SUNNYVALE ROADWAY SAFETY PLAN

Prepared for:

City of Sunnyvale

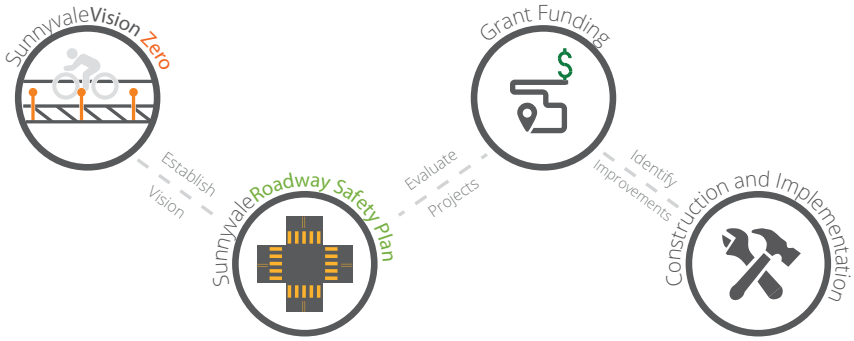
Approved by City Council
September 29, 2020

Sunnyvale

Executive Summary

The City of Sunnyvale is the second largest city in Santa Clara County with an estimated population of over 150,000 as of 2020. Sunnyvale is located in Silicon Valley on the south end of San Francisco Bay, neighboring the Cities of Santa Clara, Cupertino, and Mountain View.

The Sunnyvale Roadway Safety Plan builds upon the initial groundwork and goal setting completed through the development of the Sunnyvale Vision Zero Plan and **provides the resources necessary for the future preparation of successful Highway Safety Improvement Program (HSIP) grant applications** for design and construction funding by the City of Sunnyvale. The Roadway Safety Plan includes collision and roadway characteristic database development, review of local collision data, safety data analysis, collision profile analysis, safety countermeasure identification, and project development.



The Roadway Safety Plan development was undertaken in parallel with the 2020 Sunnyvale Active Transportation Plan, which seeks to create a safe, connected, and efficient citywide active transportation network that also provides safe access to schools. It includes descriptions of policies, infrastructure projects, and supporting programs while identifying funding sources and implementation priorities for projects which will enhance bicycling and walking in Sunnyvale.

The Roadway Safety Plan is funded through a Systemic Safety Analysis Report (SSAR) program grant provided by the California Department of Transportation (Caltrans). The SSAR program was initiated by Caltrans to help local agencies take a more proactive approach to identifying safety improvement projects by completing a system-wide, multi-year data-driven analysis of collisions. The intent of this program is 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.

Chapter 1 summarizes the project background, including a review of policies and documents which affect the development of safety projects. This includes a review of key outcomes from the Sunnyvale Vision Zero Plan.

The collision analysis process – described in Chapter 2 – involved utilizing collision data processed through Crossroads Collision Software to identify locations with a history of collisions and examining the collision trends, taking a systemic approach of evaluating higher rates of collisions or the disproportionate numbers of severe collisions. The data analysis focused on the five-year period between July 1, 2013 through June 30, 2018 – the five most recent years of data available at the time the project was undertaken.

Overall, the number of collisions has trended downward in Sunnyvale. The number of collisions decreased by 19% over a seven-year period of available data despite continued growth in vehicle miles traveled (VMT) over that time.

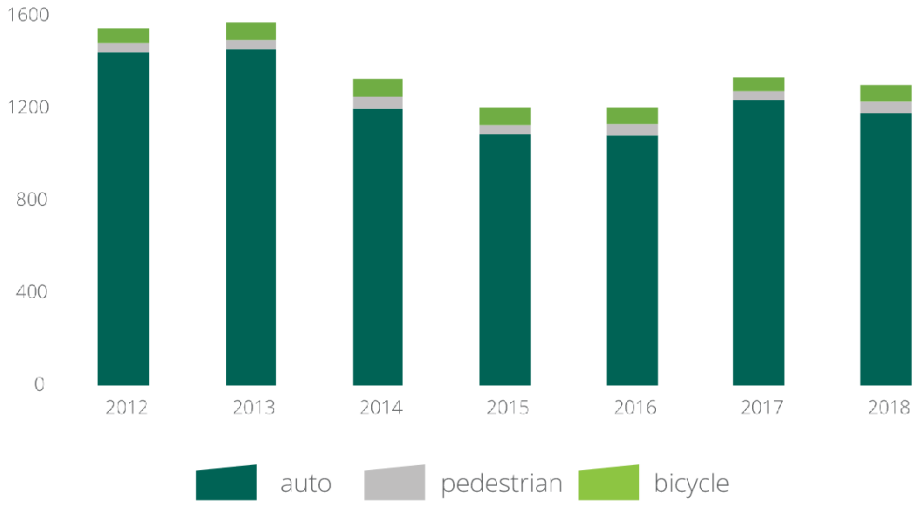
To address the safety issues identified in the collision analysis, a Safety Countermeasures Toolbox is presented in Chapter 3. The Toolbox includes a set of infrastructure improvement projects that can be used in HSIP funding applications. Each countermeasure is described along with key information from the California Local Roadway Manual, including crash reduction factors or availability of efficacy research. Many of these countermeasures are applied in the projects in Chapter 4, and the Toolbox can serve as a resource to the City for future planning and safety improvements.

Chapter 4 includes the development of representative projects and locations. Through the collision analysis process, 20 locations were identified as projects of interest – 8 signalized intersections, 6 unsignalized intersections, and 6 roadway segments. These locations were selected taking into account community feedback on areas of concern in collaboration with City staff, and were chosen to represent a variety of roadway contexts seen throughout the City of Sunnyvale. To aid in the preparation of HSIP grant applications, each project is accompanied by a cost estimate, benefit/cost ratio, and planning graphics that illustrate the proposed improvements. This chapter also includes additional funding sources that can be used to finance safety projects around the City. This list includes regional, state, and federal funding programs, along with a description of the program purpose.

Example from Safety Countermeasures Toolbox

In addition to the quantitative and geographic data analyzed as part of this project, outreach to stakeholders and the public was also performed to collect and understand local safety issues from a qualitative perspective. Technical Advisory Group meetings were held March 26, 2019 and December 11, 2019 and community workshops were hosted on April 22, 2019 and January 22, 2020 to solicit feedback on candidate countermeasures, identify locations of stakeholder interest, and ultimately share the 20 developed projects.

Collisions in Sunnyvale, 2012-2018



ENGINEER'S SEAL

Prepared by:

August 31, 2020

Steve Davis, PE Date
Professional Civil Engineer, 84524
Project Engineer

Signed for Approval

Dennis Ng 10/13/2020

Dennis Ng, PE Date
City of Sunnyvale

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

STATEMENT OF PROTECTION OF DATA FROM DISCOVERY AND ADMISSIONS

Section 148 of Title 23, United States Code

REPORTS DISCOVERY AND ADMISSION INTO EVIDENCE OF CERTAIN REPORTS, SURVEYS, AND INFORMATION – Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for any purpose relating to this section, shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location identified or addressed in the reports, surveys, schedules, lists, or other data.

ACKNOWLEDGMENTS

The Sunnyvale Roadway Safety Plan (RSP) was funded through a Systemic Safety Analysis Report Program (SSARP) grant provided by the California Department of Transportation (Caltrans). The City of Sunnyvale (City) developed a plan to evaluate transportation safety for motorists, bicyclists, and pedestrians within the City. Input was sought from a Technical Advisory Group consisting of staff from various City departments, Caltrans District 4, Santa Clara Valley Transportation Authority (VTA), and County of Santa Clara Roads and Airports Department. Two community engagements were held with opportunities to provide online feedback to solicit feedback from the community at large. City Council members and Bicycle and Pedestrian Advisory Commission representatives also provided feedback through this process. A consulting team led by Fehr & Peers, and supported by Kimley-Horn, assisted City staff in preparing the plan.

Note: Throughout this plan, reference to the "City" refers to Sunnyvale government.

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1 PROJECT BACKGROUND

This chapter provides a review of previous and ongoing planning efforts that are relevant to enhancing transportation safety in Sunnyvale. Sunnyvale aims to achieve a multimodal roadway system that responds to the evolving transportation landscape and addresses safer mobility for all.

The Sunnyvale Roadway Safety Plan builds upon the initial groundwork and goal setting completed through the development of the Sunnyvale Vision Zero Plan and provides the resources necessary for the future preparation of successful Highway Safety Improvement Program (HSIP) grant applications for design and construction funding.

The Vision Zero Plan, approved by City Council on July 30, 2019, established an ambitious long-term goal to eliminate traffic fatalities and severe injuries, starting with an immediate commitment to reduce fatalities and serious injuries in the near term. To that end, Sunnyvale aims to achieve a 50 percent reduction in fatalities and serious injuries by 2029.

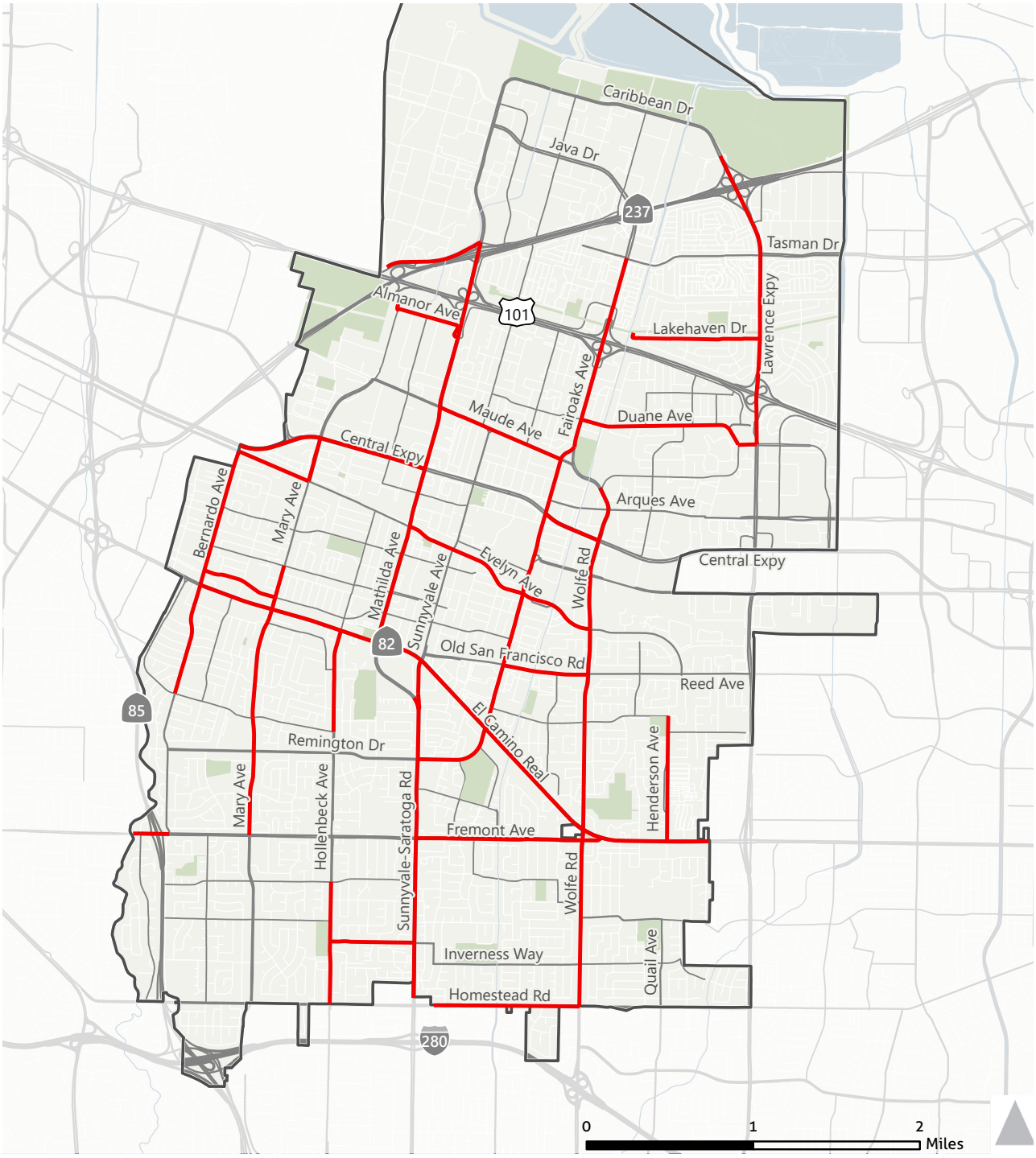
The Vision Zero Plan included an analysis of collision and roadway characteristics to establish 10 collision profiles which captured the top causes of fatal and serious injury collisions in the City. It also established a High Injury Network (HIN), shown in **Figure 1**, which accounts for 60% of the fatal and severe injury collisions in the City on just 7% of the roadway network. These profiles and the HIN were used to inform the analysis and project development for the Roadway Safety Plan.

The Roadway Safety Plan includes similar collision and roadway characteristic database development, review of local collision data, safety data analysis, collision profile analysis, safety countermeasure identification, and project development. This project is being funded through a Systemic Safety Analysis Report (SSAR) program grant provided by the California Department of Transportation (Caltrans).

The Sunnyvale Active Transportation Plan, developed in parallel with the Roadway Safety Plan, seeks to create a safe, connected, and efficient citywide active transportation network that also provides safe access to schools. It includes descriptions of policies, infrastructure projects, and supporting programs while identifying funding sources and implementation priorities for projects which will enhance bicycling and walking in Sunnyvale. Additionally, the Active Transportation Plan includes an evaluation of active transportation safety, with a 5-year review of bicycle and pedestrian collisions through a hotspot analysis. The Active Transportation Plan reflects a long-term vision for a desirable active transportation network, which may include elements of improvements or countermeasures included in this document.

Table 1 outlines key City resources for improving street safety through transportation plans, design guidelines, and area plans. Many of these documents establish goals or visions for the safe movement of people throughout Sunnyvale, including enhancing the safety of active modes for people of all ages and abilities to help achieve mode transportation and environmental targets. The resources complement the Roadway Safety Plan and other transportation safety improvement efforts undertaken by Caltrans, Santa Clara County, Santa Clara Valley Transportation Authority (VTA), and neighboring jurisdictions.

Figure 1 Vision Zero High Injury Network



Source: City of Sunnyvale Crossroads Data, 2012-2016

Table 1 – Overview of Plans and Policies

Document	Description
Sunnyvale Vision Zero Plan	Adopted in 2019, establishes a 10-year plan to reduce fatalities and serious injuries related to transportation by 50% with a focus on engineering, education, enforcement, encouragement, evaluation, engagement, and equity.
Sunnyvale Active Transportation Plan	Includes the Sunnyvale Bicycle Master Plan, Safe Routes to School Plan, and Pedestrian and Safety Circulation Plan. The ATP was completed in 2020 and identifies priority bicycle and pedestrian projects that contribute towards reducing collisions involving pedestrians and bicyclists throughout Sunnyvale.
Sunnyvale General Plan: Land Use and Transportation Element	Updated in 2017, promotes safer streets and healthy living for all users. These policies support multimodal infrastructure improvements that address bicycle and pedestrian safety, convenience and connectivity. The General Plan's comprehensive, safety-oriented complete streets policy is further strengthened by a recently adopted City Council Resolution on complete streets.
Sunnyvale Climate Action Plan 1.0 and Climate Action Playbook 2.0	Together include over 100 actions for reducing citywide greenhouse gas emissions, several of which relate to improving "sustainable circulation and transportation options." Specific actions cite improving the safety of bicyclists and pedestrians through roadway design and enforcement.
Sunnyvale Complete Streets Policy	Last updated in 2018, the Complete Streets Policy codifies Sunnyvale's commitment to creating and maintaining a safe, sustainable, integrated, efficient, and convenient transportation system serving all categories of users. It identifies that all relevant departments and agencies of the City shall work toward making Complete Streets practices a routine part of every relevant project.
Sunnyvale Design Guidelines	Including the citywide Design Guidelines, the Parking Structure Design Guidelines, and the Mixed-Use Development Toolkit, provide design guidelines for private developers to encourage safer site access, to create interesting and comfortable streetscapes, and to promote less dependence on cars.
Sunnyvale Specific, Precise, and Sense of Place Plans	These plans address multimodal transportation connectivity and safety through recommended streetscape improvements and intersection enhancements. Examples include the Fair Oaks Junction Sense of Place Plan, East Sunnyvale Sense of Place Plan, Downtown Specific Plan, Moffett Park Specific Plan, Peery Park Specific Plan, Lawrence Station Area Plan, and El Camino Real Corridor Specific Plan.
Sunnyvale Age-Friendly Action Plan	An "age-friendly city" optimizes opportunities for health, participation, and security for all people, to ensure quality of life and dignity as people age. In September 2017, the City of Sunnyvale was formally designated an Age-Friendly City by the World Health Organization and American Association of Retired Persons. As part of the commitment to the Age-Friendly network, the City adopted an action plan that encompasses the City's values and vision and provides for sustainable growth.
Sunnyvale Green Stormwater Infrastructure Plan	The City of Sunnyvale has prepared this GSI Plan to guide the siting, implementation, tracking, and reporting of GSI projects on private and City-owned land over the next several decades.

2 DATA ANALYSIS TECHNIQUES AND RESULTS

A primary component of the Roadway Safety Plan is the identification of locations with elevated risk of collisions either through their collision histories or their similarities to other locations that have more active collision patterns. A summary of the data utilized and key findings is included in this chapter. A detailed discussion of analysis methodologies is included in **Appendix B**.

2.1 DATA COLLECTION

Collision data for the five-year period spanning July 1, 2013 through June 30, 2018 – the five most recent years of data available at the time the project was undertaken – were collected from the City of Sunnyvale's Crossroads Collision Software (Crossroads). This system has access to the latest police reports, allowing validation of the City's data with Transportation Injury Mapping System (TIMS), which provides access to California crash data using the Statewide Integrated Traffic Records System (SWITRS) data for injury and fatal collisions. This helps to confirm that all relevant data is included.

Vehicular count data and roadway attributes (e.g. number of lanes, intersection traffic control, functional classification) for the Citywide roadway network was sourced through information provided by the City and outputs from the City's travel demand model. The citywide vehicular traffic volumes are visually represented in **Figure 2**. Traffic volumes from Caltrans freeways were excluded from this evaluation.

The collected data were spatially referenced and mapped in ArcGIS. Each collision was assigned to the nearest intersection within 250 feet, or the nearest roadway segment if no intersection was within range. A raw count of crashes was calculated for each intersection and roadway segment, and intersection collisions were separated by signalized and unsignalized locations.

2.2 COLLISION HISTORY ANALYSIS

2.2.1 Total Collisions

Approximately 5,811 collisions occurred within public right-of-way between July 1, 2013 and June 30, 2018 according to reported data. The time periods have been re-classified into five discrete one-year periods for the purposes of this analysis:

- Year 1 – July 1, 2013 to June 30, 2014
- Year 2 – July 1, 2014 to June 30, 2015
- Year 3 – July 1, 2015 to June 30, 2016
- Year 4 – July 1, 2016 to June 30, 2017
- Year 5 – July 1, 2017 to June 30, 2018

Figure 3 displays all Citywide collision activity for the five-year study period using data processed through Crossroads. **Figure 4** shows all collisions by type for each year and indicates that rear-end collisions are consistently the most common collision type within the City, followed by broadside and sideswipe collisions.

Figure 2 Citywide Vehicular Traffic Volumes

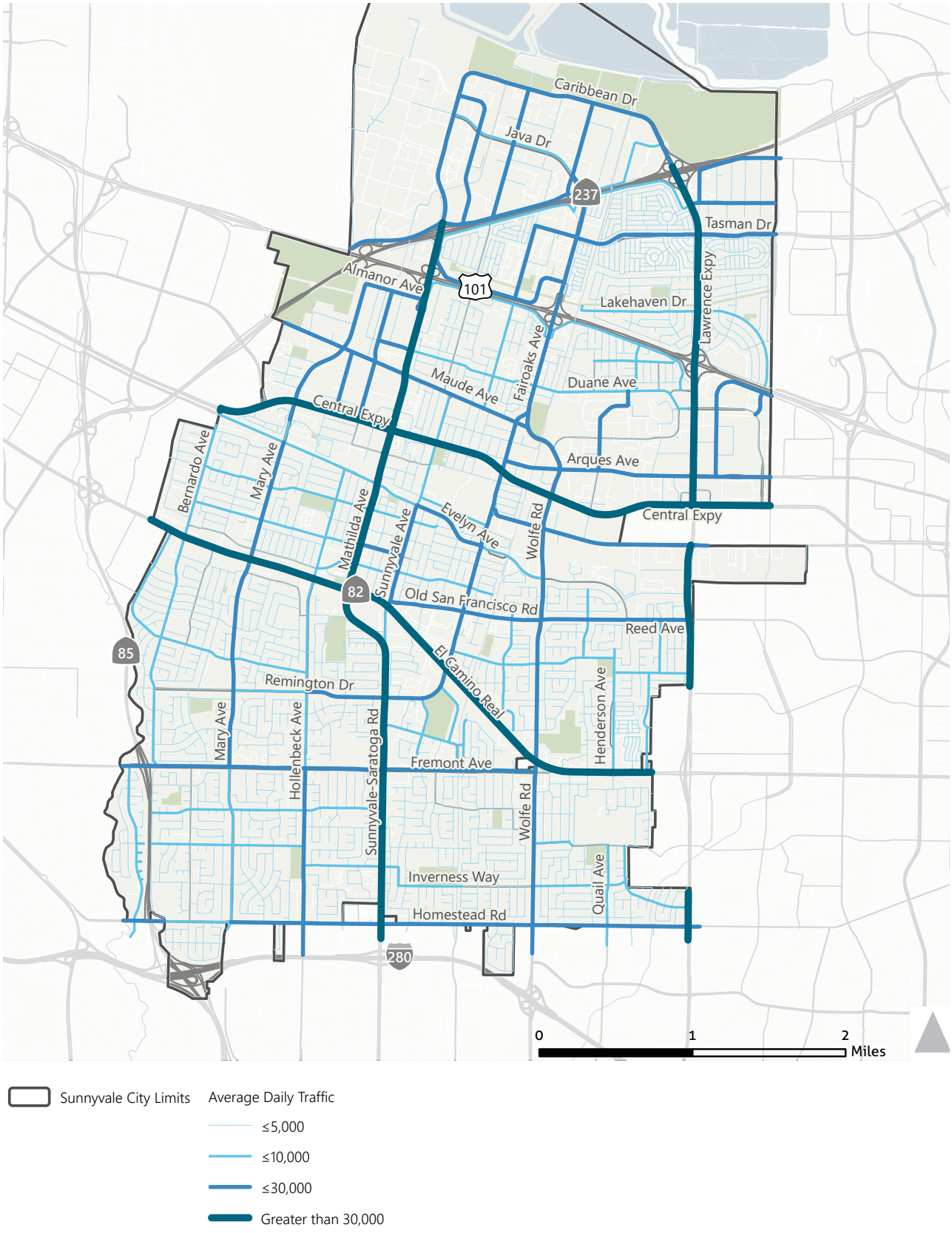


Figure 3 Citywide Collision Locations (July 1, 2013 - June 30, 2018)

