Berkeley SafeTREC

SAFE TRANSPORTATION RESEARCH AND EDUCATION CENTER

PS22021

CALIFORNIA STATE POLYTECHNIC UNIVERSITY, POMONA

COMPLETE STREETS SAFETY ASSESSMENT

Issues, Opportunities, and Suggested Strategies

Assessment Team

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October 2022

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FINAL REPORT

OCTOBER 2022

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EXECUTIVE SUMMARY

The staff at the Facilities Planning & Management Department's Office of Campus Planning, Transportation & Sustainability at the California State Polytechnic University, Pomona (Cal Poly Pomona, hereafter called the University) requested that the Safe Transportation Research and Education Center (SafeTREC) at the University of California, Berkeley conduct a Complete Streets Safety Assessment (CSSA) for roads inside and accessing the University campus. This report is the result of the research on the available existing safety data, discussions with the University staff, and field walking audit conducted by the SafeTREC evaluators.

This report is organized into the following chapters:

- Chapter 1 is an introduction to the Complete Streets Safety Assessment, objectives of the assessment and approach in conducting the assessment.
- Chapter 2 presents background information on bicyclist and pedestrian safety in and around the campus and also the history of the crashes in and around the campus.
- Chapter 3 presents field walking audit observations and suggestions for potential improvements.

Walking Audit Focus Areas

Per discussions with the University staff, the following eight (8) focus areas were studied in this assessment:

1. Camphor Lane: from University Drive – east turnaround
2. University Drive: from Camphor Lane – Building 23
3. Intersection of Palm Drive & Oak Lane
4. Kellogg Drive, Eucalyptus Lane – South Campus Dr Corridor
5. Intersection of Temple Avenue & University Drive
6. Intersection of Temple Avenue & South Campus Drive
7. Intersection of Kellogg Drive & University Drive
8. Intersection of Kellogg Drive & Innovation Way

Many of the strategies suggested in this report are appropriate for grant applications, including Office of Traffic Safety (OTS) or Active Transportation Program (ATP) funding. The strategies may also be incorporated into a bicycle or pedestrian master plan, documents that could set forth bicycle, pedestrian and streetscape policies for the University campus.

It is important to note that the CSSA is a planning level-assessment of campus roadways, based on limited field observations and anecdotal input by campus stakeholders. Additional traffic engineering studies are recommended to further explore the most appropriate roadway design countermeasures.

1. INTRODUCTION

1.1. OBJECTIVE OF THE ASSESSMENT

The objective of this CSSA is to improve safety and accessibility for all people walking and bicycling in and around the University campus. This assessment emphasizes safety and mobility issues associated with pedestrians and bicyclists.

1.2. ASSESSMENT APPROACH

The SafeTREC Safety experts conducted a pre-visit telephone interview with University staff on December 16, 2021. Two SafeTREC evaluators met with University staff and conducted a walking audit at various locations in campus on March 01, 2022. Positive practices, as well as pedestrian and bicycle safety and accessibility issues were identified at the field audit. This report is the result of the research on the available existing safety data, discussions with the University staff, input from the campus Alternative Transportation Committee, City of Pomona staff, and field walking audit conducted by the SafeTREC evaluators.

1.3. ACKNOWLEDGEMENT

Cal Poly Pomona staff members participated in the field visit and contributed to the wide range of topics addressed in this report. We would specifically like to thank Mr. Danny Wu, Executive Director of the Office of Campus Planning, Transportation & Sustainability, for providing enormous information and background documents, which helped in conducting the assessment and preparing this report.

1.4. DISCLOSURES

The suggestions presented in this report are based on limited field observations and limited time spent in the Cal Poly Pomona campus by the CSSA evaluators. These suggestions, which are based on general knowledge of best practices in pedestrian and bicycle design and safety, are intended to guide University staff in making decisions for future safety improvement projects in and around the campus, and they may not incorporate all factors, which may be relevant to the pedestrian and bicycle safety issues in the campus.

As this report is conceptual in nature, conditions may exist in the focus areas that were not observed and may not be compatible with suggestions in this report. Before finalizing and implementing any physical changes, University staff may conduct more detailed studies or further analysis to refine or discard the suggestions in this report if they are found to be contextually inappropriate or appear not to improve pedestrian and bicyclist safety or accessibility due to conditions including, but not limited to, high vehicular traffic volume or speeds, physical limitations on space or sight distance, or other potential safety concerns.

2. BACKGROUND AND CRASH HISTORY

Cal Poly Pomona is located in the City of Pomona, a suburban city in the eastern portion of Los Angeles County. The University's campus encompasses an approximately 1,725 acres in area (Wikipedia). The following figure shows the Google map of the campus area.

As indicated in the CSSA application, “There are approximately 29,103 students enrolled (Fall 2021) and 2,700 employees (faculty and staff) who work on campus, making the campus a major activity/employment center in the East San Gabriel/Pomona Valleys…. Historically, Cal Poly Pomona has been a commuter campus, in a suburban setting, with approximately 87% of the trips originating off-campus.”

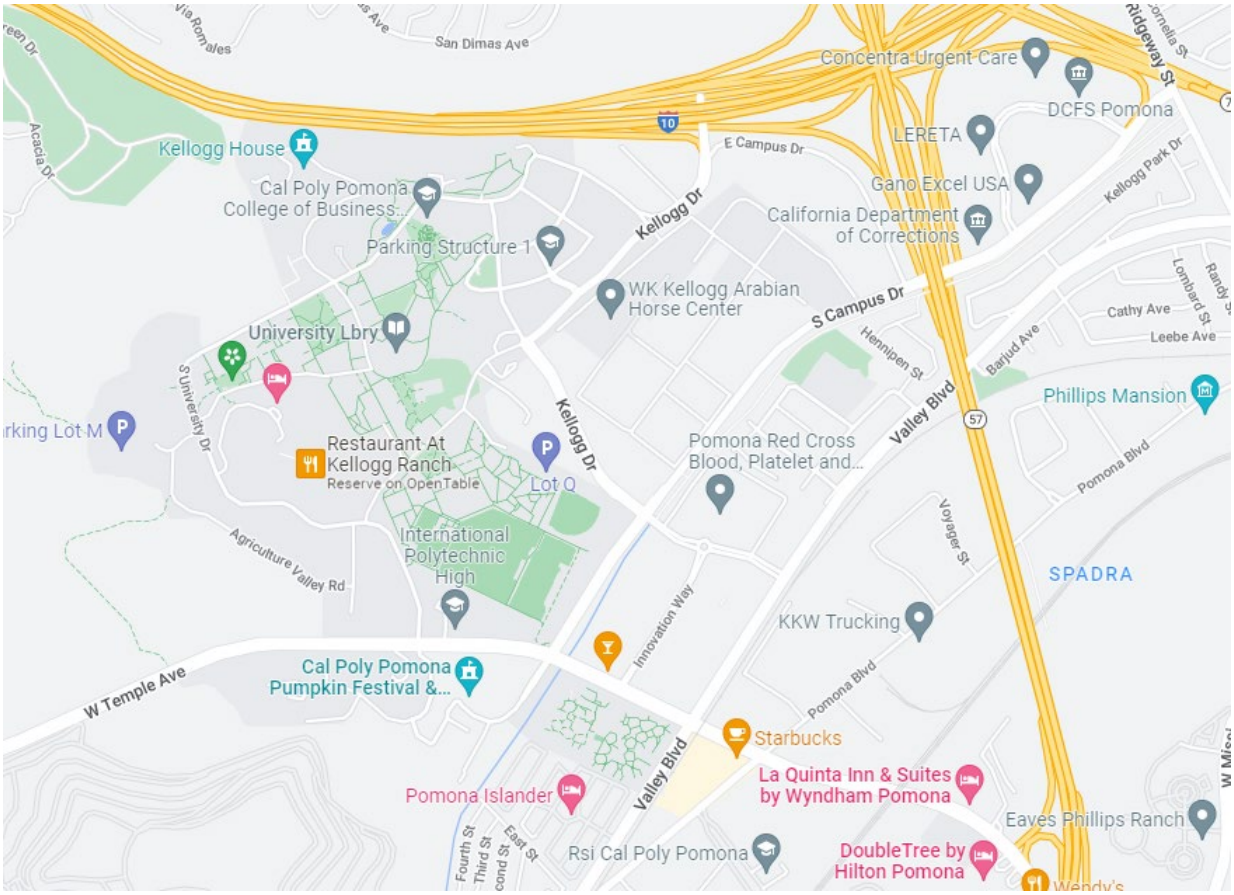


Figure 2-1: Map of Cal Poly Pomona Campus and surrounding

2.1. PEDESTRIAN AND BICYCLIST SAFETY OVERVIEW

The students at Cal Poly Pomona conducted a class project in 2020 titled, “Traffic and Pedestrian Safety on the Cal Poly Pomona Campus,” URP 4880, under supervision of Professor So-Ra Baek. In this project, students used the tool developed by SafeTREC, Transportation Injury Mapping System (https://tims.berkeley.edu/) to access bicycle and pedestrian crash data in and around the campus from 2009 to 2020. Figure 2-2 on the following two pages includes three figures taken from their report.

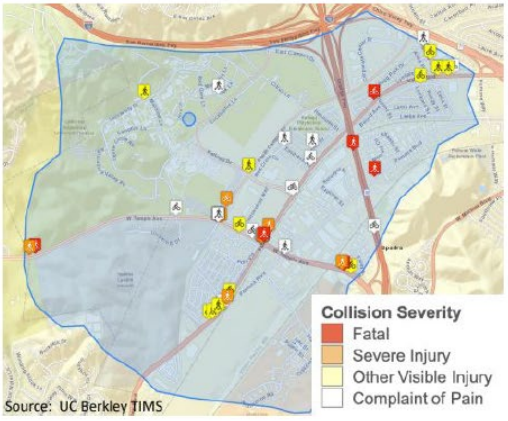
TIMS | SWITRS GIS Map
By SafeTREC, UC Berkeley

Years: 2009-2020*
*2019 - 2020 is provisional and subject to change

Locations: Pomona, Walnut, Unincorporated Los Angeles County

Crash Filters: Bicycle Crash, Pedestrian Crash

Total Number of Crashes: 52



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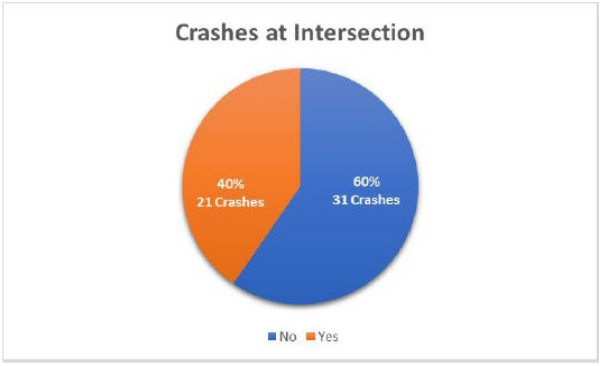
TIMS Crashes at Intersection & Within .25 mile from Campus Entrance



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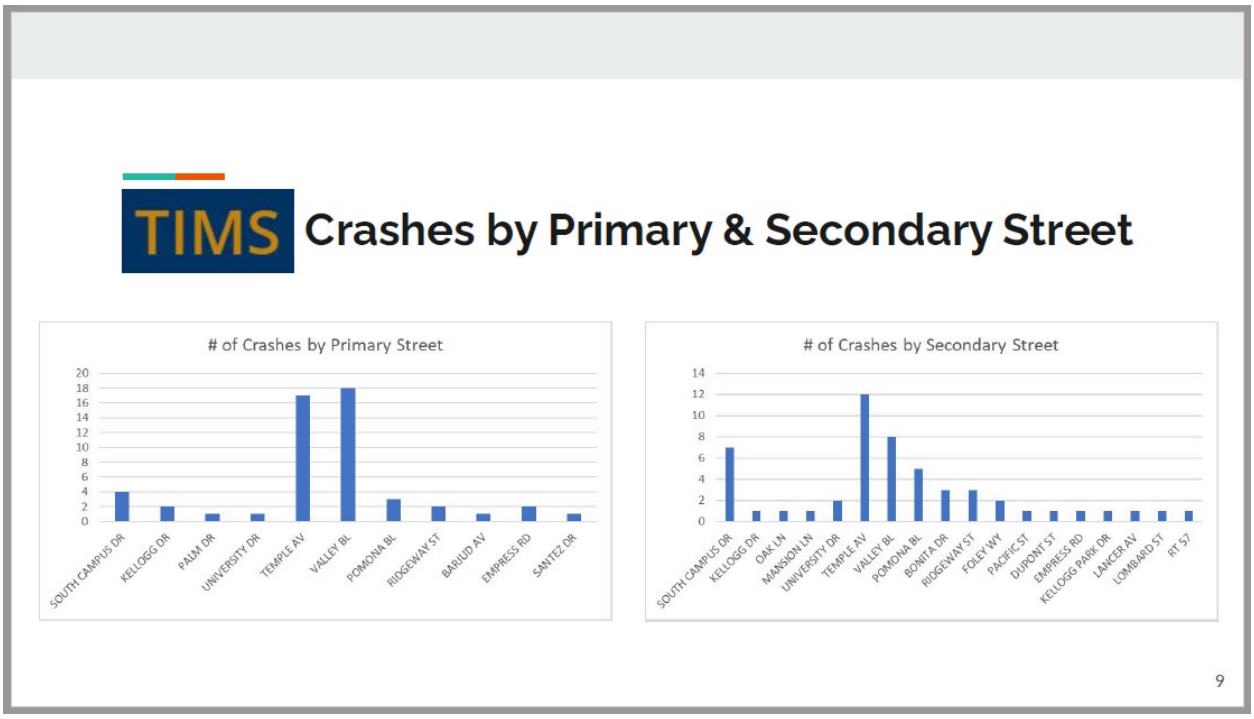


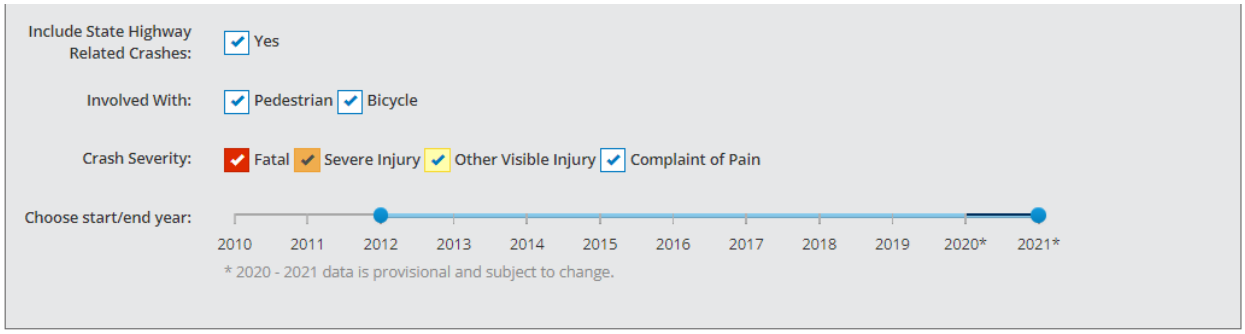
Figure 2-2: Above Figures are from "Traffic and Pedestrian Safety on the Cal Poly Pomona Campus," URP 4880

As shown in the above figures, most crashes occurred along Temple Avenue, Valley Blvd., Kellogg Dr., and S. Campus Dr. corridors, specifically at or near intersections of Temple Avenue with S. Campus Drive, and Temple Avenue with Valley Blvd.

