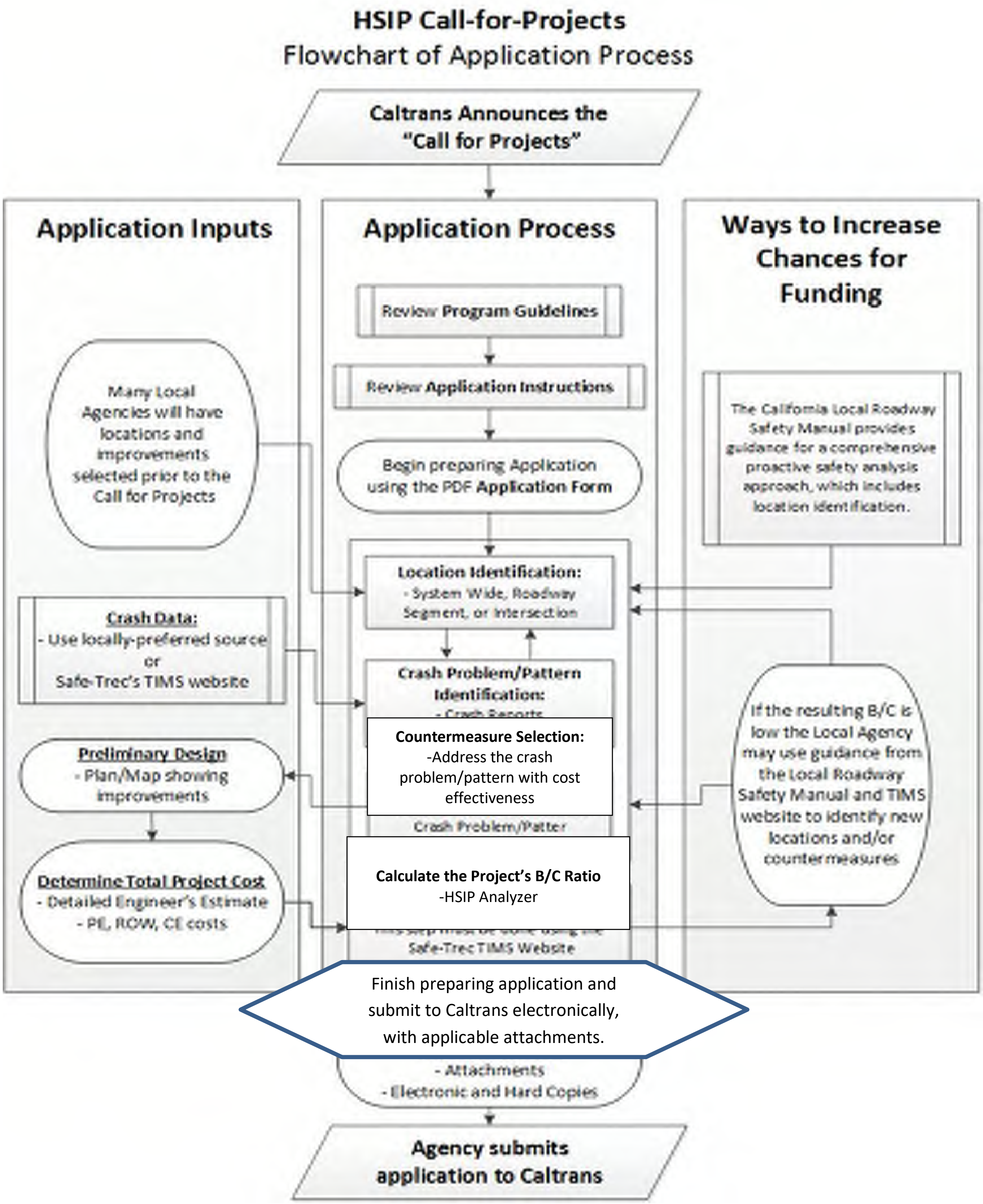
In order to perform the assessment, it is necessary to collect the required information for a certain period after strategies have been deployed at the locations. The time period varies, but whenever possible, 3 to 5 years is recommended to reduce the effects of the random nature of roadway crashes (i.e., 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

<u>Recommended Action:</u> 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 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
  - S01 through S21PB for Intersection Countermeasures – Signalized,
  - NS01 through NS23PB for Intersection Countermeasures – Unsignalized, or
  - R01 through R38 for Roadway Countermeasures.

For HSIP Calls-for-projects:

- **Funding Eligibility -** 90% or 50%.
- **Crash Types Addressed -** “All”, “Pedestrian and Bicycle”, “Night”, “Emergency Vehicle”, or “Animal”.
- **CRF -** Crash Reduction Factor used for HSIP calls-for-projects.
- **Expected Life -** 10 years or 20 years.
- **Notes -** Specific requirements are provided for utilizing the countermeasure on applications for Caltrans statewide calls-for-projects.
-

General Information:

- **Where to use** – Roadway segments and intersections with specific common characteristics can be addressed with similar countermeasures that are most effective.
- **Why it works** – A discussion of the benefit of a countermeasure is important to determine its appropriateness in addressing certain roadway crash types at areas with specific issues as determined by the data and roadway features.
- **General Qualities (Time, Cost and Effectiveness)** – This category is more subjective and can vary substantially. ‘Time’ refers to the approximate relative time it can take to implement the countermeasure. Costs can vary considerably due to local conditions, so ‘cost’ represents the relative cost of applying a countermeasure. A relative overall ‘effectiveness’ is also provided for some countermeasures. All of this subjective information may not be applicable to the unique circumstances for the agency and should not be utilized without verification by the safety practitioner.

- **FHWA CMF Clearinghouse**

- **Crash Types Addressed** – In order to effectively reduce the number and severity of roadway crashes, it is necessary to match countermeasures to the crash types they are intended to address. Depending on the type of problem, one or more of a range of countermeasures could be the most effective way to reduce the number and severity of future crashes.
- **Crash Reduction Factor** – The crash reduction factor (CRF) is an indication of the effectiveness of a particular treatment, measured by the percentage of crashes it is expected to reduce. Note: As mentioned earlier in this section, the effectiveness of a countermeasure can also be expressed as a Crash Modification Factor (CMF), which is defined mathematically as 1 – CRF. However, this document uses CRFs as they can be more insightful when analyzing roadways for potential “reductions” in crashes. There is a range of CRF values that exist for each of the countermeasures (or similar countermeasures). The range of CRFs is provided to give local safety practitioners a clear understanding that they may need to go to the FHWA CMF Clearinghouse to find the most appropriate countermeasure and CRF for their specific projects and local prioritization.

B.1 Intersection Countermeasures – Signalized

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

For HSIP Cycle 11 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:	Night, All	CRF:	20-74%

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

For HSIP Cycle 11 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%

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

For HSIP Cycle 11 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%

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

~~**For HSIP Cycle 11 Call-for-projects**~~			
~~Funding Eligibility~~	~~Crash Types Addressed~~	~~CRF~~	~~Expected Life~~
~~90%~~	~~All~~	~~40%~~	~~10 years~~
~~Notes:~~	~~This CM only applies to crashes occurring on the approaches / influence area of the new detection and signal timing.~~		

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

S05, Install emergency vehicle pre-emption systems

For HSIP Cycle 11 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%

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

For HSIP Cycle 11 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 %

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

For HSIP Cycle 11 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%

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

For HSIP Cycle 11 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%

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

For HSIP Cycle 11 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%

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

For HSIP Cycle 11 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%

S11, Improve pavement friction (High Friction Surface Treatments)

For HSIP Cycle 11 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 %

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

For HSIP Cycle 11 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 %

S13PB, Install pedestrian median fencing on approaches

For HSIP Cycle 11 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%

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

For HSIP Cycle 11 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:	All	CRF:	51%

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

For HSIP Cycle 11 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):

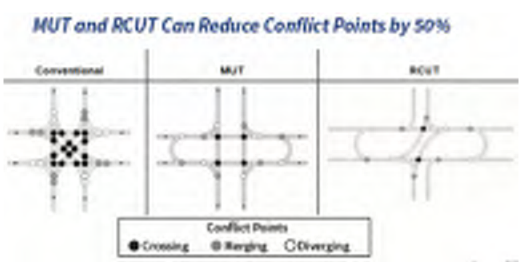
The RCUT intersection modifies the direct left-turn and through movements from cross-street approaches. Minor road traffic makes a right turn followed by a U-turn at a designated location (either signalized or unsignalized) to continue in the desired direction.

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.



General Qualities (Time, Cost and Effectiveness):

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

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

S16, Convert intersection to roundabout (from signal)

For HSIP Cycle 11 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 mini-roundabouts. The benefit of this CM is calculated using Caltrans procedure. The CRF is dependent on the ADT, project location (Rural/Urban) and the roundabout type (1 lane or 2 lanes). The benefit comes from both the reduction in the number and the severity of the crashes.		

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

S17PB, Install pedestrian countdown signal heads

For HSIP Cycle 11 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%

S18PB, Install pedestrian crossing (S.I.)

For HSIP Cycle 11 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%

S19PB, Pedestrian Scramble

For HSIP Cycle 11 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%

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

For HSIP Cycle 11 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%

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

For HSIP Cycle 11 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 left. LPIs provide (1) increased visibility of crossing pedestrians; (2) reduced conflicts between pedestrians and vehicles; (3) Increased likelihood of motorists yielding to pedestrians; and (4) enhanced safety for pedestrians who may be slower to start into the intersection.				
General Qualities (Time, Cost and Effectiveness):				
Costs for implementing LPIs are very low, since only minor signal timing alteration is required. This makes it an easy and inexpensive countermeasure that can be incorporated into pedestrian safety action plans or policies and can become routine agency practice. When considered at a single location, the LPI is usually local-funded. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	59%

B.2 Intersection Countermeasures – Non-signalized

NS01, Add intersection lighting (NS.I.)

For HSIP Cycle 11 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 11 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 11 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%

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

For HSIP Cycle 11 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 all-way stop-controlled intersections. Modern roundabouts differ from traditional traffic circles in that they operate in such a manner that traffic entering the roundabout must yield the right-of-way to traffic already in it. Roundabouts can serve moderate traffic volumes with less delay than all-way stop-controlled intersections and provide fewer conflict points. Crashes at roundabouts tend to be less severe because of the speed constraints and elimination of left-turn and right-angle movements.				
General Qualities (Time, Cost and Effectiveness):				
Construction of roundabouts are usually relatively costly and major projects, requiring the environmental process, right-of-way acquisition, and implementation under an agency's long-term capital improvement program. (For this reason, roundabouts may not be appropriate for California's Federal Safety Programs that have relatively short delivery requirements.) Even with roundabouts higher costs, they still can have a relatively high effectiveness.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Left-turn, Angle	CRF:	12 - 78 %

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

For HSIP Cycle 11 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 all-way stop-controlled intersections. Modern roundabouts differ from traditional traffic circles in that they operate in such a manner that traffic entering the roundabout must yield the right-of-way to traffic already in it. Roundabouts can serve moderate traffic volumes with less delay than all-way stop-controlled intersections and provide fewer conflict points. Crashes at roundabouts tend to be less severe because of the speed constraints and elimination of left-turn and right-angle movements.				
General Qualities (Time, Cost and Effectiveness):				
Construction of roundabouts are usually relatively costly and major projects, requiring the environmental process, right-of-way acquisition, and implementation under an agency's long-term capital improvement program. (For this reason, roundabouts may not be appropriate for California's Federal Safety Programs that have relatively short delivery requirements.) Even with roundabouts higher costs, they still can have a relatively high effectiveness.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Left-turn, Angle	CRF:	12 - 78 %

NS05mr, Convert intersection to mini-roundabout

For HSIP Cycle 11 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 control.		