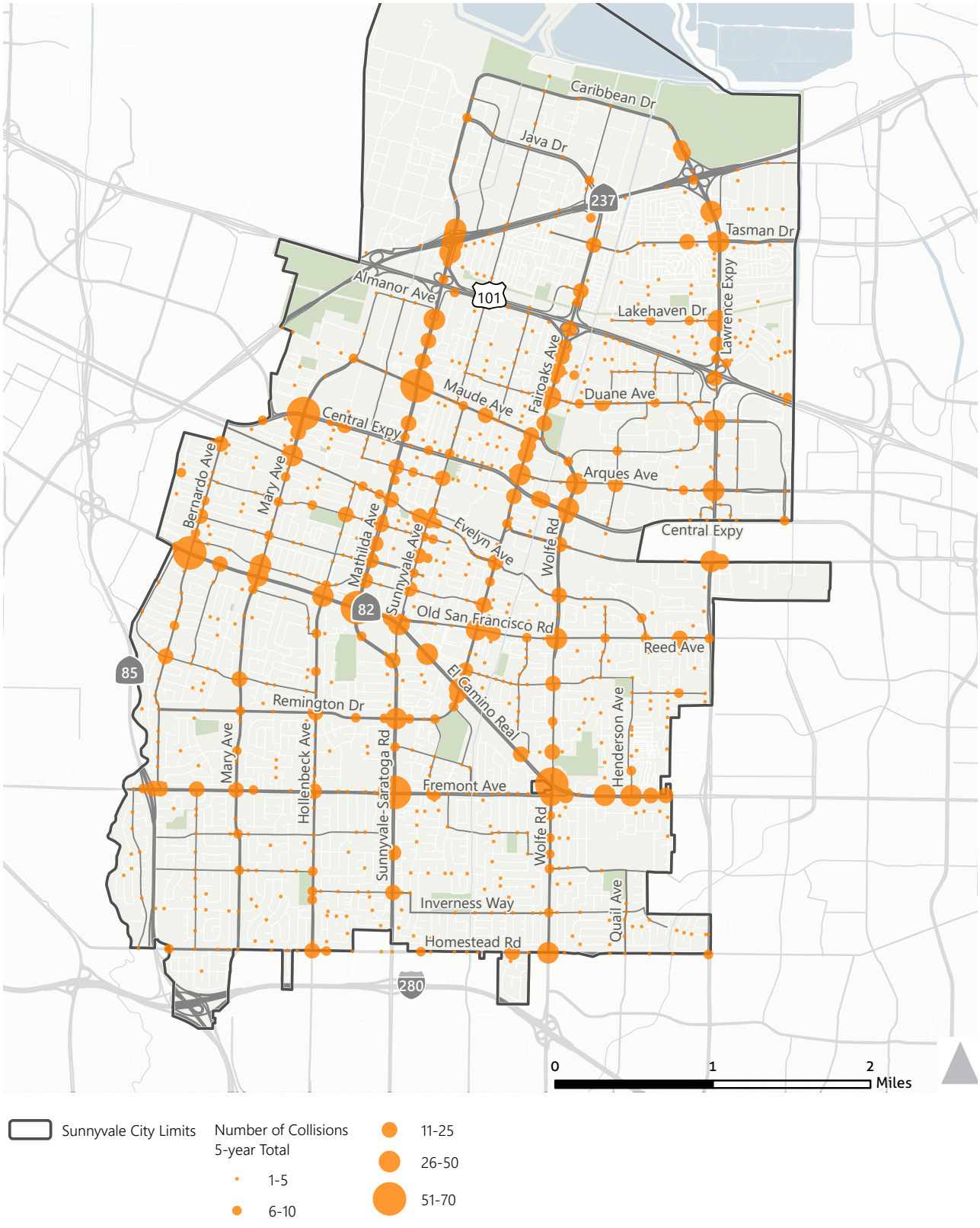
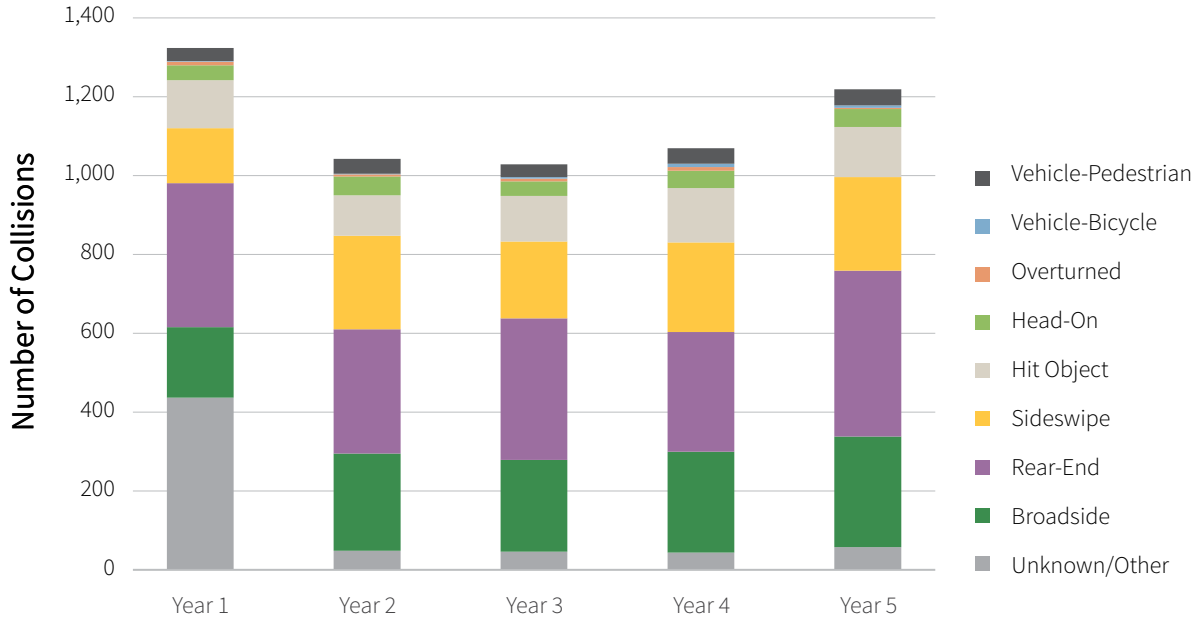


Figure 4 Citywide Collisions by Type (July 1, 2013 – June 30, 2018)



Collision types describe how a crash is reported by law enforcement based upon the parties who were involved and generally describes the manner in which contact was made between the involved parties.

Vehicle-Pedestrian collisions are any crash involving both a motor vehicle and a pedestrian.

Vehicle-Bicycle collisions are any collision involving both a motor vehicle and a bicyclist.

An **Overturned** collision is any type of crash that results in at least one vehicle rotating 90 degrees or more side-to-side or end-to-end (also known as a "rollover.")

A **Head-on** collision is between two vehicles where the primary point of contact was the front of both vehicles.

Hit Object collisions are between a vehicle and non-vehicular object in or near the roadway.

Sideswipe collisions are between vehicles, typically traveling the same direction, where the primary point of contact was the side of the vehicles.

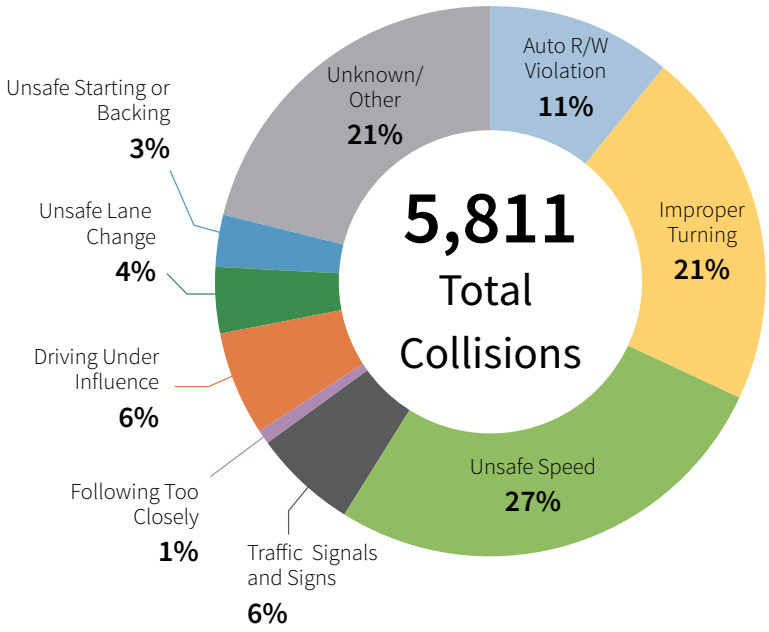
A **Rear-end** collision is between two vehicles traveling in the same direction where the front of one vehicle contacts the rear of another.

Broadside collisions are between vehicles on conflicting paths where the front of one vehicle contacts the side of another.

Unknown/Other collisions describe any reported collision that was not consistent with one of the primary collision types above or where collision type was not coded into the collision database.

Knowing the recorded causes of collisions can help identify safety factors system wide that may contribute to collisions. **Figure 5** provides a breakdown of causality for all recorded collisions. Of all the causes of collisions, approximately 56 percent are a result of unsafe speed, unsafe lane changing, unsafe starting/backing, following too closely, and improper turning.

Figure 5 Citywide Collision Causes (July 1, 2013 – June 30, 2018)



Collision causes describe the primary reason(s) for a crash reported by law enforcement based upon citations or violations of the California Vehicle Code (CVC).

Auto Right-of-Way (R/W) Violation refers to a driver infringing upon the right-of-way of another party in violation of CVC 21800-21809.

Improper Turning identifies a collision where a party made a left or right turn in violation of CVC 22100-22113.

Unsafe Speed refers to a collision where a party is identified to be traveling at a speed exceeding that deemed reasonable or prudent for conditions in violation of CVC 22350.

Traffic Signals and Signs describes a party disobeying a traffic control device such as a traffic signal or roadside sign in violation of CVC 38280-38302.

Following Too Closely refers to a driver of a motor vehicle driving behind another vehicle at distance that is too short to be reasonable or prudent for conditions in violation of CVC 21703.

Driving Under Influence identifies a collision where a driver is found to have been operating a vehicle while impaired by a substance – typically alcohol – in violation of CVC 23152.

Unsafe Lane Change describes a collision where a party moves between two lanes or deviates course in a hazardous manner and/or without signaling appropriately in violation of CVC 22107.

Unsafe Starting or Backing refers to a driver unsafely beginning movement of a stopped vehicle or backing a vehicle onto a roadway in violation of CVC 22106.

Unknown/Other refers to a collision for which the primary cause was either not reported or was not consistent with any of the CVC violations described above.

Finally, identifying the outcomes of the collision (the injuries or type of damage which occurred) is a key part of assessing the environment and safety factors around the site of the collision. **Figure 6** displays the collisions outcomes and severities for each year in the study period, with **Figure 7** displaying only the fatal and severe injury collisions. Over the period studied, there were a total of **24 fatal collisions and 65 collisions resulting in severe injury**.

Figure 6 Citywide Collision Outcomes (July 1, 2013 – June 30, 2018)

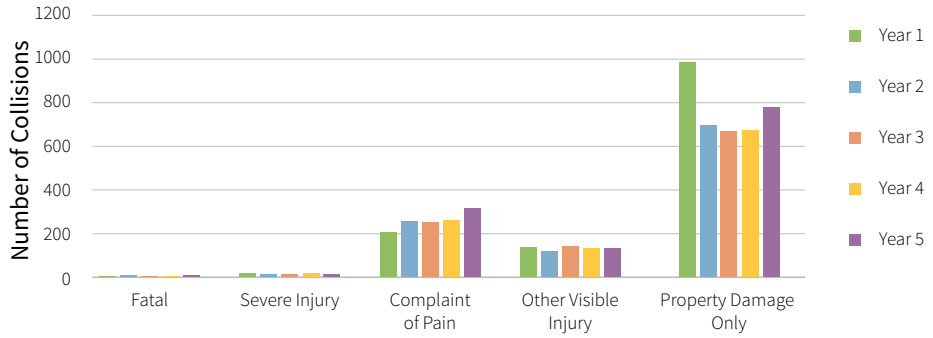


Figure 7 Citywide Fatal & Severe Injury Collision Outcomes (July 1, 2013 – June 30, 2018)

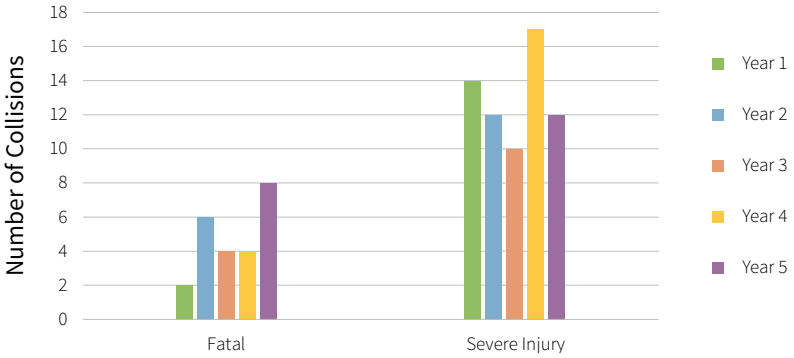


Figure 8 shows the ten intersections and ten roadway segments which had the highest number of collisions. The highest collision locations align with arterial roadways, including El Camino Real and the County Expressways. In many cases, these coincide with the High Injury Network (shown in **Figure 1**) identified in the Sunnyvale Vision Zero Plan, which accounts for 60% of the fatal and severe injury collisions in the City on just 7% of its roadway network. The top five intersections and roadway segments by functional classification have been identified in **Tables 2** and **3**, respectively.

Table 2 – Top Collision Intersections

Location	Total Collisions (5-year Period)
Signalized Intersections	
Mathilda Avenue & Maude Avenue	70
Central Expressway & Mary Avenue	69
El Camino Real & Wolfe Road	66
El Camino Real & S Mathilda Avenue	61
Fremont Avenue & Sunnyvale Saratoga Road	54
Unsignalized Intersections	
Mary Avenue & Olive Avenue	26
El Camino Real & Sycamore Terrace	25
Lawrence Expressway & 101 SB On-Ramp	24
El Camino Real & Helen Avenue	23
Bayview Avenue & Maude Avenue	21

Figure 8 Top Ten Citywide Collision Intersections and Segments

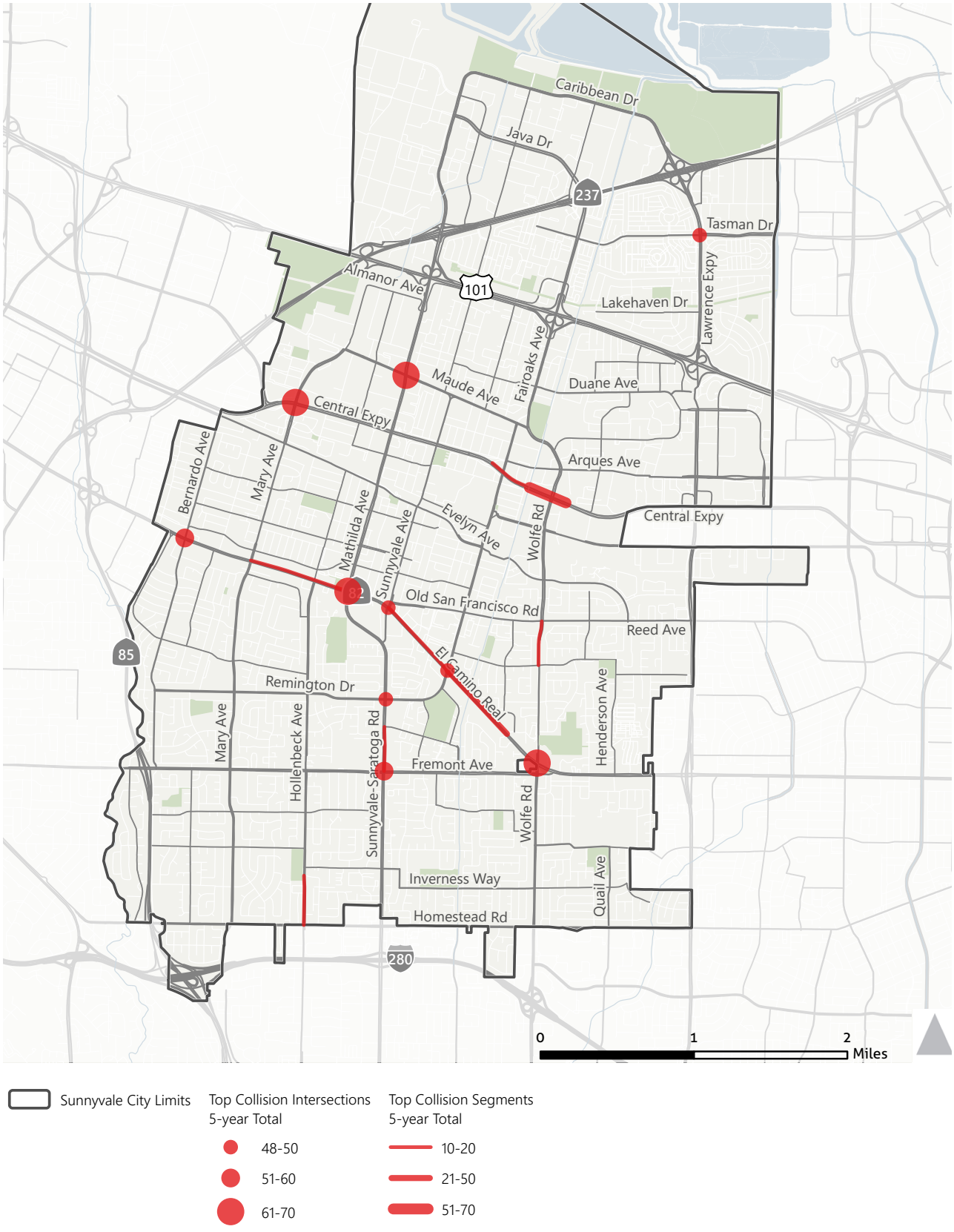
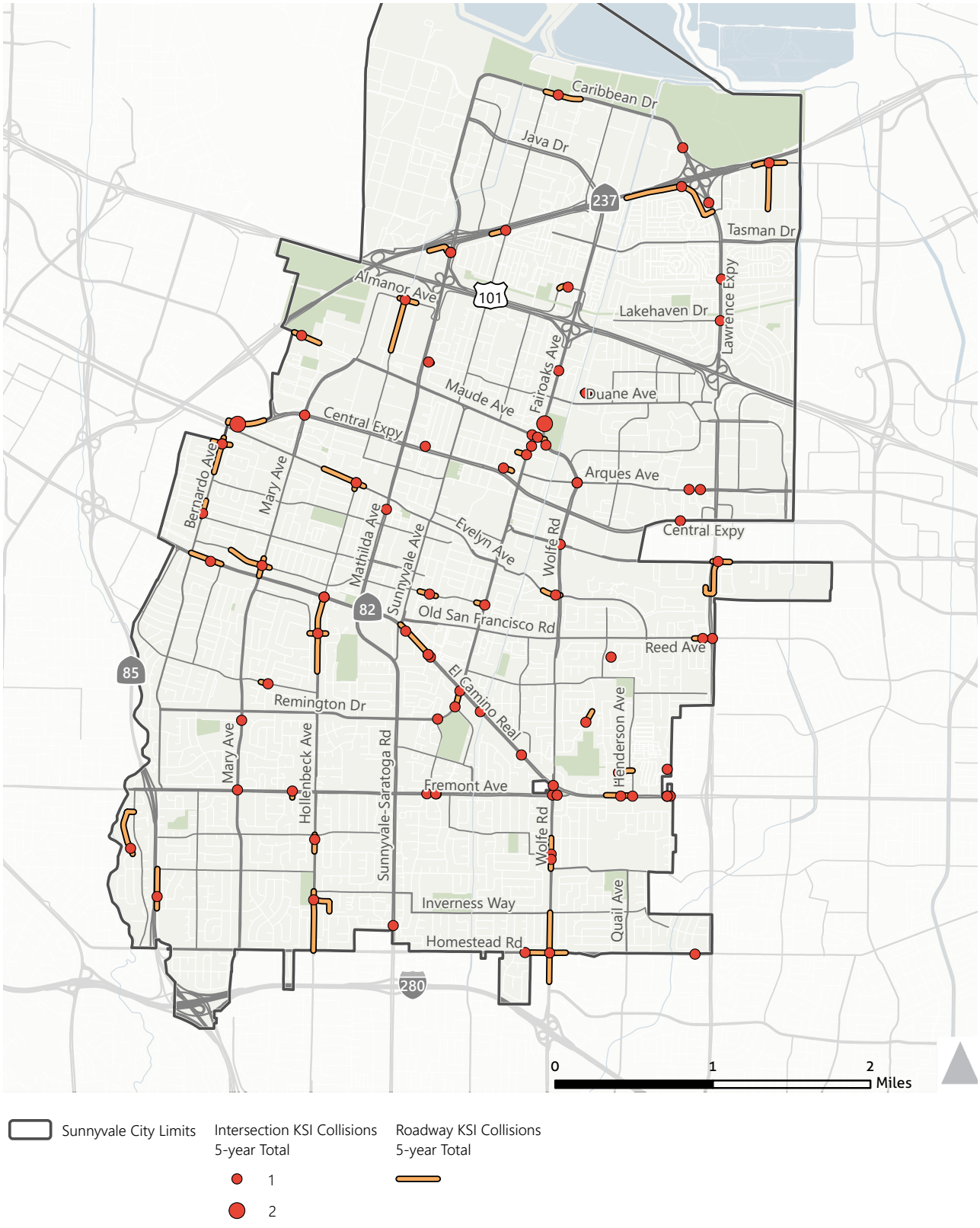


Table 3 – Top Collision Segments

Segment	From	To	Total Collisions (5-year period)
County Expressway			
Central Expressway	Wolfe Rd East Ramps	Wolfe Rd West Ramps	51
Central Expressway	Arques Ave East Ramps	Arques Avenue West Ramps	13
Central Expressway	Commercial St	San Vincente Way	12
Central Expressway	Mary Ave Intersection	Mary Ave East Ramps	8
Central Expressway	Commercial St	Wolfe Rd	7
Class I Arterial			
El Camino Real	Maria Ln	Fair Oaks Ave	21
El Camino Real	Pastoria Ave	Mary Ave	20
Sunnyvale-Saratoga Rd	Fremont Ave	Crescent Ave	18
El Camino Real	Mathilda Ave	Pastoria Ave	14
El Camino Real	Fair Oaks Ave	Cezanne Dr	14
Class II Arterial			
Wolfe Rd	Iris Ave	Reed Ave	13
Evelyn Ave	Mary Ave	City Limit	12
Fremont Ave	Sunnyvale-Saratoga Rd	Bobwhite Ave/Manet Dr	11
Sunnyvale-Saratoga Rd	El Camino Real	Fall River Ter	9
Wolfe Rd	El Camino Real	Maria Ln	7
Commercial/Industrial Collector			
Maude Ave	Pastoria Ave	Mathilda Ave	10
Maude Ave	Sunnyvale Ave	Bayview Ave	6
Weddell Dr	Ross Dr	Borregas Ave	6
Almanor Ave	Vaqueros Ave	Mathilda Ave	5
Maude Ave	Mathilda Ave	San Angelo Ave	4
Residential Collector			
Hollenbeck Ave	Homestead Rd	Grand Coulee Ave	15
Bernardo Ave	Ayala Dr	Cortez Dr	6
Ahwanee Ave	Mathilda Ave	San Aleso Ave	6
Bernardo Ave	Homestead Rd	Helena Dr	4
Henderson Ave	El Camino Real	Valerian Way	4
Local			
Acalanes Dr	McKinley Ave	Bernardo Ave	6
San Zeno Way	Sonora Ct	Kifer Rd	5
Wildwood Ave	Torrance Ave	Fairwood Ave	5
Rockefeller Dr	Mary Ave	Lime Dr	4
Westside Ave	Sunnyvale-Saratoga Rd	Dead End	3

Figure 9 Citywide Fatal and Severe Injury Collision Locations (July 1, 2013 – June 30, 2018)

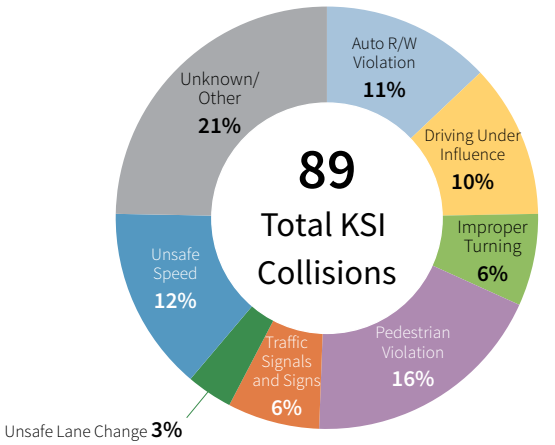


2.2.2 Fatal & Severe Injury Collisions

Identifying locations and contributing factors of fatal and severe injury collisions – also known as Killed or Severely Injured (KSI) collisions – is a key step in detecting any patterns in location or design of the roadway/intersection that are potentially affecting their occurrence. **Figure 9** shows the locations of the 89 fatal and severe injury collisions that occurred in Sunnyvale during the study period. Most fatal collisions occurred at or near intersections rather than at mid-block locations along roadway segments. In addition, the fatal collisions typically occurred on a Class I or Class II arterial. **Figure 10** displays the percentage of KSI collisions by their cited cause, with unsafe speed and pedestrian violations representing the greatest causes by citation.