2.2. PEDESTRIAN AND BICYCLE CRASH DATA

In this assessment the SafeTREC's TIMS (https://tims.berkeley.edu/) was utilized further to analyze the crash data in and around the University in the City of Pomona. To conduct a more focused analysis, the pedestrian and bicycle crash data from 2012 to 2021 (2020-2021 provisional) was analyzed.

Utilizing the Active Transportation Planning (ATP) Map feature of TIMS, the bicycle and/or pedestrian crashes around the University are depicted in the following figures. These figures reflect the same results that the students concluded in their report, namely that the most crashes occurred on Temple Avenue, Valley Blvd, and S. Campus Drive. During the 10-year period between 2012 and 2021, there were 11 crashes involving bicyclists, and 15 involving pedestrians in and around the campus area. One pedestrian crash was fatal, and three crashes resulted in severe injuries.



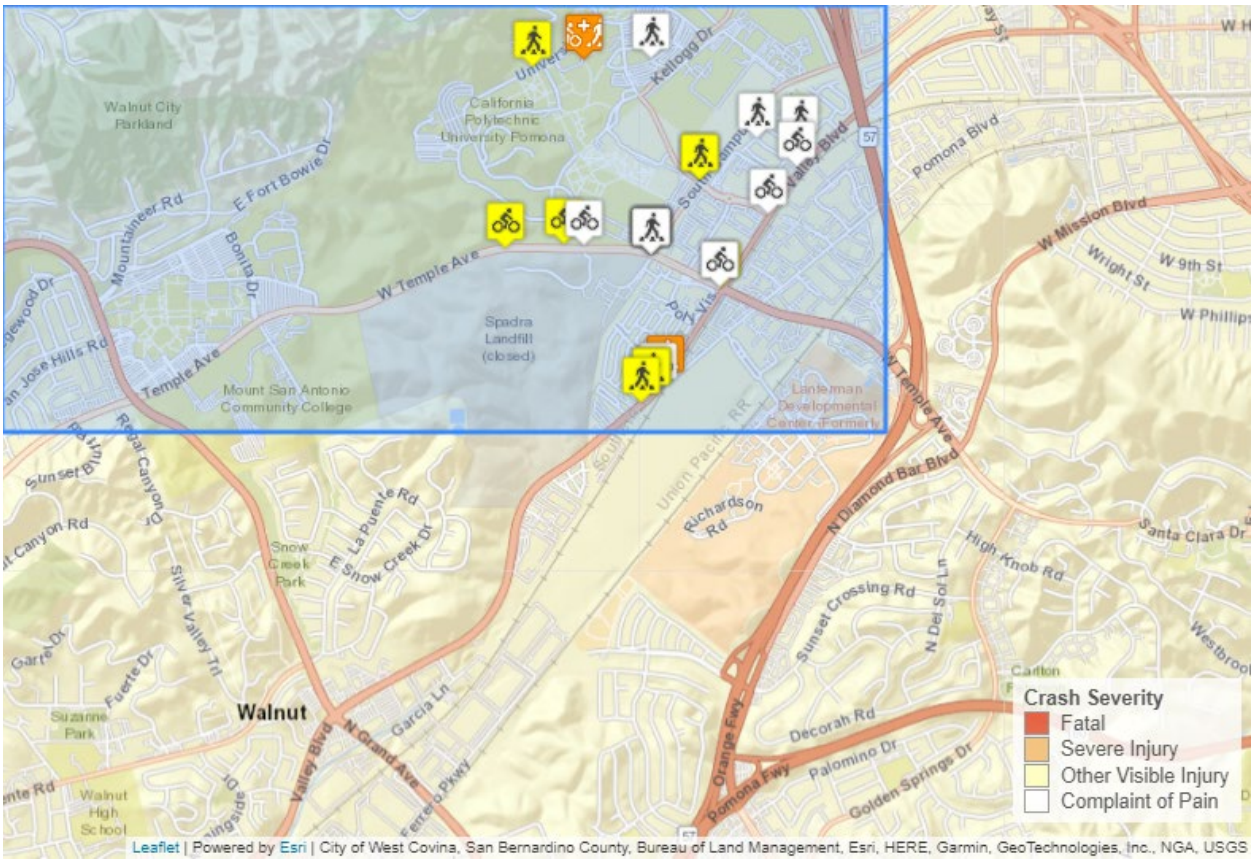


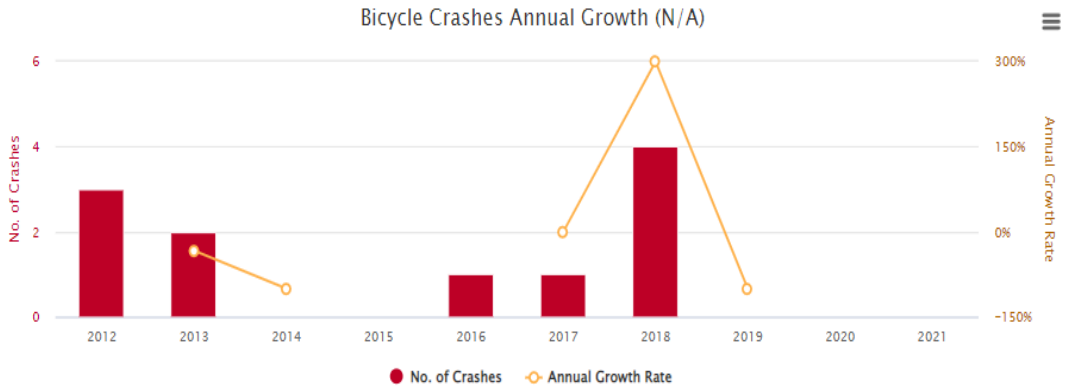
Figure 2-3: Pedestrian & Bicycle Crashes on and around the Cal Poly Pomona Campus 2012 to 2021

ATP Tool Summaries:

- **Summary Results:** high-level summaries for pedestrians and bicyclists on a year-by-year basis.

Summary Results

Involved With	Fatal	Severe Injury	Visible Injury	Complaint of Pain	Total
Bicycle	0	1	5	5	11
Pedestrian	1	2	5	7	15



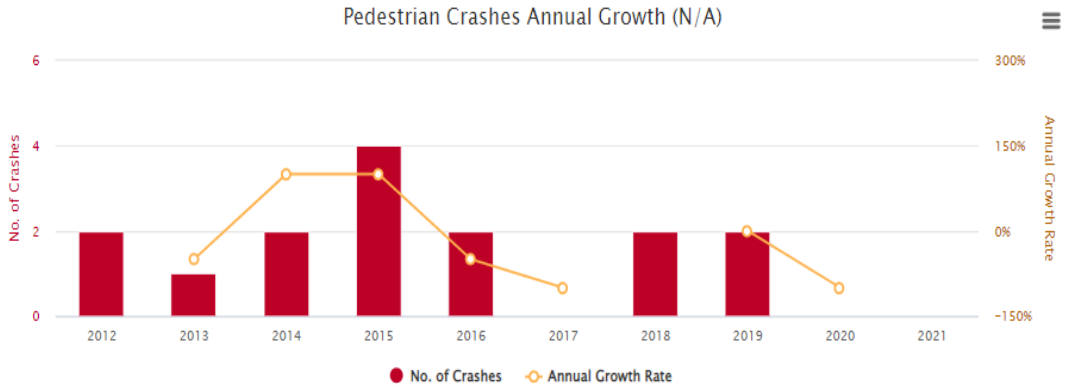
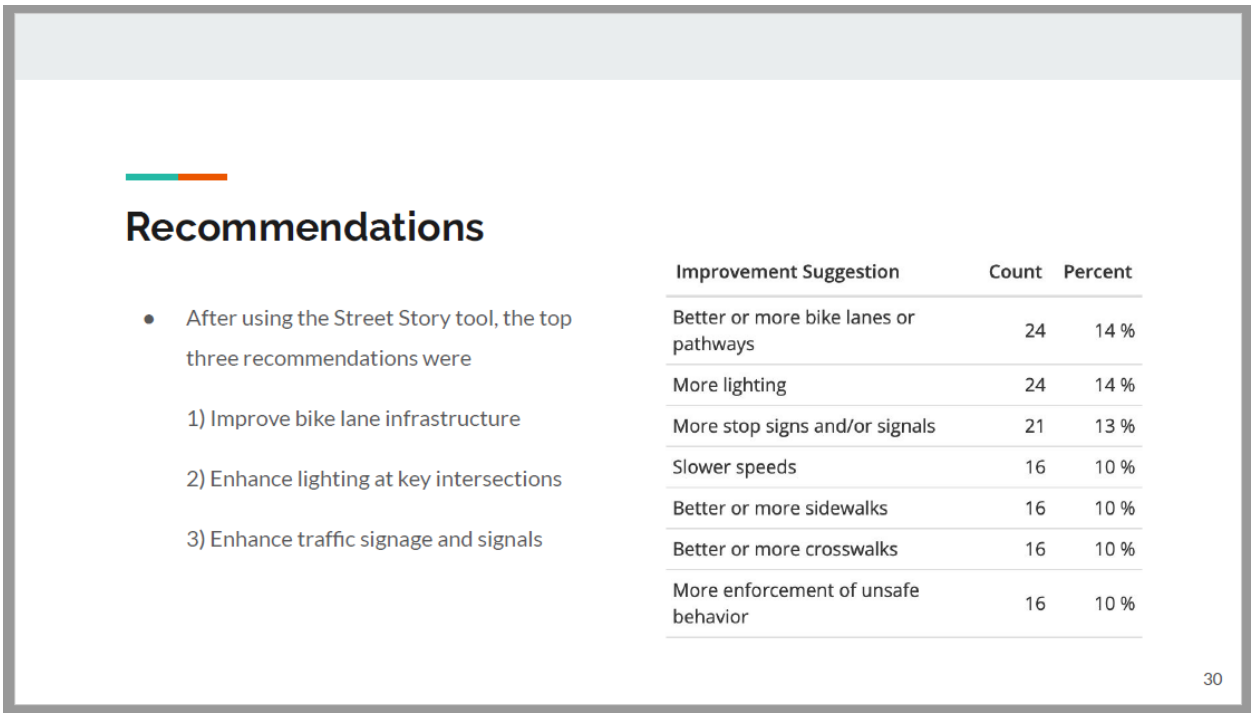


Figure 2-4: High-Level Summaries for Pedestrian and Bicycles Crashes on Year-by-Year Basis in and around the Cal Poly Pomona Campus

2.3. STREET STORY

The Street Story (https://streetstory.berkeley.edu/) is a relatively new tool developed by UC Berkeley's Safe Transportation Research and Education Center (SafeTREC), funded by the Office of Traffic Safety (OTS). Street Story is a community engagement tool that allows residents, community groups and agencies to provide and collect information about transportation crashes, near-misses, general hazards and safe locations to travel. Street Story is free to use and publicly accessible. It features a survey where people can record travel experiences. Once a record has been entered, the information is publicly accessible on the website with maps and tables that can be downloaded.

In their class project, “Traffic and Pedestrian Safety on the Cal Poly Pomona Campus,” URP 4880, students utilized the Street Story tool. The following figure shows their suggestions based on their analysis of Street Story.



Recommendations

- After using the Street Story tool, the top three recommendations were

  1) Improve bike lane infrastructure

  2) Enhance lighting at key intersections

  3) Enhance traffic signage and signals

Improvement Suggestion	Count	Percent
Better or more bike lanes or pathways	24	14 %
More lighting	24	14 %
More stop signs and/or signals	21	13 %
Slower speeds	16	10 %
Better or more sidewalks	16	10 %
Better or more crosswalks	16	10 %
More enforcement of unsafe behavior	16	10 %

30

Figure 2-5: Above Figure is from “Traffic and Pedestrian Safety on the Cal Poly Pomona Campus,” URP 4880

It is suggested that Cal Poly Pomona staff use this free tool to collect information and data from their students, staff, and faculty, as well as visitors, for the University’s safety needs assessments, transportation safety planning efforts, other safety programs, and project proposals. They can provide the link to the tool on their website and encourage the community to utilize it in order to share their experiences and concerns, as well as to learn about others’ experiences related to traffic safety in and around the campus.

3. COMPLETE STREETS AUDIT RESULTS AND SUGGESTIONS

3.1. OVERVIEW

"College campuses are multimodal settings with very high levels of walking and biking in conjunction with high levels of vehicular traffic, which increases risks for bicyclists and pedestrians."[1]

Complete Streets audits are typically conducted as an initial step to improve the street environment for all travel modes and users within the selected area. Many individuals can participate: residents, stakeholders, and affiliated individuals. During the audits, positive practices are observed, and issues and opportunity areas are noted. Observations are made of the interactions among motorists, pedestrians, and bicyclists. Observations are based on the behavior of these different road users, particularly at intersections. For each opportunity area, the group discusses possible suggestions to address safety and operational concerns. Complete Streets walking audits are highly interactive, with many field observations. The audits are a means to observing and learning how to "see through the eyes of pedestrians and bicyclists."

This chapter presents observations and suggestions made during field observations conducted on February 28 and March 1, 2022.

Suggestions in this chapter are based on best practices and discussions with participants regarding local (campus) needs and feasibility. These suggestions are based on limited field observations and time spent in and around the University by the CSSA evaluators. These suggestions are intended to guide University staff in making decisions for future safety improvement projects on the campus; they may not incorporate all factors relevant to pedestrian and bicycling safety issues at the University. This report is conceptual in nature, and conditions may exist in the focus areas that were not observed and may not be compatible with suggestions presented below. Before finalizing and implementing any physical changes, University staff may choose to conduct more detailed studies or further analysis to refine or discard the suggestions in this report, if they are found to be contextually inappropriate or appear not to improve bicycling or pedestrian safety or accessibility due to conditions including, but not limited to, high vehicular traffic volume or speeds, physical limitations on space or sight distance, or other potential safety concerns.

To comprehensively plan for improving convenience and safety for pedestrians, bicyclists, and other users of human-scaled mobility devices throughout an entire city or campus, an Active Transportation Plan (ATP) is typically developed. Based on the evaluators' interactions with staff, participation at a campus alternative transportation committee meeting, and observation of issues and opportunities, it is suggested that the University pursue development of a campus-wide ATP in the near future, with a scope to include Cal Poly's interface with travelways of the City of Pomona and Los Angeles County. The 2021 *Bicycle Friendly University Feedback Report* prepared by the League of American Bicyclists recommended the creation of a Campus Bicycle Master Plan, which can be thought of a component of an Active Transportation Plan.