General information				
Where to use:				
Mini-roundabouts are characterized by a small diameter (45-90 ft) and traversable islands (central island and splitter islands). Mini-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. Mini-roundabouts are most effective in lower speed environments in which all approaching roadways have posted speed of 30 mph or less and an 85th-percentile speed of less than 35 mph near the proposed yield and/or entrance line. For any location with an 85th-percentile speed above 35 mph, the mini-roundabout can be included as part of a broader system of traffic calming measures to achieve an appropriate speed environment.				
Why it works:				
Mini-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 mini-roundabouts are the Compact size, operational efficiency, traffic safety improvement and traffic Calming.				
General Qualities (Time, Cost and Effectiveness):				
Construction costs for mini-roundabouts vary widely depending upon the extent of sidewalk modifications or other geometric improvements and the types of materials used. In most cases, mini-roundabouts have been installed with little or no pavement widening and with only minor changes to curbs and sidewalks. Construction costs can be minimum for an installation consisting entirely of pavement markings and signage or moderate for mini-roundabouts that include raised islands and pedestrian improvements.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	NA	CRF:	NA

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

For HSIP Cycle 11 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%

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

For HSIP Cycle 11 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%

NS08, Install Flashing Beacons at Stop-Controlled Intersections

For HSIP Cycle 11 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%

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

For HSIP Cycle 11 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%

NS10, Install transverse rumble strips on approaches

For HSIP Cycle 11 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%

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

For HSIP Cycle 11 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%

NS12, Improve pavement friction (High Friction Surface Treatments)

For HSIP Cycle 11 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 %

NS13, Install splitter-islands on the minor road approaches

For HSIP Cycle 11 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 %

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

For HSIP Cycle 11 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 %

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

For HSIP Cycle 11 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%

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

For HSIP Cycle 11 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):

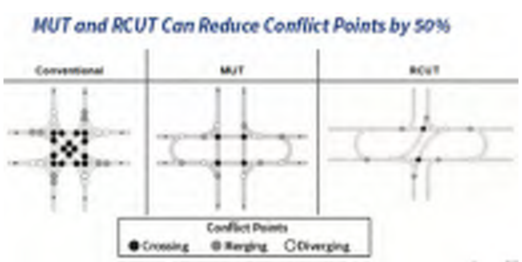
The RCUT intersection modifies the direct left-turn and through movements from cross-street approaches. Minor road traffic makes a right turn followed by a U-turn at a designated location (either signalized or unsignalized) to continue in the desired direction.

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.



General Qualities (Time, Cost and Effectiveness):

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

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

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

For HSIP Cycle 11 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 %

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

For HSIP Cycle 11 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 %

NS19PB, Install raised medians (refuge islands)

For HSIP Cycle 11 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 %

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

For HSIP Cycle 11 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 %

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

For HSIP Cycle 11 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%

NS22PB, Install Rectangular Rapid Flashing Beacon (RRFB)

For HSIP Cycle 11 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%

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

For HSIP Cycle 11 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

R01, Add Segment Lighting

For HSIP Cycle 11 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 11 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 11 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 11 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 11 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 11 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 11 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 11 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. **Agencies need to consider and document impacts of additional turning movements at nearby intersections.**				
Why it works:				
Adding raised medians is a particularly effective strategy as it adds to or reallocates the existing cross section to incorporate a buffer between the opposing travel lanes and reinforces the limits of the travel lane. Raised median may also be used to limit unsafe turning movements along a roadway.				
General Qualities (Time, Cost and Effectiveness):				
In some cases this strategy may be a retrofit into the existing roadway by utilizing a portion of the existing paved shoulder. These raised medians can be installed directly over the existing pavement. Cost and time to implement could significantly increase if the paved area is not sufficient to include a median. The surface treatment of the raised median also significantly affects their cost-effectiveness: standard concrete or other hardscape surfaces are usually more cost effective than landscaped medians. When agencies opt to install landscaping in conjunction with new raised medians, the project design and construction costs can significantly increase due to excavation, backfill/top-soil, water-connection, irrigation, planting, maintenance needed for the landscaping. When agencies opt to install landscaping in conjunction with new raised medians, the portion of the cost for landscaping and other non-safety related items that exceeds 10% of the project total cost is not federally participated and must be funded by the applicant.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Head-on	CRF:	20 - 75 %

R09, Install median (flush)

For HSIP Cycle 11 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 11 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 11 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 safety decelerate to negotiate a turning movement. This CM can also be used to improve the safety of merging vehicles at a lane-drop location.				
Why it works:				
A lane that does not provide enough deceleration length and storage space for turning traffic may cause the turn queue to back up into the adjacent through lane. This can contribute to rear-end and sideswipe crashes. An acceleration lane is an auxiliary or speed-change lane that allows vehicles to accelerate to highway speeds (high speed roadways) before entering the through-traffic lanes of a highway. Additionally, if acceleration by entering traffic takes place directly on the traveled way, it may disrupt the flow of through-traffic and cause rear-end and sideswipe collisions.				
General Qualities (Time, Cost and Effectiveness):				
Costs are highly variable. Where sufficient median or shoulder space exists it may be possible to provide acceleration/deceleration lanes at a moderate cost. Where the roadway must be widened and additional right-of-way must be acquired, higher costs and a lengthy time-to-construct are likely. The expected effectiveness of this CM must be assessed for each individual location.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Sideswipe, Rear-End	CRF:	10 - 75 %

R12, Widen lane (initially less than 10 ft)

For HSIP Cycle 11 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 11 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 11 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 11 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/striping upgrades to MUTCD standards/recommendations, rumble strips, etc.), 2) they have already monitored the crash occurrences after these improvements were installed, and 3) the 'after' crash rate is still unacceptably high. This 'incremental approach' (or a special exception from the HSIP program manager) must be documented in the Narrative Questions in the application and a summary of the 'before' and 'after' crash analysis must be attached to the application.		

General information

Where to use:

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

Why it works:

Based on the best available research, adding shoulder or widening an existing shoulder provides a greater area to regain control of a vehicle, as well as lateral clearance to roadside objects such as guardrail, signs and poles. They may also provide space for disabled vehicles to stop or drive slowly, provide increased sight distance for through vehicles and for vehicles entering the roadway, and in some cases reduce passing conflicts between motor vehicles and bicyclists and pedestrians. The likely safety benefits for adding or widening an existing shoulder generally increase as the widening width increases - practitioners should refer to NCHRP Report 500 Series, the CMF Clearinghouse or other references for more details.

General Qualities (Time, Cost and Effectiveness):

Shoulder widening costs would depend on whether new right-of-way is required and whether extensive roadside modification is needed. Since shoulder widening can be a relatively expensive treatment, one of the keys to creating a cost effective project with at least a medium B/C ratio is targeting higher-hazard roadways.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Fixed Object, Run-off Road, Sideswipe	CRF:	15 - 75 %

R16, Curve Shoulder widening (Outside Only)

For HSIP Cycle 11 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 11 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/striping upgrades to MUTCD standards/recommendations, rumble strips, etc.), 2) they have already monitored the crash occurrences after these improvements were installed, and 3) the 'after' crash rate is still unacceptably high. This 'incremental approach' (or a special exception from the HSIP program manager) must be documented in the Narrative Questions in the application and a summary of the agency's 'before' and 'after' crash analysis must be attached to the application.

General information

Where to use:

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

Why it works:

Increasing the radius of a horizontal curve can be very effective in improving the safety performance of the curve. Curve modification reduces the likelihood of a vehicle leaving its lane, crossing the roadway centerline, or leaving the roadway at a horizontal curve; and minimizes the adverse consequences of leaving the roadway. Horizontal alignment improvement projects are expected to include standard/improved superelevation elements, which should be considered part of this CM and not an additional CM.

General Qualities (Time, Cost and Effectiveness):

This strategy is a long-term, higher-cost alternative for improving the safety of a horizontal curve because it usually involves total reconstruction of the roadway. It may also require acquisition of additional right-of-way and an environmental review. This strategy, albeit costly, has shown that increasing the radius of curvature can significantly reduce total curve-related crashes by up to 80 percent. The expected effectiveness of this CM must be assessed for each individual location.

FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	24 - 90%

R18, Flatten crest vertical curve

For HSIP Cycle 11 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/striping upgrades to MUTCD standards/recommendations, rumble strips, etc.), 2) they have already monitored the crash occurrences after these improvements were installed, and 3) the 'after' crash rate is still unacceptably high. This 'incremental approach' (or a special exception from the HSIP program manager) must be documented in the Narrative Questions in the application and a summary of the agency's 'before' and 'after' crash analysis must be attached to the application.		

General information

Where to use:

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

Why it works:

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

General Qualities (Time, Cost and Effectiveness):

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

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

R19, Improve curve superelevation

For HSIP Cycle 11 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 roadways features. When simple overlay fixes are pursued, a systematic installation approach may be appropriate. The expected effectiveness of this CM must be assessed for each individual location.

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

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

For HSIP Cycle 11 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 11 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 11 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 11 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 11 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 11 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 11 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) {**<u>This CM does not apply to dynamic regulatory speed warning signs.</u>** 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 11 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 11 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/marking features, no-passing zone limits needing adjustment, and missing striping/markings that may otherwise go unnoticed. More information on this concepts is available on the Local Assistance HSIP webpage under an RSSA example document. Note: When federal safety funding is used for these installations in high-wear-locations, the local agency is expected to maintain the improvement for a minimum of 10 years.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Head-on, Run-off Road, All	CRF:	0 - 44 %

R29, Install no-passing line

For HSIP Cycle 11 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 11 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/stripes

For HSIP Cycle 11 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%

R32PB, Install bike lanes

For HSIP Cycle 11 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 %

R33PB, Install Separated Bike Lanes

For HSIP Cycle 11 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 %

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

For HSIP Cycle 11 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 %

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

For HSIP Cycle 11 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%

R36PB, Install raised pedestrian crossing

For HSIP Cycle 11 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%

R37PB, Install Rectangular Rapid Flashing Beacon (RRFB)

For HSIP Cycle 11 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%

R38, Install Animal Fencing

For HSIP Cycle 11 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 Safety 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. The following spreadsheet is offered as an example, but each agency’s spreadsheet should include data and be formatted as necessary to meet their needs.

	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”								
2) Roadway Segment (PM 5.3 to PM 7.8)								

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 – 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) $$Benefit\ (Annual) = \sum_{s=0}^{3} \frac{CRF \times N \times CC_{ave}}{Y}$$

- CRF : Crash reduction factor in each countermeasure.
- S : Severity (0: PDO, 1: Minor Injury, 2: Injury, 3: Severe Injury/Fatal). See the below table.
- N : Number of Crashes, in severity levels, related to selected countermeasure.
- Y : Crash data time period (Year).
- CC_{ave} : Crash costs in severity levels.

Severity (S)	Crash Severity *	Location Type	Crash Cost ***
3	**Fatality and Severe Injury Combined (KA)	Signalized Intersection	$1,787,000
3		Non Signalized Intersection	$2,843,000
3		Roadway	$2,461,000
2	Evident Injury – Other Visible (B)		$159,900
1	Possible Injury–Complaint of Pain (C)		$90,900
0	Property Damage Only (O)		$14,900

* 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, a crash cost for a Fatality (K) of $8,112,200, and a crash cost of a Severe/Disabling Injury (A) of $437,100. These costs are used in the HSIP Analyzer.

*** Based on Table 7-1, Highway Safety Manual (HSM), First Edition, 2010. Adjusted to 2022 Dollars.

2) *Benefit (Life) = Benefit (annual) x Years of service life*

3) BCR (each countermeasure): $$Benefit\ \ Cost\ Ratio_{(CM)} = \frac{Benefit\ (Life)_{(CM)}}{Total\ Project\ Cost_{(CM)}}$$

4) BCR (project): $$BCR\ (Project) = \frac{\sum_{CM=1}^{n} Benefit\ (Life)_{(CM)}}{Total\ \ Project\ Cost}$$

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

As demonstrated throughout the manual, SafeTREC's TIMS website http://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).*

<u>SWITRS Query & Map:</u>

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

<u>SWITRS GIS Map:</u>

The SWITRS GIS Map offers an interactive map-centric approach to viewing and querying SWITRS collision data, with the capability of multiple tasks including Rank by Intersection, Collision Diagram, etc.