Of the 89 total KSI collisions, 48 involved active transportation modes – 33 were pedestrian-involved and 15 were bicycle-involved.

Figure 10 Citywide Fatal and Severe Injury Collision Causes (July 1, 2013 – June 30, 2018)



2.2.3 Bicycle and Pedestrian Collisions

2.2.3.1 Pedestrian Collisions

Collisions between vehicles and pedestrians more frequently result in a severe injury or fatality. Identifying the historical patterns of these collisions is a large component in the analysis process. As shown in **Figure 11,** during the study period, a total of 201 pedestrian-involved collisions occurred. Of the 201 collisions, 12 resulted in fatality, 21 were reported with severe injury, 78 with visible injuries, and 79 with complaints of pain. **Figure 12** displays the locations of pedestrian collisions and **Table 4** identifies what action the pedestrian was taking at the time of collision. Pedestrians in these collisions were most frequently identified as crossing in a crosswalk at an intersection. The location with the greatest number of pedestrian collisions was the intersection of El Camino Real and Cezanne Drive, which includes permissive left-turn movements across parallel crosswalks.

Figure 11 Pedestrian Collision Outcomes

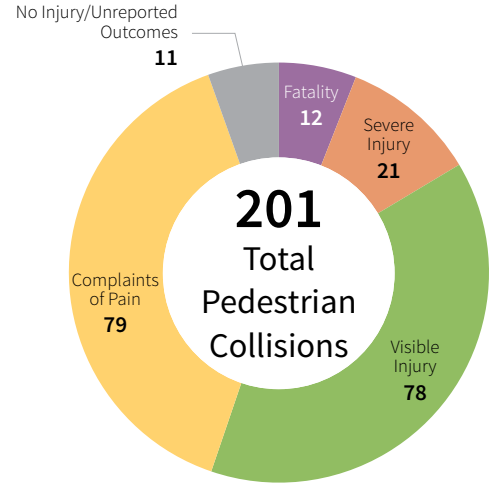


Figure 12 Pedestrian-Involved Collisions

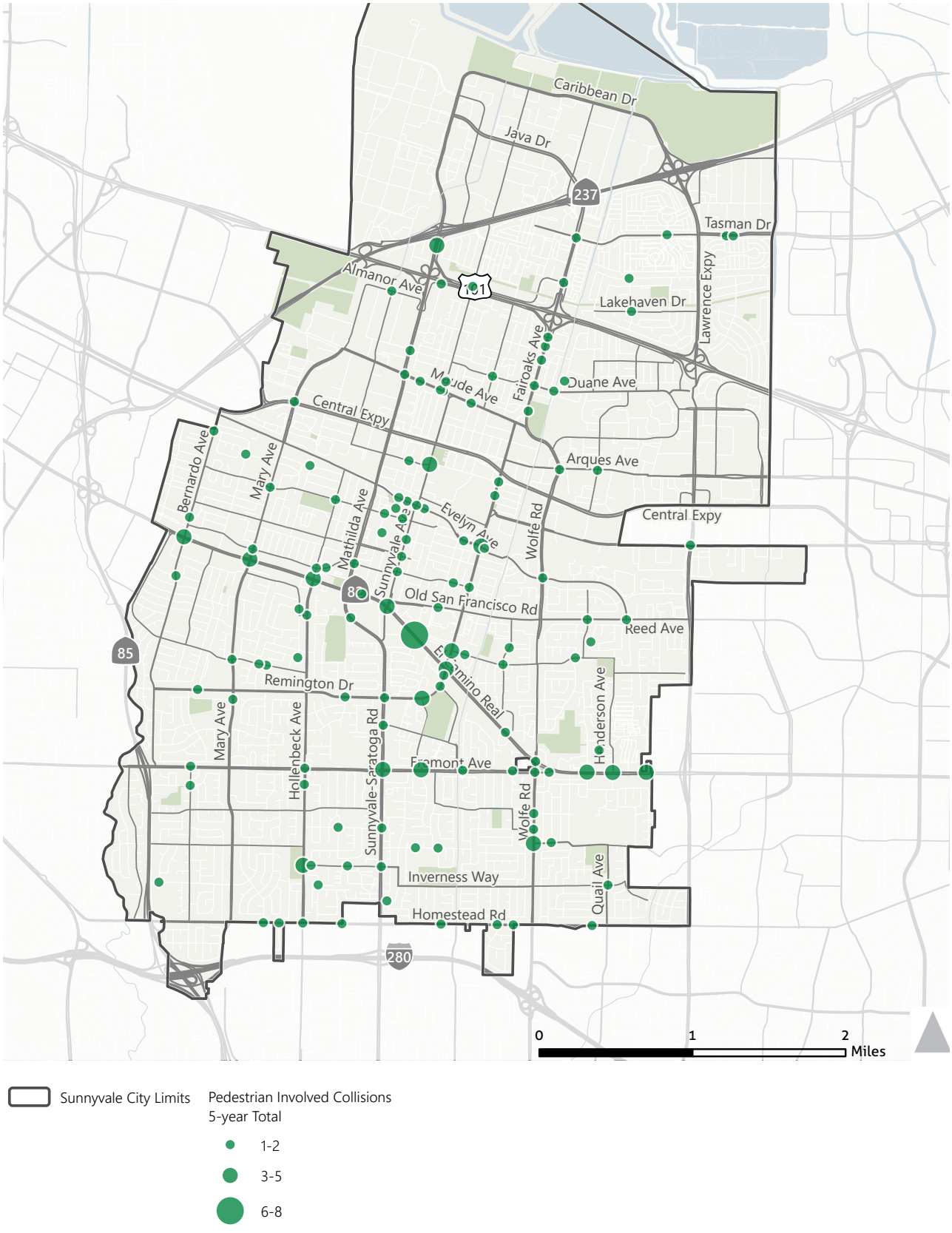


Table 4 - Action of Pedestrian in Collision

Year	Number of Collisions by Pedestrian Action					
	Crossing in Crosswalk at Intersection	Crossing in Crosswalk Not at Intersection	Crossing Not in Crosswalk	In Road (Walking along Roadway)	Not in Road	Total
Year 1	28	3	7	4	8	35
Year 2	35	1	9	3	2	45
Year 3	16	0	3	5	7	19
Year 4	31	1	8	2	4	40
Year 5	28	0	9	4	2	37
Total	138	5	36	18	23	176

Note: Collisions where pedestrian action was not reported are not included in this table.

2.2.3.2 Bicycle Collisions

Like pedestrian collisions, the identification of vehicle-bicycle collision locations is important in understanding areas of the network where there are factors that may be affecting the safety of these transportation modes. As seen in **Figure 13**, of the 333 bicycle-involved collisions, 3 resulted in a fatality, 12 were reported with severe injury, 173 with visible injury, and 114 with complaints of pain. These collisions are visually represented in **Figure 14**. The location with the highest number of bicycle-involved collisions is the intersection of El Camino Real and Sunnyvale Saratoga Road, which was substantially modified between mid-2016 and mid-2017 to eliminate channelized right-turns and improve crosswalks. Six of the seven bicycle-involved collisions at this location occurred prior to completion of this improvement project, and five of these collisions were of types that would have been addressed by the implemented countermeasures.

The locations with the next highest number of bicycle-involved collisions are the intersections of Fremont Avenue at Sunnyvale Saratoga Road, which is adjacent to Fremont High School and two corners currently being planned for redevelopment, and El Camino Real at Mary Avenue. Both are relatively large intersections with a high level of exposure for bicyclists crossing either roadway.

Figure 13 Bicycle Collision Outcomes

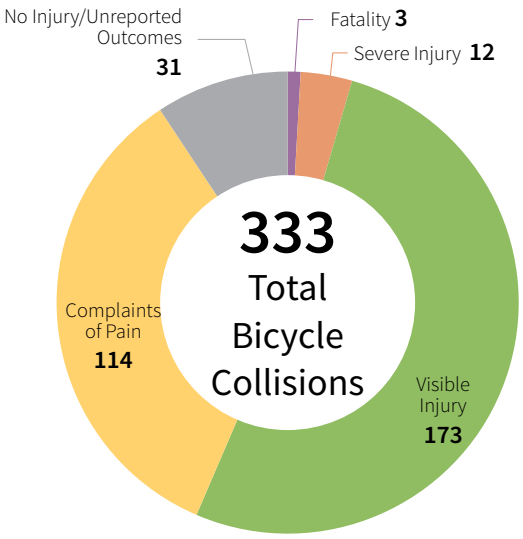
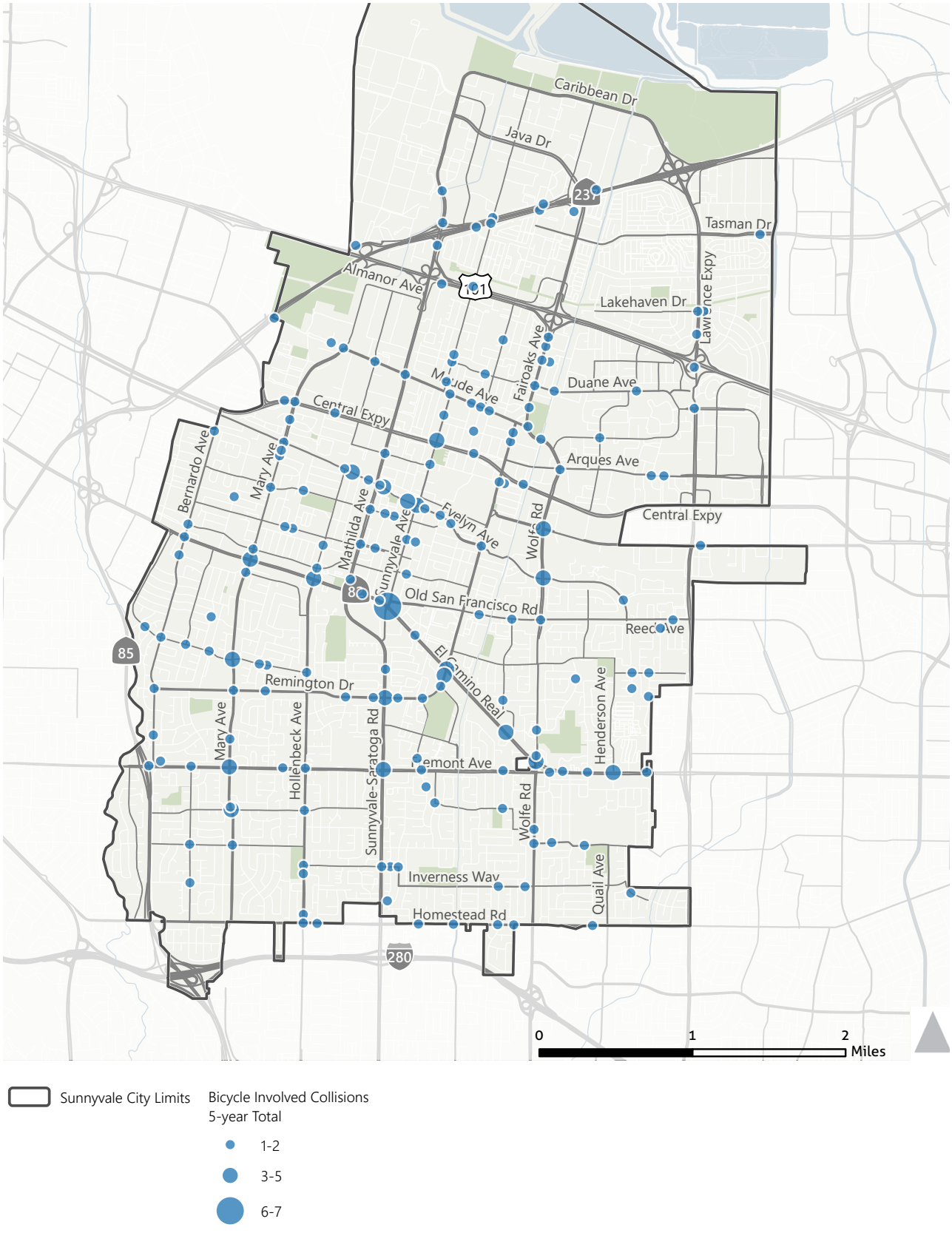


Figure 14 Bicycle-Involved Collisions



2.3 COLLISION RATE & SYSTEMIC ANALYSIS

A systemic approach to safety focuses on evaluating an entire roadway network, identifying high-risk roadway characteristics and driver behaviors based upon crash history. A systemic analysis can also employ analysis of collision rates to identify locations with a proportionally higher number of collisions rather than relying upon the raw number of collisions identified in the collision history. These methods can both help to identify locations in the City which may have potential for future collisions rather than strictly identifying those where collisions have already occurred.

2.3.1 Critical Crash Rate

Various methodologies are available for analysis of collisions, including those described in the *Local Roadway Safety Manual*: A Manual for California's Local Road Owners (LRSM Version 1.5, April 2020) and the AASHTO *Highway Safety Manual* (HSM), published in 2010.

To provide the most benefit and to be competitive for funding, the LRSM recommends analysis leading to countermeasure selection should focus on both intersections and roadway segments and be considerate of roadway characteristics and traffic volumes. The result should be a list of locations that are most likely to benefit from cost-effective countermeasures, preferably prioritized by benefit/cost ratio. The manual suggests using a mixture of quantitative and qualitative measures to identify and rank locations that considers both crash frequency and crash rates.

The HSM provides several statistical methods for screening roadway networks to identify high risk locations based on overall collision histories. In addition to flat crash quantities, the method used in this study is referred to as Critical Crash Rate (CCR). The CCR methodology provides a statistical review of locations to determine where risk is higher than that experienced by other similar locations. It is also the first step in analyzing for patterns that may suggest systemic issues that can be addressed at that location and proactively at others to prevent new safety challenges from emerging.

The Critical Crash Rate compares the observed crash rate to the expected crash rate at a location based on facility type and volume using a locally calculated average crash rate for the specific type of intersection or roadway segment being analyzed. Based on traffic volumes and a weighted citywide crash rate for each facility type, a critical crash rate threshold is established to determine locations with higher crash rates that are unlikely to be random. The threshold is calculated for each location individually based on its traffic volume and the crash profile of similar facilities.

After this analysis was completed, the locations were ranked by their categories according to that level of exceedance. The CCR analysis identified locations that have statistically higher crash rates than other similar locations as shown in **Appendix A**.

2.3.2 Probability of Specific Crash Types Exceeding Threshold Proportion

The HSM also describes a methodology for determining the probability that crash type is greater than an identified threshold proportion. This helps to identify locations where a crash type is more likely to occur. The methodology first determines the frequency of a specific collision type at an individual location, then determines the observed proportion of that collision type relative to all collision types at that location and the calculated threshold for the collision type Citywide.

Tables included in **Appendix A** show the number of crashes occurring at locations in Sunnyvale by crash type, and highlights locations in which the probability of those crash types exceeding the threshold proportion is greater than 33%. The tables separately reflect roadway segments/corridors, signalized intersections, and unsignalized intersections. The rankings include a breakdown of crash type as well as crashes occurring in the dark, in wet conditions, or with risky driver behavior.

2.3.3 Collision Profiles

Based upon the analysis of collision history, collision rates, and contextual factors, collision profiles or typologies can be identified. These profiles describe roadway characteristics and/or driver behaviors that are found to be leading to collisions, and can therefore be used in a systemic methodology to proactively identify locations which have similar contexts but may have experienced fewer collisions in the past.

Collision profiles were also developed as part of the Sunnyvale Vision Zero Plan, with ten specific profiles representing the top KSI collision patterns across the City defined and evaluated. The Vision Zero Plan also identified candidate countermeasures for each of the ten profiles. The Roadway Safety Plan data analysis indicates that the same ten profiles, shown in **Table 5**, continue to represent a large proportion of the fatal and severe injury crashes.

Table 5 - Collision Profiles

Collision Profile	% of All KSI (# of All KSI)	% of Auto KSI (# of Auto KSI)	% of Bicycle KSI (# of Bicycle KSI)	% of Pedestrian KSI (# of Pedestrian KSI)
Conflicting Through Movement at Intersection	31% (28)	46% (19)	60% (9)	
Left Turn at Signalized Intersection	25% (22)	24% (10)	20% (3)	27% (9)
Walking or Bicycling on Major Roadway (Expressway, Arterial, or Collector)	18% (16)		67% (10)	18% (6)
60+ Year Old Pedestrians at Intersection	17% (15)			45% (15)
Unmarked Pedestrian Crossing	15% (13)			39% (13)
Speed-related Conflict	13% (12)	20% (8)	7% (1)	9% (3)
Influence of Drugs or Alcohol	11% (10)	17% (7)	13% (2)	3% (1)
Midblock Bicycle Conflict	7% (6)		40% (6)	
Red Light Violation at Signalized Intersection	7% (6)	7% (3)	13% (2)	3% (1)
Children Walking or Biking Near School	2% (2)		13% (2)	

Note: Because an individual collision may be categorized under multiple profiles, the values in the table do not sum to 100%. Cells without a percentage KSI represent profiles where zero KSI collisions occurred for a given mode.

Investigation into the locations, associated collisions types, and contextual characteristics for these profiles was conducted. Additional considerations for some typologies were identified, including:

- Signalized intersections which do not have protected left-turn phases for all movements were found to have an increased occurrence of undesirable interactions between all modes. Ten intersections with this condition were collectively found to be the site 11% of KSI collisions and 7% of bicycle/pedestrian-involved collisions Citywide. As identified in the Vision Zero "Left Turn at Signalized Intersection" profile, the addition of protected turn phases and/or leading pedestrian intervals may be appropriate countermeasures for this condition.

- Unsignalized intersections where queuing and/or a lack of available gaps make maneuvers challenging, particularly at side-street stops, were found to have an increased potential for "Conflicting Through Movement at Intersection" collisions. Sight distance was observed to be limited by vehicles parked or queued on the major roadway in many locations. In addition to previously identified countermeasures, adjustments to intersection geometrics and control features may help to improve visibility.

- Many intersections with the greatest occurrence of "Red Light Violation at Signalized Intersection" collisions have signal equipment that is not standard with current guidance from the California Manual of Uniform Traffic Control Devices (CA MUTCD) pertaining to the number, placement, or size of signal heads. Most intersections along El Camino Real have a single mast-arm signal head to govern three through travel lanes, while some older traffic signal installations in the City still employ 8” traffic signal heads. As visibility of signal indications is positively correlated to driver compliance, upgrading traffic signal hardware may be an appropriate countermeasure at locations with this collision type in addition to previously identified countermeasures such as dilemma-zone detection and signal timing adjustments.

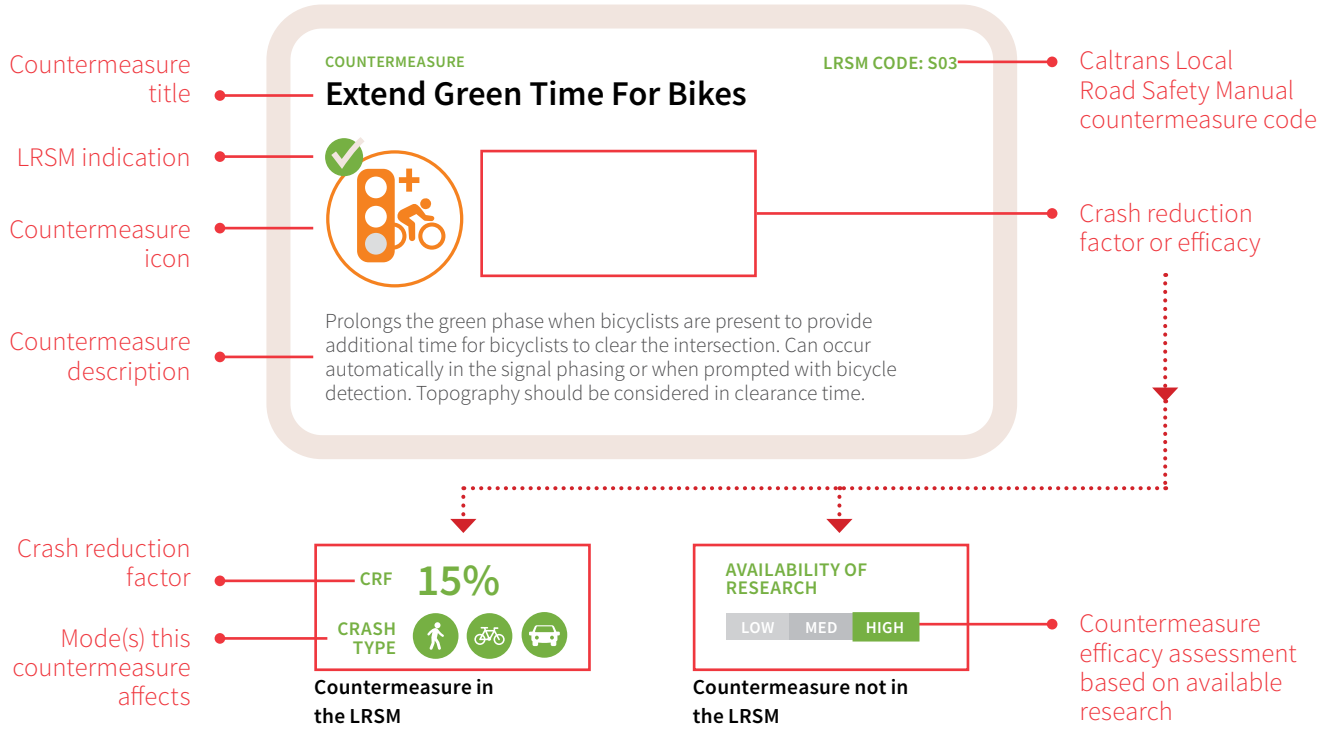
3 SAFETY COUNTERMEASURES TOOLBOX

Safety Countermeasures Toolbox

This chapter presents key safety countermeasures applicable in different roadway contexts across Sunnyvale. Many of these countermeasures are recommended for the 20 project locations of interest included in this report. A complete Safety Countermeasure Toolbox containing 88 countermeasures can be found in **Appendix C**.