[1] Koukaitou-Sideris, A., Medury, A., Fink, C., Grembek, O., Shafizadeh, K., Wong, N., & Orrick, P. (2014). Crashes on and Near College Campuses: A Comparative Analysis of Pedestrian and Bicyclist Safety, *Journal of the American Planning Association*, 80:3, 198-217.

3.2. FOCUS AREAS

University staff requested the following focus areas be studied.

Table 3-1: Focus Areas

#	Focus Area	Segments	Issues
1	Camphor Lane	University Drive – east turnaround	Sidewalk gap, bicycle options
2	University Drive	Camphor Lane – Building 23	Crosswalks, bicycle options
3	Palm Drive & Oak Lane	Intersection	Crosswalks
4	Kellogg Drive, Eucalyptus Lane – South Campus Drive	Corridor	Bicycle and pedestrian options
5	Temple Avenue & University Drive	Intersection	Bicycle and pedestrian options
6	Temple Avenue & South Campus Drive	Intersection	Bicycle and pedestrian options
7	Kellogg Drive & University Drive	Intersection	Crosswalks
8	Kellogg Drive & Innovation Way	Intersection	Roundabout features

Figure 3-1 highlights these focus areas on a map.

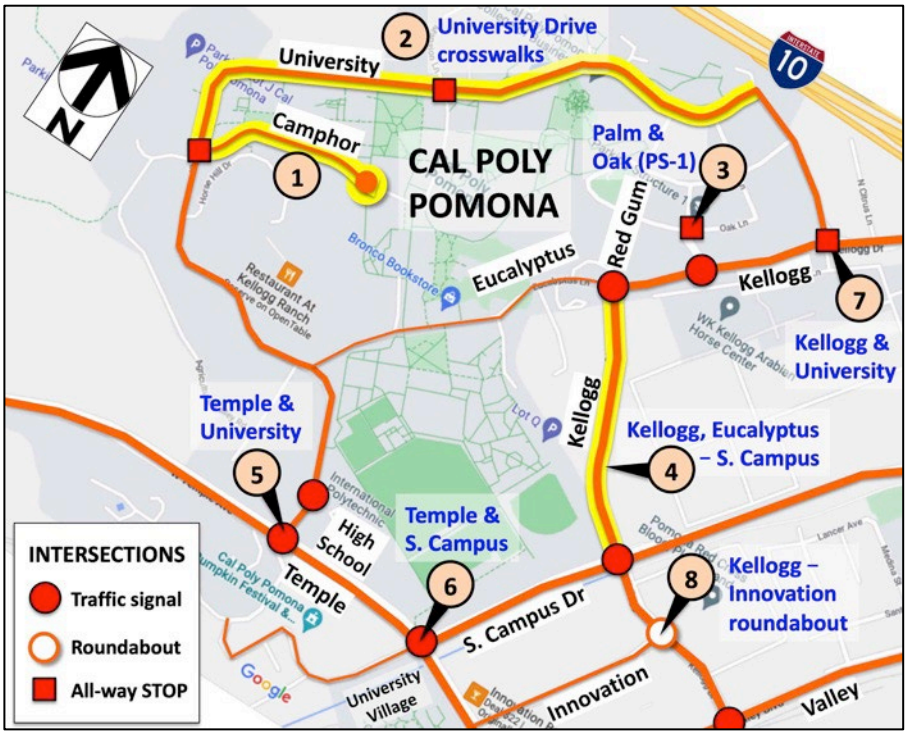


Figure 3-1: Map of Focus Areas

The evaluator explored the vicinity of each focus area with campus staff and stakeholders on the day of the field visit. Staff observations and notes appear in each subsection. Observations were conducted soon after the University returned to in-person classes during the Spring 2022 semester, however, because the Covid-19 pandemic was still underway what was observed may not reflect pre-pandemic peak period operation.

The following illustrated subsections address the focus areas listed and mapped above. Each contains an overview, observations, analysis, and suggestions.

This chapter concludes with Section 3.3, General Suggestions, which presents several treatments relevant to the focus areas that could also be considered for campus-wide application.

3.2.1. FOCUS AREA #1: Camphor Lane between University Drive and East Turnaround

Overview and Requests

Camphor Lane extends east from an all-way STOP controlled intersection with University Drive, between the southern edge of the Science and Environmental Design buildings and the hill where the Kellogg West Conference Center is located. The segment open to motor traffic ends approximately 0.3 miles (1,500', ~5-minute walk) east at a cul-de-sac between the Campus Center (Building 97) and Music (Building 24). The Camphor Lane designation continues east through a vehicle barrier approximately 250' (~1-minute walk) to Olive Lane Walk.

Campus staff requested a review of pedestrian conditions and bicycle options.

Figure 3-2, drawn on the campus map base, is an overview of the street and its eastern turnaround (orange), north sidewalk (blue), and marked crosswalk at the Kellogg Center steps (yellow).

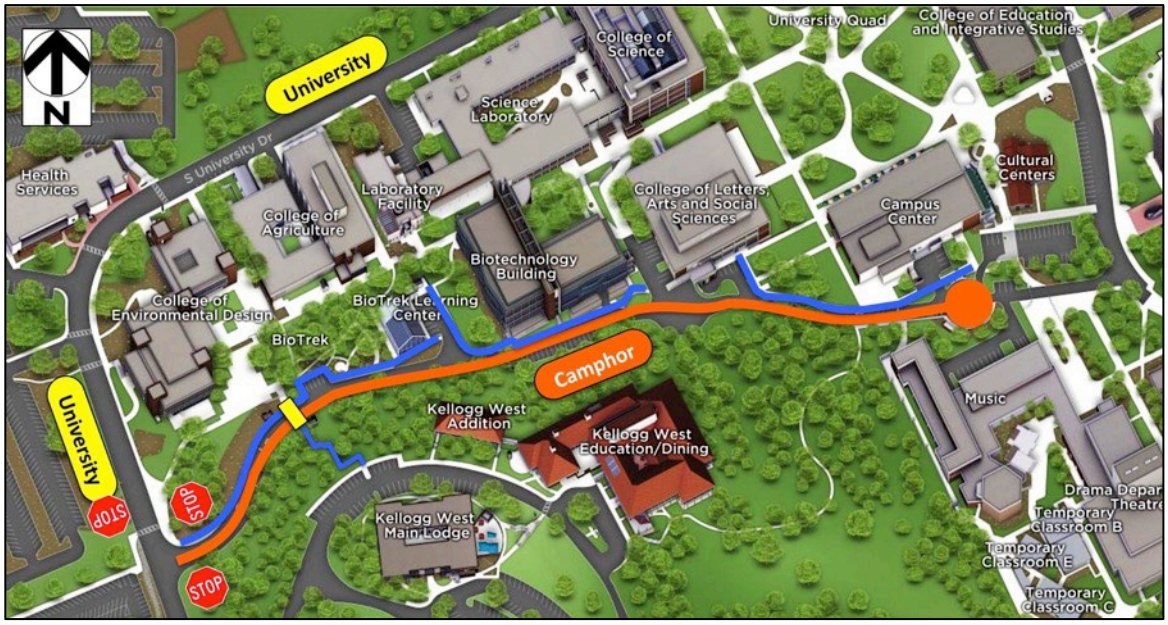


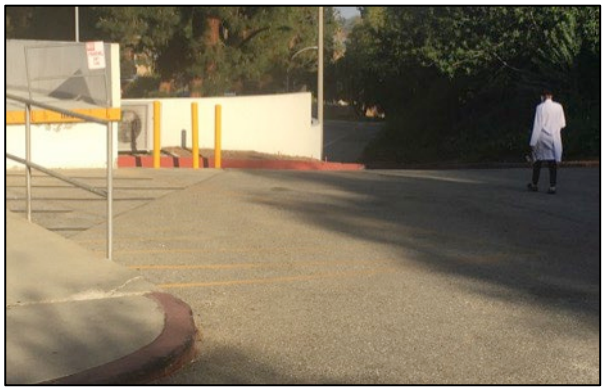
Figure 3-2: Camphor Lane Between University and Building 24 Turnaround

The street has one traffic lane in each direction, a double-yellow (no passing) centerline, no bike lanes, no parallel on-street parking (except for service vehicles), two pockets of perpendicular parking, and several driveways that access loading docks and off-street parking.

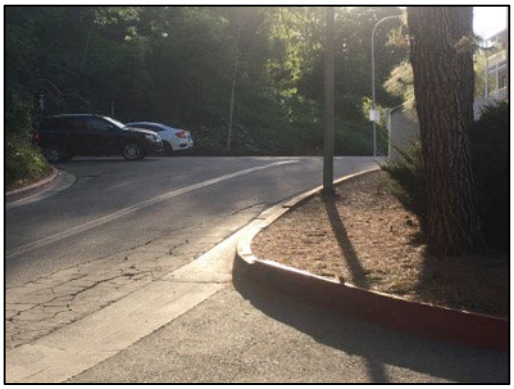
There is a continuous north sidewalk except behind Building 5 (College of Letters, Arts and Social Sciences), across its loading dock area and along the retaining wall between the dock and the building's south driveway. In that vicinity the street also descends sharply to the east.

a) Crosswalk at base of Kellogg West Conference Center stairs, facing east

b) Base of stairs (low lip)



c) Walking route past Building 5 loading dock, facing east (downhill)



d) Sidewalk gap and steep grade just east of Building 5 loading dock

Figure 3-3: Camphor Lane Observations

Observations and Analysis

Crosswalk at Kellogg Conference Center Stairway

As shown in Figure 3-3 a & b, there is a marked mid-block crosswalk at base of the staircase up to the Kellogg West Conference Center, at the location indicated by a yellow rectangle in Figure 3-2. Single-sided W11-2 (Pedestrian Symbol) signs face each approach. The east-facing sign (on the north sidewalk) is mounted to a streetlight pole. The west-facing sign is mounted on a wooden

post at the base of the stairs, in an area that no pedestrians traverse. Neither is accompanied by a W16-7p Downward Pointing Arrow plaque to indicate the crosswalk location.

The landing area at the base of the stairs is flush with the street except for a one-inch lip that may be a tripping hazard. That landing has a detectable warning strip (yellow raised dots).

The crosswalk's north end has no detectable warning strip or curb ramp. Visually impaired walkers can use the stairs and need a detectable warning to determine where to enter the street to align with the crosswalk. A curb ramp would assist visually impaired persons and also those with hip mobility issues who find it awkward to step up or down at a curb.

Sidewalk Gap Behind Building 5

There appears to be sufficient width to install a 36" or wider sidewalk along the side of the existing retaining wall. Striping a walkway (two white lines) diagonally across the loading dock area would guide pedestrians to this added sidewalk segment.

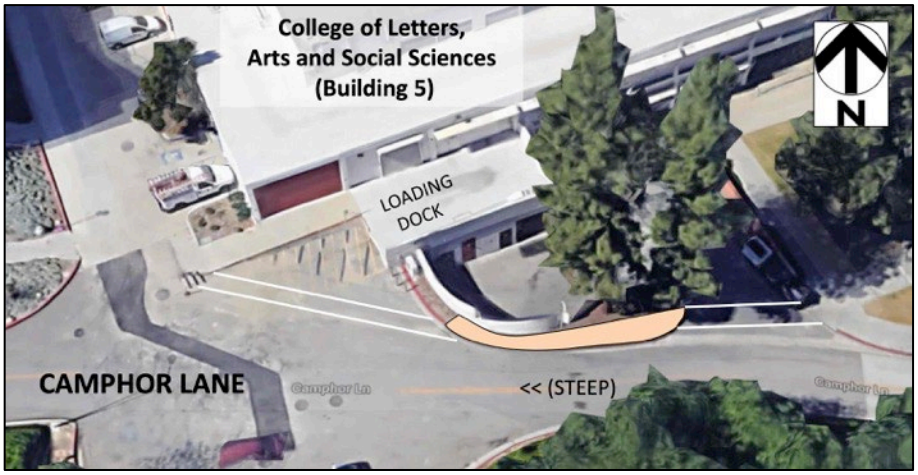


Figure 3-4: Camphor Lane behind Building 5 – sidewalk gap closure concept

Bicycle Accommodations

Because the street is a dead-end for private vehicles, motor traffic volume is low. However, it is used for deliveries to buildings and informally by app-based ride-hailing services for pickup/drop-off of passengers because the eastern turnaround is conveniently located in the campus core.

Because motor traffic volume is low, there is no need for bike lanes even if they would fit. Due to the horizontal curves on the relatively flat segment between University and Building 5, motor vehicles will mostly travel at bicycle compatible speeds. On the short steep segment behind Building 5, climbing (westbound) bicyclists will typically travel much slower than motor vehicles.

Adding periodic Shared Lane Markings ("sharrows") centered in the lane (typically 5' from the centerline) could help to encourage bicyclists to use the full width of the narrow lanes, especially when descending at speed.

To remind motorists that state law requires that bicycles be passed with safe clearance, R117 (CA) "PASS [BIKES] 3 FT MIN] regulatory signs could inform eastbound drivers entering from University Drive and westbound drivers before the steep segment behind Building 5.

Bicyclists unfamiliar with the campus and motorists considering using a bicycle could benefit from bicycle guide signs, with direction and distance to destinations along Camphor Lane and in the campus core. The MUTCD D1-series signs may be useful (those with the "c" suffix include distance).

a) R117 (CA) sign

b) D1-series bicycle guide signs

c) Shared Lane Marking ("sharrow")

Figure 3-5: Bicycle Signs and "Sharrow" Marking

Suggestions

Table 3-2: Suggestions for Camphor Lane

#	Location	Item	Suggestion
1	Crosswalk at Kellogg Center staircase	Warning signs	Add W16-7p Downward Pointing Arrow plaques below the existing W11-2 Pedestrian Symbol signs. Ensure that the bottom edge of the north sign assembly is at least 7' above the sidewalk. (The south sign assembly is in a non-walking area.) Consider adding a west-facing sign assembly on the northern pole (the one on the sidewalk).
		Stair base lip	Remove trip hazard by reconstructing step or conforming asphalt
2	Building 5 loading dock area and retaining wall	Sidewalk gap	Install sidewalk for approximately 50' along wall, in landscape area. Consider adding two white lines across dock area and lower driveway.
3	Bicycle accommodations	Markings	Consider placing Shared Lane Markings ("sharrows) at each end and spaced periodically in-between.
		Regulatory signs	Consider R117 (CA) "PASS [BIKES] 3 FT MIN signs just in from University Drive and facing east before the grade behind Building 5.
		Guide signs	Indicate destinations with direction (arrows) and optionally distance. Consider MUTCD D1-series bicycle guide signs.

3.2.2. FOCUS AREA #2: University Drive Mid-Block Crossings and Bicycle Options

Overview and Requests

University Drive extends 1.8 miles from Temple Avenue to Kellogg Drive, forming the northern part of the campus perimeter loop, as well as the main campus roadway through the core of campus. However, a portion of University Drive from Camphor Lane to Red Gum Lane was anticipated to under go a pavement rehabilitation project, at the time of this CSSA. Much of the signage, striping and ADA crossings are anticipated to be addressed as part of that ongoing capital renewal project.