<u>Collision Diagram Tool:</u>

The Collision Diagram tool allows users to generate an interactive collision diagram. The Collision Diagram is accessible through SWITRS GIS Map after a set of collisions is selected.

<u>ATP Maps & Summary Data:</u>

The ATP Maps & Summary Data tool utilizes interactive collision maps to find pedestrian and bicycle collisions hot spot 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; 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	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 Bikesafe and Pedsafe
    - 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 E - Countermeasure Toolbox

High-risk Intersections

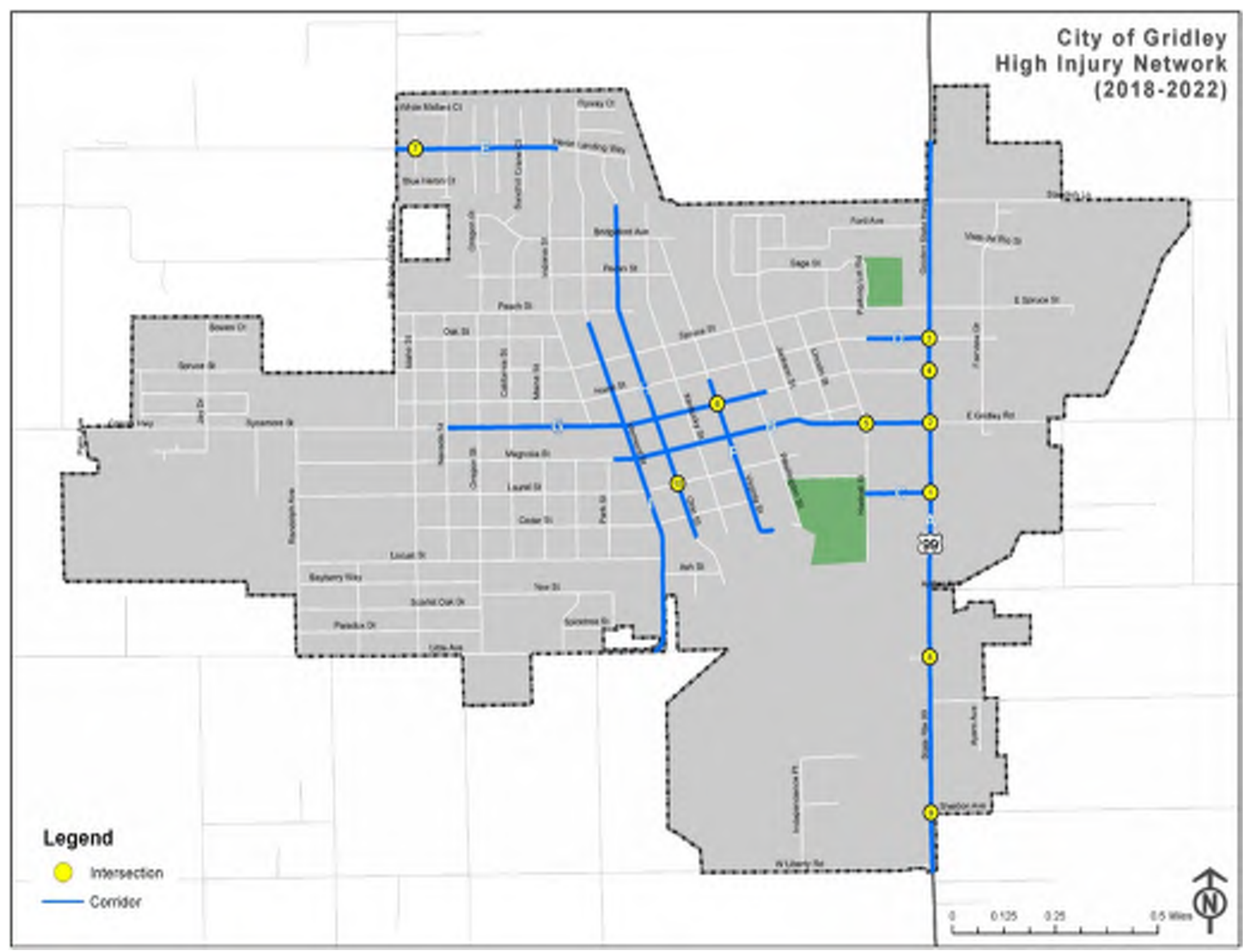
ID	Intersection	Control	Consolidated CMs (HSIP-Eligible - Refer to LRSM* 2022) CM1	CM2	CM3	CM4	Collision Info (2018-2022)	Additional CM (non-HSIP)
1	SR 99 and Cherry St	One Way Stop Controlled	NS03	NS14			2 SI, 3 VI, 1 CoP, 2 HeadOn, 3 Broadside, 1 Ped, 2 Bicycle, 4 AutoROW, 1 Improper Passing	Installing Signal is subject to Warrant Study. If not warranted, next recommended CM is NS23PB.
2	SR 99 and Magnolia St/E Gridley St	Signalized	S02	S03	S12	S09	3 SI, 3VI, 3 CoP, 5 Broadside, 2 sideswipe, 1 rear end, 5 traffic signal violation, 2 improper turning, 1 AutoROW	
3	Heron Landing Way and W Biggs Gridley Rd	Two Way Stop Controlled	NS01	NS06	NS02		2 SI, 1 Head-on, 1 unsafe speed, 1 traffic signal vio, nighttime, bicycle	Pavement resurface (pot holes), sign "Turning Vehicles Yield to Bikes"
4	SR 99 and Hazel St	Signalized	S02	S03	S12	S09	2 SI, 1 CoP,2 sideswipe, 1 rear end, 1 traffic signal violation, 1 PedROW	Restrict RTOR from Hazel (Community Comments)
5	SR 99 and Sycamore St	Signalized	S02	S03	S12	S09	1 SI, broadside, traffic signal violation	
6	Magnolia St and Haskell St	Two Way Stop Controlled	NS02	NS01			1 Fatal, PedROW, Nightitme	High visibility crosswalk
7	Sycamore St and Virginia St	Two Way Stop Controlled	NS02	NS01	NS06		1 SI, Overturned, Motorcycle	Restrict On-street parking near intersection
8	SR 99 and Evelyn Dr	One Way Stop Controlled	NS01	NS06			1 SI, 1 VI, 1 broadside, 1 hit object, 1 DUI, 1 Improper turning	Restrict parking and stopping on shoulders
9	SR 99 and Sheldon Ave	Two Way Stop Controlled	NS06	NS14			1 SI, 1 CoP, 1 broadside, wrong side, AutoROW, Bicycle	sign "Turning Vehicles Yield to Bikes"
10	Laurel St and Ohio St	One Way Stop Controlled	NS02				2 VI, 1 sideswipe, 1 broadside, 2 AutoROW	

ID	EA - 1 Improve Intersection Safety CM1	CM2	CM3	EA - 2 Address Broadside collisions CM1	CM2	CM3	EA - 3 Address Rear-end collisions CM1	CM2	CM3
1	NS03	NS14		NS03	NS14				
2	S02	S03		S02	S03	S12	S03	S02	S11
3	NS01	NS06	NS02						
4	S02	S03	S12				S03	S02	S11
5	S02	S03		S02	S03	S12			
6	NS02	NS01							
7	NS02	NS01	NS06						
8	NS01	NS06		NS06					
9	NS06	NS14		NS06	NS14				
10	NS02			NS02					

ID	EA - 4 Address Nighttime collisions CM1	CM2	CM3	EA - 5 Address Pedestrian and Bicycle collisions CM1	CM2	CM3	EA - 6 Address collisions on SR 99 CM1	CM2	CM3	Collisions near school CM1	CM2	CM3
1	NS01			NS03	NS23PB		NS03	NS14				
2				S20PB			S02	S03	S09			
3	NS01											
4				S20PB			S02	S03	S09			
5				S20PB			S02	S03	S09			
6	NS01			NS22PB						NS22PB		
7	NS01											
8	NS01						NS01	NS06				
9							NS06	NS14				
10	NS01											

Code	Countermeasure Name
HSIP/Non-HSIP Code	
S01	Add intersection lighting
S02	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number
S03	Improve signal timing (coordination, phases, red, yellow, or operation)
S05	Install emergency vehicle pre-emption systems
S06	Install left-turn lane and add turn phase (signal has no left-turn lane or phase before)
S07	Provide protected left turn phase (left turn lane already exists)
S08	Convert signal to mast arm (from pedestal-mounted)
S09	Install raised pavement markers and striping (Through Intersection)
S10	Install flashing beacons as advance warning (S.I.)
S11	Improve pavement friction (High Friction Surface Treatments)
S12	Install raised median on approaches (S.I.)
S13PB	Install pedestrian median fencing on approaches
S14	Create directional median openings to allow (and restrict) left-turns and U-turns (S.I.)
S15	Reduced Left-Turn Conflict Intersections (S.I.)
S16	Convert intersection to roundabout (from signal)
S17PB	Install pedestrian countdown signal heads
S18PB	Install pedestrian crossing (S.I.)
S19PB	Pedestrian Scramble
S20PB	Install advance stop bar before crosswalk (Bicycle Box)
S21PB	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)

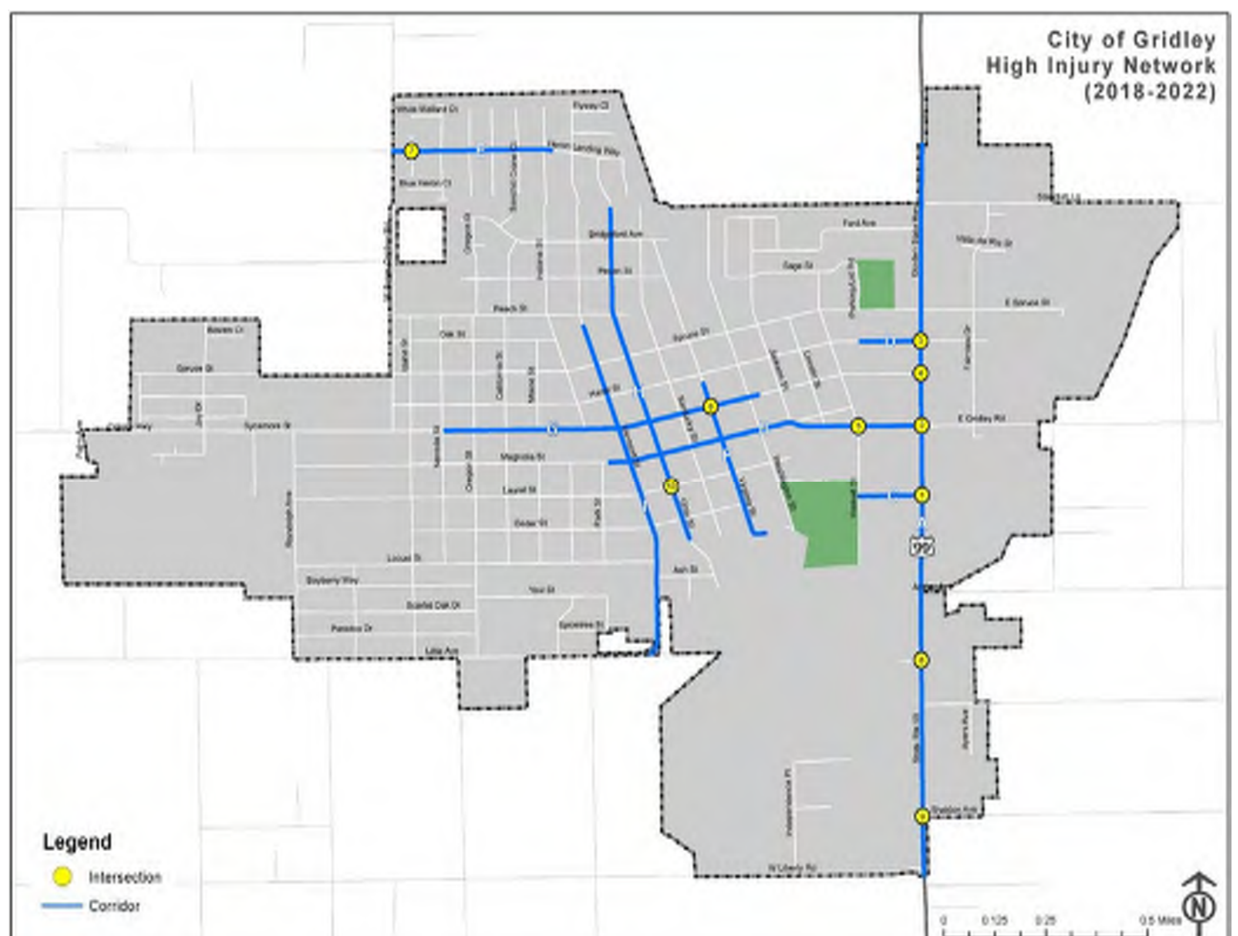
Code	Countermeasure Name
NS01	Add intersection lighting (NS.I.)
NS02	Convert to all-way STOP control (from 2-way or Yield control)
NS03	Install Signals
NS04	Convert intersection to roundabout (from all way stop)
NS05	Convert intersection to roundabout (from 2-way stop or Yield control)
NS05m	Convert intersection to mini-roundabout
NS06	Install/upgrade larger or additional stop signs or other intersection warning/regulatorysigns
NS07	Upgrade intersection pavement markings (NS.I.)
NS08	Install Flashing Beacons at Stop-Controlled Intersections
NS09	Install flashing beacons as advance warning (NS.I.)
NS10	Install transverse rumble strips on approaches
NS11	Improve sight distance to intersection (Clear Sight Triangles)
NS12	Improve pavement friction (High Friction Surface Treatments)
NS13	Install splitter-islands on the minor road approaches
NS14	Install raised median on approaches (NS.I.)
NS15	Create directional median openings to allow (and restrict) left-turns and u-turns (NS.I.)
NS16	Reduced Left-Turn Conflict Intersections (NS.I.)
NS17	Install right-turn lane (NS.I.)
NS18	Install left-turn lane (where no left-turn lane exists)
NS19PB	Install raised medians (refuge islands)
NS20PB	Install pedestrian crossing at uncontrolled locations (signs and markings only)
NS21PB	Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)
NS22PB	Install Rectangular Rapid Flashing Beacon (RRFB)
NS23PB	Install Pedestrian Signal (including Pedestrian Hybrid Beacon (HAWK))