Many of the countermeasures are Caltrans-approved, with an associated Crash Reduction Factor (CRF) and crash type (i.e., all modes, bicycle and pedestrian crashes only, etc.) as outlined in the 2020 California Local Roadway Safety Manual (LRSM). The higher the CRF (100% being the highest), the greater the expected reduction in crashes. Countermeasures not in the LRSM are scored on a "low-medium-high" AVAILABILITY OF RESEARCH scale based on proven safety studies; otherwise, denoted as "N/A" when limited safety studies are available. The higher the AVAILABILITY OF RESEARCH rating, the greater the expected reduction in crashes.

What You'll See Inside:



Safety Research Sources

A Vision for Transportation Safety, SFMTA and SFDPH for TRB, 2015.
Application of Pedestrian Crossing Treatments for Streets and Highways, NCHRP, 2016.
California Local Roadway Safety Manual, Caltrans, FHWA & SafeTrec, 2020.
Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments, NCHRP, 2017.
Evaluation of Bicycle-Related Roadway Measures, Pedestrian and Bicycle Information Center, 2014.
Evaluation of Pedestrian-Related Roadway Measures, Pedestrian and Bicycle Information Center, 2014.

Safety Countermeasures Toolbox

SUMMARY OF COUNTERMEASURES

✓ INCLUDED IN LRSM

A. SIGNAL TIMING & PHASING

Additional Signal Heads ✓
Leading Pedestrian Interval ✓
New Traffic Signal ✓
Permissive Lefts To Protected ✓

B. INTERSECTION & ROADWAY DESIGN

New Sidewalk ✓
Raised Median ✓
Road Diet ✓
Turn Radius Reduction

C. SIGNS & MARKINGS

Advance Stop Bar ✓
Advance Yield Markings ✓
Parking Restrictions/Daylighting ✓
Radar Speed Feedback Sign ✓

D. BIKEWAY DESIGN

Bike Box ✓
Class II Bike Lane ✓
Class IV Separated Bikeway ✓
Green Bike Lane Conflict Zone Markings

E. PEDESTRIAN CROSSINGS

Pedestrian Hybrid Beacon ✓
Pedestrian Refuge Island ✓
Raised Crosswalk ✓
Rectangular Rapid Flashing Beacon ✓

F. OTHER

Access Management/Close Driveway
Far-Side Bus Stop
Intersection, Street-Scale Lighting ✓
Remove Obstructions For Sightlines ✓

G. LOW-COST AND QUICK-BUILD

Hardened Centerline ✓
Paint and Plastic Pedestrian Refuge Area ✓
Paint and Plastic Separated Bikeway ✓
Paint and Plastic Turn Radius Reduction

A. Signal Timing & Phasing

COUNTERMEASURE

Additional Signal Heads

LRSM CODE: S02

CRF 15%

CRASH TYPE

Additional signal heads allow drivers to anticipate signal changes farther away from intersections, decreasing the likelihood of driver error resulting in a collision.

COUNTERMEASURE

Leading Pedestrian Interval

LRSM CODE: S03

CRF 60%

CRASH TYPE

Gives people walking a head start, making them more visible to drivers turning right or left. "WALK" signal comes on a few seconds before the cars get their green light. May be used in combination with No Right Turn on Red restrictions.

COUNTERMEASURE

New Traffic Signal

LRSM CODE: NS03

CRF 25%

CRASH TYPE

New traffic signals can help to organize travel of all modes at an intersection, limiting interactions between vehicles, pedestrians, and bicyclists with conflicting movements. Using this countermeasure for HSIP applications requires documentation of signal warrants.

COUNTERMEASURE

Permissive Lefts to Protected

LRSM CODE: S06/S07

CRF 30%-55%

CRASH TYPE

Provides a protected green arrow phase for left turning vehicles while showing a red light for both on-coming traffic and parallel pedestrian crossings. Eliminates conflicts between pedestrians and left-turning vehicles.

B. Intersection & Roadway Design

COUNTERMEASURE

New Sidewalk

LRSM CODE: R34PB

CRF 80%

CRASH TYPE

Sidewalks and walkways are "pedestrian lanes" that provide people with space to travel within the public right-of-way that is separated from roadway vehicles. They are associated with reduced crashes where pedestrians were walking along the roadway.

COUNTERMEASURE

Raised Median

LRSM CODE: S12/NS14/R08

CRF 25%

CRASH TYPE

A concrete or landscaped area, between the two directions of travel. Reduces vehicular speeding and discourages risky turning movements.

COUNTERMEASURE

Road Diet

LRSM CODE: R14

CRF 30%

CRASH TYPE

Depending on the street, road diets may change the number of lanes, turn lanes, center turn lanes, bike lanes, parking lanes, and/or sidewalks. Road diets optimize street space to benefit all users by improving the safety and comfort of pedestrians and bicyclists, and reducing vehicle speeds and the potential for rear end collisions.

COUNTERMEASURE

Turn Radius Reduction

AVAILABILITY OF RESEARCH

LOW MED HIGH

Modifies the corner of an intersection to reduce turning radii for vehicles. Results in shorter crossings for pedestrians, reduced speed for turning vehicles, better sight lines, and space for landscaping, green infrastructure, and other amenities.

LRSM COUNTERMEASURE

C. Signs & Markings

COUNTERMEASURE

Advance Stop Bar

LRSM CODE: S20PB

CRF 15%

CRASH TYPE

A stop bar placed 5 to 7 feet ahead of the crosswalk at stop signs and signals reduces instances of vehicles encroaching on the crosswalk.

COUNTERMEASURE

Advance Yield Markings

LRSM CODE: NS07

CRF 25%

CRASH TYPE

Yield lines are placed 20 to 50 feet in advance of pedestrian crossings to increase visibility of pedestrians. Can reduce the likelihood of a multiple-threat crash at unsignalized midblock crossings.

COUNTERMEASURE

Parking Restrictions/Daylighting

LRSM CODE: NS11

CRF 20%

CRASH TYPE

By restricting parking at curbs in front of intersection crosswalks, sight lines are cleared between pedestrian crossings and oncoming motorists, reducing the risk of collision. Reducing visibility obstructions caused by parked vehicles, known as daylighting, allows all users to better gauge interactions.

COUNTERMEASURE

Radar Speed Feedback Sign

LRSM CODE: R26

CRF 30%

CRASH TYPE

A roadway treatment that uses radar to alert drivers to their actual speed relative to the posted speed limit, encouraging drivers who exceed to the speed limit to slow down.

D. Bikeway Design

COUNTERMEASURE

Bike Box

LRSM CODE: S20PB

CRF 15%

CRASH TYPE

A designated area at the head of a traffic lane at a signalized intersection that provides bicyclists with a safe and visible way to get ahead of queuing traffic during the red signal phase.

COUNTERMEASURE

Class II Bike Lane

LRSM CODE: R32PB

CRF 35%

CRASH TYPE

Using designated lane markings, pavement legends, and signage, bike lanes provide dedicated street space for bicyclists, typically adjacent to the outer vehicle travel lane.

COUNTERMEASURE

Class IV Separated Bikeway

LRSM CODE: R33PB

CRF 45%

CRASH TYPE

Space on the roadway set aside for the exclusive use of bicycles and physically separated from vehicle traffic. Types of separation may include, but are not limited to, grade separation, flexible posts, physical barriers, or on-street parking.

COUNTERMEASURE

Green Bike Lane Conflict Zone Markings

AVAILABILITY OF RESEARCH

LOW MED HIGH

Green pavement within a bicycle lane to increase visibility of bicyclists and to reinforce bicycle priority. The green pavement can be either as a corridor treatment or as a spot treatment in conflict areas such as frequently used driveways.

LRSM COUNTERMEASURE

E. Pedestrian Crossings

COUNTERMEASURE
Pedestrian Hybrid Beacon
LRSM CODE: NS23PB

CRF 55%

CRASH TYPE

Pedestrian-activated beacon used at mid-block crosswalks and side-street stop controlled crossing locations to notify oncoming motorists to stop with a series of red and yellow lights.

COUNTERMEASURE
Pedestrian Refuge Island
LRSM CODE: S12/NS19PB

CRF 25%-45%

CRASH TYPE

Pedestrian refuge islands provide a 6' minimum protected area for pedestrians at the center of the roadway. They reduce the exposure time for pedestrian crossing the intersection. They simplify crossings by allowing pedestrians to focus in one direction of traffic at a time.

COUNTERMEASURE
Raised Crosswalk
LRSM CODE: R36PB

CRF 35%

CRASH TYPE

The crosswalk is elevated to match the sidewalk to make pedestrians more visible to approaching vehicles. Typically located at midblock crossings, they encourage motorists to yield to pedestrians and reduce vehicle speed.

COUNTERMEASURE
Rectangular Rapid Flashing Beacon
LRSM CODE: NS22PB/R37PB

CRF 35%

CRASH TYPE

Pedestrian-activated flashing lights and additional signage enhance the visibility of marked crosswalks and alert motorists to pedestrian crossings.

F. Other

COUNTERMEASURE
Access Management/Close Driveway

AVAILABILITY OF RESEARCH
LOW MED HIGH

Vehicles entering and exiting driveways may conflict with pedestrians and with vehicles on the main road, especially at driveways within 250 feet of intersections. Closing driveways near intersections with high crash rates related to driveways may reduce potential conflicts.

COUNTERMEASURE
Far-Side Bus Stop

AVAILABILITY OF RESEARCH
LOW MED HIGH

Far-side bus stops are located immediately after an intersection, allowing the bus to pass through the intersection before stopping for passenger loading and unloading. Far-side stops encourage pedestrians to cross behind the bus for greater visibility, and can improve transit service reliability.

COUNTERMEASURE
Intersection, Street-Scale Lighting
LRSM CODE: S01/NS01/R01

CRF 35%-40%

CRASH TYPE NIGHT TIME

Street and intersection lighting helps make other road users or hazards more visible to motorists at night, improving driver perception and reaction time and reducing the risk of collision.

COUNTERMEASURE
Remove Obstructions For Sightlines
LRSM CODE: NS11

CRF 20%

CRASH TYPE

Remove objects that may prevent drivers and pedestrians from having a clear sightline. May include installing red curb at intersection approaches to remove parked vehicles (also called "daylighting"), trimming or removing landscaping, or removing or relocating large signs.

LRSM COUNTERMEASURE

G. Low-Cost and Quick-Build

COUNTERMEASURE

Hardened Centerline

LRSM CODE: S09

CRF 10%

CRASH TYPE

Uses paint to widen left-turn radii and rubber curb with plastic bollards on the receiving roadway's centerline to modify the angle of motorists turning left. Widening the turning radii of left-turning vehicles expands the field of vision for drivers and increases the visibility of pedestrians.

COUNTERMEASURE

Paint and Plastic Pedestrian Refuge Area

LRSM CODE: S12/NS16

CRF 25%-45%

CRASH TYPE

Paint and plastic post pedestrian refuge spaces provide a designated area for pedestrians at the center of the roadway. Pedestrian refuge areas constructed from paint and plastic should be implemented in conjunction with additional safety projects, such as an Rectangular Rapid Flashing Beacon (RRFB) or road diet, to reduce pedestrian exposure.

COUNTERMEASURE

Paint and Plastic Separated Bikeway

LRSM CODE: R33PB

CRF 45%

CRASH TYPE

A lane on the roadway dedicated to bicycles that is physically separated from vehicles by a raised barrier of plastic posts and painted pavement.

COUNTERMEASURE

Paint and Plastic Turn Radius Reduction

AVAILABILITY OF RESEARCH

LOW MED HIGH

A painted corner with plastic posts to reduce the turning radii at an intersection. Results in reduced speed for turning vehicles, better sight lines, and reduced pedestrian exposure.

LRSM COUNTERMEASURE

3.1 COUNTERMEASURE TOOLBOX SOURCES

Some countermeasures that are not included in the 2020 California Local Roadway Safety Manual (LRSM) were provided as part of the Countermeasure Toolbox for several reasons:

- The countermeasures complement or enhance the efficacy of those which are included in the LRSM.
- The countermeasures are emerging tools that are gaining traction throughout California and/or the United States, and may not yet have a history of academic research or efficacy studies, but are likely to be included in future iterations of the LRSM or other safety guidance documents.
- Though the HSIP funding source is based on countermeasure documentation in the LRSM, other funding sources may be more applicable for certain projects or contexts and allow for the inclusion of other countermeasure types.

Availability of Research

The availability of research rating for these countermeasures is listed as one of the following in the toolbox:

- Low – No or limited research on safety benefits is available or safety benefits are modest
- Medium – Research on efficacy is available, but safety benefits are modest
- High – A large body of research is available and safety benefits are well documented

The sources used to develop this qualitative rating system are listed below for reference. These sources have compiled and summarized the independent research of public agencies and academic institutions. The body of safety countermeasure research is always growing and the ratings listed in this document reflect the available research summarized within the following sources at the time of publication of this report:

- A Vision for Transportation Safety, SFMTA and SFDPH for TRB, 2015
- Application of Pedestrian Crossing Treatments for Streets and Highways, NCHRP, 2016
- California Local Roadway Safety Manual, Caltrans, FHWA & SafeTrec, 2020
- Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments, NCHRP, 2017
- Evaluation of Bicycle-Related Roadway Measures, Pedestrian and Bicycle Information Center, 2014
- Evaluation of Pedestrian-Related Roadway Measures, Pedestrian and Bicycle Information Center, 2014
- FHWA Crash Modification Factors Clearinghouse

4 PROJECT RECOMMENDATIONS

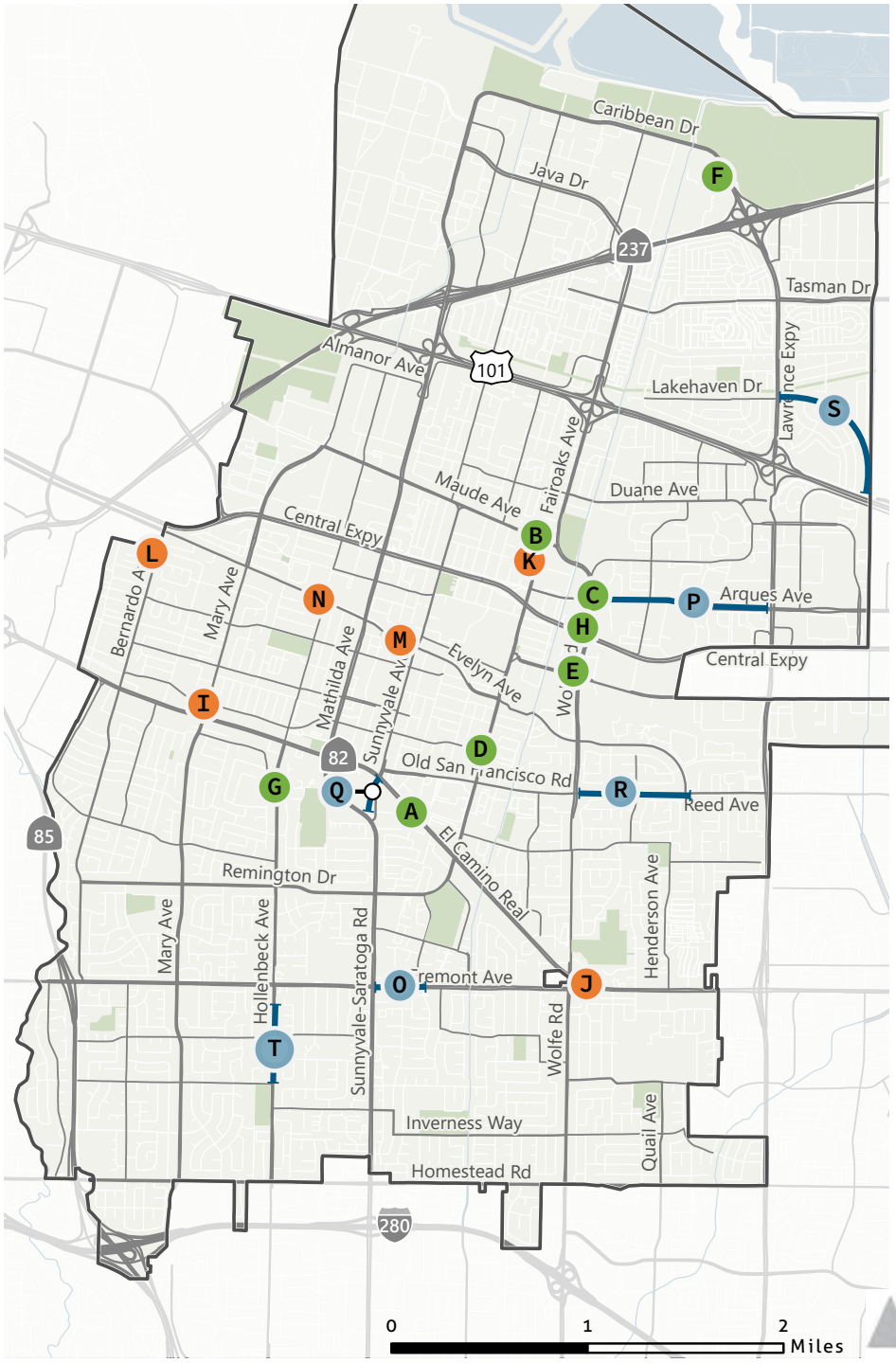
Through the collision analysis process, 20 sites were identified as locations of interest – 8 signalized intersections, 6 unsignalized intersections, and 6 roadway segments. These locations were selected in collaboration with the City taking into account community feedback on areas of concern, the number of collisions, Critical Crash Rate, and probability of specific crash types exceeding threshold proportion. Detailed collision data summaries, benefit/cost analysis sheets with cost estimate, and collision stick diagrams for each project can be found in **Appendices E-G**.

The 20 project locations – shown in **Figure 15** – were specifically chosen to represent a variety of intersection and roadway contexts seen throughout the City of Sunnyvale rather than strictly identifying the 20 locations with the highest collision occurrences or priority. Candidate treatments at some locations represent cost-effective "quick-build" solutions which may increase competitiveness of grant applications and allow for more rapid implementation of interim solutions.

To aid in the evaluation and preparation of potential HSIP grant applications, each project is accompanied by a cost estimate, benefit/cost ratio, and planning graphics that illustrate the proposed improvements. By developing an array of representative projects as part of the Roadway Safety Plan, the City will be equipped with a number of templates which can potentially be applied as part of other future projects or grant applications that are contextually similar to those included here. Additional information about the HSIP program, specifically, is included in the subsequent section.

This chapter also includes additional funding sources that can be used to finance safety projects around the City. This list includes regional, state, and federal funding programs, along with a description of each of the funding source's purpose.

Figure 15 Project Locations



Signalized Intersections	
A	Cezanne Drive & El Camino Real
B	Fair Oaks Avenue & Maude Avenue
C	Wolfe Road & Arques Avenue
D	Fair Oaks Avenue & Olive Avenue
E	Wolfe Road & Kifer Road
F	Caribbean Drive & Moffett Park Drive
G	Danforth Drive & Hollenbeck Avenue
H	Wolfe Road & Central WB off-ramp
Unsignalized Intersections	
I	Mary Avenue & Olive Avenue
J	Fremont Avenue & Eleanor Way
K	Fair Oaks Avenue & Taylor Avenue
L	Bernardo Avenue & Ayala Drive
M	Evelyn Avenue & Murphy Avenue
N	Evelyn Avenue & Pastoria Avenue
Roadway Segments	
O	Fremont Avenue from Sunnyvale Saratoga to Bobwhite / Manet
P	Arques Avenue from Wolfe to Lawrence Expressway
Q	Sunnyvale Saratoga Road from El Camino Real to Mathilda Avenue
R	Reed Avenue from Wolfe to Evelyn
S	Sandia Avenue from Lawrence Expressway to Wildwood
T	Hollenbeck Avenue from Bend to The Dalles

4.1 HSIP GRANT PROGRAM

The HSIP program in California funds local highway safety improvement projects. Normally an HSIP call-for-projects is made every one-to-two years, with HSIP Cycle 10 having been announced in May 2020 for submission of applications by September 4, 2020. It is recommended that applications be submitted early, and Caltrans Division of Local Assistance (DLA) may be available to assist with evaluation of early applications to ensure they are compliant with requirements.

Cycle 10 includes an estimated $220 million in available funding, segregated into several categories. While $178 million in funding is available for any safety improvements through Benefit Cost Ratio (BCR) applications, funding set-asides for guardrail upgrades, pedestrian crossing enhancements, installation of edgelines, and projects undertaken by federally recognized tribes are also available. The funding set-aside options do not require the application of BCR analysis. **Table 6** outlines the application categories for HSIP Cycle 10.

Table 6 - Summary of Application Categories for HSIP Cycle 10

Application Category	Description	Max Number of Application per Agency	Max Amount per Agency
Benefit Cost Ratio (BCR)	Benefit Cost Ratio (BCR)	No Limit	$10 million
Funding Set-asides (SA)	Guardrail Upgrades	1	$1 million
	Pedestrian Crossing Enhancements	1	$250,000
	Installing Edgelines	1	$250,000
	Tribes	1	$250,000

The HSIP grant program primarily relies upon BCR analysis to evaluate and rank project selections, and this analysis is based upon the most recently available 3-5 years of historical crash data as entered into the Caltrans HSIP Analyzer worksheet. As a result, HSIP applications require sufficient crash history at a project location to justify the proposed safety improvements. A systemic approach to developing HSIP applications would allow the City to group together multiple locations which have similar characteristics and require similar countermeasures, aggregating the benefits and costs for those locations. Combining one location which has experienced many collisions with another contextually similar location which has experienced fewer collisions may make it possible for both to be improved through the HSIP program if the resulting aggregate BCR is sufficient for selection.

Because of this, Caltrans will allow agencies to submit the same location in multiple applications for Cycle 10 if it is being done as part of systemic approach. If an intersection with a history of many collisions is submitted as a standalone project, it could also be included in two other applications including differing numbers of contextually similar locations. Ultimately, the application serving the largest number of locations that is above the BCR cutoff will be selected for funding. For example, if the standalone intersection has a BCR of 13.5 and the other two applications result in BCRs of 9.4 for two intersections and 6.7 for three intersections, Caltrans would fund the project consisting of two intersections with a BCR of 9.4 if its BCR threshold is determined to be 7.5.

Unlike previous HSIP calls-for-projects, Cycle 10 allows countermeasures from one category – Signalized Intersections (S), Nonsignalized Intersections (NS), or Roadways (R) – to be used in a single HSIP Analyzer worksheet for project applications. If a safety corridor improvement includes multiple contexts, one application may have multiple HSIP Analyzer worksheets attached. In this event, the overall project BCR is calculated manually from the sum of the benefits and costs. Alternately, different locations can be submitted as individual projects rather than combined into a single project if the safety countermeasures proposed are dissimilar. Note that the minimum funding threshold for a project is $100,000 for HSIP Cycle 10, so similar smaller projects may need to be combined to qualify for funding.

Project applications involving state highways are generally expected to be Caltrans-initiated in HSIP Cycle 10, though Local HSIP may be used to fund projects on the state highway system where the state highway acts as the "main street" for the local agency. If a local agency seeks HSIP funding on the state highway system, the application is required to include a letter of support from Caltrans District Traffic Operations. Regardless of the applicant, intersection improvements on the state highway system require completion of an Intersection Control Evaluation (ICE) and a cost sharing agreement with Caltrans.

Local agencies are ineligible to receive HSIP funds in Cycle 10 if they have existing HSIP projects red-flagged for not meeting delivery requirements on past HSIP projects as of September 30, 2020 and/or have more than one existing HSIP project that has not entered the construction phase within five years of project selection as of September 30, 2020. Agencies are encouraged to coordinate with the appropriate DLA Engineer if they have questions about eligibility.