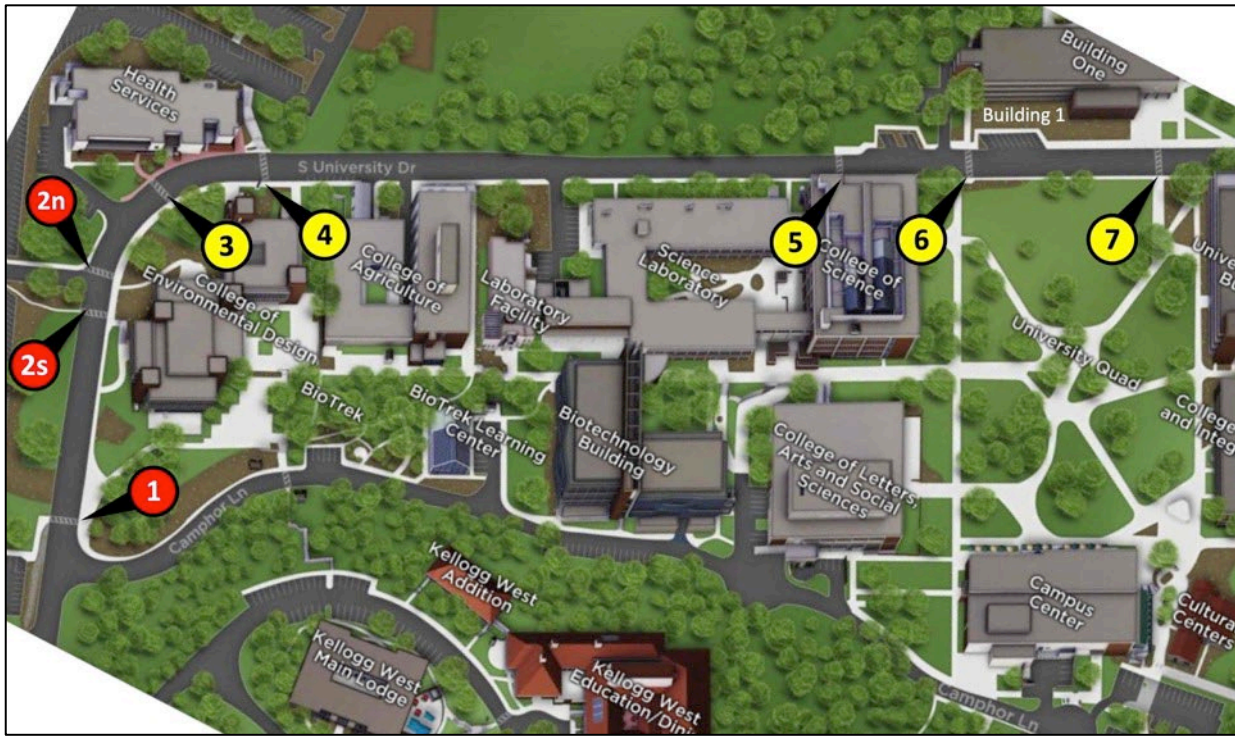
Nonetheless, campus staff requested a review of crosswalks and bicycle options on the 0.8-mile segment between Camphor Lane and Alamitos Residence Hall (Building 22), to help with future project scoping and phasing. This segment has:

- One traffic lane in each direction
- Continuous sidewalk on at least one side
- Parallel parking on some segments
- Pockets of perpendicular parking at various locations
- No bike lanes or bicycle-specific signs or markings

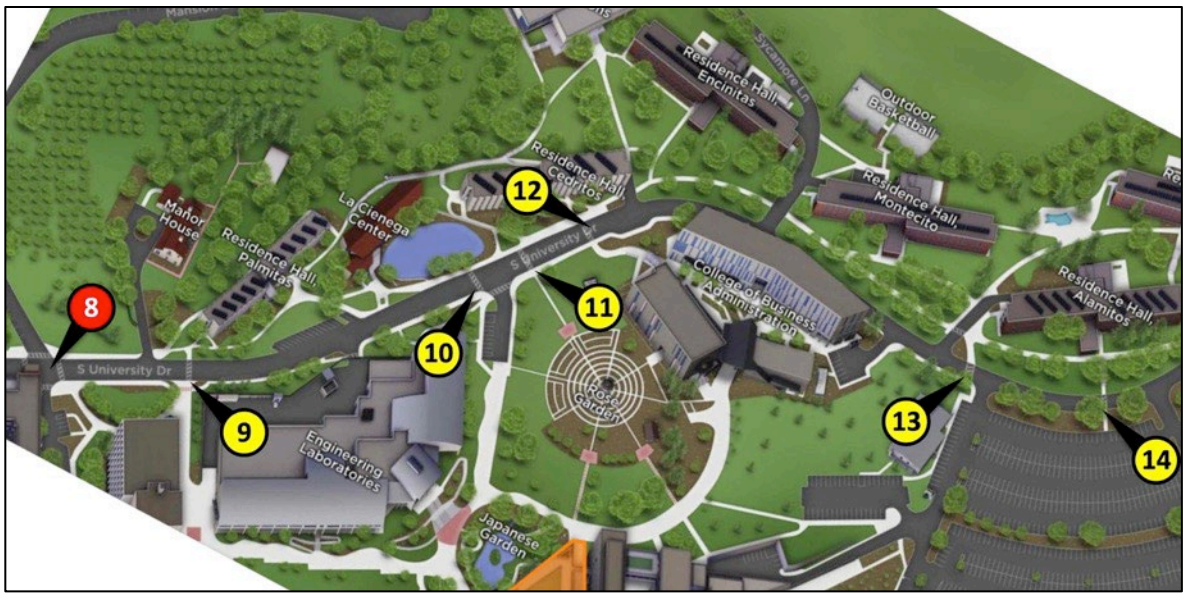
Crosswalks

Locations and Attributes

Figure 3-6 shows the 14 crosswalks or crosswalk groups along the study segment. Red pins indicate STOP-controlled approaches; yellow pins indicate uncontrolled approaches.



a) Western Portion (Camphor Lane – Building 1)



b) Eastern Portion (Building 1 – Alamitos Residence Hall / Building 22)

Figure 3-6: University Drive Crosswalks – Key Map

Table 3-3 summarizes the attributes of the crosswalks (see legend and notes below table). Shaded rows indicate STOP-control,

Table 3-3: University Drive Crosswalks – Attributes

#	[Building] Location (compass)	Leg	Ctrl	RCW	Mkgs	Signs at XW	Notes
1	Camphor Lane	N	S	Y	T4	SB: WRC	1
2s	Lot J driveway	N	S	N	T4	STOP	
2n		S	S	N	T4	STOP	
3	[46] Health Center (W)	NA	U	Y	T4	2 WRC	
4	[46] Health Center (E)	NA	U	Y	T4	None	2, 3
5	[3, 8] Science	NA	U	Y	T4	2 WRC	
6	[1] Building 1 / Quad (W)	NA	U	Y	T4	WB: WRC	4
7	[1] Building 1 / Quad (E)	NA	U	Y	T4	WB: WRC EB: YB	
8	Olive Lane Walk / Mansion Lane	ALL	S	N	T4	STOP	5
9	Engineering driveway / Palmitas Hall	E	U	N	T4	None	6
10	Rose Garden lot driveway / pond	W	U	N	T4	2 W11-2	
11	Rose Garden axis / Cedritos Hall (W)	NA	U	Y	T4	2 WRC	
12	[58, 163, 164] Cedritos / Bus. Admin	NA	U	Y	T4	None	7
13	Red Gum Lane / Alamitos Hall (W)	W	U	Y	C, T4	2 WRC	
14	Alamitos Hall (center)	NA	U	Y	C, T4	EB: WRC WB: WRC+YB	8

LEGEND

Abbr	Meaning	Values
Ctrl	Traffic control	S = STOP (controlled approach), U = Uncontrolled *(For clarity, STOP-controlled locations are shaded orange)*
RCW	Raised crosswalk	Y (Yes, speed table), No (at street grade)
Mkgs	Markings	T4 = Triple-Four (two rows of 4’ wide white rectangles separated by 4’)
Signs at XW	Signs located at the crosswalk	WRC = Non-standard warning sign (yellow diamond shape) with pedestrian symbol above a line above the text “RAISED CROSSWALK” W11-2 = MUTCD standard Pedestrian Symbol sign 2 XXX = Type XXX sign facing each approach YB = Round yellow flashing beacon (a.k.a. “yellow ball beacon”)

NOTES

Note	Description
1	Warning sign is mounted below STOP sign (may reduce comprehension of STOP sign)
2	**Sharp crest vertical curve restricts visibility for eastbound approaching traffic**
3	Warning sign and round yellow flashing beacon 50’ east, facing westbound traffic
4	Warning sign is 10’-15’ upstream of crosswalk. Relocate to crosswalk.

5	Bollard-triggered In-Pavement Warning Lights on all 4 crosswalks (no buttons to press)
6	South end of crosswalk ends within wide driveway apron
7	Warning signs are upstream of crosswalk. Relocate to crosswalk.
8	Yellow ball beacon 450' east, facing westbound traffic

Signs and Markings

Eleven (11) of the crosswalks have uncontrolled approaches; these are known as "uncontrolled crosswalks" (Table 3-3, rows without orange shading). Uncontrolled crosswalks should always have warning signs (yellow diamond shape) at the crosswalk. Three (#4, #9, #12) currently have no warning signs at the crosswalk and one (#6) has a warning sign on only one approach.

The non-standard warning signs labeled "WRC" above have three elements: a pedestrian symbol, a horizontal line that appears to depict the raised portion of the crosswalk, and the words "RAISED CROSSWALK" below that combined graphic. These convey two messages:

- (graphic) Crosswalk – expect pedestrians
- (word message) The crosswalk is raised (i.e., expect deflection; reduce speed if needed)

However, the word message is not needed because all 10 raised crosswalks have MUTCD-standard "speed hump" chevron markings on both approaches. Thus all "WRC" signs could be replaced with standard W11-2 + W16-7p crosswalk warning sign assemblies, which are likely recognizable earlier because they have a much larger pedestrian icon and are used nationwide.

It is worth noting that the University recently retained a contractor to rehabilitate the pavement on University Drive between Camphor Lane and Red Gum Lane. This project is referred to as the Roads & Walkways Project Phase K (a.k.a. University Drive Shuttle-Lane Project). As part of the contract, the contractor will replace existing roadway traffic signs and striping with CA MUTCD compliant signs, and will construct ADA access improvements at the crosswalks.

Figure 3-7: Typical Raised Crosswalk With Existing 1-Sided Warning Signs (#5)

The CA MUTCD W84 (CA) "SPEED HUMPS AHEAD" sign can be used to inform motorists upon entry to a street segment with raised crosswalks.

a) Existing non-standard sign at raised crosswalks

b) MUTCD standard warning sign assembly to be located at the crosswalk (note larger pedestrian symbol)

c) CA MUTCD W84 sign

Figure 3-8: Crosswalk-Related Signs

Suggestions

Table 3-4: Suggestions for University Drive crosswalks

#	Location	Item	Suggestion
1	Uncontrolled crosswalks	Sign assemblies at crosswalks	Replace non-standard signs ("WRC") with W11-2 Pedestrian Symbol signs above W16-7p Downward Pointing Arrow plaques.
2		Sign location	Relocate all crosswalk warning sign assemblies that are not adjacent to their crosswalk, to their crosswalk.
3		Increasing sign conspicuity by double-siding	Consider making all crosswalk warning sign assemblies double-sided so they visually "bracket" each approach. *NOTE: The left-side arrow and the left-side "walker" should point into the street. MUTCD 2A.06 Design of Signs permits mirror-imaged symbols. Special ordering may be needed to obtain.*
4	Entire study segment	Advance warning sign	Consider installing CA MUTCD W84 (CA) "SPEED HUMPS AHEAD" signs in advance of series of raised crosswalks
5	All signs	Sign height where pedestrians travel	Ensure that the bottom edge of the lowest sign or plaque on the post is at least 7' above the walking surface.
6	Health Center, east crosswalk	Visibility to eastbound drivers	Relocate crosswalk closer to the crest so its signs (to be added) and markings are seen early enough by eastbound drivers. To block pedestrians from continuing to cross on the current alignment – which directly serves their desire line, remove the bottom segment of the north staircase and install a fence to turn pedestrians westward, to the west end of the existing fence.
7	#7, #14	Round beacons	Consider removing the slow-flashing round beacons.
8	All uncontrolled crosswalks	Optional additional active warning device	After installing standard crosswalk warning sign assemblies (see #1 above), if motorist-yielding behavior is deemed insufficient at any uncontrolled crosswalk, consider installing Rectangular Rapid Flashing Beacons at that crosswalk.

Bicycle Options

Existing Conditions

The study segment currently has one travel lane each way and a double-yellow (no passing) centerline. There is insufficient width for bike lanes, and except westbound (uphill) between the Quad and the Health Center, motorists probably do not travel much faster than bicyclists due to the raised crosswalks. (A westbound bike lane there would indeed benefit bicyclists, if right-of-way is available.)

Despite the lack of bike lanes, the 25 MPH posted speed and relatively low volume presumably enables motorists to safely pass bicyclists by partly or fully encroaching into the opposing lane, across the double-yellow centerline. Some state vehicle codes include what is known as an "Obstacle Clause," specifically allowing this maneuver – if done safely -- whenever a traveler or object ahead is either stopped or moving much more slowly than normal traffic. Currently, California Vehicle Code (CVC) has no such provision. That said, this maneuver is routine throughout the state, and is not typically cited by law enforcement unless performed unsafely.

The CA MUTCD has two regulatory signs that could be considered to cue safe passing of bicyclists. The R4-11 ("[BIKES] MAY USE FULL LANE") reminds all travelers that it is legal for bicyclists to occupy a lane that is too narrow for safe passing within the lane (14' minimum width not counting door-opening zone along parallel-parked vehicles, if present). However, this sign does not by itself cue safe passing behavior.

In contrast, that is the specific purpose of California's R117 (CA) sign ("PASS [BIKES] 3 FT MIN"). It is suggested to consider installing R117 (CA) signs periodically, except where sightlines (due to vertical or horizontal curves) are inadequate for safe passing (for example, approaching the top of the hill by the Health Center).

Before the R4-11 and R117 (CA) signs became available, it was common practice to install Share The Road ("STR") sign assemblies to encourage cooperation in shared lanes by motorists and bicyclists, specifically in shared-lane situations. However, FHWA's MUTCD FAQ (https://mutcd.fhwa.dot.gov/knowledge/faqs/faq_part9.htm#signsq5) now discourages this:

> ***Q: Should "share the road" signing be used to inform drivers of the likely presence of bicyclists and to inform them to pass bicyclists safely?***
>
> *A: …In the years since its adoption in the 2000 MUTCD, research has shown that the "share the road" message when applied to bicyclists does not adequately communicate the responsibilities of either user group on the roadway. Road users are unclear whether "share the road" means that drivers should give space when passing or that bicyclists should pull to the side to allow drivers to pass. Where bicyclists are expected or preferred to use the full lane, that message is more clearly communicated with the Bicycles May Use Full Lane (R4-11) sign, supplemented by shared-lane markings as appropriate…*

The above guidance does not mention California's R117 (CA) sign because it is state-specific. On campus it is suggested to consider using the R117 (CA) as needed rather than the R4-11.

a) CA MUTCD R117 (CA)

b) MUTCD R4-11

c) Share The Road assembly (now discouraged by FHWA)

Figure 3-9: Signs To Encourage Safe Shared Lane Use

The Shared Lane Marking (Figure 3-5(c)) could also be considered. Figure 3-10 reprints Figure 9C-108 (CA) from the current version of the California MUTCD, which illustrates proper "sharrow" placement relative to the available safe rideable width (the "Effective Lane").