High-risk Roadway Segments

ID	Roadway Segment	Consolidated CMs (HSIP-Eligible - Refer to LRSM* 2022)						Collision Info (2018-2022)	Additional CM (non-HSIP)**	EA - 1 Improve Intersection Safety			EA - 2 Address Broadside collisions			EA - 3 Address Rear-end collisions			EA - 4 Address Nighttime collisions			EA - 5 Address Pedestrian and Bicycle collisions			EA - 6 Address collisions on SR 99			Collisions near school		
		CM1	CM2	CM3	CM4	CM5	CM6			CM1	CM2	CM3	CM1	CM2	CM3	CM1	CM2	CM3	CM1	CM2	CM3	CM1	CM2	CM3	CM1	CM2	CM3	CM1	CM2	CM3
A	SR 99: Within City Limits	R01	R22	R27	R02	R33PB	R31	Fatal 1, 13 SI, 18 VI, 14 CoP, 16 broadside, 7 sidewipe, 7 rearend, 6 headon, 4 hit object, 3 Ped, 10 nighttime, 12 AutoROW, 7 Traffic singal/sign, 6 improper turning, 4 unsafe speed, 3 wrong side, 2 DUI	R35PB at SR99/Obermayer, add 'wrong side' sign							R22	R27	R21	R01	R27		R35PB	R34PB	R33PB	R01	R22	R02			
B	Magnolia St: SR 99 to Park St	R01	R22	R27	R36PB	R32PB		Fatal 1, 1 VI, 2 CoP, 2 broadside, 2 Ped, 1 PedROW, 1 DUI, 1 nightime	Pavement resurface and striping, traffic calming and all-way stop near school										R01	R27	R22	R36PB	R32PB					R36PB	R32PB	
C	Cherry St: SR 99 to Haskell St	R01	R22	R27	R34PB	R30	R02	1 SI, 3 VI, 1 CoP, 5 AutoROW, DUI, unsafe lane change, improper turning, 4 nighttime, 5 broadside, rearend, sideswipe, hit object	Pavement resurface and striping							R22	R27		R01	R22	R27	R34PB						R34PB		
D	Hazel St: SR 99 to Haskell St	R01	R22	R27				broadside, AutoROW	Pavement resurface and striping										R01											
E	Heron Landing Way: Indiana St to West City Limit	R01	R28	R22				No roadway collisions											R01											
F	Virginia St: Hazel St to Washington St	R01	R28	R22				No roadway collisions	Pavement resurface and striping										R01											
G	Sycamore St: Jackson St to Nevada St	R01	R22	R27	R35PB			2 VI, 1 CoP, 1 Readend, 1 broadside, 1 hit object, 2 imprper turning, 1 AutoROW	Pavement resurface and striping, restrict parking near intersection to improve sight distance, traffic calming near school							R22	R27		R01	R22		R35PB						R35PB		
H	Ohio St: Heron Landing Way to Ash St	R01	R22	R27	R35PB	R28	R02	No roadway collisions	Pavement resurface and striping							R22	R27		R01	R22		R35PB						R35PB		
I	Vermont St: Peach St to South City Limit	R01	R22	R27	R35PB	R28	R02	No roadway collisions	Pavement resurface and striping, conduct warrant study for all way stop at intersections							R22	R27		R01	R22		R35PB						R35PB		

Code	Countermeasure Name
R01	Add Segment Lighting
R02	Remove or relocate fixed objects outside of Clear Recovery Zone
R03	Install Median Barrier
R04	Install Guardrail
R05	Install impact attenuators
R06	Flatten side slopes
R07	Flatten side slopes and remove guardrail
R08	Install raised median
R09	Install median (flush)
R10PB	Install pedestrian median fencing
R11	Install acceleration/ deceleration lanes
R12	Widen lane (initially less than 10 ft)
R13	Add two-way left-turn lane (without reducing travel lanes)
R14	Road Diet (Reduce travel lanes from 4 to 3 and add a two way left-turn and bike lanes)
R15	Widen shoulder
R16	Curve Shoulder widening (Outside Only)
R17	Improve horizontal alignment (flatten curves)
R18	Flatten crest vertical curve
R19	Improve curve superelevation
R20	Convert from two-way to one-way traffic
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
R32PB	Install bike lanes
R33PB	Install Separated Bike Lanes
R34PB	Install sidewalk/pathway (to avoid walking along roadway)
R35PB	Install/upgrade pedestrian crossing (with enhanced safety features)
R36PB	Install raised pedestrian crossing
R37PB	Install Rectangular Rapid Flashing Beacon (RRFB)
R38	Install Animal Fencing



Non-Engineering Countermeasures

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

HSIP Eligible Countermeasures

City of Gridley LRSP

Countermeasures for Intersections

Sr. No.	Code	Countermeasure Name	CM Description	CRF	Federal Funding	Systemic Approach Opportunity
Signalized						
HSIP/Non-HSIP Code						
1	S01	Add intersection lighting	Provision of lighting at intersection.	40%	90%	Medium
2	S02	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, an	Includes New LED lighting, signal back plates, retro-reflective tape outlining the back plates, or visors to increase signal visibility, larger signal heads, relocation of the signal heads, or additional signal heads.	15%	90%	Very High
3	S03	Improve signal timing (coordination, phases, red, yellow, or operation)	Includes adding phases, lengthening clearance intervals, eliminating or restricting higher-risk movements, and coordinating signals at multiple locations.	15%	50%	Very High
5	S05	Install emergency vehicle pre-emption systems	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	70%	90%	High
6	S06	Install left-turn lane and add turn phase (signal has no left-turn lane or phase before)	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.	55%	90%	Low
7	S07	Provide protected left turn phase (left turn lane already exists)	Left turns are widely recognized as the highest-risk movements at signalized intersections. Providing Protected left-turn phases 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	30%	90%	High
8	S08	Convert signal to mast arm (from pedestal-mounted)	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.	30%	90%	Medium
9	S09	Install raised pavement markers and striping (Through Intersection)	Adding clear pavement markings can guide motorists through complex intersections. When drivers approach and traverse through complex intersections, drivers may be required to perform unusual or unexpected maneuvers	10%	90%	Very High
10	S10	Install flashing beacons as advance warning (S.I.)	Increased driver awareness of an approaching signalized intersection and an increase in the driver's time to react.	30%	90%	Medium
11	S11	Improve pavement friction (High Friction Surface Treatments)	Improving the skid resistance at locations with high frequencies of wet road crashes and/or failure to stop crashes	55%	90%	Medium
12	S12	Install raised median on approaches (S.I.)	Raised medians next to left turn lanes at intersections offer a cost effective means for reducing crashes and improving operations at higher volume intersections	25%	90%	Medium
13	S13PB	Install pedestrian median fencing on approaches	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.	30%	90%	Low
14	S14	Create directional median openings to allow (and restrict) left-turns and U-turns (S.I.)	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	50%	90%	Medium
15	S15	Reduced Left-Turn Conflict Intersections (S.I.)	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).	50%	90%	Medium
16	S16	Convert intersection to roundabout (from signal)	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.	Varies	90%	Low
17	S17PB	Install pedestrian countdown signal heads	Signals that have signalized pedestrian crossing with walk/don't walk indicators and where there have been pedestrian vs. vehicle crashes.	25%	90%	Very High
18	S18PB	Install pedestrian crossing (S.I.)	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.	25%	90%	High

19	S19PB	Pedestrian Scramble	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.	40%	90%	High
20	S20PB	Install advance stop bar before crosswalk (Bicycle Box)	Signalized Intersections with a marked crossing, where significant bicycle and/or pedestrians volumes are known to occur.	15%	90%	Very High
21	S21PB	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	Addition of LPI gives pedestrians the opportunity to enter an intersection 3-7 seconds before vehicles are given a green indication; only minor signal timing alteration is required.	60%	90%	Very High