4.2 PROJECT DEVELOPMENT

In addition to the quantitative and geographic data analyzed as part of this project, a combination of in-person and virtual (remote using satellite, aerial, and virtual photograph imagery from sources such as Google and Bing) investigations were conducted to better understand existing conditions, constraints, opportunities, and needs at each representative project location. The combination of data analysis and site investigations were utilized to identify issues and candidate treatments.

Outreach to stakeholders and the public was performed to collect and understand local safety issues from a qualitative perspective. Technical Advisory Group meetings were held March 26, 2019 and December 11, 2019 and community workshops were hosted on April 22, 2019 and January 22, 2020 to solicit feedback on candidate countermeasures, identify locations of stakeholder interest, and ultimately share the 20 potential safety improvements at the 20 project locations. A summary of the findings from community outreach events can be found in **Appendix D**.

Unit construction costs are based on the most recent available estimates for public agency projects in the Bay Area. Environmental cost is assumed to be an additional cost equal to 10% of total construction costs. PS&E cost is assumed to be an additional cost equal to 15% of total construction costs. Construction management/engineering cost is assumed to be an additional cost equal to 10% of total construction costs. Note that the HSIP Analyzer worksheet allows the combination of environmental and PS&E costs to represent a maximum of 25% of the construction cost.

In 2019, the City adopted the Green Stormwater Infrastructure Plan, which aims to gradually transform the City's traditional storm drainage infrastructure to green stormwater infrastructure. Green stormwater infrastructure, such as bioretention rain gardens and pervious pavement, helps to reduce pollutants discharged in stormwater to local waterways. Integrating green stormwater components into pedestrian facilities, such as curb extensions, can improve pedestrian safety and create more appealing walking routes.

"Green Streets," or streets that use a holistic stormwater management approach, have benefits beyond improving stormwater quality and reducing runoff. Green streets can provide shade and enhanced air quality improvements through an increased tree canopy, incorporate protected bicycle lanes buffered by vegetative features, and overall improve the beauty of a neighborhood with more plantings. The City will evaluate opportunities to integrate green streets and green stormwater infrastructure as part of the roadway recommendations.

4.3 PRIORITIZATION OF REPRESENTATIVE PROJECTS

Each of the 20 representative projects were evaluated to develop a list of the locations that are most likely to benefit from cost-effective countermeasures. Based upon guidance from the LRSM, the project prioritization focused primarily on upon benefit/cost ratio – a critical metric for HSIP applications – while also taking into account collision activity, opportunities for systemic applications, and potential challenges to implementation. Table 7 shows the prioritization of the representative projects, with the projects described in greater detail in the subsequent layout cutsheets. Alternate project prioritization lists sorted by total number of collisions and number of KSI collisions can be found in **Appendix E**.

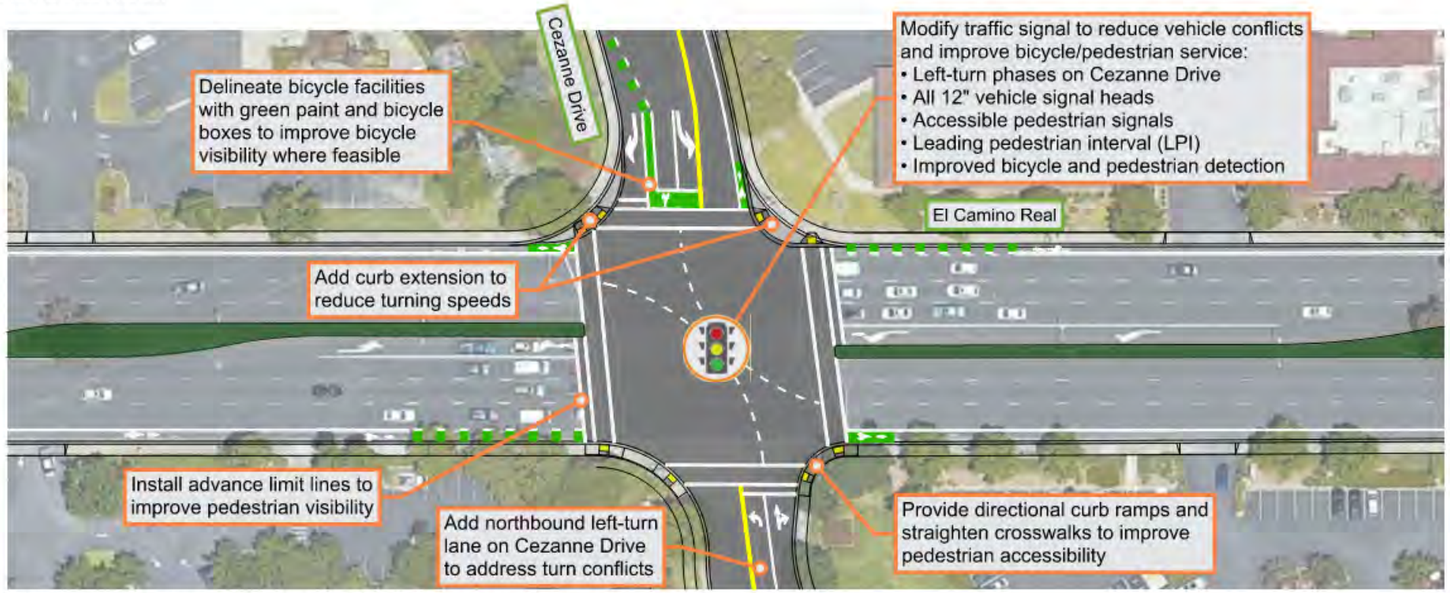
Table 7 - HSIP Prioritization of Representative Projects by Benefit/Cost Ratio

Loc	Project Segment / Intersection	Location Type	Total Project Cost (2020 Dollars)	B/C Ratio	Total Crashes	Fatal	Severe Injury	Notes
K	Fair Oaks Avenue & Taylor Avenue	Unsignalized	$20,100	234.98	15	0	1	Project falls below minimum funding cost, is a potential candidate for a systemic approach combined with similar locations.
N	Evelyn Avenue and Pastoria Avenue	Unsignalized	$49,100	53.94	5	1	1	Project falls below minimum funding cost, is a potential candidate for a systemic approach combined with similar locations.
L	Bernardo Avenue & Ayala Drive	Unsignalized	$66,700	42.37	17	0	2	Project falls below minimum funding cost, is a potential candidate for a systemic approach combined with similar locations if City pilots two all-way stop protected intersections.
A	Cezanne Drive & El Camino Real	Signalized	$460,700	39.39	39	1	2	May not be eligible for City lead in Cycle 10, may better fit for other grant programs or coordination with Caltrans for State lead.
T	Hollenbeck Avenue from Bend to The Dalles	Residential Collector	$136,600	16.11	12	0	1	HSIP Cycle 10 requirements may not accommodate a corridor this short being included with the signal improvements.
O	Fremont Avenue from Sunnyvale Saratoga to Bobwhite / Manet	Class II Arterial	$696,000	14.69	82	1	2	HSIP Cycle 10 may require applying for both signalized intersections separately.
M	Evelyn Avenue & Murphy Avenue	Unsignalized	$157,800	8.61	14	0	0	Potential HSIP Cycle 10 candidate location.
D	Fair Oaks Avenue & Olive Avenue	Signalized	$310,800	8.37	23	0	1	Potential HSIP Cycle 10 candidate location.
HSIP Cycle 9 Selection Threshold B/C = 7.5								
J	Fremont Avenue & Eleanor Way	Unsignalized	$111,600	7.21	10	0	0	HSIP Cycle 10 may not allow combination of quick-build intersection treatment and sidewalk gap closure on one application.
P	Arques Avenue from Wolfe to Lawrence Expressway	Class II Arterial	$880,200	6.93	35	0	2	City should pursue only if confident in moving forward with median/left-turn elimination.

Loc	Project Segment / Intersection	Location Type	Total Project Cost (2020 Dollars)	B/C Ratio	Total Crashes	Fatal	Severe Injury	Notes
E	Wolfe Road & Kifer Road	Signalized	$466,900	6.26	22	0	1	Potential HSIP Cycle 10 candidate location for quick-build protected intersection pilot.
C	Wolfe Road & Arques Avenue	Signalized	$391,500	5.22	32	0	2	Project may be better candidate to include as an element in a larger corridor improvement.
B	Fair Oaks Avenue & Maude Avenue	Signalized	$184,400	5.21	25	1	0	May be feasible to revisit project with reduced cost and improve B/C Ratio.
I	Mary Avenue & Olive Avenue	Unsignalized	$882,600	5.06	26	0	1	May not be able to demonstrate Section A of Warrant 7 or meet Warrants 4/5 for signalization per HSIP Cycle 10 requirements.
S	Sandia Avenue from Lawrence Expressway to Wildwood	Residential Collector	$376,100	4.30	27	0	0	Project will be more competitive for HSIP if it does not include curb extensions at all locations.
G	Hollenbeck Avenue & Danforth Drive	Signalized	$259,200	4.15	10	0	1	B/C Ratio could be improved with addition of pedestrian scramble phase. Location included 2 pedestrian collisions out of 10 total and is adjacent to a school.
HSIP Cycle 10 Application Threshold B/C = 3.5								
Q	Sunnyvale Saratoga Road from El Camino Real to Mathilda Avenue	Class II Arterial	$146,000	2.58	8	0	0	Project is a better candidate for local funds or applications less focused on B/C driven by collision severity, particularly with inclusion of new midblock crossing.
H	Wolfe Road and Central WB off-ramp	Signalized	$143,600	1.70	13	0	0	Project may be better candidate to include as an element in a larger corridor improvement.
R	Reed Avenue from Wolfe to Evelyn	Residential Collector	$1,459,900	0.86	56	0	0	Project is a better candidate for local funds or applications less focused on B/C driven by collision severity.
F	Caribbean Drive & Moffett Park Drive	Signalized	N/A	N/A	16	0	1	Regional project, likely to be led by VTA or Caltrans rather than City.

A El Camino Real & Cezanne Drive

El Camino Real is six lanes with left-turn lanes at this intersection, while Cezanne Drive has one travel lane in each direction with left- and right-turn lanes only in the southbound direction at El Camino Real. There were 39 collisions at the project intersection between during the five-year study period, including three severe injury/fatal collisions. Collisions along El Camino Real often involved speed as a contributing factor. Other notable collision patterns have included rear ends, pedestrian- or bicyclist-involved collisions, and broadside/left-turn collisions. The project area is served by VTA Bus Routes 22 and Rapid 522, and major nearby destinations include multiple retail centers, food services, medical facilities, and Helios School.



Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	28
Bicycle	2
Pedestrian	9

Notable Collision Types

Rear End 11

Aggressive 10

Pedestrian 9

Dark 8

Broadside 7

Project Description

- Modify traffic signal to provide left-turn phases for all approaches, upgrade to all 12" signal heads, and implement LPI with enhanced bicycle and pedestrian detection
- Modify striping to provide northbound left-turn lane and enhanced bicycle pavement markings
- Add curb extensions to northeast and southeast corners, upgrade all curb ramps
- Cut back medians on El Camino Real to provide straightened crosswalks

Estimated Project Costs (2020 Dollars)

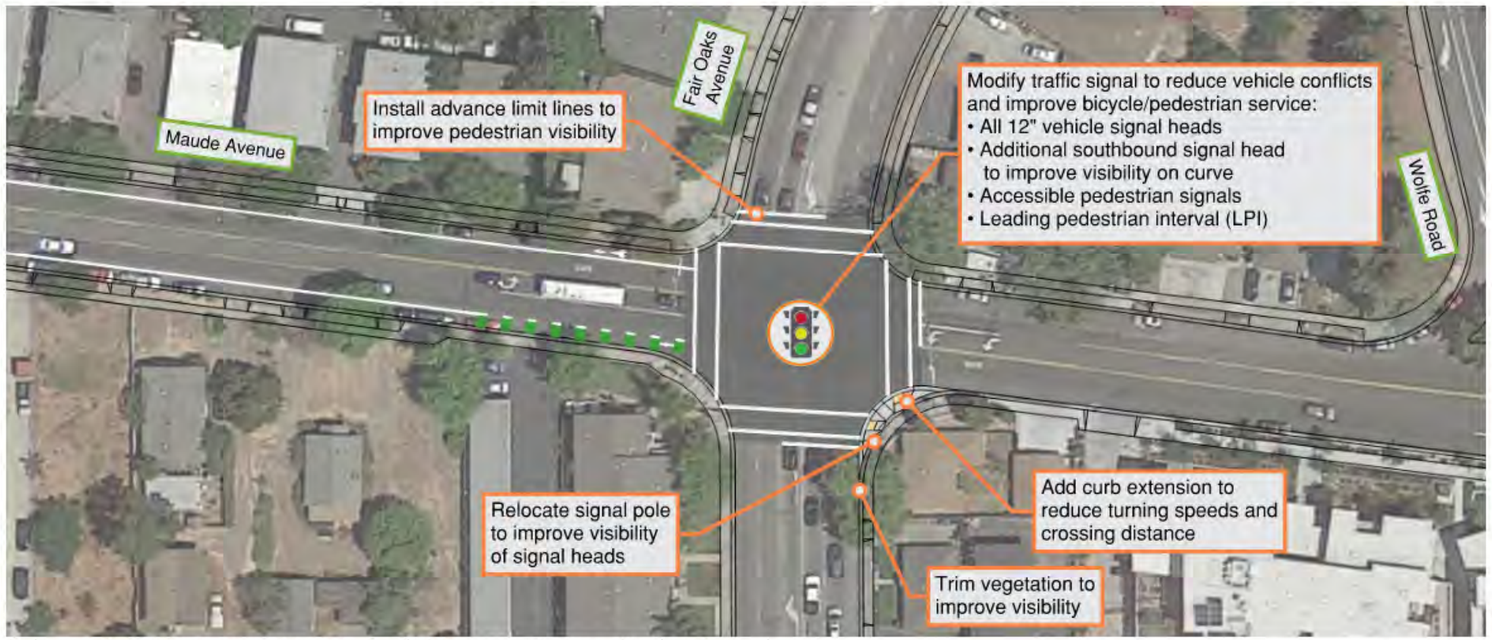
Traffic Signal Modification	$250,000
Civil Improvements	$60,100
Contingency	$62,920
Total Construction Cost (rounded)	$372,200
Environmental	$25,300
PS&E	$37,900
Construction Engineering	$25,300
Total Project Cost	**$460,700**

Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
S02: Improve signal hardware	0.15 (All)
S06: Install left-turn lane and add turn phase	0.55 (All)
S21PB: Modify signal phasing to implement LPI	0.6 (Ped & Bike)
Total Expected Benefit	$18,147,430
Maximum Federal Reimbursement	90%
Project Benefit/Cost Ratio	**39.39**

B Fair Oaks Avenue & Maude Avenue

Fair Oaks Avenue at this intersection is four lanes with left-turn lanes in both directions and nearby on-street parking in the northbound direction. Maude Avenue has one travel in each direction with left-turn lanes and on-street parking in both directions. There were 25 collisions in the area near the intersection during the study period, including one fatal collision. Notable collision patterns were broadside/left-turn collisions, rear ends, and collisions occurring at dark. The project area is served by VTA Bus Routes 55 and 56, and major nearby destinations include Fair Oaks Park and The King's Academy.



Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	25
Bicycle	0
Pedestrian	0

Notable Collision Types

Aggressive	8	Broadside	8	Dark	8

Rear End 8

Project Description

- Modify traffic signal to provide an additional southbound signal head, upgrade to all 12" signal heads, and implement LPI with enhanced bicycle and pedestrian detection
- Relocate Type 1 pole and trim vegetation in southeast corner to improve visibility
- Add curb extension and upgrade curb ramps in southeast corner to reduce turning speeds
- Install advance limit lines

Estimated Project Costs (2020 Dollars)

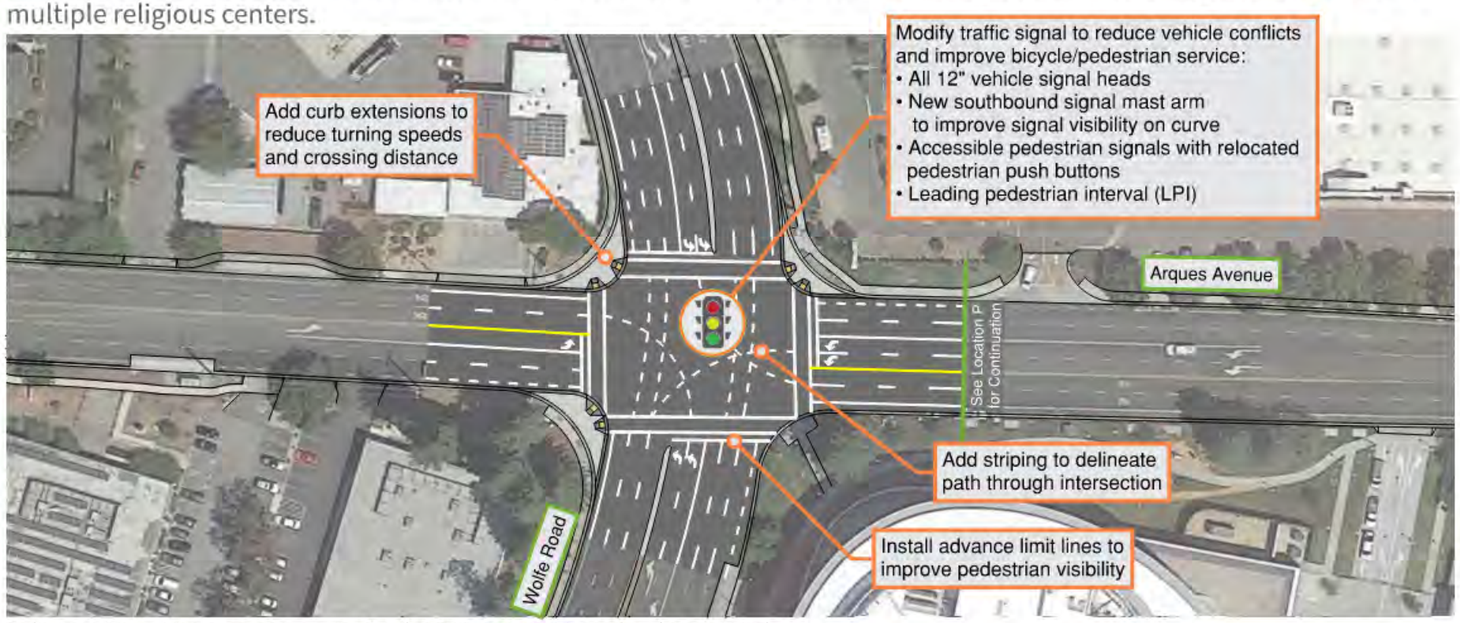
Traffic Signal Modification	$75,000
Civil Improvements	$16,520
Contingency	$18,300
Total Construction Cost (rounded)	$109,900
Environmental	$11,000
PS&E	$16,500
Construction Engineering	$11,000
Total Project Cost	**$148,400**

Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
S02: Improve signal hardware	0.15 (All)
S20PB: Install advance stop bar before crosswalk	0.15 (Ped & Bike)
S21PB: Modify signal phasing to implement LPI	0.6 (Ped & Bike)
Total Expected Benefit	$773,700
Maximum Federal Reimbursement	100%
Project Benefit/Cost Ratio	**5.21**

C Wolfe Road & Arques Avenue

Wolfe Road at this intersection is six lanes with dual left-turn lanes and bicycle lanes in both directions. Arques Avenue is four lanes with bicycle lanes, dual westbound left-turn lanes, and a single eastbound left-turn lane. The intersection is located in a curve along Wolfe Road, hindering sight distance for some movements. There were 32 collisions at the intersection during the study period, including two severe injury collisions. Notable collision patterns were broadside/left-turn collisions, sideswipes, rear ends, and influence of drugs or alcohol. The project area is served by VTA Bus Route 20 as well as ACE and Caltrain Shuttles. Major nearby destinations include retail centers, food services, major office parks, and multiple religious centers.



Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	30
Bicycle	1
Pedestrian	1

Notable Collision Types

Broadside	10	Sideswipe	8	Impaired	6
Rear End	6				

Project Description

- Modify traffic signal to provide a new mast arm for southbound Wolfe Road, upgrade to all 12" signal heads, and implement LPI with enhanced bicycle and pedestrian detection
- Provide striping through intersection to delineate vehicle paths
- Add curb extensions and upgrade curbs ramps in northeast, northwest, and southeast corners
- Install advance limit lines

Estimated Project Costs (2020 Dollars)

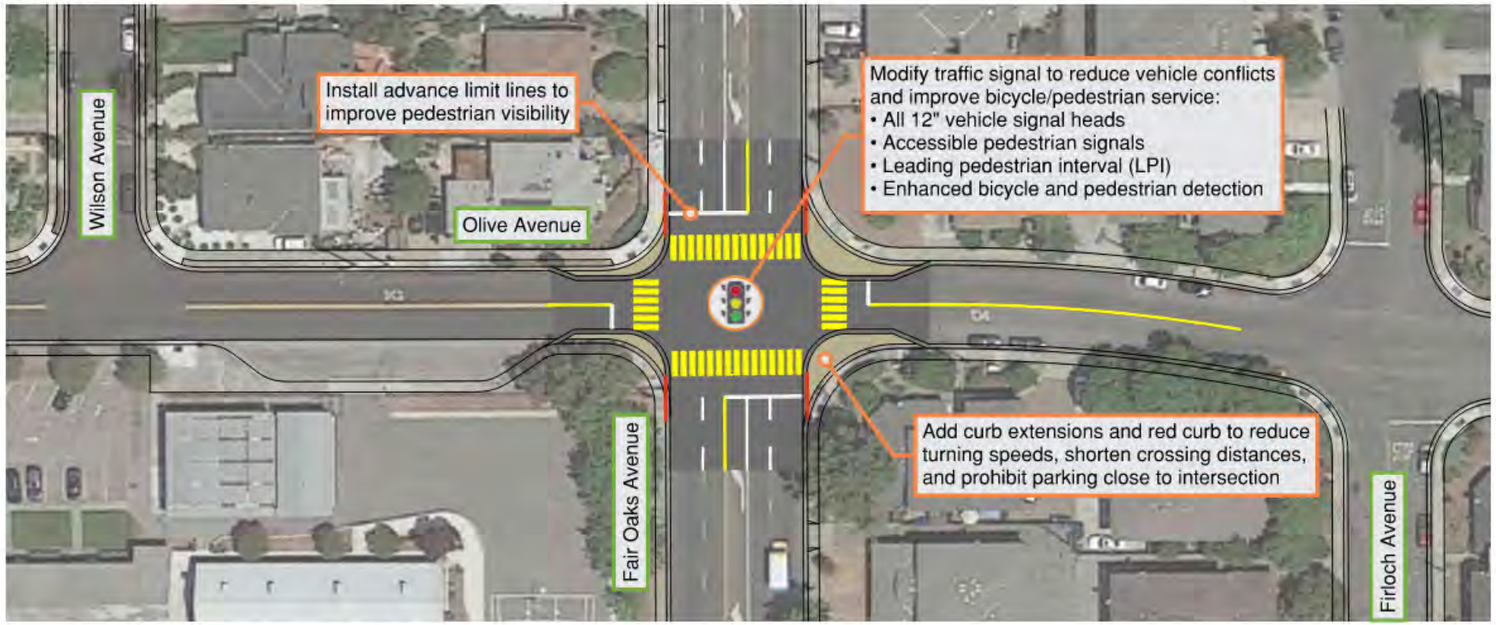
Traffic Signal Modification	$175,000
Civil Improvements	$66,650
Contingency	$48,330
Total Construction Cost (rounded)	$290,000
Environmental	$29,000
PS&E	$43,500
Construction Engineering	$29,000
Total Project Cost	**$391,500**

Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
S02: Improve signal hardware	0.15 (All)
S09: Install pavement markers through intersection	0.1 (All)
S21PB: Modify signal phasing to implement LPI	0.6 (Ped & Bike)
Total Expected Benefit	$2,042,350
Maximum Federal Reimbursement	100%
Project Benefit/Cost Ratio	**5.22**

D Fair Oaks Avenue & Olive Avenue

Fair Oaks Avenue at this intersection is four lanes with left-turn lanes and nearby on-street parking in both directions. Olive Avenue has one travel in each direction with a westbound right-turn lane and on-street parking in both directions east of Fair Oaks Avenue. There were 23 collisions in the area near the intersection during the study period, including one severe injury collision. Notable collision patterns were rear ends, sideswipes, pedestrian-involved collisions, collisions with parked vehicles, and influence of drugs or alcohol. Speed was often cited as a contributing factor in collisions. The project area is served by VTA Bus Route 56, and major nearby destinations Ellis Elementary School, Helios School, and multiple religious centers.



Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	21
Bicycle	0
Pedestrian	2

Notable Collision Types

Rear End 8

Impaired 7

Sideswipe 7

Project Description

- Modify traffic signal to upgrade to all 12" signal heads and implement LPI with enhanced bicycle and pedestrian signal infrastructure
- Add curb extensions with red curb and upgrade curbs ramps on all intersection corners
- Install advance limit lines

Estimated Project Costs (2020 Dollars)

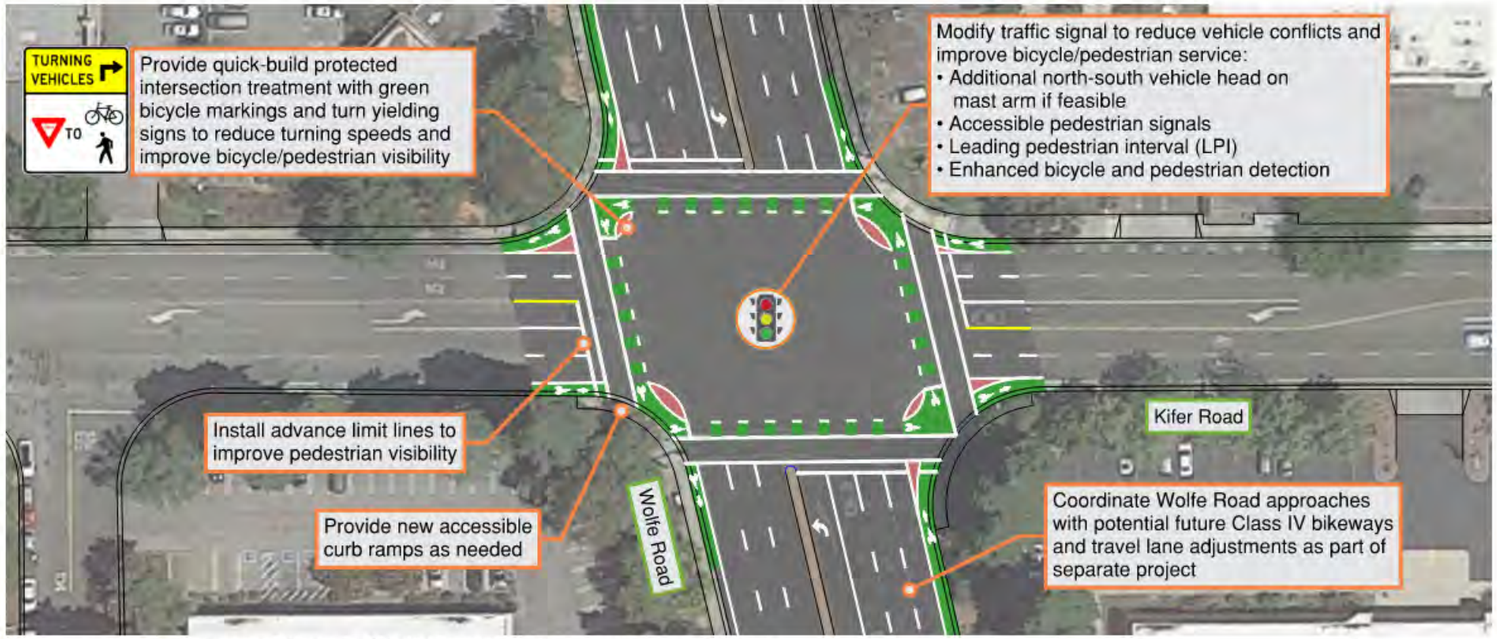
Traffic Signal Modification	$125,000
Civil Improvements	$66,800
Contingency	$38,350
Total Construction Cost (rounded)	$230,200
Environmental	$23,000
PS&E	$34,600
Construction Engineering	$23,000
Total Project Cost	**$310,800**

Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
S02: Improve signal hardware	0.15 (All)
S20PB: Install advance stop bar before crosswalk	0.15 (Ped & Bike)
S21PB: Modify signal phasing to implement LPI	0.6 (Ped & Bike)
Total Expected Benefit	$2,601,770
Maximum Federal Reimbursement	100%
Project Benefit/Cost Ratio	**8.37**

E Wolfe Road & Kifer Road

Wolfe Road at this intersection is six lanes with left-turn lanes and bicycle lanes in both directions. Kifer Road is four lanes and has left-turn lanes and bicycle lanes in both directions. There were 22 collisions at the intersection during the study period, including one severe injury collision. Notable collision patterns were rear end, broadside/left-turn, and bicycle-involved collisions. Speed was often cited as a contributing factor in collisions. The project area is served by the ACE Shuttle, and major nearby destinations include food services, light industrial uses, and office parks.



Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	18
Bicycle	4
Pedestrian	0

Notable Collision Types

Rear End 9

Aggressive 8

Broadside 7

Bike 4

Project Description

- Modify traffic signal to provide additional north-south mast-arm heads, upgrade to all 12" signal heads, and implement LPI with enhanced bicycle and pedestrian detection
- Modify striping to provide quick-build protected intersection treatment with delineators
- Upgrade curb ramps in southwest corner
- Cut back medians on Wolfe Road to provide straightened crosswalks

Estimated Project Costs (2020 Dollars)

Traffic Signal Modification	$200,000
Civil Improvements	$88,125
Contingency	$57,625
Total Construction Cost (rounded)	$345,800
Environmental	$34,600
PS&E	$51,900
Construction Engineering	$34,600
Total Project Cost	**$466,900**

Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
S02: Improve signal hardware	0.15 (All)
S20PB: Install advance stop bar before crosswalk	0.15 (Ped & Bike)
S21PB: Modify signal phasing to implement LPI	0.6 (Ped & Bike)
Total Expected Benefit	$2,923,750
Maximum Federal Reimbursement	100%
Project Benefit/Cost Ratio	**6.26**

F Caribbean Drive & Moffett Park Drive

Caribbean Drive is a six-lane arterial with auxiliary turn lanes at major intersections and a speed limit of 45 mph. Bicycle lanes are provided north of Moffett Park Drive, but are not provided through the SR 237 interchange to the south and do not continue on Lawrence Expressway.

Moffett Park Drive has one travel lane in each direction, and the Baylands Park driveway opposite Moffett Park Drive also includes a westbound right-turn lane. Yield-control channelized right turns are provided on the southbound and eastbound approaches at the signalized intersection of Caribbean Drive with Moffett Park Drive. Weekday commute-hour bus service is provided on Caribbean Drive connecting with the major office parks located in the project area. Baylands Park and Twin Creeks also serve as major destinations in the area, and a multi-use trail is planned along Caribbean Drive to the north.

There were 16 collisions in the immediate vicinity of the project intersection between during the five-year study period, including one severe injury collision. Notable collision patterns have included rear ends, sideswipes, and collisions at dark. Speed or influence of drugs or alcohol were often cited as a contributing factor. A large share of the rear end and sideswipe collisions are related to drivers maneuvering between ramps at the adjacent SR 237 interchange and desired travel lanes on northbound Caribbean Drive at Moffett Park Drive. As such, this project is intended to present alternatives for safety improvements to both the Moffett Park intersection and SR 237 interchange. Alternative A represents a typical interchange alignment with traffic signals, while Alternative B is a diverging diamond interchange that can enhance vehicular travel efficiency to/from interchange ramps.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	16
Bicycle	0
Pedestrian	0

Notable Collision Types


Impaired 5


Dark 5


Rear End 4


Sidewipe 4

Project Description

- Modify the SR 237 interchange with Caribbean Drive/Lawrence Estimated
- Expressway to address collisions resulting from weaving and shifting movements
- Provide continuous bicycle and pedestrian facilities along Caribbean Drive/Lawrence Expressway across SR 237
- Modify the intersection of Caribbean Drive & Moffett Park Drive/Baylands Park to remove right-turn pork-chip islands, add left-turn signal phases for all movements, and include bicycle and pedestrian accommodations
- In Alternative B, construct a diverging diamond interchange (DDI) to improve vehicular travel efficiency for movements to/from the SR 237 freeway

Estimated Project Costs (2020 Dollars)

Total Project Cost: $50-$100 million

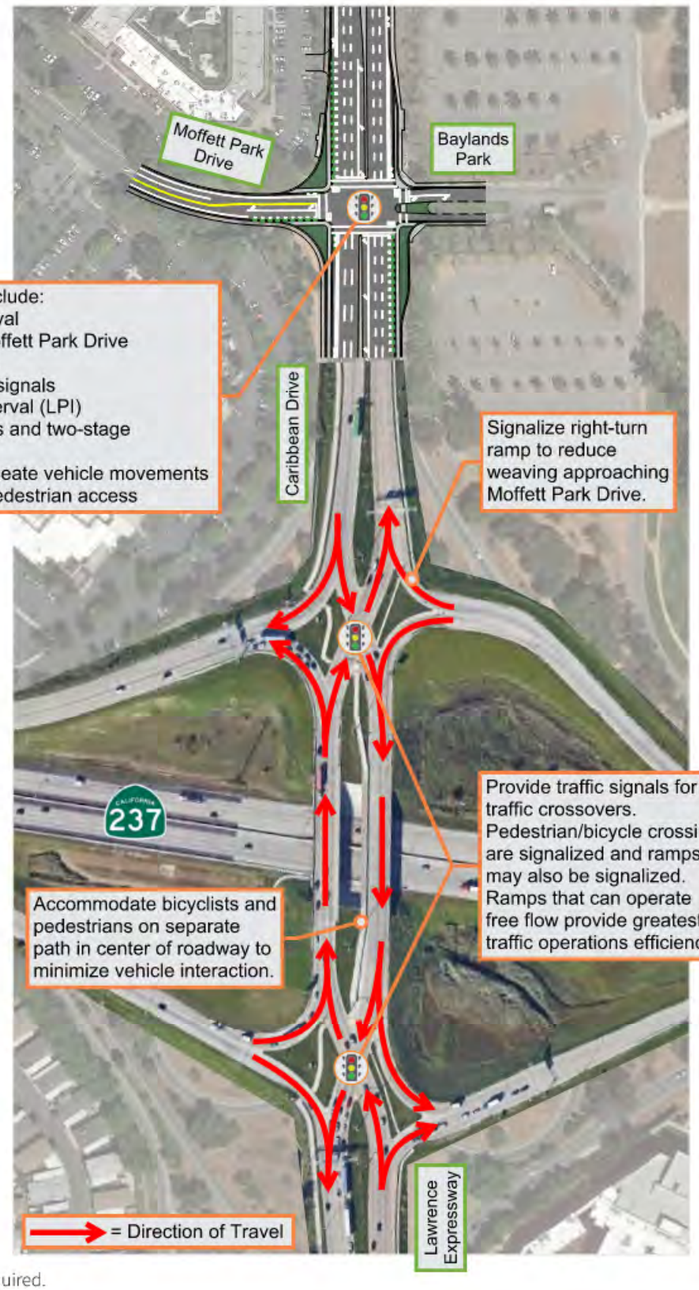
Total project costs will be dependent upon factors including:

- Selected interchange improvement alternative
- Feasibility of maintaining existing overpass structure
- Potential need for separate active transportation structure
- Right-of-way and environmental investigation

This project would require collaboration with partner agencies such as Caltrans, Santa Clara County Roads and Airport Department, and Santa Clara Valley Transportation Authority (VTA).

Alternative A

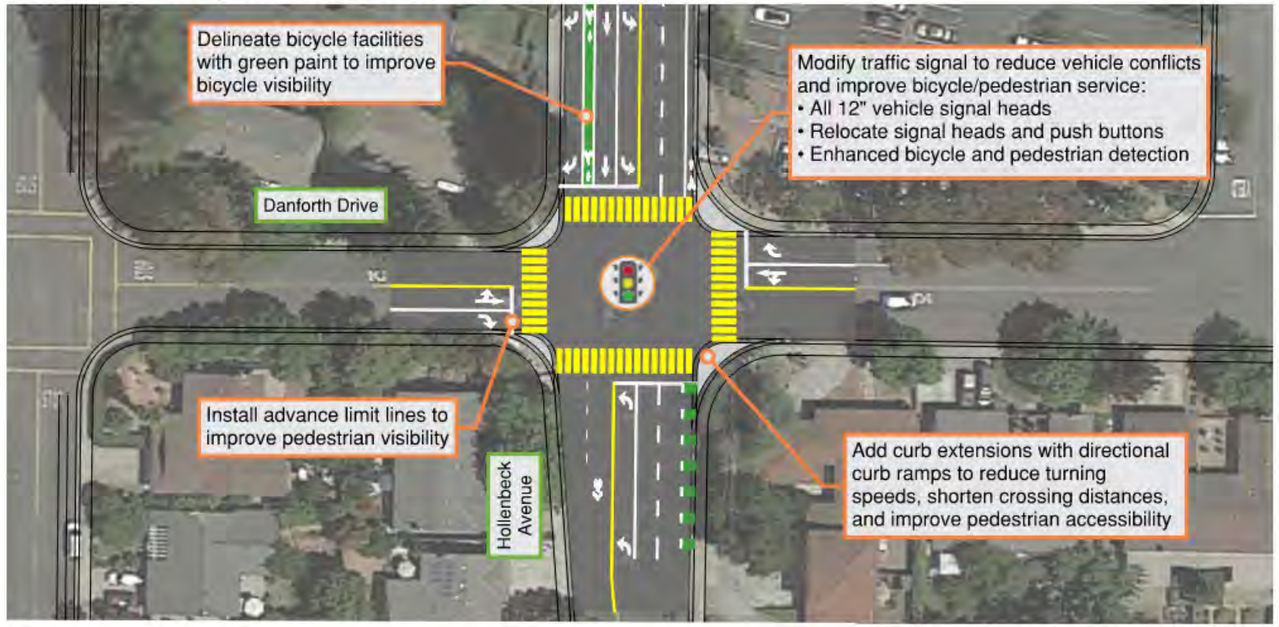
Alternative B



Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

G Hollenbeck Avenue & Danforth Drive

Hollenbeck Avenue transitions from a four-lane roadway with turn lanes and bicycle lanes north of Danforth Drive to a two-lane roadway with on-street parking south of the intersection. Danforth Drive is generally a two-lane roadway with on-street parking and few pavement markings, though right-turn lanes are provided in both directions at Hollenbeck Avenue. There were 10 collisions at the project intersection during the five-year study period, including one severe injury collision. Notable collision patterns have included pedestrian-involved collisions, rear ends, and sideswipes. Speed or influence of drugs or alcohol were often cited as a contributing factor. Major nearby destinations include retail centers, Las Palmas Park, and Cumberland Elementary School. The project area does not currently see any direct transit service, though by VTA Bus Routes 22 and Rapid 522 utilize El Camino Real to the north.



Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	8
Bicycle	0
Pedestrian	2

Notable Collision Types

Impaired	3	Aggressive	2	Pedestrian	2
Rear End	2	Sideswipe	2		

Project Description

- Modify traffic signal to upgrade to all 12" signal heads, relocate signal heads and push buttons, and provide with enhanced bicycle and pedestrian detection
- Add curb extensions with red curb and upgrade curbs ramps on all intersection corners
- Install advance limit lines
- Delineate approaching bicycle facilities with green paint

Estimated Project Costs (2020 Dollars)

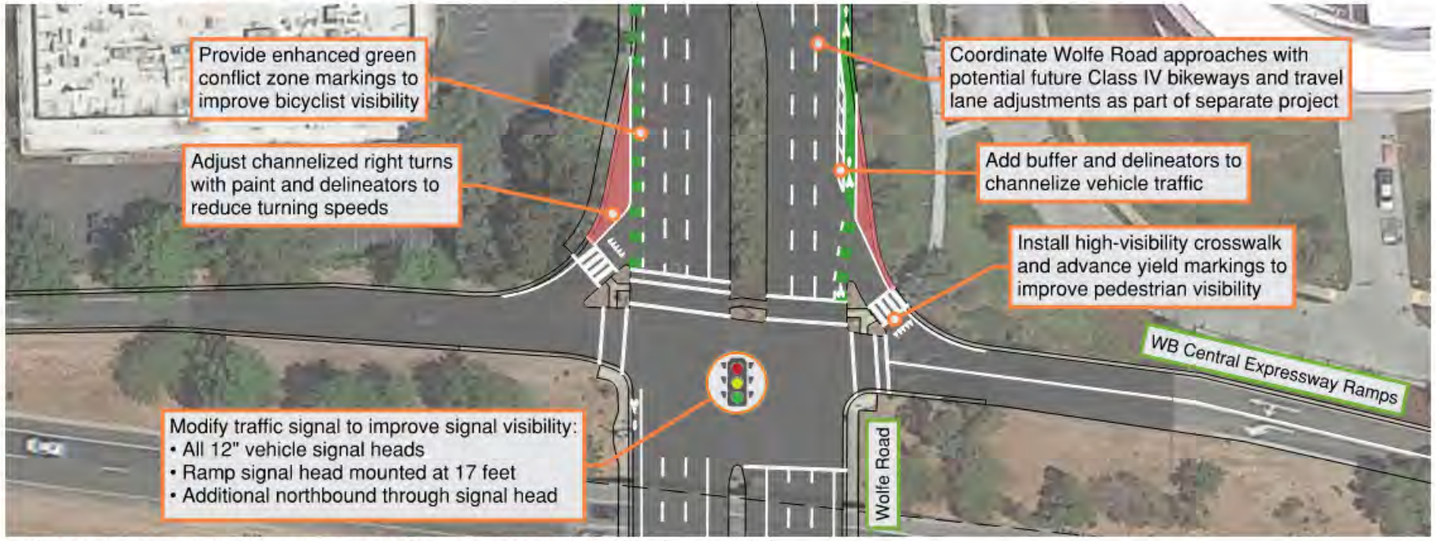
Traffic Signal Modification	$100,000
Civil Improvements	$59,960
Contingency	$32,000
Total Construction Cost (rounded)	$192,000
Environmental	$19,200
PS&E	$28,800
Construction Engineering	$19,200
Total Project Cost	**$259,200**

Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
S02: Improve signal hardware	0.15 (All)
S20PB: Install advance stop bar before crosswalk	0.15 (Ped & Bike)
Total Expected Benefit	$1,074,500
Maximum Federal Reimbursement	100%
Project Benefit/Cost Ratio	**4.15**

H Wolfe Road & WB Central Expressway Ramps

Wolfe Road at this location has three northbound through lanes with a left-turn lane, four southbound through lanes with a channelized right turn, and bicycle lanes in both directions. Central Expressway passes over Wolfe Road, and the westbound ramp provides one dedicated left-turn lane and one lane that can be used for all movements with a channelized right turn. The intersection is located less than 250 feet north of the EB Central Expressway Ramps and is directly adjacent to the bridge overhead, somewhat limiting visibility. There were 13 collisions at the intersection during the study period, none of which involved a severe injury or fatality. Notable collision patterns were broadside/left-turn collisions and rear ends, while speed or influence of drugs or alcohol were often cited as a contributing factor. The project area is served by ACE and Caltrain Shuttles, with VTA Bus Route 20 utilizing Arques Avenue to the north. Major nearby destinations include food services, light industrial uses, and office parks.



Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	13
Bicycle	0
Pedestrian	0

Notable Collision Types

Broadside	5	Rear End	5	Aggressive	4
Impaired	4				

Project Description

- Modify traffic signal to provide all 12" signal heads and additional northbound/westbound signal heads
- Adjust right-turn paths with quick-build pavement markings and delineators
- Install high-visibility crosswalks and advance yield markings for right turns
- Install advance limit lines
- Adjust signal timing and coordination with adjacent intersections

Estimated Project Costs (2020 Dollars)

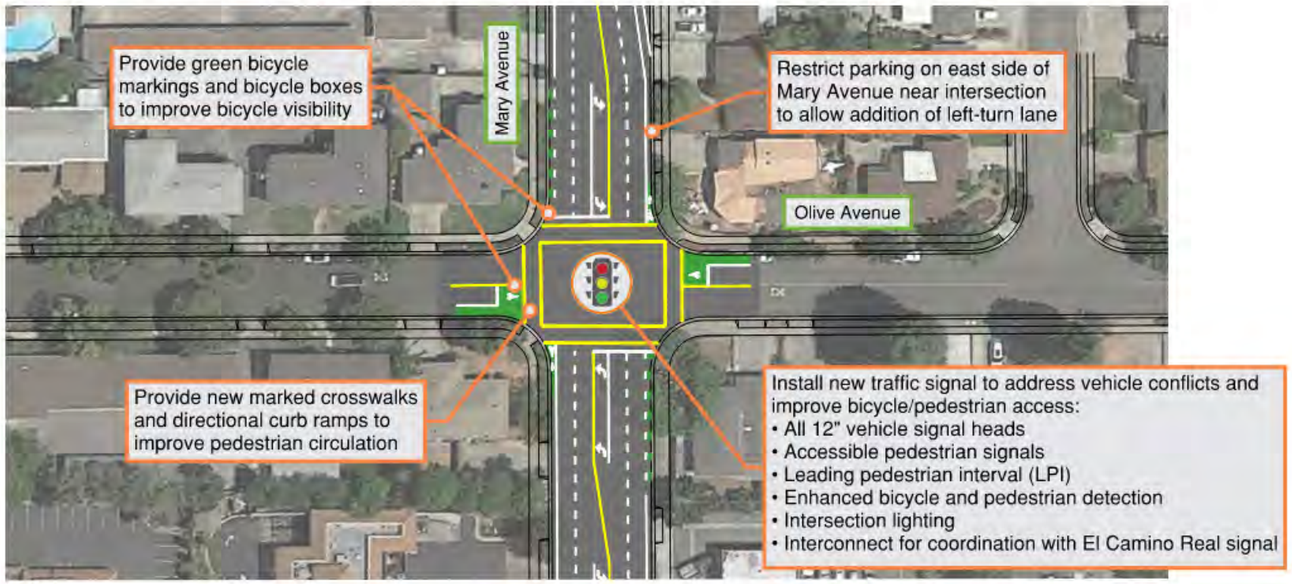
Traffic Signal Modification	$75,000
Civil Improvements	$13,420
Contingency	$17,680
Total Construction Cost (rounded)	$106,200
Environmental	$10,700
PS&E	$16,000
Construction Engineering	$10,700
Total Project Cost	**$143,600**

Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
S02: Improve signal hardware	0.15 (All)
S03: Improve signal timing	0.15 (All)
S20PB: Install advance stop bar before crosswalk	0.15 (Ped & Bike)
Total Expected Benefit	$242,600
Maximum Federal Reimbursement	50%
Project Benefit/Cost Ratio	**1.70**

1 Mary Avenue & Olive Avenue

Mary Avenue is four lanes with bicycle lanes in both directions, on-street parking in the northbound direction north of Olive Avenue, and a southbound left-turn lane for the El Camino Real intersection approximately 350 feet south of this location. Olive Avenue is a two-lane roadway with on-street parking in both directions and stop signs at Mary Avenue. There were 26 collisions at the intersection during the study period, including one severe injury collision. Notable collision patterns were broadside/left-turn collisions, which accounted for nearly 70% of the collisions during the study period, as well as bicycle-involved collisions and incidents occurring at dark. Major nearby destinations include multiple retail centers, food services, Sunnyvale Christian School, and Skywalk Bible Church. Olive Avenue also provides a connection to City of Sunnyvale civic uses to the east, including the Public Library and City Hall. The intersection does not currently see any direct transit service, though VTA Bus Routes 22 and Rapid 522 utilize El Camino Real to the south.



Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	23
Bicycle	2
Pedestrian	1

Notable Collision Types

Broadside	18	Dark	6	Bike	2

Impaired 2

Project Description

- Install new traffic signal with all 12" signal heads, intersection lighting, accessible pedestrian signals, LPI with enhanced bicycle and pedestrian detection, and interconnect/ coordination with signal at El Camino Real
- Provide new curb ramps and marked crosswalks for all pedestrian movements
- Enhance bicycle lane markings and provide bicycle boxes
- Restrict parking on Mary Avenue to facilitate addition of new left-turn lanes

Estimated Project Costs (2020 Dollars)

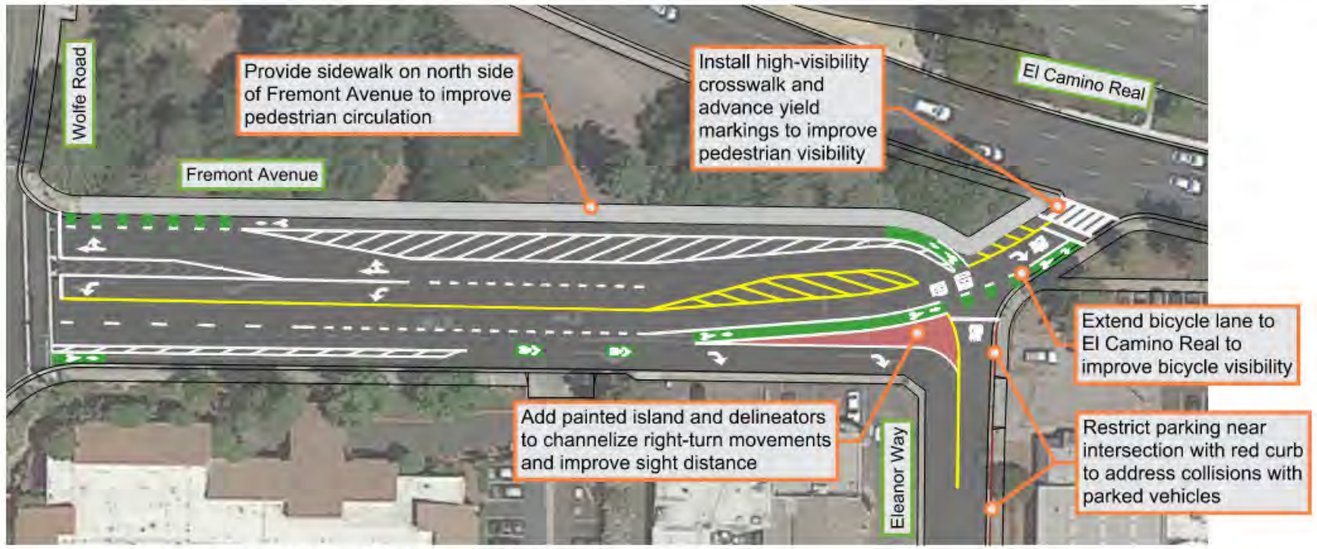
Traffic Signal Modification	$500,000
Civil Improvements	$44,720
Contingency	$108,950
Total Construction Cost (rounded)	$653,700
Environmental	$65,400
PS&E	$98,100
Construction Engineering	$65,400
Total Project Cost	**$882,600**

Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
NS03: Install signals	0.3 (All)
Total Expected Benefit	$4,467,250
Maximum Federal Reimbursement	100%
Project Benefit/Cost Ratio	**5.06**

J Fremont Avenue & Eleanor Way

Fremont Avenue transitions from a four-lane roadway with turn lanes west of Eleanor Way to a single lane providing eastbound-only access to El Camino Real east of Eleanor Way. An eastbound right-turn lane is provided at Eleanor Way. Eleanor Way has one travel in each direction with a stop sign at Fremont Avenue, on-street parking, and few pavement markings. There were 14 collisions in the area near the intersection during the five-year study period, none of which involved a severe injury or fatality. Notable collision patterns were rear ends and sideswipes concentrated on eastbound Fremont Avenue, pedestrian-involved collisions for pedestrians crossing Eleanor Way, collisions with parked vehicles, and influence of drugs or alcohol. The project area is served by VTA Bus Routes 22, 56, and Rapid 522, and major nearby destinations include retail centers, food services, Golfland USA, Sunken Gardens Golf Course, and Wild Palms Hotel.



Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	11
Bicycle	1
Pedestrian	2

Notable Collision Types

Dark 6

Rear End 5

Impaired 4

Sideswipe 4

Project Description

- Adjust vehicle paths and improve visibility at Fremont Avenue & Eleanor Way with pavement markings and delineators
- Provide missing sidewalk on the north side of Fremont Avenue between Wolfe Road and El Camino Real
- Add high-visibility crosswalk and advance limit line markings at El Camino Real
- Restrict parking on Eleanor Way near Fremont Avenue

Estimated Project Costs (2020 Dollars)

Civil Improvements	$68,775
Contingency	$13,750
Total Construction Cost (rounded)	$82,600
Environmental	$8,300
PS&E	$12,400
Construction Engineering	$8,300
Total Project Cost	**$111,600**

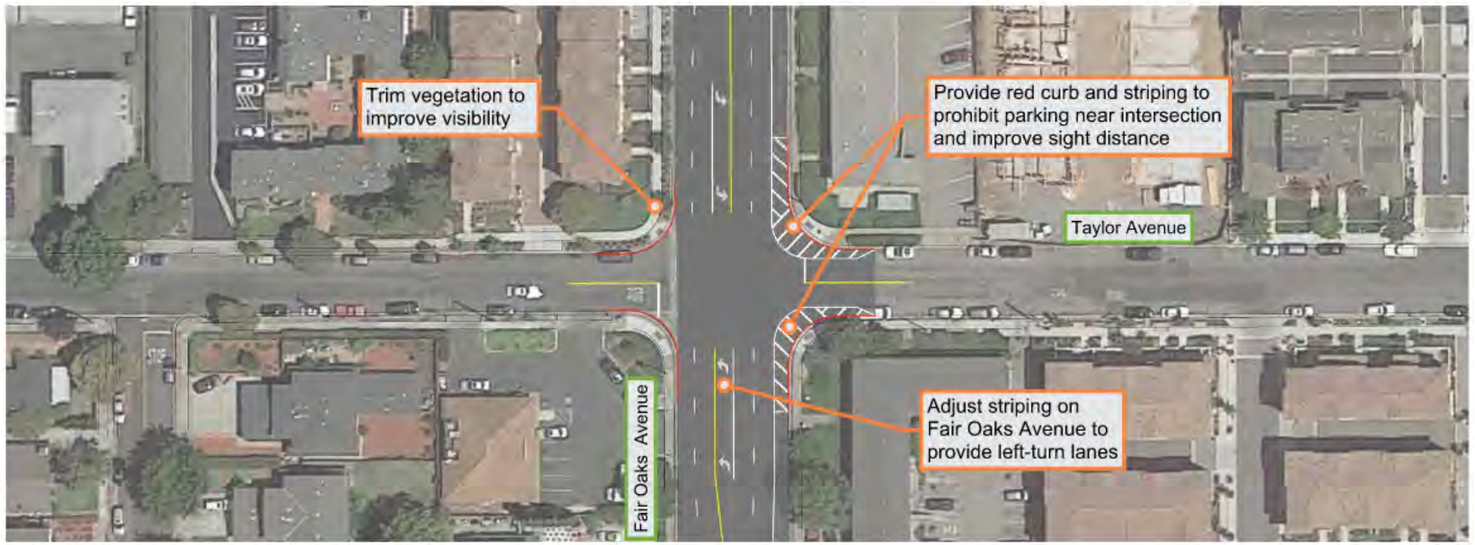
Benefit/Cost Ratio*

Applied LRSM Countermeasures	Crash Reduction Factor
NS07: Upgrade intersection pavement markings	0.15 (All)
NS11: Improve sight distance to intersection	0.15 (All)
R34PB: Install sidewalk/pathway	0.15 (Ped & Bike)
Total Expected Benefit	$804,160
Maximum Federal Reimbursement	90%
Project Benefit/Cost Ratio*	**7.21**

* B/C Ratio based upon combination of separate calculations for NS and R improvements.

K Fair Oaks Avenue & Taylor Avenue

Fair Oaks Avenue at this intersection is four lanes with on-street parking in the northbound direction, while Taylor Avenue has one travel in each direction with stop signs at Fair Oaks Avenue, on-street parking, and few pavement markings. There were 15 collisions in the area near the intersection during the study period, including one severe injury collision. Notable collision patterns were broadside/left-turn collisions for drivers traveling to or from Taylor Avenue, sideswipes, and influence of drugs or alcohol. Speed was often cited as a contributing factor in collisions. The project area is served by VTA Bus Routes 55 (to the north) and 56, and major nearby destinations include Fair Oaks Park and The King's Academy.



Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	14
Bicycle	1
Pedestrian	0

Notable Collision Types

Impaired	9	Broadside	6	Other	5
Sideswipe	5				

Project Description

- Adjust pavement markings to provide left-turn lanes on Fair Oaks Avenue
- Provide red curb and pavement markings to prohibit parking near intersection
- Trim vegetation as needed to improve visibility

Estimated Project Costs (2020 Dollars)

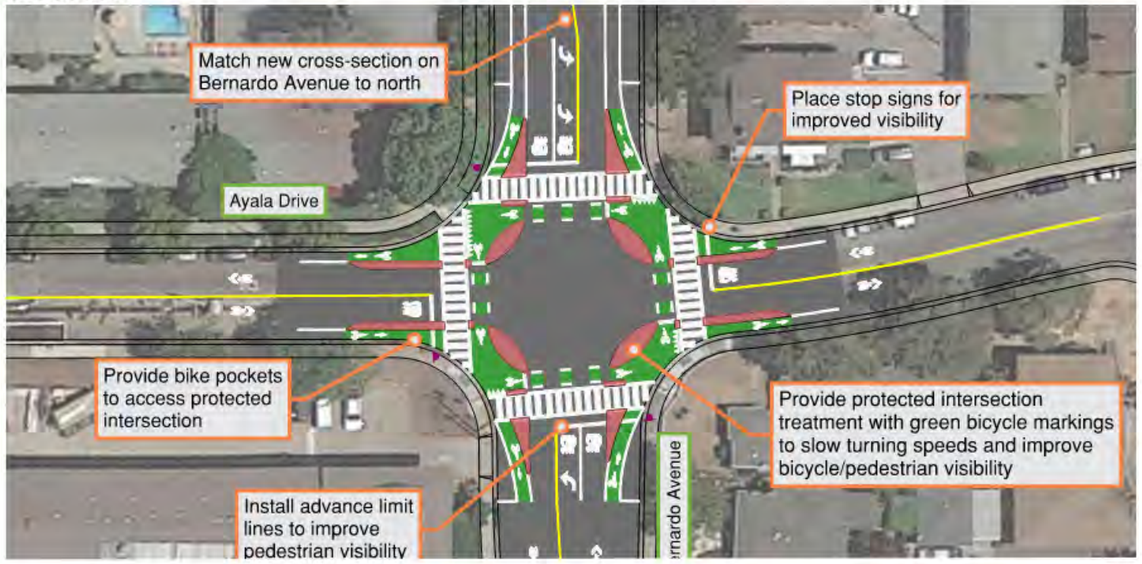
Civil Improvements	$12,300
Contingency	$2,460
Total Construction Cost (rounded)	$14,800
Environmental	$1,500
PS&E	$2,300
Construction Engineering	$1,500
Total Project Cost	**$20,100**

Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
NS11: Improve sight distance to intersection	0.2 (All)
NS18: Install left-turn lane	0.35 (All)
Total Expected Benefit	$4,723,033
Maximum Federal Reimbursement	90%
Project Benefit/Cost Ratio	**234.98**

L Bernardo Avenue & Ayala Drive

Bernardo Avenue provides one through travel lane in each direction with left-turn lanes at Ayala Drive and a center two-way left-turn lane north to Evelyn Avenue. Buffered bicycle lanes are provided north of Ayala Drive, while on-street parking is allowed to the south with no existing bicycle lanes. Ayala Drive has one travel in each direction with on-street parking and few pavement markings. The intersection operates using all-way stop control. There were 17 collisions in the area near the intersection during the study period, including two severe injury collisions. Notable collision patterns were sideswipes, collisions occurring at dark, bicycle- and pedestrian-involved collisions, and influence of drugs or alcohol. Sideswipe collisions often involved parked vehicles near the intersection. The location is in a primarily residential context, with nearby destinations including light industrial uses, Vargas Elementary School, and St. Cyprian Church. The intersection does not currently see any direct transit service, though VTA Bus Route 53 utilizes Bernardo Avenue and Washington Avenue to the south.



Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	11
Bicycle	3
Pedestrian	3

Notable Collision Types

Impaired	8	Sideswipe	6	Dark	5
Bike	3	Pedestrian	3		

Project Description

- Modify striping to provide protected intersection treatment bicycle markings, high-visibility crosswalks, and delineators
- Enhance bicycle treatments for access to protected intersection, match new cross-section to north on Bernardo Avenue
- Relocate stop signs
- Install advance limit lines

Estimated Project Costs (2020 Dollars)

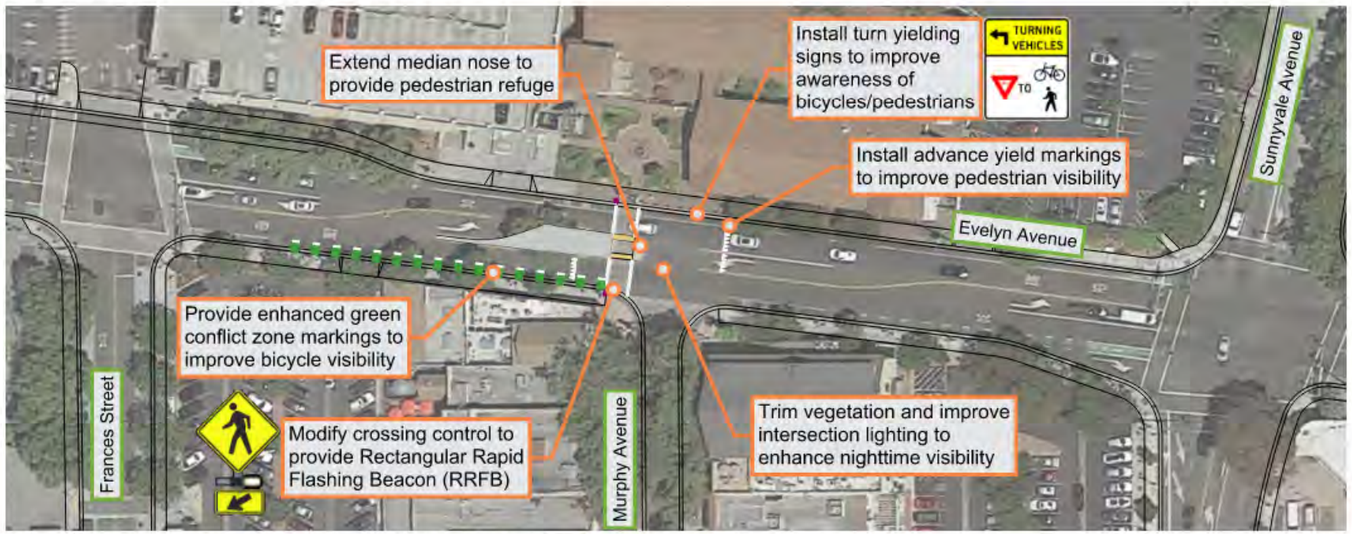
Civil Improvements	$41,025
Contingency	$8,200
Total Construction Cost (rounded)	$49,300
Environmental	$5,000
PS&E	$7,400
Construction Engineering	$5,000
Total Project Cost	**$66,700**

Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
NS03: Upgrade intersection pavement markings	0.25 (All)
Total Expected Benefit	$2,826,350
Maximum Federal Reimbursement	100%
Project Benefit/Cost Ratio	**42.37**

M Evelyn Avenue & Murphy Avenue

This intersection is located at the terminus of Historic Murphy Avenue in downtown Sunnyvale, which is a brick-paved two-lane with on-street parking and a high level of activation to the adjacent public spaces. Evelyn Avenue provides one through travel lane and a bicycle lane in each direction with a westbound left-turn lane at Murphy Avenue. A decorative crosswalk with a flashing beacon is provided across the west leg of the intersection. There were 14 collisions in the area near the intersection during the study period, none of which involved a severe injury or fatality. Notable collision patterns were collisions occurring at dark and bicycle- and pedestrian-involved collisions, with speed was often cited as a contributing factor. Many major destinations are near this location in downtown Sunnyvale, including retail shops, food services, Sunnyvale Caltrain Station, and the weekend Sunnyvale Farmers' Market. Given its proximity to Caltrain and these major destinations, the immediate area is served by many transit services, including VTA Bus Routes 20, 21, 53, 55, and Rapid 523.



Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	8
Bicycle	3
Pedestrian	3

Notable Collision Types

Dark 5

Aggressive 4

Bike 3

Pedestrian 3

Project Description

- Extend median on Evelyn Avenue to provide pedestrian refuge
- Upgrade pedestrian crossing with installation of RRFB and advance yield markings
- Provide green conflict zone markings and turn yielding signs
- Trim vegetation and improve intersection lighting

Estimated Project Costs (2020 Dollars)

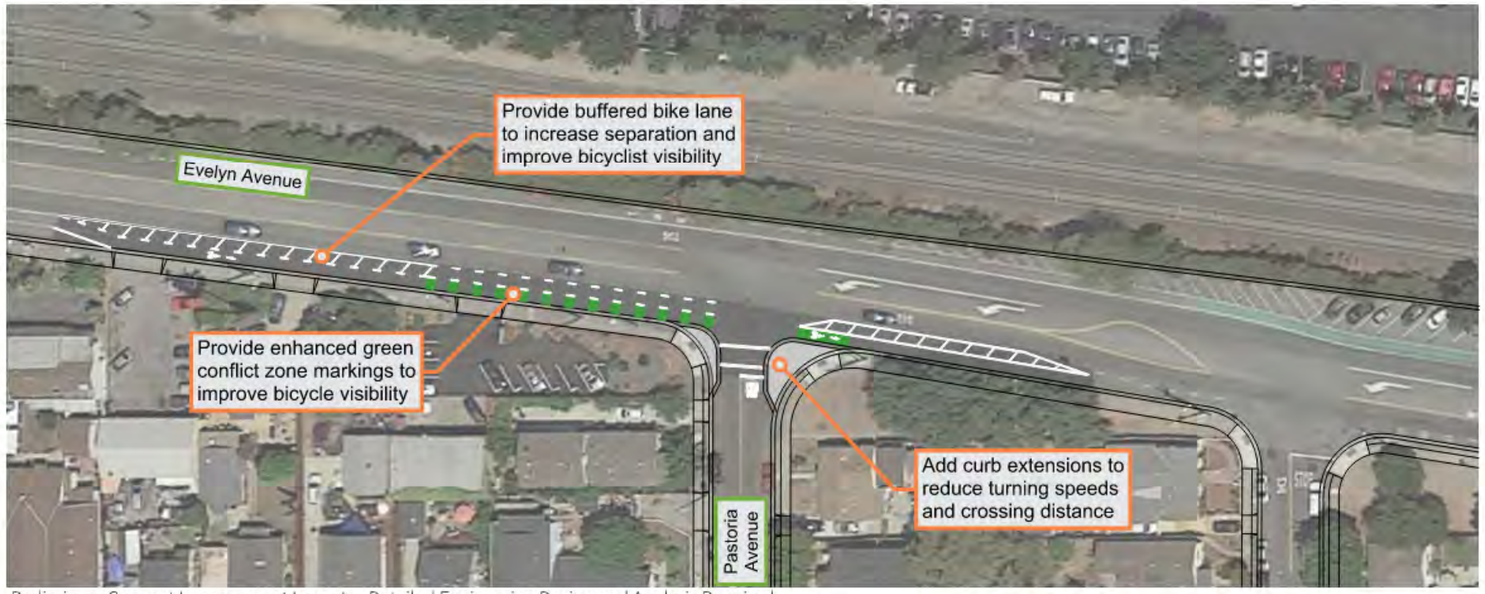
RRFB & Lighting Improvements	$85,000
Civil Improvements	$12,320
Contingency	$19,460
Total Construction Cost (rounded)	$116,800
Environmental	$11,700
PS&E	$17,600
Construction Engineering	$11,700
Total Project Cost	**$157,800**

Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
NS07: Upgrade intersection pavement markings	0.25 (All)
NS19PB: Install raised median/refuge island	0.45 (Ped & Bike)
NS22PB: Install RRFB	0.35 (Ped & Bike)
Total Expected Benefit	$1,358,040
Maximum Federal Reimbursement	90%
Project Benefit/Cost Ratio	**8.61**

N Evelyn Avenue & Pastoria Avenue

Evelyn Avenue provides one through travel lane and a bicycle lane in each direction with a westbound left-turn lane at Pastoria Avenue. On-street parking is provided in the eastbound direction to the west of the intersection, but is prohibited in the immediate vicinity of the intersection. Pastoria Avenue is a two-lane roadway with on-street parking and a stop sign at Evelyn Avenue. There were 5 collisions in the area near the intersection during the study period, two of which involved a severe injury or fatality. Notable collision patterns were sideswipes, collision with fixed objects, and influence of drugs or alcohol. The location is in a primarily residential context, with nearby destinations including light industrial uses, Washington Park, Stratford School Sunnyvale, and downtown Sunnyvale. The intersection does not currently see any direct transit service, though many transit routes and Caltrain service are accessible in downtown Sunnyvale to the east.



Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	4
Bicycle	1
Pedestrian	0

Notable Collision Types

Impaired 3

Sideswipe 2

Fixed Obect 2

Project Description

- Provide buffered bike lane on eastbound Evelyn Avenue
- Enhance bicycle conflict zones with green pavement markings
- Add curb extensions at Evelyn Avenue & Pastoria Avenue intersection
- Install advance limit lines and new stop signs

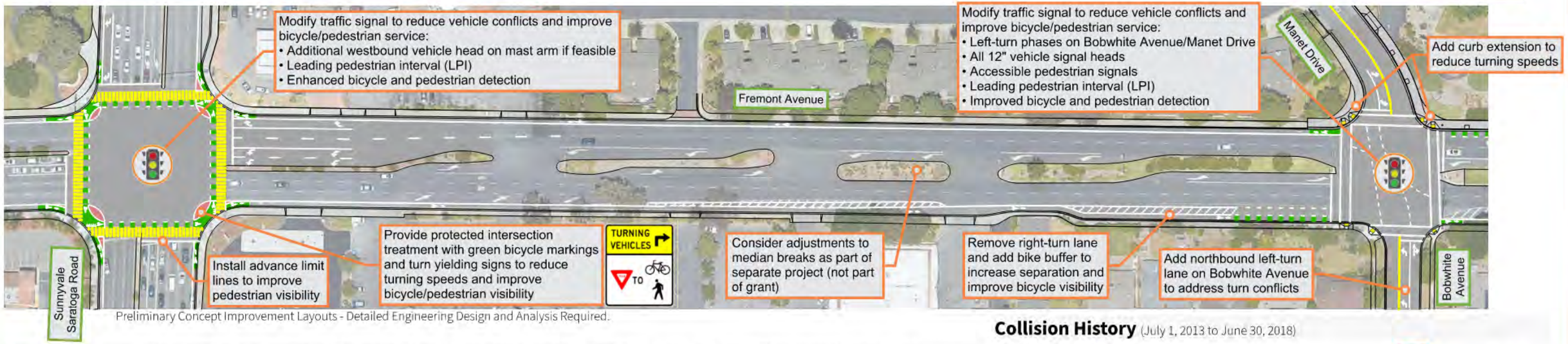
Estimated Project Costs (2020 Dollars)

Civil Improvements	$30,100
Contingency	$6,020
Total Construction Cost (rounded)	$36,200
Environmental	$3,700
PS&E	$5,500
Construction Engineering	$3,700
Total Project Cost	**$49,100**

Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
NS03: Upgrade intersection pavement markings	0.25 (All)
Total Expected Benefit	$2,648,250
Maximum Federal Reimbursement	100%
Project Benefit/Cost Ratio	**53.94**

O Fremont Avenue - Sunnyvale Saratoga Road to Bobwhite Avenue/Manet Drive



Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Fremont Avenue in this section is four to six lanes with auxiliary turn lanes at major intersections and a speed limit of 40 miles per hour. Bicycle lanes are provided in both directions, and in some locations a buffer is provided. The intersections with Sunnyvale Saratoga Road and Bobwhite Avenue/Manet Drive operate utilizing traffic signal control. There were a total of 82 collisions along this segment during the study period, two of which resulted in a severe injury or fatality. Notable collision patterns were rear ends, broadside/left-turn collisions, sideswipes, and bicycle- and pedestrian-involved collisions. Speeding was often cited as a contributing factor in collisions. The area is served by VTA Bus Routes 55 and Rapid 523, and major nearby destinations include retail centers, food services, and Fremont High School.

Project Description

- Modify traffic signals to upgrade to all 12" signal heads and implement LPI with enhanced multimodal detection
- Provide left-turn lanes and protected signal phases on Manet Drive/Bobwhite Avenue
- Modify striping to provide protected intersection treatment with delineators at Sunnyvale Saratoga Road
- Remove eastbound right-turn lane and install buffered bike lane on Fremont Avenue at Manet Drive/Bobwhite Avenue

Estimated Project Costs (2020 Dollars)

Traffic Signal Improvements	$350,000
Civil Improvements	$79,500
Contingency	$85,900
Total Construction Cost (rounded)	$515,400
Environmental	$51,600
PS&E	$77,400
Construction Engineering	$51,600
Total Project Cost	**$696,000**

Benefit/Cost Ratio*

Applied LRSM Countermeasures	Crash Reduction Factor
S02: Improve signal hardware	0.15 (All)
S07: Provide protected left-turn phase	0.3 (All)
S21PB: Modify signal phasing to implement LPI	0.6 (Ped & Bike)
Total Expected Benefit	$10,221,970
Maximum Federal Reimbursement	100%
Project Benefit/Cost Ratio*	**14.69**

* B/C Ratio based upon combination of separate calculations for different locations.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	65
Bicycle	10
Pedestrian	7

Notable Collision Types

Rear End 30

Broadside 19

Sideswipe 12

Bike 10

Pedestrian 7

P Arques Avenue - Wolfe Road to Lawrence Expressway

Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Arques Avenue is generally a five-lane roadway providing two travel lanes and a bicycle lane in each direction as well as a center two-way left-turn lane between Wolfe Road and Lawrence Expressway. The speed limit varies between 35 and 40 mph. Dedicated left-turn lanes are provided at its signalized intersections with Commercial Street/Deguigne Drive and Santa Trinita Avenue. Multiple driveways allow direct access to primarily retail and office uses on each side of Arques Avenue, generally not aligning opposite one another. There were a total of 35 collisions along this segment, one of which resulted in a severe injury. Notable collision patterns were broadside/left-turn collisions, rear ends, and bicycle- and pedestrian-involved collisions. Speeding or influence of drugs or alcohol was often cited as a contributing factor in collisions. The corridor is served by VTA Bus Route 20 as well as ACE and Caltrain Shuttles. Major nearby destinations include retail centers, food services, major office parks, and multiple religious centers.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	30
Bicycle	3
Pedestrian	2

Notable Collision Types

Broadside 12 | Impaired 7 | Aggressive 6 | Rear End 6 | Sidewipe 6

Project Description

- Provide raised median with consolidated inbound left-turn access along Arques Avenue
- Modify traffic signals to upgrade to all 12" signal heads and implement LPI with enhanced bicycle and pedestrian detection
- Enhance bicycle conflict zones with green pavement markings and add buffered bicycle lanes with delineators where feasible
- Install advance limit lines at intersections
- Project requires additional coordination with adjacent property owners to identify appropriate access controls

Estimated Project Costs (2020 Dollars)

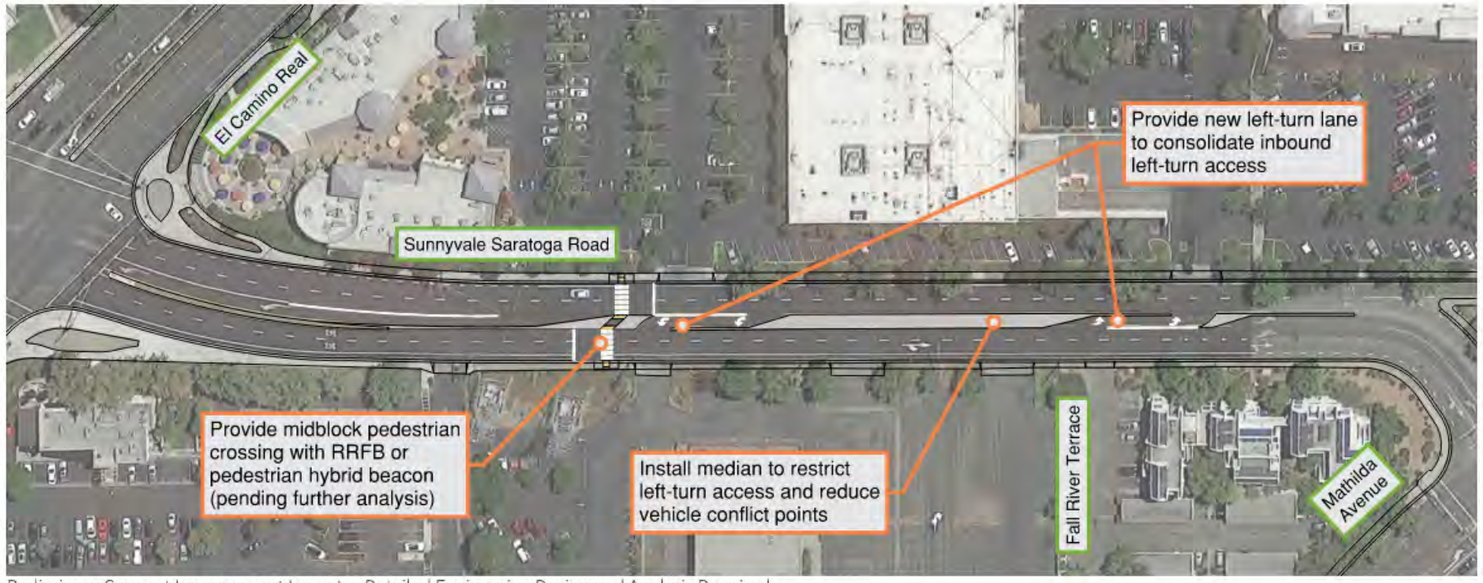
Traffic Signal Improvements	$200,000
Civil Improvements	$343,300
Contingency	$108,660
Total Construction Cost (rounded)	$652,000
Environmental	$65,200
PS&E	$97,800
Construction Engineering	$65,200
Total Project Cost	**$880,200**

Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
S02: Improve signal hardware	0.15 (All)
S21PB: Modify signal phasing to implement LPI	0.6 (Ped & Bike)
R08: Install raised median	0.25 (All)
Total Expected Benefit	$6,097,930
Maximum Federal Reimbursement	90%
Project Benefit/Cost Ratio	**6.93**

Q Sunnyvale Saratoga Road - El Camino Real to Mathilda Avenue

Sunnyvale Saratoga Road between El Camino Real and Mathilda Avenue is a five-lane roadway providing two travel lanes and a bicycle lane in each direction as well as a center two-way left-turn lane. The speed limit is 35 mph. Multiple driveways allow direct access to properties on each side of Sunnyvale Saratoga Road, generally not aligning opposite one another. There were 9 collisions along this segment, none of which involved a severe injury or fatality. The predominant collision type was broadside/left-turn collisions involving the driveways. The project area is served by VTA Bus Routes 22, 55, Rapid 522, and Rapid 523, and major nearby destinations include multiple retail centers and food services.

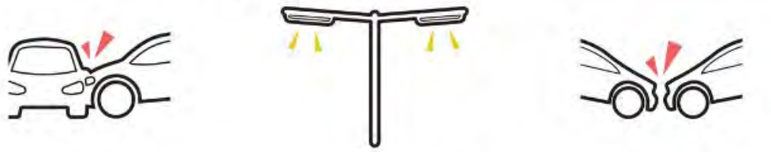


Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	9
Bicycle	0
Pedestrian	0

Notable Collision Types



Broadside	6	Dark	1	Head On	1

Impaired 1

Project Description

- Provide raised median with consolidated inbound left-turn access along Sunnyvale Saratoga Road
- Install midblock pedestrian crossing with RRFB or pedestrian hybrid beacon (pending further analysis, not included in cost estimate)
- Project requires additional coordination with adjacent property owners to identify appropriate access controls

Estimated Project Costs (2020 Dollars)

Civil Improvements	$90,020
Contingency	$18,000
Total Construction Cost (rounded)	$108,100
Environmental	$10,800
PS&E	$16,300
Construction Engineering	$10,800
Total Project Cost	**$146,000**

Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
R08: Install raised median	0.25 (All)
Total Expected Benefit	$376,800
Maximum Federal Reimbursement	90%
Project Benefit/Cost Ratio	**2.58**

R Reed Avenue - Wolfe Road to Evelyn Avenue

Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Reed Avenue between Wolfe Road and Evelyn Avenue generally provides two eastbound travel lanes, one westbound travel lane, a center two-way left-turn lane, and bicycle lanes in both directions. The speed limit is 35 mph. There were a total of 56 collisions along this segment, 42 of which occurred at the intersection of Wolfe Road/Reed Avenue/Old San Francisco Road. None of the collisions resulted in fatality or severe injury, though four did involve bicycles or pedestrians. Notable collision patterns were rear ends, broadside/left-turn collisions, and sideswipes. Collisions were generally concentrated at the intersections along the corridor, and speeding or influence of drugs or alcohol was often cited as a contributing factor in collisions. The corridor is directly served by VTA Bus Route 21, and VTA Bus Route 56 also passes through the intersection of Wolfe Road/Reed Avenue/Old San Francisco Road on the west end of the corridor. The corridor is in a primarily residential context, with nearby destinations including small retail centers, food services, and Ponderosa Elementary School.

Project Description

- Modify traffic signals to upgrade to all 12" signal heads and implement LPI with enhanced multimodal detection
- Add curb extensions at Reed Avenue & Sequoia Drive, reduce corner radii at Reed Avenue & Wolfe Road
- Remove one eastbound travel lane and install buffered bike lane on Reed Avenue with delineators where feasible
- Remove pork-chop islands and install protected intersection at Reed Avenue & Evelyn Avenue
- Provide green bicycle conflict zone markings and dd advance limit lines at all intersections

Estimated Project Costs (2020 Dollars)

Traffic Signal Improvements	$600,000
Civil Improvements	$301,035
Contingency	$180,200
Total Construction Cost (rounded)	$1,081,300
Environmental	$108,200
PS&E	$162,200
Construction Engineering	$108,200
Total Project Cost	**$1,459,900**

Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
S02: Improve signal hardware	0.15 (All)
S20PB: Install advance limit line before crosswalk	0.15 (Ped & Bike)
S21PB: Modify signal phasing to implement LPI	0.6 (Ped & Bike)
Total Expected Benefit	$1,260,700
Maximum Federal Reimbursement	100%
Project Benefit/Cost Ratio	**0.86**

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	52
Bicycle	1
Pedestrian	3

Notable Collision Types

Rear End 18

Aggressive 18

Broadside 14

Sideswipe 9

Impaired 9

S Sandia Avenue - Lawrence Expressway to

Sandia Avenue between Lawrence Expressway and Wildwood Avenue is generally a two-lane roadway with on-street parking on both sides, few pavement markings, and a speed limit of 25 mph. There were a total of 27 collisions along this segment, 16 of which occurred at the intersection with Blazingwood Drive. None of the collisions resulted in fatality or severe injury, though one did involve a bicycle. Notable collision patterns were rear ends and broadside/left-turn collisions, collisions at dark, and collisions with parked vehicles. The corridor is not directly served by transit, though bus service is provided by VTA Route 55 on Lawrence Expressway. The corridor is in a primarily residential context, with nearby destinations including retail centers, Fairwood Park, California Young World, and Valley Faith United Methodist Church.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	26
Bicycle	1
Pedestrian	0

Notable Collision Types

Broadside 10

Sidewipe 9

Dark 6

Wildwood Avenue

Project Description

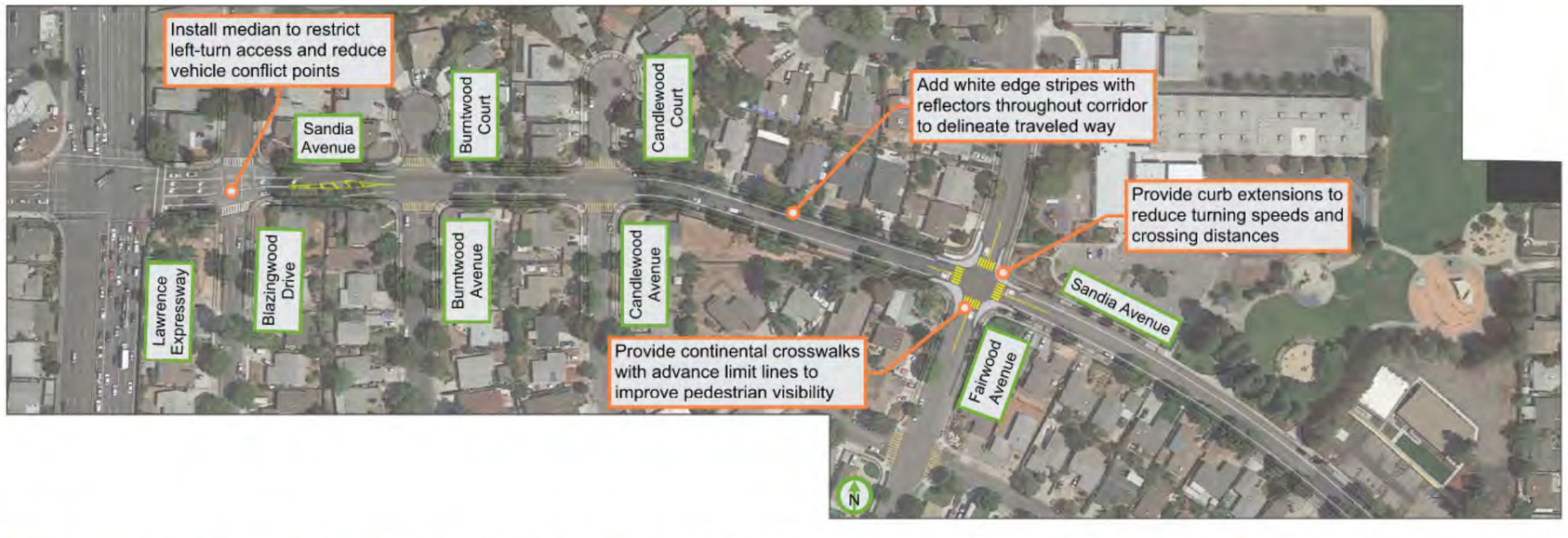
- Provide raised median to restrict left turns at Sandia Avenue & Blazingwood Drive
- Adjust pavement markings to delineate westbound lanes on Sandia Avenue approaching Lawrence Expressway
- Provide curb extensions with new curb ramps and stop signs at intersections
- Add white edge stripes with reflectors throughout corridor

Estimated Project Costs (2020 Dollars)

Civil Improvements	$231,800
Contingency	$36,360
Total Construction Cost (rounded)	$278,300
Environmental	$28,000
PS&E	$41,800
Construction Engineering	$28,000
Total Project Cost	**$376,100**

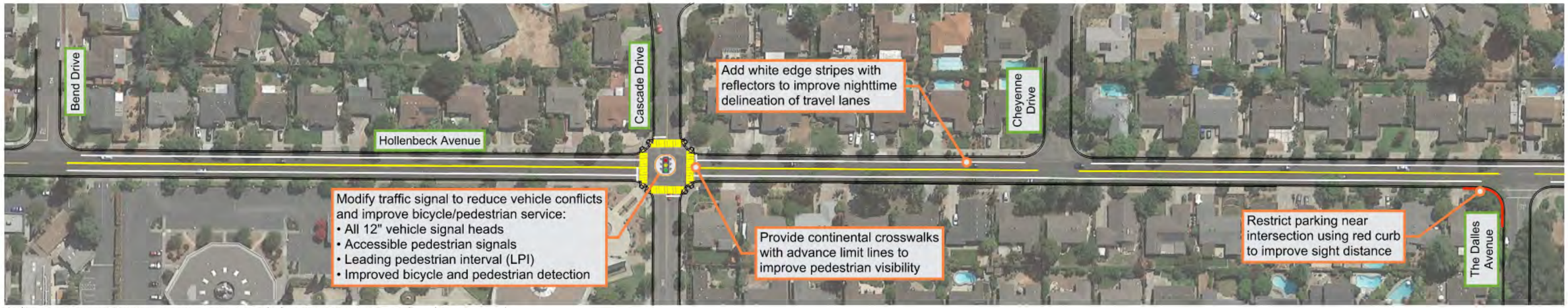
Benefit/Cost Ratio

Applied LRSM Countermeasures	Crash Reduction Factor
NS07: Upgrade intersection pavement marking	0.25 (All)
NS15: Create direction median openings	0.5 (All)
R28: Install edge-lines and centerlines	0.25 (All)
Total Expected Benefit	$1,616,650
Maximum Federal Reimbursement	90%
Project Benefit/Cost Ratio	**4.30**



Preliminary Concept Improvement Layouts -
Detailed Engineering Design and Analysis Required.

T Hollenbeck Avenue - Bend Drive to The Dalles



Preliminary Concept Improvement Layouts - Detailed Engineering Design and Analysis Required.

Hollenbeck Avenue is generally a two-lane roadway with on-street parking on both sides, a double-yellow centerline, and a speed limit of 30 mph. The intersection of Hollenbeck Avenue and Cascade Drive is signalized. There were a total of 12 collisions along this segment, one of which resulted in a severe injury. Notable collision patterns were sideswipes, rear ends, collisions at dark, and collisions with parked vehicles. The corridor is not directly served by transit, though bus service is provided by multiple VTA bus routes on nearby arterial roadways. The corridor is in a primarily residential context, with nearby destinations including Serra Park, Nimitz Elementary School, Resurrection Catholic School, and Church of the Resurrection.

Project Description

- Modify traffic signal to upgrade to all 12" signal heads and implement LPI with enhanced multimodal detection
- Install continental crosswalks and advance limit lines at Hollenbeck Avenue & Cascade Drive
- Add white edge stripes with reflectors throughout corridor
- Restrict parking with new red curb near The Dalles Avenue

Estimated Project Costs (2020 Dollars)

Traffic Signal Improvements	$75,000
Civil Improvements	$9,020
Contingency	$16,800
Total Construction Cost (rounded)	$100,900
Environmental	$10,200
PS&E	$15,200
Construction Engineering	$10,200
Total Project Cost	**$136,600**

Benefit/Cost Ratio*

Applied LRSM Countermeasures	Crash Reduction Factor
S02: Improve signal hardware	0.15 (All)
S21PB: Modify signal phasing to implement LPI	0.6 (Ped & Bike)
R28: Install edge-lines and centerlines	0.25 (All)
Total Expected Benefit	$2,201,870
Maximum Federal Reimbursement	100%
Project Benefit/Cost Ratio*	**16.11**

* B/C Ratio based upon combination of separate calculations for different locations.

Collision History (July 1, 2013 to June 30, 2018)

Motor Vehicle	10
Bicycle	1
Pedestrian	1

Notable Collision Types

Sideswipe 6

Dark 5

Rear End 4

Aggressive 3

4.4 POTENTIAL FUNDING SOURCES

Although the focus of the Roadway Safety Plan is readying the City to submit HSIP applications, other funding sources can be explored for the implementation of RSP projects. Table 8 outlines regional, state, and federal programs related to transportation, air quality, sustainability, and housing.

Table 8 - Funding Sources

Funding Source	Program Purpose	Eligible Projects
Congestion Mitigation and Air Quality (CMAQ) Improvement Program	The FAST Act continued the CMAQ program to provide a flexible funding source to State and local governments for transportation projects and programs to help meet the requirements of the Clean Air Act. Funding is available to reduce congestion and improve air quality for areas that do not meet the National Ambient Air Quality Standards for ozone, carbon monoxide, or particulate matter (non-attainment areas) and for former non-attainment areas that are now in compliance (maintenance areas).	• Design • Non-infrastructure • Construction
Highway Safety Improvement Program (HSIP)	Significantly reduce traffic fatalities and serious injuries on all public roads, including non-State-owned roads.	• Data Collection and Analysis • Planning • Construction
Active Transportation Program (ATP)	Increase the safety and use of active transportation by funding a broad spectrum of projects that achieve greenhouse gas reduction goals, enhance public health, and support disadvantaged communities.	• Planning • Design • Non-Infrastructure • Construction
SB-1 Transportation Funding	The Road Maintenance and Rehabilitation Program was created to address deferred maintenance on the state highway system and the local street and road system by prioritizing basic road maintenance and road rehabilitation projects and critical safety projects.	• Construction
Santa Clara County Measure B	A one-half cent sales tax measure in Santa Clara County for transportation improvements to enhance transit, highways, expressways and active transportation through April 1, 2047.	• Planning • Design • Non-Infrastructure • Construction
Metropolitan Transportation Commission (MTC) One Bay Area Grant (OBAG) Program	Federally funded program administered by MTC to invest in local street and road maintenance, streetscape enhancements, bicycle and pedestrian improvements, transportation planning, and safe routes to school while advancing regional housing goals.	• Planning • Design • Non-Infrastructure • Construction

Funding Source	Program Purpose	Eligible Projects
Caltrans Sustainable Transportation Planning Grant Program	The Caltrans HQ Office of Regional Planning manages the Sustainable Transportation Planning Grant Program. It funds local and regional multimodal transportation and land use planning projects that further the region's RTP SCS (where applicable), contribute to the State's GHG reduction targets, and also assist in achieving the Caltrans Mission and Grant Program Overarching Objectives.	• Planning • Design
California Office of Traffic Safety (OTS)	State, County, and local highway safety needs are prioritized in programs to prevent serious injury and death resulting from motor vehicle crashes.	• Planning • Design • Non-Infrastructure
Affordable Housing and Sustainable Communities (AHSC)	The AHSC Program provides grants and/or loans for projects that will reduce VMT and benefit Disadvantaged Communities through increasing accessibility of affordable housing, employment centers, and key destinations	• Planning • Design • Non-Infrastructure • Construction