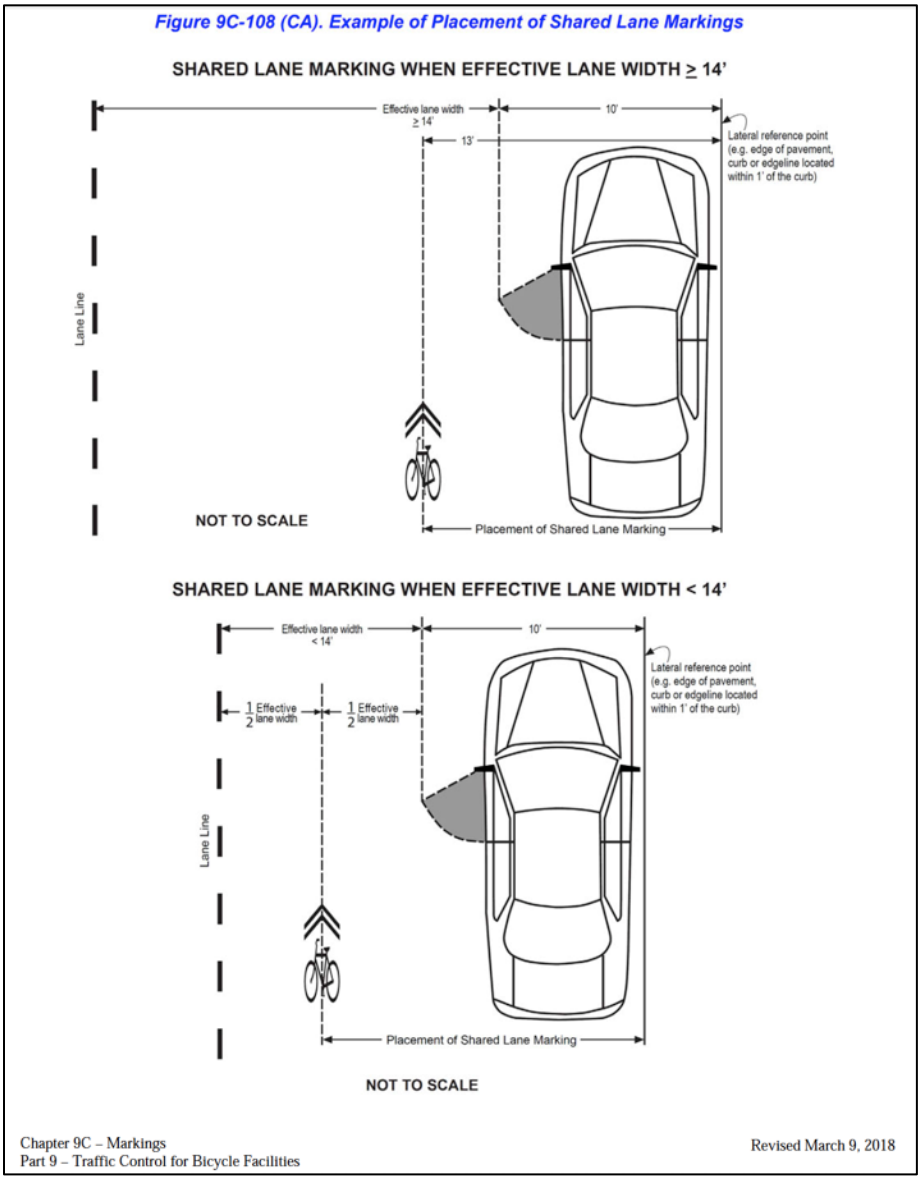


Figure 3-10: California MUTCD Figure 9C-108 (CA) – Sharrow placement

Planned conditions

The Campus Master Plan Update (2019) slide presentation includes a proposed cross section that would remove parallel parking and add an eastbound transit lane shared with bicycles, emergency vehicles and campus service vehicles. (It did not state whether the raised crosswalks would be reconstructed to span the new three-lane cross section, or would only span the non-transit travel lanes.)

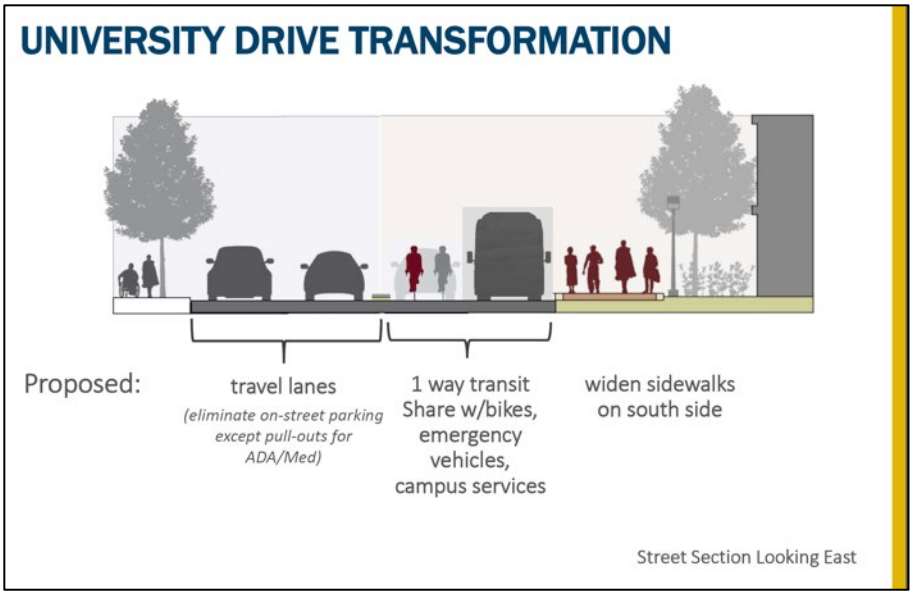


Figure 3-11: Draft 2040 Campus Master Plan Update Proposed Cross-Section

When the eastbound transit lane is implemented there will presumably be no need for R117 (CA) "PASS [BIKES] 3 FT MIN" in the eastbound direction because drivers of shuttles, emergency vehicles and campus service vehicles will be expected to know (or will be trained) to do this safely.

In the development of engineering plans for the street transformation, consider providing a westbound bike lane on the steep segment between the Quad and the Health Center, if sufficient total width exists, to enable bicyclists to climb the hill without passing conflicts.

3.2.3. FOCUS AREA #3: Palm Drive / Oak Lane (Parking Structure 1) intersection

Overview and Requests

Oak Lane runs east-west through the eastern (parking-intensive) area of the campus. Palm Drive intersects from the south at an all-way STOP controlled intersection whose north leg is the south access of Parking Structure 1, with two entry lanes and one exit lane. Palm is a one-block street that connects to Kellogg Drive at a traffic signal just 250' south of Oak.

Campus staff requested a review of pedestrian safety and intersection operations.

For motor traffic, Oak Lane's west leg serves only the north driveway of Parking Lot F8; immediately beyond it is closed to motor traffic by a line of bollards. Oak Lane's east leg has two approach lanes, from both of which left turns can be made, and two departing lanes. The #1 (left) departing lane passes by a staffed visitor information booth at which parking permits can be purchased; the #2 (right) departing lane bypasses the booth.

Palm Drive has two approach lanes with an advance limit line, and two departing lanes. Both approach lanes can proceed straight into Parking Structure 1.

Crosswalks with "Triple-4" patterns are present on the west and south (Palm) legs. The south crosswalk (across Palm) has bollard-triggered In-Pavement Warning Lights (no buttons to press). There are no crosswalk markings across the north (PS1) leg or the east (Oak) leg.

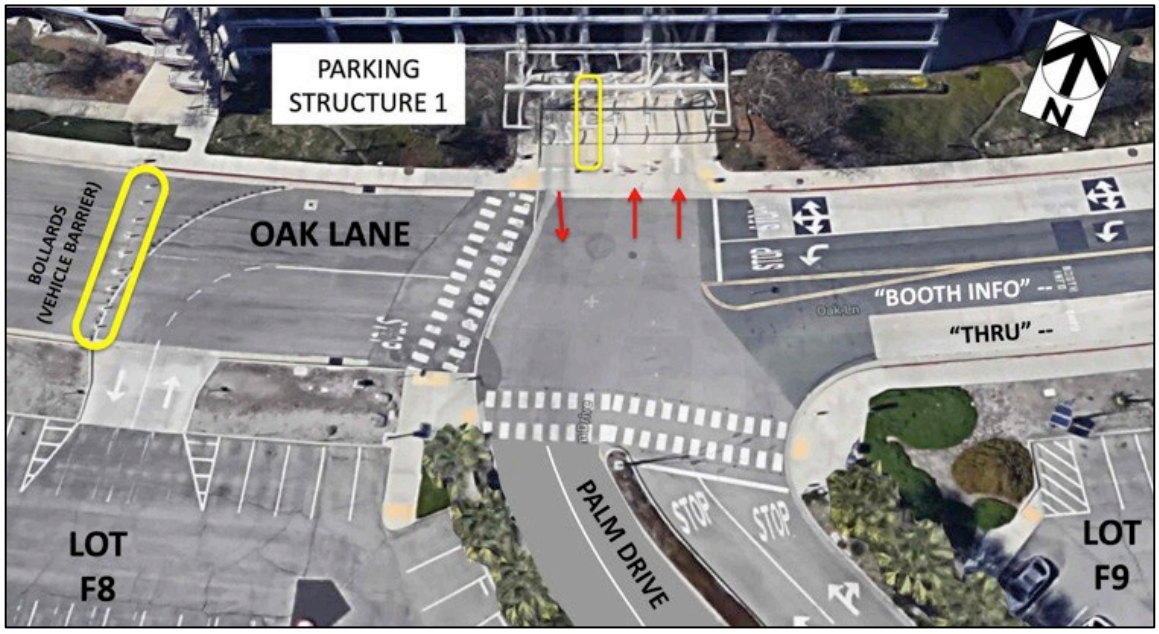


Figure 3-12: Parking Structure 1 south access at Palm / Oak

Observations

Several factors combine to create considerable uncertainty and hesitation at this intersection:

- Motorists proceed asynchronously from the six approach lanes as they obtain gaps.
- Vehicles entering PS1 are sometimes delayed, causing following motorists to wait in their approach lane or sometimes while partly across the intersection.
- At peak periods many pedestrians use the south leg, making it challenging for motorists to proceed straight across to enter or exit PS1, or to turn left from Oak Lane's east leg.

The evaluator parked in Parking Structure 1. The internal queue for the southbound (Palm Drive) egress was very long and took many minutes. (Although PS1 has a north access on Magnolia Lane, using that exit incurs additional delay for motorists bound for westbound Kellogg Drive because of the need to either also traverse the Oak/Palm intersection or proceed east to often-congested University Drive to turn right onto Kellogg.)

Analysis

The number of interactions (thus potential conflicts and uncertainty) among motorists and between motorists and pedestrians at this intersection is strongly related to total entering vehicle volume and also to pedestrian crossing volume across the south leg. If either volume component could be reduced while still serving all trips (pedestrian and motorist), intersection operation could be improved and delays reduced.

Reducing South-Leg Pedestrian Volume by Increasing Use of the East And North Crosswalks

Many pedestrians who use the south crosswalk are traveling between Lot F9 (SE quadrant) and the campus core west of PS1. If a substantial fraction could instead use the intersection's east and north legs, this could reduce motorist delay and hesitation related to the south crosswalk.

The east leg receives only one lane of traffic from other legs. A painted median narrows down the departure, setting up a 200' queue lane for the visitor booth 300' east of Palm. Widening that median installing a raised island would enable comfortable use of the east crosswalk.

The north crosswalk spans PS1's two entry lanes and single exit lane. Rectangular islands that protect the structure's columns separate these three lanes. Extending those islands to the north sidewalk would provide refuge areas for pedestrians there.

Figure 3-13: Concept For Enhancing East And North Crosswalks

Reducing Vehicle Volume at Palm/Oak With a New Connection to Westbound Kellogg

It might also be possible to reduce the vehicle volume through the Palm/Oak intersection during the afternoon peak by giving motorists who park in PS1 and surrounding lots another way to enter westbound Kellogg Drive. Cypress Lane runs north-south from University Drive at Alamitos Hall (Building 22), between lots F1/F2, F3/F4, PS1/F5, and F9/F10 before dead-ending at the drainage channel that separates lots F9/F10 from the north edge of Kellogg Drive.

If that south dead-end became a right-turn-only egress to westbound Kellogg Drive, it could enable motorists bound for westbound Kellogg from PS1 via its north (Magnolia) driveway and users of all lots served by Cypress to avoid the Palm/Oak intersection. Implementation could necessitate changes to Lot F9 and F10 driveways along the southernmost block of Cypress.

A traffic volume analysis for the entire parking complex east of Red Gum Lane, accounting for all potential changes in motorist route choice due to the addition of this access to westbound Kellogg, could perhaps confirm its utility for decongesting Palm/Oak especially in the afternoon / evening. Such an analysis is beyond the scope of this report.

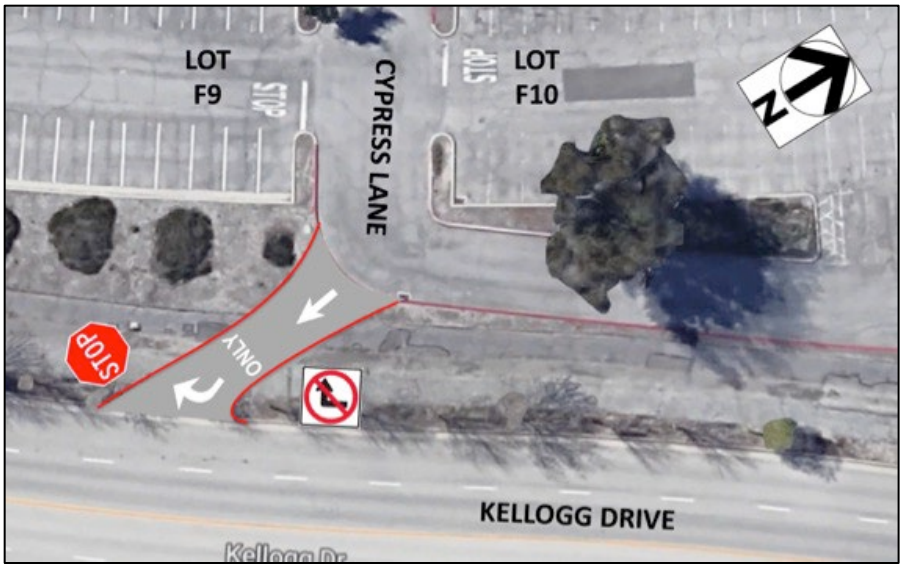


Figure 3-14: Concept For Connecting Cypress Lane To Westbound Kellogg Drive

Suggestions

Table 3-5: Suggestions for Palm Drive / Oak Lane / PARKING Structure 1 intersection

#	Location	Item	Suggestion
1	East leg & crosswalk	Improving for pedestrians	Widen the painted median island to the south to narrow the departure to one lane. Install a raised island. Mark crosswalk.
2	North leg (PS1) crosswalk	Improving for pedestrians	Extend the two islands between the lanes, southward to the back of the north sidewalk, to serve as refuge areas for north-leg pedestrians.
3	Cypress Lane	South dead-end	Consider connecting to westbound Kellogg Drive with a right-turn-out-only junction (i.e., no ingress from Kellogg and no access to eastbound Kellogg).