Unsignalized

Sr. No.	Code	Countermeasure Name	CM Description	CRF	Federal Funding	Systemic Approach Opportunity
1	NS01	Add intersection lighting (NS.I.)	Provision of lighting at intersection.	40%	90%	Medium
2	NS02	Convert to all-way STOP control (from 2-way or Yield control)	Unsignalized intersection locations that have a crash history and have no controls on the major roadway approaches. However, all-way stop control is suitable only at intersections with moderate,and relatively balanced volume levels on the intersection approaches. Under other conditions, the use of all-way stop control may create unnecessary delays and aggressive driver behavior.	50%	90%	High
3	NS03	Install Signals	Installation of traffic signals	25%	90%	Low
4	NS04	Convert intersection to roundabout (from all way stop)	Intersections that have a high frequency of right-angle and left-turn type crashes. Whether such intersections have existing crash patterns or not, a roundabout provides an alternative to signalization. The primary target locations for roundabouts should be moderate-volume unsignalized intersections.	Varies	90%	Low
5	NS05	Convert intersection to roundabout (from 2-way stop or Yield control)	Intersections that have a high frequency of right-angle and left-turn type crashes. Whether such intersections have existing crash patterns or not, a roundabout provides an alternative to signalization. The primary target locations for roundabouts should be moderate-volume unsignalized intersections.	Varies	90%	Low
6	NS05mr	Convert intersection to mini-roundabout	Mini-roundabouts are characterized by a small diameter (45-90 ft) and traversable islands (central island and splitter islands).	30%	90%	High
7	NS06	Install/upgrade larger or additional stop signs or other intersection warning/regulatorysigns	Additional regulatory and warning signs at or prior to intersections will help enhance the ability of approaching drivers to percieve them	15%	90%	Very High
8	NS07	Upgrade intersection pavement markings (NS.I.)	Typical improvements include "Stop Ahead" markings and the addition of centerlines and stop bars	25%	90%	Very High
9	NS08	Install Flashing Beacons at Stop-Controlled Intersections	Flashing beacons can reinforce driver awareness of the Non-Signalized intersection control and can help mitigate patterns of right-angle crashes related to stop sign violations. Post-mounted advanced flashing beacons or overhead flashing beacons can be used at stop-controlled intersections to supplement and call driver attention to stop signs.	15%	90%	High
10	NS09	Install flashing beacons as advance warning (NS.I.)	Installation of advance flashing beacoms to call drivers attention to intersection control signs	30%	90%	High
11	NS10	Install transverse rumble strips on approaches	Transverse rumble strips are installed in the travel lane for the purposes of providing an auditory and tactile sensation for each motorist approaching the intersection.	20%	90%	High
12	NS11	Improve sight distance to intersection (Clear Sight Triangles)	Unsignalized intersections with restricted sight distance and patterns of crashes related to lack of sight distance where sight distance can be improved by clearing roadside obstructions without major reconstruction of the roadway.	20%	90%	High
13	NS12	Improve pavement friction (High Friction Surface Treatments)	Non-signalized Intersections noted as having crashes on wet pavements or under dry conditions when the pavement friction available is significantly less than needed for the actual roadway approach speeds. This treatment is intended to target locations where skidding and failure to stop is determined to be a problem in wet or dry conditions and the target vehicle is unable to stop due to insufficient skid resistance.	55%	90%	Medium
14	NS13	Install splitter-islands on the minor road approaches	The installation of a splitter island allows for the addition of a stop sign in the median to make the intersection more conspicuous.	40%	90%	Medium
15	NS14	Install raised median on approaches (NS.I.)	Effective access management is key to improving safety at, and adjacent to, intersections. The number of intersection access points coupled with the speed differential between vehicles traveling along the roadway often contributes to crashes. Any access points within 250 feet upstream and downstream of an intersection are generally undesirable.	25%	90%	Medium
16	NS15	Create directional median openings to allow (and restrict) left-turns and u-turns (NS.I.)	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.	50%	90%	Medium
17	NS16	Reduced Left-Turn Conflict Intersections (NS.I.)	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.	50%	90%	Medium
18	NS17	Install right-turn lane (NS.I.)	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.	20%	90%	Low
19	NS18	Install left-turn lane (where no left-turn lane exists)	Many collisions at unsignalized intersections are related to left-turn maneuvers. A key strategy for minimizing such collisions is to provide exclusive left-turn lanes, particularly on high-volume and high-speed major-road approaches. When considering new left-turn lanes, potential impacts to non-motorized users should be considered and mitigated as appropriate.	35%	90%	Low

20	NS19PB	Install raised medians (refuge islands)	Intersections that have a long pedestrian crossing distance, a higher number of pedestrians, or a crash history. Raised medians decrease the level of exposure for pedestrians and allow pedestrians to concentrate on (or cross) only one direction of traffic at a time.	45%	90%	Medium
21	NS20PB	Install pedestrian crossing at uncontrolled locations (signs and markings only)	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.	25%	90%	High
22	NS21PB	Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features	Non-signalized intersections where pedestrians are known to be crossing intersections that involve significant vehicular traffic. They are especially important at school crossings and intersections with turn pockets.flashing beacons, curb extensions, advanced "stop" or "yield" markings, and other safety features should be added to complement the standard crossing elements.	35%	90%	Medium
23	NS22PB	Install Rectangular Rapid Flashing Beacon (RRFB)	Rectangular Rapid Flashing Beacon (RRFB) includes pedestrian-activated flashing lights and additional signage that enhance the visibility of marked crosswalks and alert motorists to pedestrian crossings. It uses an irregular flash pattern that is similar to emergency flashers on police vehicles. RRFBs are installed at unsignalized intersections and mid-block pedestrian crossings.	35%	90%	Medium
24	NS23PB	Install Pedestrian Signal (including Pedestrian Hybrid Beacon (HAWK))	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.	55%	90%	Low

Countermeasures for Roadway Segments

Sr. No.	Code	Countermeasure Name	CM Description	CRF	Federal Funding	Systemic Approach Opportunity
1	R01	Add Segment Lighting	Provision of lighting along roadways.	35%	90%	Medium
2	R02	Remove or relocate fixed objects outside of Clear Recovery Zone	Known locations or roadway segments prone to collisions with fixed objects such as utility poles, drainage structures, trees, and other fixed objects, such as the outside of a curve, end of lane drops, and in traffic islands. A clear recovery zone should be developed on every roadway, as space is available. In situations where public right-of-way is limited, steps should be taken to request assistance from property owners, as appropriate.	35%	90%	High
3	R03	Install Median Barrier	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.	25%	90%	Medium
4	R04	Install Guardrail	Guardrail is installed to reduce the severity of lane departure crashes. However, guardrail can reduce crash severity only for those conditions where striking the guardrail is less severe than going down an embankment or striking a fixed object. Guardrail should only be installed where it is clear that crash severity will be reduced, or there is a history of run-off-the-road crashes at a given location that have resulted in severe crashes.	25%	90%	High
5	R05	Install impact attenuators	Impact attenuators are typically used to shield rigid roadside objects such as concrete barrier ends, steel guardrail ends and bridge pillars from oncoming automobiles. Attenuators should only be installed where it is impractical for the objects to be removed.	25%	90%	High
6	R06	Flatten side slopes	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.	30%	90%	Medium
7	R07	Flatten side slopes and remove guardrail	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.	40%	90%	Medium
8	R08	Install raised median	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.	25%	90%	Medium
9	R09	Install median (flush)	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.	15%	90%	Medium
10	R10PB	Install pedestrian median fencing	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.	35%	90%	Low
11	R11	Install acceleration/ deceleration lanes	Areas proven to have crashes that are the result of drivers not being able to turn onto a high speed roadway to accelerate until the desired roadway speed is reached and areas that do not provide the opportunity to safety decelerate to negotiate a turning movement.	25%	90%	Low

12	R12	Widen lane (initially less than 10 ft)	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.	25%	90%	Medium
13	R13	Add two-way left-turn lane (without reducing travel lanes)	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.	30%	90%	Medium
14	R14	Road Diet (Reduce travel lanes from 4 to 3 and add a two way left-turn and bike lanes)	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.	30%	90%	Medium
15	R15	Widen shoulder	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.	30%	90%	Medium
16	R16	Curve Shoulder widening (Outside Only)	Roadway curves noted as having frequent lane departure crashes due to inadequate or no shoulders, resulting in an unsuccessful attempt to reenter the roadway.	45%	90%	Medium
17	R17	Improve horizontal alignment (flatten curves)	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.	50%	90%	Low
18	R18	Flatten crest vertical curve	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.	25%	90%	Low
19	R19	Improve curve superelevation	Roadways noted as having frequent lane departure crashes and inadequate or no superelevation. Safety can be enhanced when the superelevation is improved or restored along curves where the actual superelevation is less than the optimal.	45%	90%	Medium
20	R20	Convert from two-way to one-way traffic	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.	35%	90%	Medium
21	R21	Improve pavement friction (High Friction Surface Treatments)	Improving the skid resistance at locations with high frequencies of wet road crashes and/or failure to stop crashes	55%	90%	High
22	R22	Install/Upgrade signs with new fluorescent sheeting (regulatory or warning)	Additional or new signage can address crashes caused by lack of driver awareness or complaince of roadway signing.	15%	90%	Very High
23	R23	Install chevron signs on horizontal curves	Roadways that have an unacceptable level of crashes on relatively sharp curves during periods of light and darkness.		90%	
24	R24	Install curve advance warning signs	Addition of advance curve warning signs; may also include horizontal alignment and/or advisory speed warning signs	25%	90%	Very High
25	R25	Install curve advance warning signs (flashing beacon)	Roadways that have an unacceptable level of crashes on relatively sharp curves. Flashing beacons in conjunction with warning signs should only be used on horizontal curves that have an established severe crash history to help maintain their effectiveness.	40%	90%	Very High
26	R26	Install dynamic/variable speed warning signs	Includes the addition of dynamic speed warning signs (also known as Radar Speed Feedback Signs)	30%	90%	High
27	R27	Install delineators, reflectors and/or object markers	Installation of delineators, reflectors and/or object markers are intended to warn drivers of an approaching curve or fixed object that cannot easily be removed.	15%	90%	Very High
28	R28	Install edge-lines and centerlines	Any road with a history of run-off-road right, head-on, opposite-direction-sideswipe, or run-off-road-left crashes is a candidate for this treatment -install where the existing lane delineation is not sufficient to assist the motorist in understanding the existing limits of the roadway. Depending on the width of the roadway, various combinations of edge line and/or center line pavement markings may be the most appropriate.	25%	90%	Very High
29	R29	Install no-passing line	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.	45%	90%	Very High
30	R30	Install centerline rumble strips/stripes	Center Line rumble strips/stripes can be used on virtually any roadway – especially those with a history of head-on crashes.	20%	90%	High
31	R31	Install edgeline rumble strips/stripes	Shoulder and edge line milled rumble strips/stripes should be used on roads with a history of roadway departure crashes.	15%	90%	High
32	R32PB	Install bike lanes	Roadway segments noted as having crashes between bicycles and vehicles or crashes that may be preventable with a buffer/shoulder.	35%	90%	High
33	R33PB	Install Separated Bike Lanes	Separated bikeways are most appropriate on streets with high volumes of bike traffic and/or high bike-vehicle collisions, presumably in an urban or suburban area. Separation types range from simple, painted buffers and flexible delineators, to more substantial separation measures including raised curbs, grade separation, bollards, planters, and parking lanes.	45%	90%	High
34	R34PB	Install sidewalk/pathway (to avoid walking along roadway)	Areas noted as not having adequate or no sidewalks and a history of walking along roadway pedestrian crashes. In rural areas asphalt curbs and/or separated walkways may be appropriate.	80%	90%	Medium
35	R35PB	Install/upgrade pedestrian crossing (with enhanced safety features)	Roadway segments with no controlled crossing for a significant distance in high-use midblock crossing areas and/or multilane roads locations. flashing beacons, curb extensions, medians and pedestrian crossing islands and/or other safety features should be added to complement the standard crossing elements.	35%	90%	Medium
36	R36PB	Install raised pedestrian crossing	On lower-speed roadways, where pedestrians are known to be crossing roadways that involve significant vehicular traffic.	35%	90%	Medium

37	R37PB	Install Rectangular Rapid Flashing Beacon (RRFB)	Rectangular Rapid Flashing Beacon (RRFB) includes pedestrian-activated flashing lights and additional signage that enhance the visibility of marked crosswalks and alert motorists to pedestrian crossings. It uses an irregular flash pattern that is similar to emergency flashers on police vehicles. RRFBs are installed at unsignalized intersections and mid-block pedestrian crossings	35%	90%	Medium
38	R38	Install Animal Fencing	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).	80%	90%	Medium

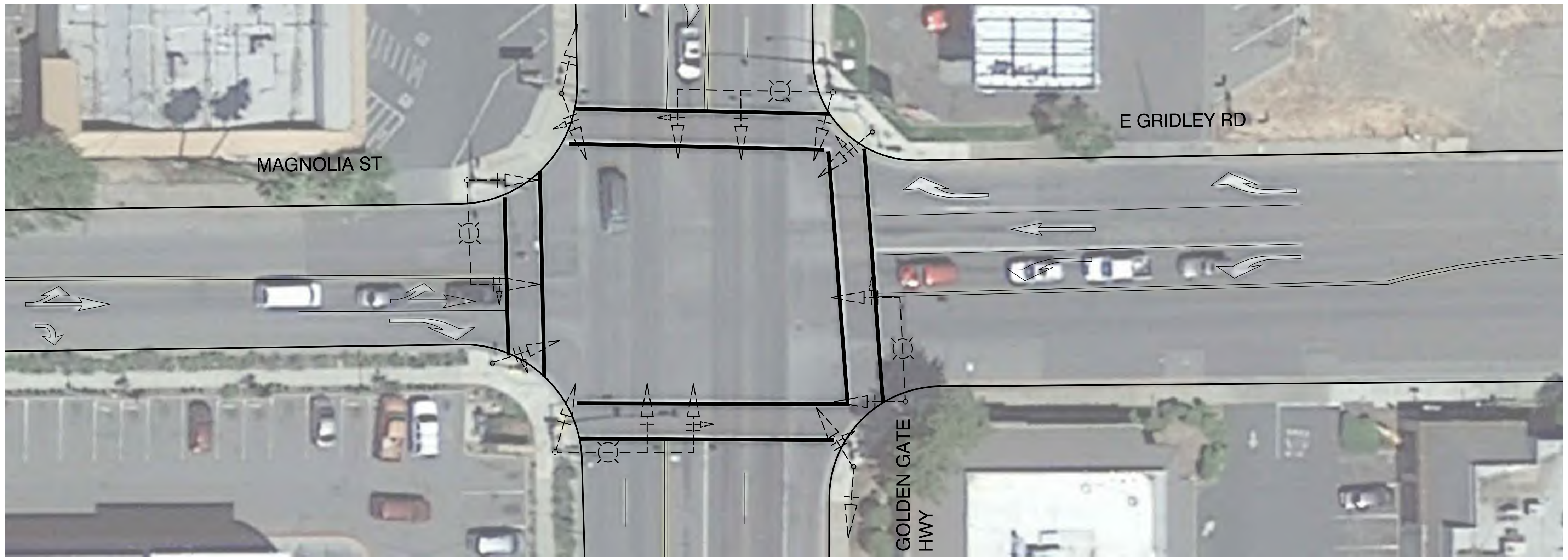
Appendix F - HSIP Analyzer (B/C Ratio Calculation)

Appendix G - Safety Projects Exhibits

PROJECT 1: MAGNOLIA ST/ E GRIDLEY RD AND GOLDEN STATE HWY

GRIDLEY
CALIFORNIA

TJKM



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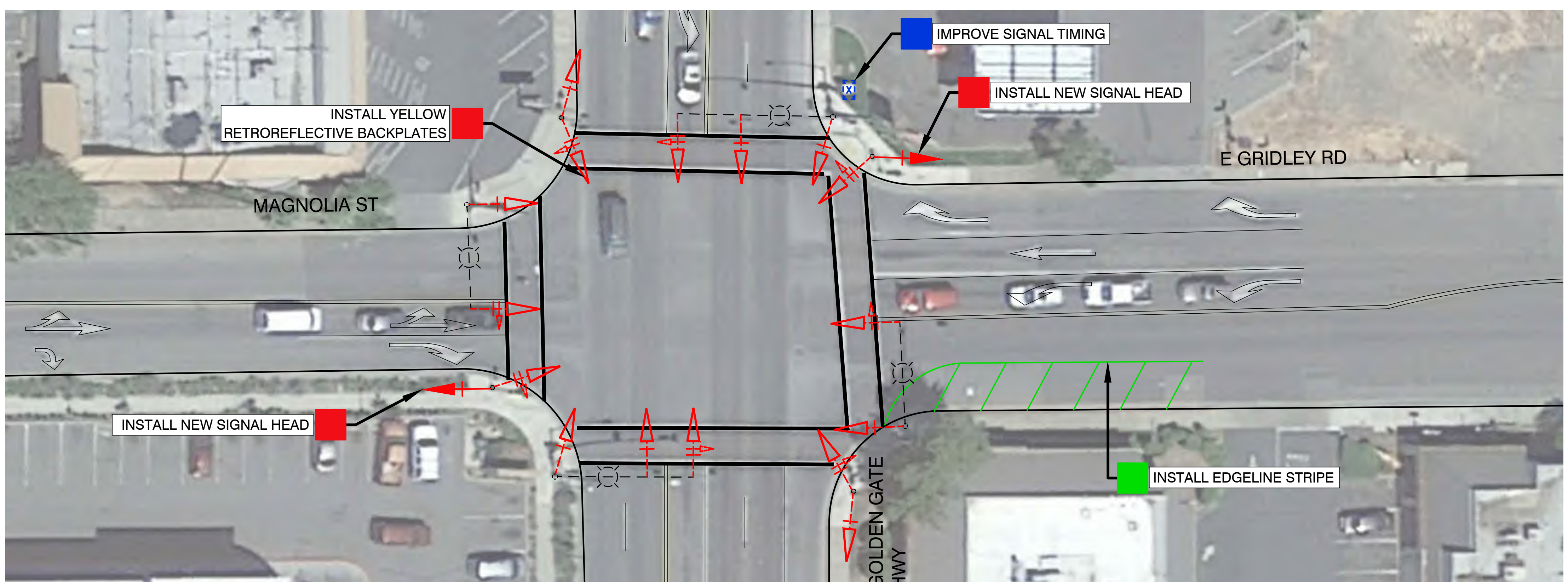


PROPOSED CONDITIONS

LEGEND:

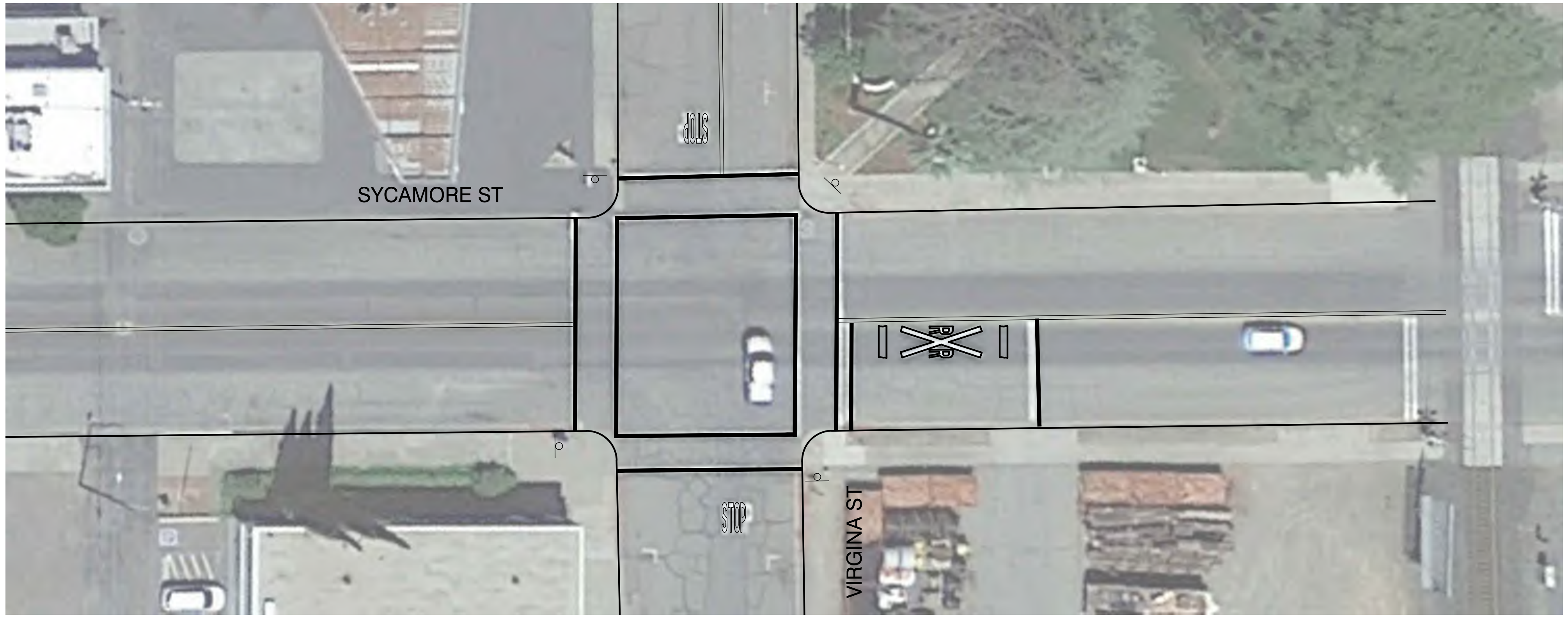
- COUNTERMEASURE S02 IMPROVEMENTS
- COUNTERMEASURE S03 IMPROVEMENTS
- COUNTERMEASURE S09 IMPROVEMENTS

N

0 20' 40'

SCALE: 1"=40'

PROJECT 2: SYCAMORE ST AND VIRGINIA ST



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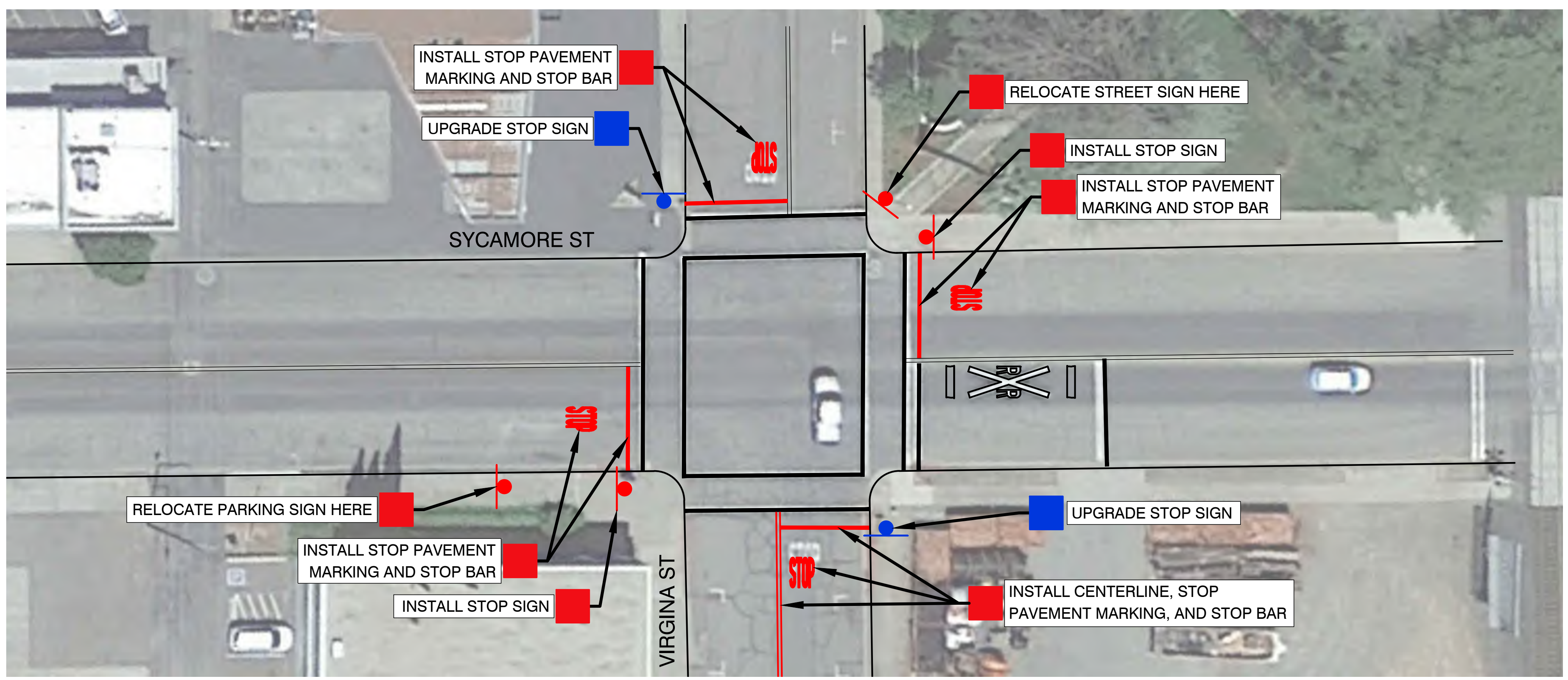
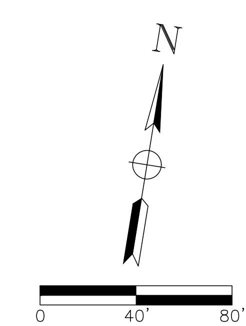