3.2.4. FOCUS AREA #4: Kellogg Drive between Eucalyptus Lane and South Campus Drive

Overview and Goals

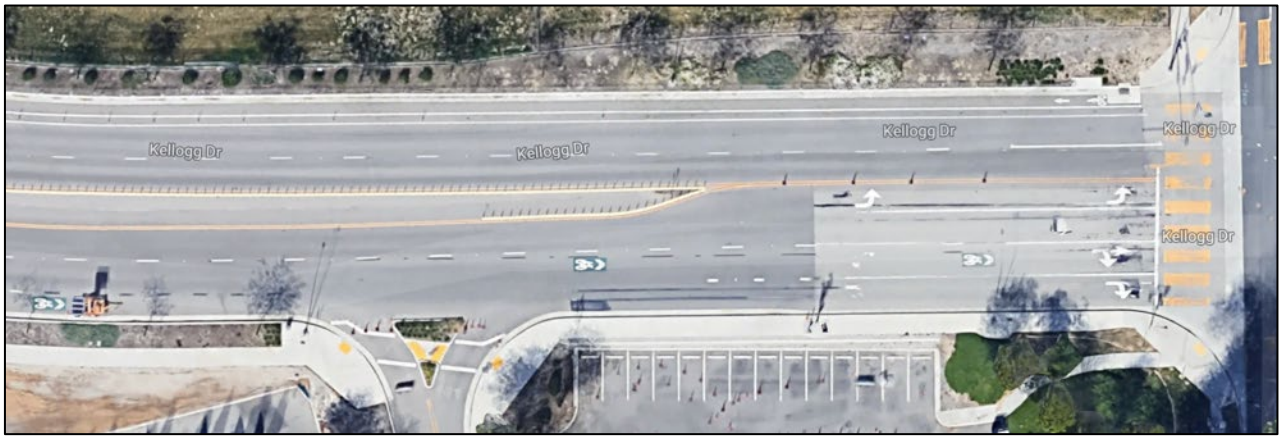
Kellogg Drive runs east-west between the I-10 interchange and its signalized intersection with Red Gum Lane (north leg) and Eucalyptus Lane (west leg). It runs north-south between that intersection and its signalized T intersection with Valley Boulevard, between which it crosses South Campus Drive (signal) and Innovation Way (roundabout).

The north-south segment between Eucalyptus and South Campus Drive is approximately 1,900’ long (about 1/3 mile). On this stretch the east side is occupied by agricultural parcels with no driveways. The west side is more developed with the Phase I dormitories and CenterPoint Dining Hall. It has a wide tree-buffered sidewalk that functions as a shared use path and two driveway T-intersections: Lot Q and P (full-movement) and Lot B (right-in / right-out) respectively 700’ and 250’ from South Campus Drive.

There are protected bike lanes in both directions for most of the segment's length. The buffers have flexible delineators in some areas. However, most of the delineators are missing due to damage and vandalism.

a) South leg at Eucalyptus / Red Gum: northbound through bike lane beyond mixing zone

b) Lot Q and P driveway: dashed bike lane with green infill



c) Lot B driveway – South Campus Drive: shared through+right option lane with sharrows

Figure 3-15: Kellogg Drive between Eucalyptus Lane and South Campus Drive

Observations and Analysis

In the northbound direction approaching the Eucalyptus Lane / Red Gum Lane / Kellogg Drive signal the protected bike lane transitions to a long conflict area where right-turning motorists cross to enter a right turn only lane, along which there is a through bicycle lane. Bicyclists continuing northbound onto Red Gum Lane are not able to hit the pedestrian call button, and so a green signal phase is often not triggered if no vehicle is waiting on that same approach.

The street signs on the mast arms at this intersection are also confusing for motorists. Motorists taking southbound Kellogg Drive are often confused as to whether to continue onto Eucalyptus Lane or turn left on Kellogg Drive, as the approaches are slightly skewed. The skip-striping through the intersection also do not present clear turn guidance.

The southbound buffered bike lane ends over 100' north of the Lot B driveway, south of which Kellogg's approach to South Campus Drive has four lanes: left-only, through-only, through-and-right, and right-only. Because the rightmost through lane is an option through-and-right lane there

is no way to mark a through bike lane that is controlled by the same signal phase as the vehicular movements. Instead, through bicyclists are guided by green-backed Shared Lane Markings ("sharrows") centered in the #3 (through-and-right option) lane.

Preparing to proceed through by merging into a shared option lane that carries high traffic volume at peak periods, from which many vehicles turn right, and controlling that lane by riding centered in it, are high-stress maneuvers that can challenge even experienced bicyclists especially in low-light and nighttime conditions. The state of the practice in bikeway network planning uses the Level of Traffic Stress ("LTS") framework, which rates segments and intersection approaches on a scale of 1 (least stress) to 4 (highest stress). The LTS approach seeks to create a low-stress network that serves all significant destinations with LTS 1 or 2 segments and intersections because higher-stress ones are effectively gaps for traffic-sensitive users. The bicycle movements expected on the southbound approach to South Campus Drive would probably be rated LTS 3 or 4.

On Kellogg Drive's north-south segment, all pedestrian traffic is already accommodated on the wide west sidewalk because the east side has only agricultural uses and has no driveways or sidewalk. It seems likely that with current land use, all bicycle traffic on this segment could also be accommodated just on the west side with either a two-way in-street cycle track or the bicycle portion of a wide off-street shared-use path ("side-path"). Several factors support this:

- Because the Kellogg Drive – South Campus Drive – Temple Avenue through route is a "zigzag" for motorists that carries cross-town traffic unrelated to the University in addition to campus-associated traffic, the northbound right turn and westbound left turn from Kellogg to Kellogg and the southbound right turn and eastbound left turn between Kellogg and South Campus Drive are especially heavy, with three of these four movements served by multiple turn-only or through-and-turn option lanes that create challenges for both bicyclists and pedestrians.

- Northbound (campus-bound) bicyclists arriving from South Campus Drive, upon reaching the southwest corner at Eucalyptus Lane, could proceed either:

    - West along Eucalyptus (low volume, connects to off-street shared-use paths),

    - North (needing only to cross the one-way entrance driveway of the Student Services Building's transit / drop-off / pickup loop before reaching a shared sidewalk to continue west), or

    - East via the south-leg crosswalk and the abandoned segment of Eucalyptus Lane to the Equestrian Center, Interim Design, Apparel and the Facilities complex.

Also, Red Gum Lane (the north leg of the Eucalyptus Lane / Red Gum Lane / Kellogg Drive intersection) has a motor vehicle closure just north of the Lot C / Lot F8 driveways, beyond which bicyclists can use the full street width to continue into the campus core.

Accommodating all bicycle traffic on a west-side bikeway between Eucalyptus Lane and South Campus Drive would eliminate the high-stress southbound "lane-control" situation approaching South Campus Drive and the somewhat high-stress northbound lateral move across the right turning movement approaching the Eucalyptus Lane signal.

Eliminating the east-side northbound bike lane north of South Campus Drive would, however, require that bicyclists northbound on Kellogg Drive approaching South Campus Drive from the south transition to the northwest corner of that intersection. Experienced bicyclists may legally use the northbound left turn lane like a vehicle, however providing a Two-Stage Bicycle Turn Box at the intersection's north corner (if feasible) would enable that maneuver to be performed as a northbound through movement followed by a westbound through movement. See Focus Area #5 for details of Turn Boxes`.

Less experienced bicyclists could use the south and west crosswalks to reach the northwest corner. Because the City of Pomona is planning to construct a 14-foot wide 3.5-mile shared use path ("San Jose Creek Greenway Trail") along San Jose Creek, which crosses Kellogg Drive adjacent to the south crosswalk, it seems likely that the south crosswalk will be enhanced to support additional two-way bicycle traffic related to the trail – possibly with "cross-bike" markings parallel to the pedestrian crosswalk. As such, that crosswalk / cross-bike can also serve bicyclists approaching on northbound Kellogg Drive who wish to reach the northwest corner to enter the suggested west-side cycle track. Figure 3-16 is a map from the July 7, 2018 Inland Valley Daily Bulletin article titled *"Pomona Plans to convert San Jose Creek Channel into a trail."*

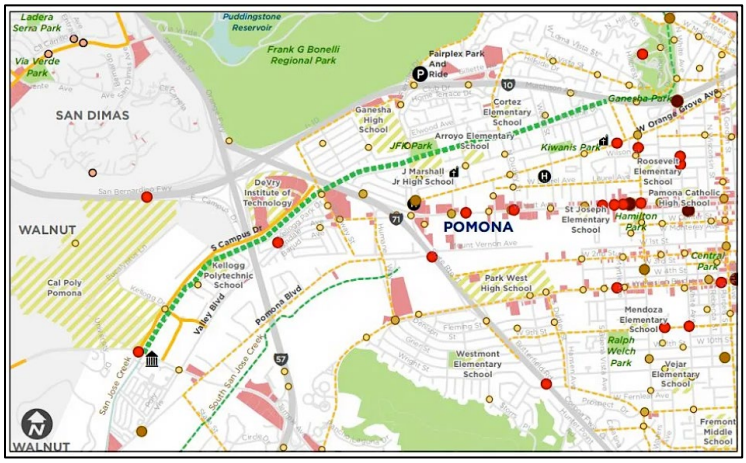


Figure 3-16: San Jose Creek Greenway Trail alignment (Daily Bulletin, 2018)

Suggestions

Table 3-6: Suggestions for Kellogg Drive between Eucalyptus and South Campus Drive

#	Location	Item	Suggestion
1	Kellogg / Red Gum / Eucalyptus westbound approach	Directional Sign	Install a directional sign indicating Kellogg Drive left turn and Red Gum Lane right turn.
2	Kellogg Drive protected bike lane	a) Alignment & bikeway type	Medium-long term: Consider eliminating the northbound protected bike lane and transferring its width to the west side to create a two-way cycle track on that side.
		b) Separators (both directions)	Short-term: Evaluate options for replacing or augmenting the raised separators with more durable devices that provide equal or superior protection from motor vehicle traffic.
3	Eucalyptus signal	West leg	If a west-side two-way cycle track is implemented to the south, consider adding a “cross-bike” (two-way bicycle crossing) inboard of the west crosswalk
4	Red Gum Lane Eucalyptus	West side 2-way bikeway	Continue the two-way cycle track north along the west side of Red Gum Lane to either: * the east-west sidewalk along the north side of the Student Services Building’s transit loop, or * just beyond the motor vehicle barrier at the Lot C / Lot F8 driveways
5	Eucalyptus east of Kellogg	Bicycle accommodation	Provide a bicycle ramp between the Eucalyptus/Kellogg intersection’s southeast corner sidewalk area and the western dead end of old Eucalyptus Lane. Provide a bicycle through onto the east-end cul-de-sac of the abandoned segment of Eucalyptus. Add a traffic signal camera to detect bicyclists approaching westbound from the east leg of Eucalyptus Lane. (The four major approaches already have traffic detection cameras.)

Figure 3-17 illustrates several of these suggestions, with connections to other campus areas.

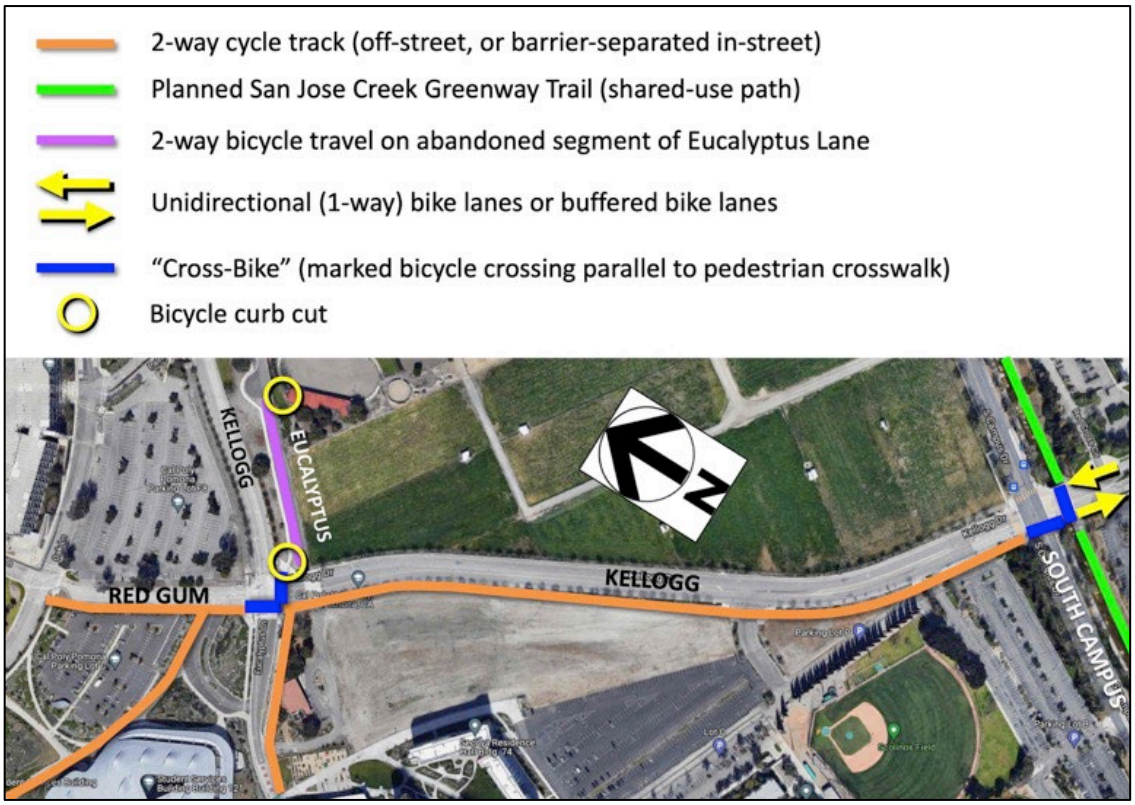


Figure 3-17: Kellogg Drive / Red Gum Lane Cycle Track Network Concept

3.2.5. FOCUS AREA #5: Temple Avenue / University Drive intersection

Overview and requests

Temple Avenue, a multi-lane arterial, intersects University Drive at a signal on the south edge of campus. Here Temple Avenue runs east-west and University Drive runs north-south, as shown in Figure 3-18. The International Polytechnic High School's parking lot occupies the northeast corner; the other corner parcels are agricultural. University's south leg continues up a hill, past Cal Poly Farm's west driveway, to the 16-acre Lyle Center for Regenerative Studies.