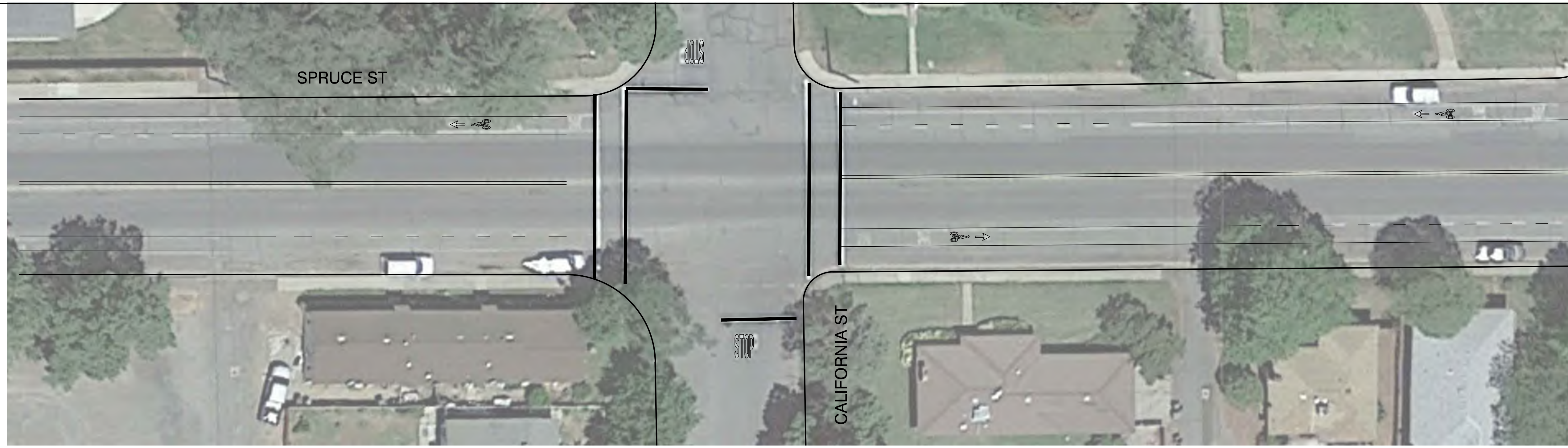
PROPOSED CONDITIONS

LEGEND:

- COUNTERMEASURE NS02 IMPROVEMENTS (red)
- COUNTERMEASURE NS06 IMPROVEMENTS (blue)



PROJECT 3: CALIFORNIA ST AND SPRUCE ST



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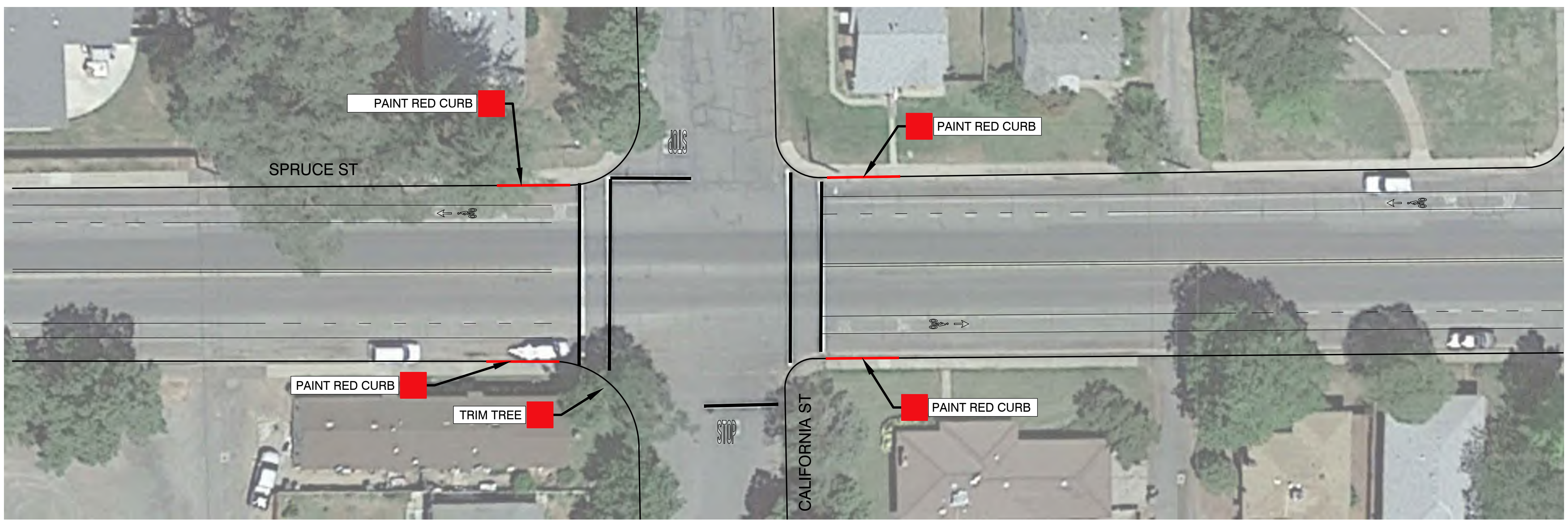


PROPOSED CONDITIONS

LEGEND:

COUNTERMEASURE NS11 IMPROVEMENTS

N

0 40' 80'

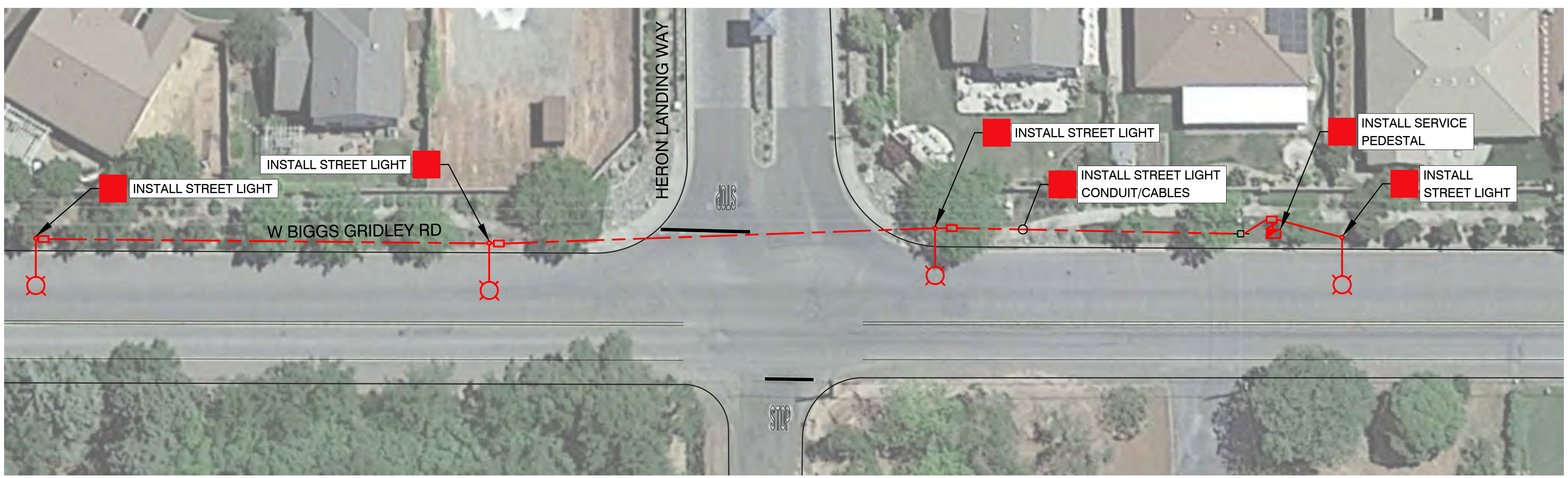
SCALE: 1"=40'

PROJECT 4: W BIGGS GRIDLEY RD AND HERON LANDING WAY

GRIDLEY
CALIFORNIA

TJKM
4305 Hacienda Drive, Suite 550
Pleasanton, CA 94588
tjkm@tjkm.com

EXISTING CONDITIONS



PROPOSED CONDITIONS

LEGEND:

COUNTERMEASURE R01 IMPROVEMENTS

N

0 20' 40'

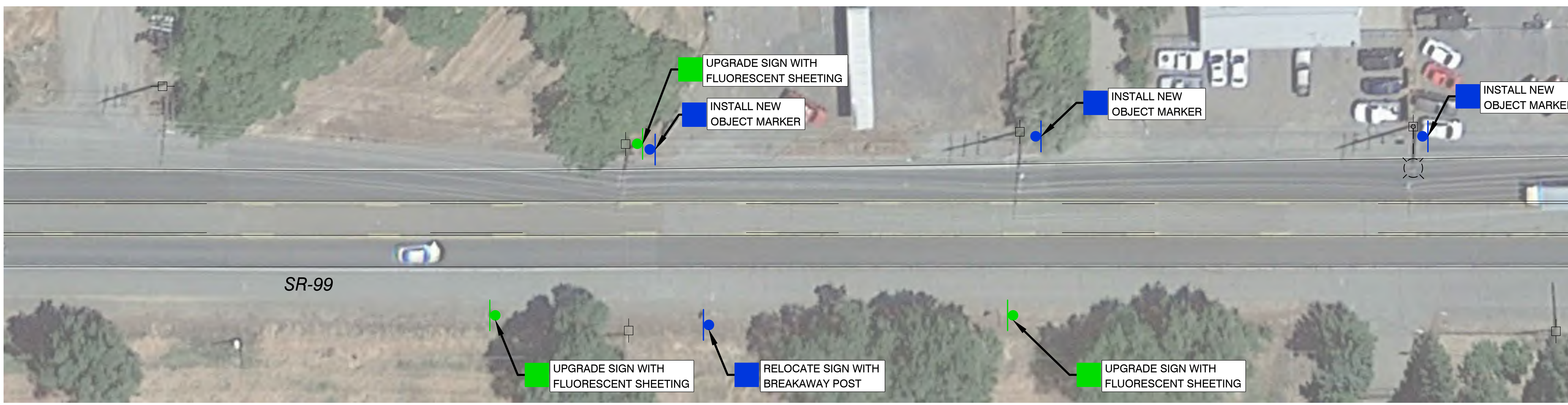
SCALE: 1"=40'

PROJECT 5: STATE ROUTE 99

GRIDLEY CALIFORNIA

TJKM

EXISTING CONDITIONS



EXISTING CONDITIONS

LEGEND:

- COUNTERMEASURE R22 IMPROVEMENTS
- COUNTERMEASURE R27 IMPROVEMENTS

N

0 20' 40'