The only sidewalk is on the east side of University's north leg. Marked yellow high-visibility crosswalks on the east and north legs connect the northeast corner to far-side bus stops on Temple's south side (eastbound) and north side (westbound).

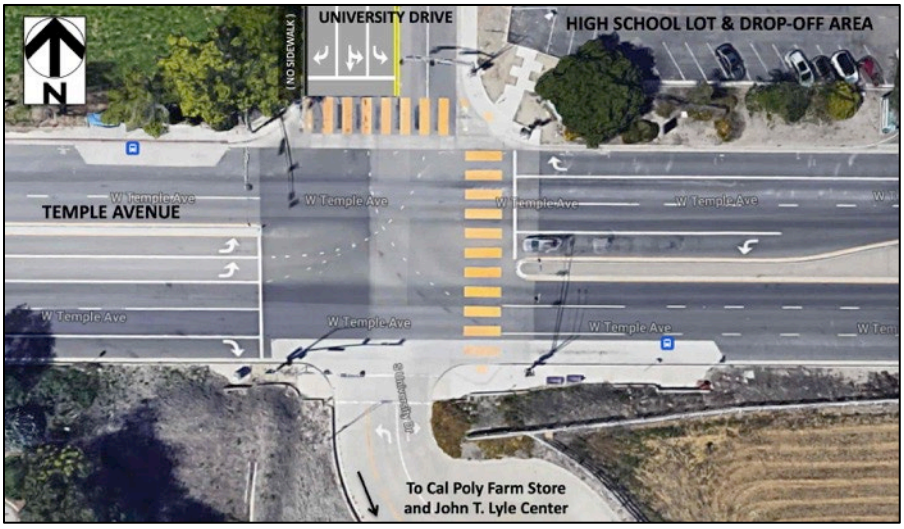


Figure 3-18: Temple Avenue / University Drive intersection

Temple's west and east legs are controlled by the County of Los Angeles and the City of Pomona, respectively. The County's Temple Avenue Complete Street Improvements project proposed to add one-way cycle tracks for 3/4 mile west of University Drive, connecting to the recently completed City of Walnut / Mt. Sac Class II Bike Lanes. Figure 3-**19** from that project shows the proposed lane configuration – 7' bike lanes and 5' buffers with flexible delineators, i.e., basic one-way cycle tracks. We assume this cross section is distant from University Drive and thus does not depict left or right turn lanes.

Campus staff requested ideas to facilitate a future connection for bicyclists between the west (Temple Avenue) leg and University Drive, assuming the County of Los Angeles's bikeway project advances.

Analysis

This is a four-way intersection at which bicyclists may legally make all through and turning movements. For commutes to and from campus via the west leg (serving the City of Walnut), the key movements are the left turn from eastbound Temple Avenue and the southbound right turn

onto westbound Temple Avenue. The latter movement will have no conflict with traffic on Temple Avenue because the proposed westbound cycle track will receive it.

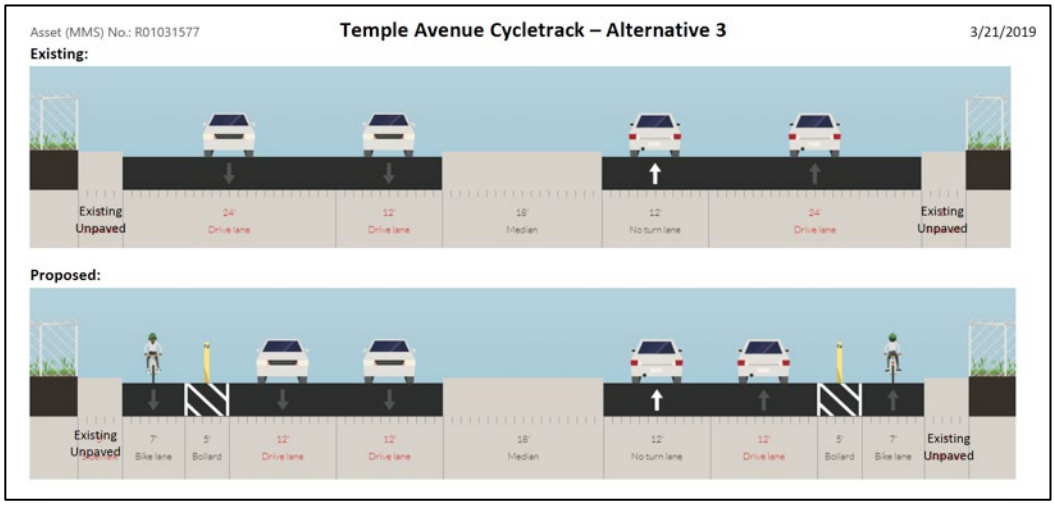


Figure 3-19: Temple at University west leg – existing and proposed

Eastbound bicyclists may legally turn left like a vehicle by merging across both through lanes into the left turn lane, but Temple's traffic speeds and volume make this daunting and risky for all but the most experienced riders. Instead, most bicyclists will likely make the movement using a so-called "two-stage left turn," which consists of a through movement while their signal is still green, a stop near the far corner to reorient the bike and wait for green on the cross street, then a through movement on the cross street. This movement can be supported by a "Two-Stage Bicycle Turn Box" — an area large enough for bicyclists to stop and reorient the bicycle, colored green and containing left-turn arrow and bicycle-and-rider markings. Figure 3-20 (from the National Association of City Transportation Officials / NACTO) shows two typical locations for the box relative to motor vehicle lanes and the approaching bicycle movement. The right-hand option is applicable at Temple / University (visualize east at the top of the figure).

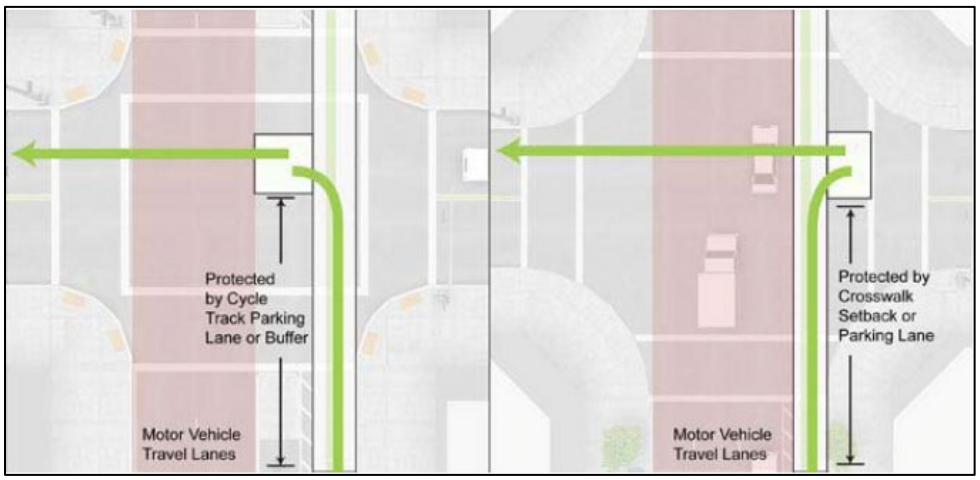


Figure 3-20: Two-Stage Bicycle Left Turn Box Location Options (NACTO)

In July 2017 FHWA issued Interim Approval Memorandum IA-20 for turn boxes, and Caltrans adopted IA-20 in August 2017. FHWA's IA-20 memo includes two MUTCD-style figures showing its application — one for when the box's use by bicyclists is optional (i.e., where a vehicular left turn lane exists, as is the case at Temple / University — see Figure 3-21) and one for when it is mandatory (i.e., where no vehicular left turn lane exists). Note the optional D11-series guide signs to inform bicyclists about the box's purpose and use. Those signs are intentionally not regulatory (black-on-white) signs because this figure depicts the non-mandatory case (bicyclists could legally turn left from the left travel lane). Also note the "No Turn On Red" restrictions where right turns cross the boxes.

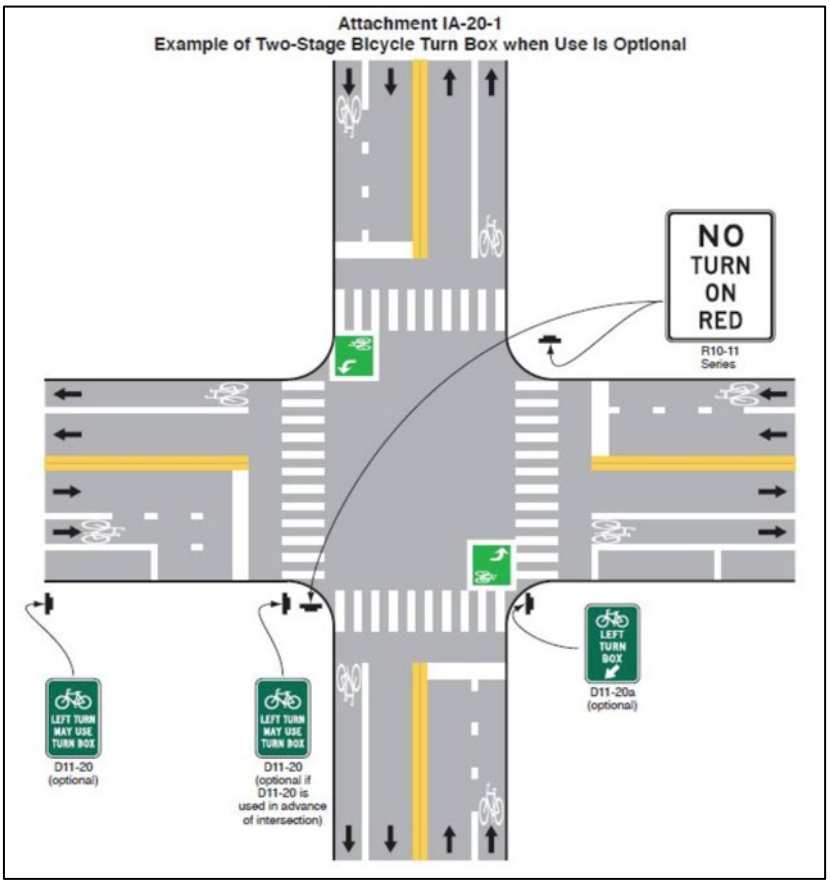


Figure 3-21: FHWA Interim Approval IA-20 Figure Applicable Where Vehicular Left Turns Are Legal

Figure 3-22 shows an example in San Francisco. The turn box is in the area "shadowed" by (i.e., directly downstream of) the parking lane and curb extension on the approach (top of photo).

At this San Francisco intersection there is a marked crosswalk behind the turn box (left side of photo). A marked crosswalk likewise exists across University's south leg at Temple, however there are no pedestrian destinations on the southwest quadrant (a vacant hillside) or nearby on that leg's west side, so a southeast corner turn box could potentially occupy the eastern half of what is now the south-leg crosswalk, and could extend north to Temple's south curb face (unlike the inner line of a crosswalk).

Figure 3-22: Two-Stage Bicycle Left Turn Box Example (11th & Howard Streets, SF)

This section does not conclude with a concept figure for use of a turn box at Temple / University because the future lane configuration of Temple's west leg was not known as of this writing. The conceptual layout would depend on:

- whether eastbound vehicular right turns will use a dedicated right turn lane as is currently the case, or a "mixing zone" that the eastbound cycle track transitions into, and
- whether the City of Pomona implements a bike lane or cycle track continuing east

Suggestions

Table 3-7: Suggestions for Temple Avenue at University Drive

#	Location	Item	Suggestion
1	Eastbound approach, south leg	Two-stage bicycle turn box	a) Consider incorporating a turn box near the southeast corner of the intersection, along with appropriate guide and regulatory signs as suggested by Figure 3-21.
			b) If the south-leg crosswalk is deemed unnecessary, consider using its eastern half as part of the turn box.
2	Westbound approach, north leg	Two-stage bicycle turn box	If the City of Pomona adds a westbound bike lane or cycle track on the east leg, consider incorporating a turn box near the northwest corner to support two-stage bicycle left turns toward the south leg (Cal Poly Farm, Lyle Center). (Because the north-leg's marked crosswalk serves the westbound far-side bus stop, it should be retained.)
3	East crosswalk	Signal phasing	Consider adding a Leading Pedestrian Interval (LPI) phase, a.k.a. Pedestrian Head Start.
4		Signs	Consider prohibiting westbound right turn on red, perhaps at peak periods.

3.2.6. FOCUS AREA #6: Temple Avenue / South Campus Drive intersection

Overview and Requests

The major signalized intersection of Temple Avenue and South Campus Drive defines the south corner of the main campus. Although the intersection's legs are not aligned with the cardinal compass directions, this section will use the convention that Temple runs east-west and South Campus Drive runs north-south. The intersection's four quadrants are respectively occupied by:

- [NW] Large digital sign and landscape mound with palm trees, southwest corner of Athletics area, south end of Parking Structure 2, west end of Parking Lot B
- [NE] West end of Innovation Village (research and development buildings)
- [SE] Northeast corner of University Village (student residences); its north driveway is 240' west of Temple.
- [SW] Agricultural field (Cal Poly Farm and the Pumpkin Festival & Pumpkin Patch)

The intersection's west, north and east crosswalks are marked with high-visibility yellow "Continental" markings (ladder rungs). The south crosswalk is visually distinguished with a contrasting pavement treatment but does not have white or yellow paint or thermoplastic markings.

Campus staff requested a review of the intersection from a pedestrian and bicycle perspective, and also of routes into the campus from University Village.