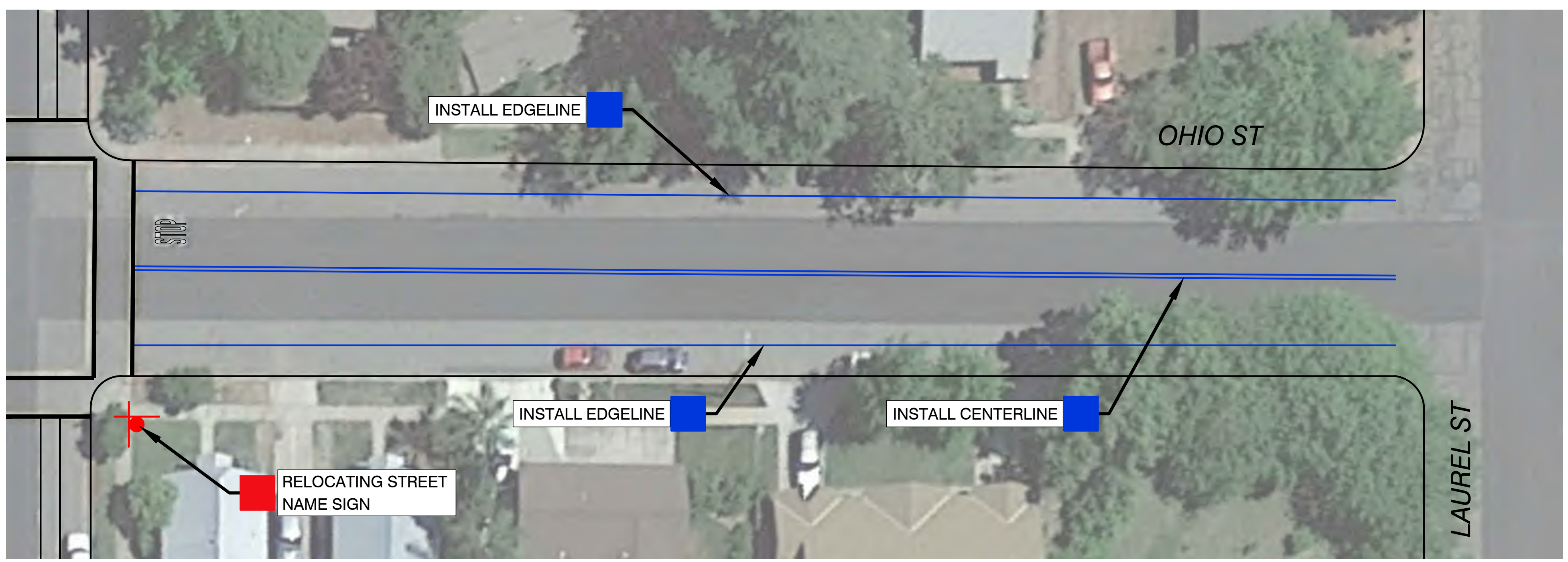
SCALE: 1"=40'

PROJECT 6: OHIO ST (MAGNOLIA ST TO LAUREL ST)

GRIDLEY CALIFORNIA

TJKM 4305 Hacienda Drive, Suite 550 Pleasanton, CA 94588 tjkm@tjkm.com

EXISTING CONDITIONS



PROPOSED CONDITIONS

LEGEND:

- COUNTERMEASURE R02 IMPROVEMENTS
- COUNTERMEASURE R28 IMPROVEMENTS

N

0 20' 40'

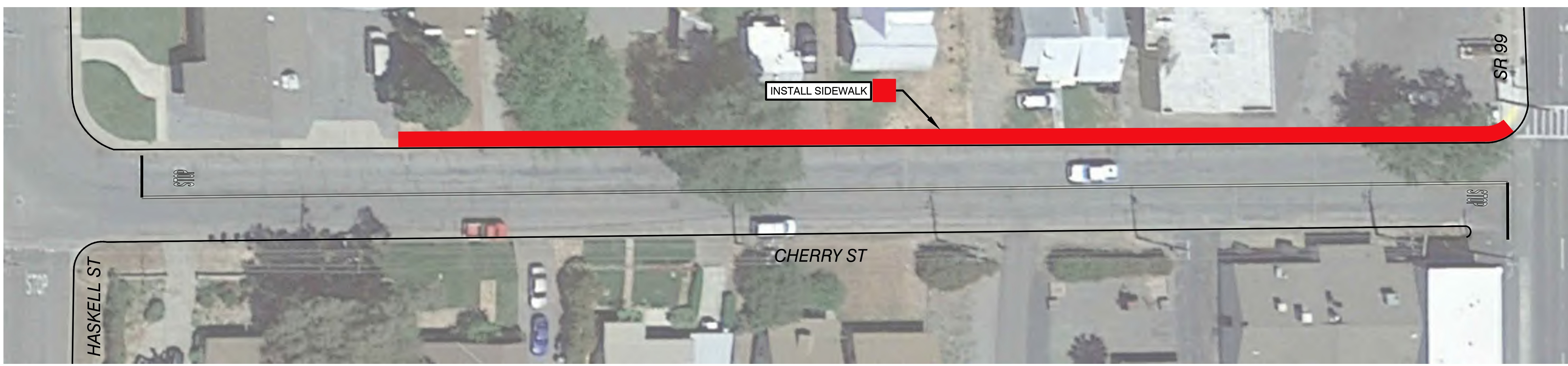
SCALE: 1"=40'

PROJECT 7: CHERRY ST (HASKELL ST TO SR-99)

GRIDLEY CALIFORNIA

TJKM 4305 Hacienda Drive, Suite 550 Pleasanton, CA 94588 tjkm@tjkm.com

EXISTING CONDITIONS



PROPOSED CONDITIONS

LEGEND:

COUNTERMEASURE R34 IMPROVEMENTS

0 20' 40'

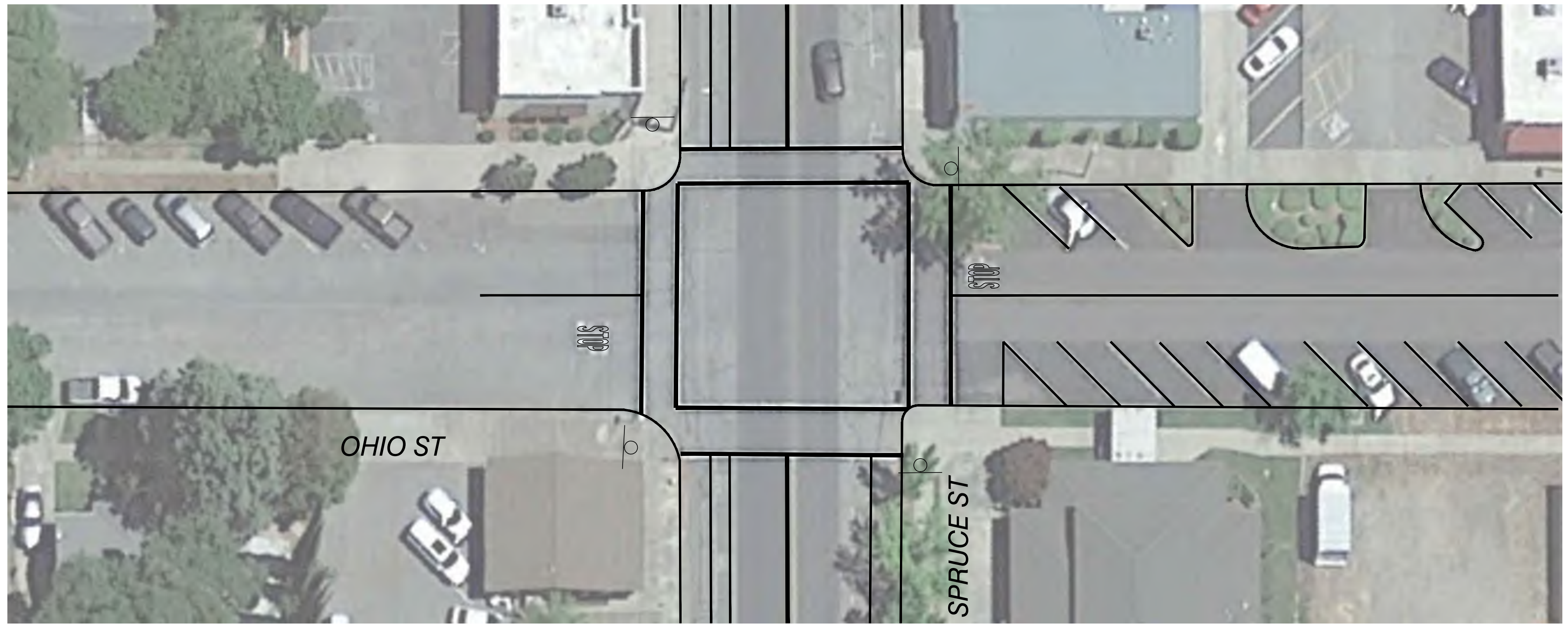
SCALE: 1"=40'

N

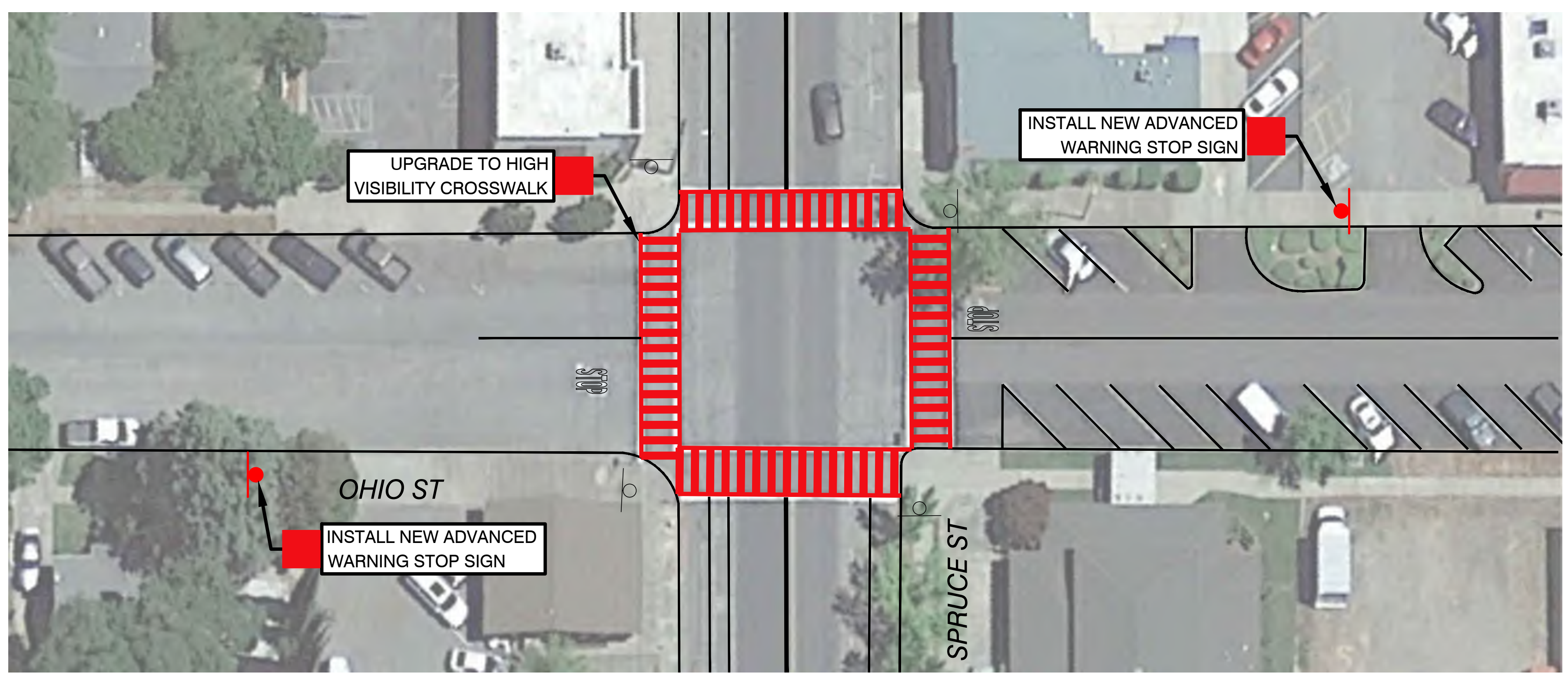
PROJECT 7: SPRUCE STREET & OHIO STREET

GRIDLEY CALIFORNIA

TJKM 4305 Hacienda Drive, Suite 550 Pleasanton, CA 94588 tjkm@tjkm.com



EXISTING CONDITIONS



PROPOSED CONDITIONS

LEGEND:

COUNTERMEASURE R35 IMPROVEMENTS

N

0 20' 40'

SCALE: 1"=40'