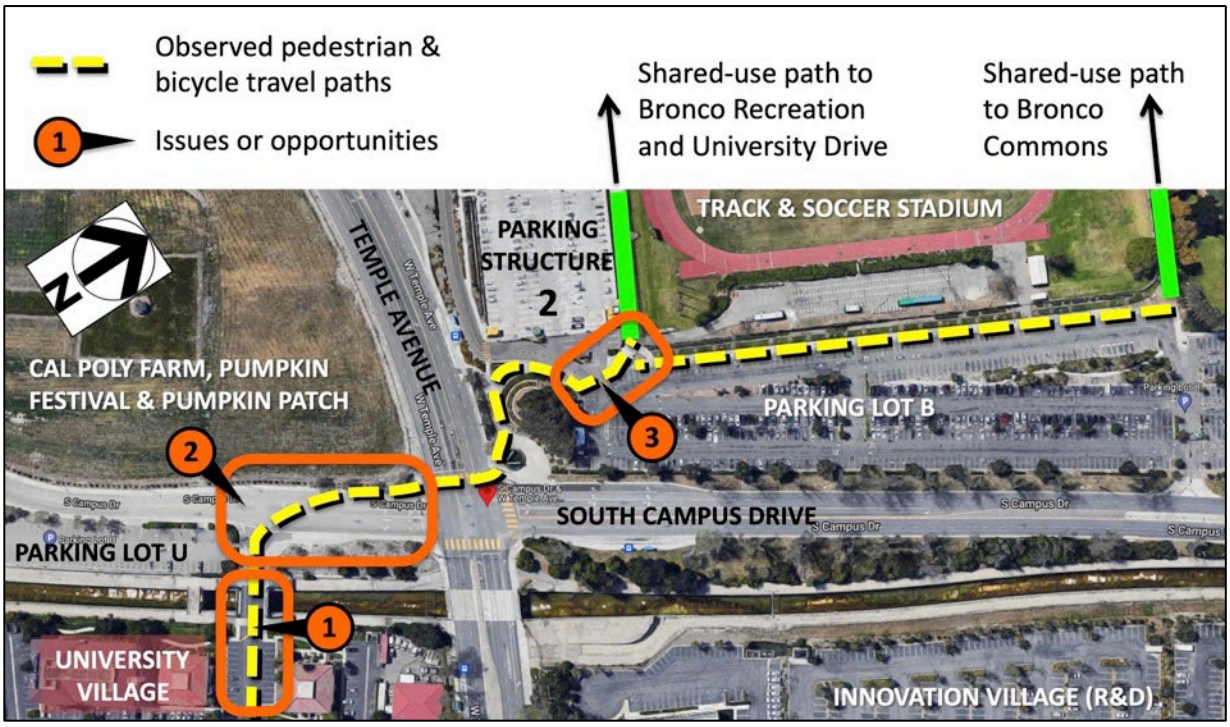


Figure 3-23: Temple / South Campus intersection and U-Village route to campus

Figure 3-23 shows the intersection and its vicinity, plus two key shared-used paths (green) that connect north through the Athletics complex to Bronco Commons / Recreation, University Drive, and the campus core to the north. The dashed yellow line indicates pedestrian and bicyclist movements observed during the field visit. The numbered orange rectangles indicate areas with opportunities to increase pedestrian and bicyclist convenience, comfort and safety.

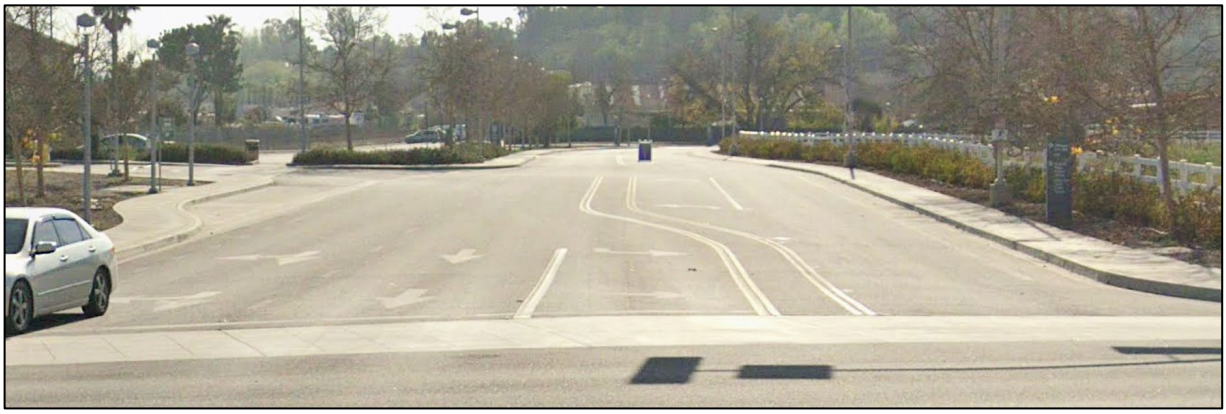
The following discussion is presented in two sections — south of Temple Avenue (Areas 1 & 2) and north of Temple (Area 3).

Between University Village and Temple

Observations

Figure 3-24 shows University Village's north driveway (Area 1 in Figure 3-23) and the south leg of South Campus Drive that connects it to Temple Avenue (Area 2).

a) [Area 1] University Village Driveway Facing East From Temple; Lot U At Right



b) [Area 2] South Campus Drive South Leg; University Village Driveway at Center Left

Figure 3-24: University Village North Access on South Campus Drive

As shown by the dashed yellow line in Figure 3-23, most pedestrians traveling from University Village to campus and back do not use the east sidewalk and the intersection's south, east or north crosswalks. They instead walk a direct "desire line" diagonally across South Campus Drive, along the west sidewalk, and cross Temple Avenue at the west crosswalk. From there they follow the wide walkway around the west side of the large monument sign, cross Lot B's northwest access road on a marked crosswalk, and either continue west on the wide path along the north

side of Parking Structure 2 or north along the westerly edge of Lot B to another wide path between the Track and Soccer fields and the baseball stadium.

Most University Village bicyclists basically followed the same travel path except for riding in the street northbound along the west edge of South Campus Drive, and returning further south in the street, in or near the westbound left turn lane that serves the driveway.

Analysis

The “cross diagonally and follow the north edge” travel choice reduces both absolute travel time and travel-time uncertainty. In contrast, using the south sidewalk and west crosswalk (“two legs of a triangle”) takes longer — especially if a northbound vehicle is turning right onto Temple — and risks missing the west crosswalk’s pedestrian phase, incurring several additional minutes of delay due to the signal’s long cycle time. Because relatively few vehicles travel south of Temple and most are going to or from the U-Village driveway, pedestrians and bicyclists generally experience few conflicts when crossing the street diagonally near the driveway.

It would be advantageous to support the direct “desire line” used by University Village residents while reducing or eliminating vehicle-pedestrian and vehicle-bicycle conflicts.

For pedestrians, the driveway has sidewalks on both sides but there is no mid-block crosswalk and refuge island to support crossing directly to the north sidewalk. However, the south leg of the driveway intersection is ideal for this because it is opposite the southbound left turn lane.

For bicyclists, the driveway has no bike lanes or exclusive bikeway. Bicyclists who use the entry/exit lanes must get in line with motor vehicles, and can be delayed by entering or exiting vehicles. Bicyclists who use sidewalks conflict with pedestrians. Providing bicyclists with a separate way to connect between University Village’s internal streets and South Campus Drive west of the driveway would avoid those conflicts.

The driveway has its own bridge over the San Jose Creek channel. 60’ west there is a smaller bridge possibly used by vehicles that service the creek corridor. That bridge could convey a shared use path across the creek, connecting University Village’s north perimeter walkway (which could be widened for shared use) along the east edge of Parking Lot U to a crosswalk across South Campus Drive just west of the driveway. South Campus Drive’s west sidewalk could be widened for shared use between that crosswalk and Temple Avenue.

Figure 3-25 shows the combined pedestrian and bicycle concept. Crosswalk warning sign assemblies are not shown.

Figure 3-25: Concept for Improved University Village Ped-Bike Route To Campus

Table 3-8: Suggestions for University Village links to Temple / South Campus intersection

#	Location	Item	Suggestion
1	University Village north driveway	Pedestrian and bicycle access across street at driveway	Install a crosswalk just west of driveway with high-visibility markings. In the mid-street area "shadowed" by the westbound left turn lane, install a raised median refuge (pair of islands) Install crosswalk warning sign assemblies, using W11-15 Trail symbol signs because of expected use by bicyclists.
2	Separate bicycle path to suggested crosswalk	Alignment	Utilize the small service vehicle bridge across the San Jose Creek channel just west of the driveway. Widen University Village's north perimeter walkway for shared use between that bridge and the north end of the nearest north-south drive aisle to the west. Install a path from the north end of the small bridge, along the south and east edges of Parking Lot U, to the new crosswalk.
3	Shared use along north side of South Campus Drive	Operating width	Widen the north sidewalk to at least 12' between the new crosswalk and the northwest corner waiting area at Temple. If needed, provide a larger storage area behind that corner to accommodate eastbound pedestrians and bicyclists waiting to cross Temple, and to safely receive westbound pedestrians and bicyclists who cross simultaneously.
4	South crosswalk at Temple Avenue	Markings	To provide a higher-contrast edge for guiding low-vision pedestrians across the street, consider adding 12" white or yellow lines adjacent to the existing contrasting pavement treatment.
5	Crosswalks at Temple Avenue	Signal phasing	Consider adding Leading Pedestrian Interval (LPI), a.k.a. Pedestrian Head Start, phasing to the west crosswalk (across Temple) and possibly other crosswalks at this intersection.

Between Temple / South Campus Drive Intersection And Central Campus

Observations

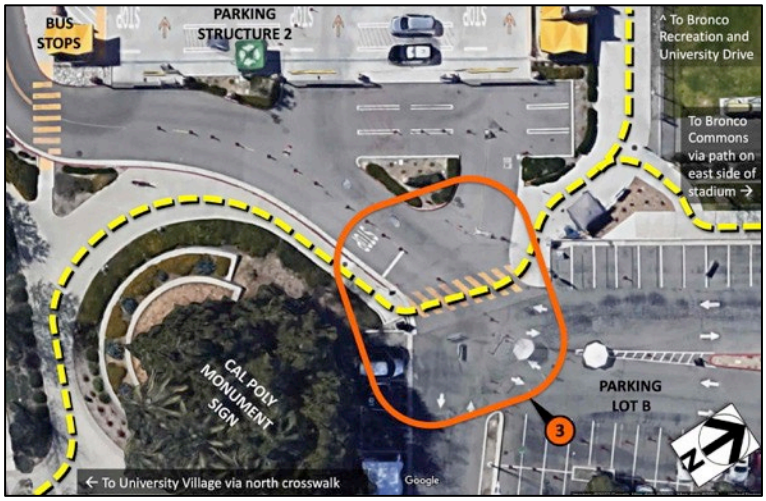
As noted in the previous section and depicted in Figure 3-23 and Figure 3-27, after crossing Temple Avenue via the west crosswalk, pedestrians and bicyclists share a wide walkway around the large landscape feature on the intersection's northeast corner, then cross the north access road of Lot B near the east end of Parking Structure 2 (PS2) via a marked crosswalk, then either continue west on the path along the north side of PS2 or north along Lot B's west edge to another wide path that runs between the Track and Soccer fields and the baseball stadium.

Figure 3-26: Walkway Around Digital Sign And Landscape Feature On Northeast Corner

The crosswalk at the west end of Lot B has high-visibility markings but no warning signs. It has five approaching vehicle movements — two eastbound (into Lot B) and three westbound (out of Lot B). Eastbound, the main approach is STOP-controlled but the approach from PS2's closest drive aisle does not, and it is not clear whether motorists departing PS2 obey that sign. The westbound approaches from Lot B's three drive aisles have no STOP signs.

Suggestions

To improve motorist yielding compliance, enhancements could be considered for the crosswalk and for nearby circulation. Crosswalk warning sign assemblies would identify and highlight the location. Double-sided assemblies would also present left-side signs. Because of high bicycle use, the warning signs could be the W11-15 Trail symbol (bike above "walker"). Finally, raising the crosswalk would create a slow point, as with the raised crosswalks on University Drive.



a) Context

b) Trail crossing sign assembly (W11-15 sign at top)

b) View from junction of Lot B's three western drive aisles. Note digital sign and adjacent parked vehicle.

Figure 3-27: Crosswalk Across Parking Lot B Northwest Access Road

In addition to improving the crosswalk, combining multiple approaches into single flows could potentially help motorists focus on the crosswalk. On the west side this would involve the south end of Parking Structure 2's east drive aisle and its parking stalls near the crosswalk. On the east side, it would involve Lot B's three aisles and their mixing zone near the crosswalk.

Table 3-9: Suggestions for crosswalk at Parking Lot B west access point

#	Location	Item	Suggestion
1	Crosswalk	Signs	Install double-sided crosswalk warning sign assemblies consisting of W11-15 Trail symbol signs above W16-7p Downward Pointing Arrow plaques.
2		Traffic calming	Consider raising the crosswalk and installing MUTCD standard speed table chevron markings like the ones on University Drive's raised crosswalks.
3		South end sightline obstructions	Evaluate whether the real-time "parking spaces available" sign blocks visibility of eastbound sidewalk users from westbound motorists. Evaluate whether a tall or large vehicle parked in the stall closest to the real-time "parking spaces available" sign blocks visibility of eastbound sidewalk users from westbound motorists. If either is found to be the case, implement solutions.
3	Drive aisle junctions near the crosswalk	PS2 east drive aisle	Consider realigning to form a combined intersection with PS2's central drive aisle, further away from the crosswalk.
		Lot B drive aisles that end near the crosswalk	Evaluate whether joining the three drive aisles would increase motorist awareness of the crosswalk. If so, modify Lot B's west-end circulation area accordingly.

3.2.7. FOCUS AREA #7: Kellogg Drive / University Drive Intersection

Overview

University Drive currently has a 4-way STOP-controlled intersection at Kellogg Drive near the north end of campus and terminates 125' east at 3-way STOP-controlled intersection with Eucalyptus Lane. (Although the legs of both intersections are not aligned with the cardinal compass directions, this section will use the convention that Kellogg and Eucalyptus run north-south and University Drive runs east-west.)

Campus staff requested a review of the University / Kellogg intersection for safety and convenience of all modes, with particular attention to pedestrian connectivity between the campus core and Eucalyptus Lane in this area.

Kellogg connects to Interstate 10 and is the north access to campus. A two-lane non-stop slip lane receives the high volume of AM southbound arrivals turning right onto University Drive from the I-10 Freeway.

Figure 3-28: University at Kellogg and Eucalyptus – Existing Conditions

Observations and Analysis

Connecting Pedestrians Across The Existing Intersection

Eucalyptus Lane has a sidewalk along its west side between Citrus Drive (350' north of University) and Kellogg's intersection with Red Gum Lane (1,500' south of University). A sidewalk also connects the southeast corner of the University / Eucalyptus intersection along the south edge of Parking Lot E2 to the front walkway of adjacent Building 89 (Interim Design Center).

University Drive has no sidewalks or marked crosswalks between Eucalyptus Lane and the main campus. There is ample width to add a sidewalk in the south-side landscape area between Kellogg and Eucalyptus (embanked up, with a few small trees) and west of Kellogg (a line of tall mature trees). The only obstacle is the drainage swale along Kellogg's west side, which can be easily bridged.

The southwest and southeast corner radii seem overly large (approximately 35'). If they could be reduced to, say, 25' that would substantially shorten the crosswalk and also enable the northbound limit line to be moved closer to University. See items (1) and (2) in Figure 3-29.

W11-2 Pedestrian Symbol signs are mounted beneath the STOP signs on University's eastbound approach to Eucalyptus and on Eucalyptus' northbound approach to University. Crosswalk warning signs are not appropriate on STOP- or signal-controlled approaches, so these signs and can be removed (and reused elsewhere). See items (3) in Figure 3-29.

The suggested curb ramps and their detectable warning strips (yellow) are oriented directly across the street because there is currently no need for crosswalks on the west or east legs.

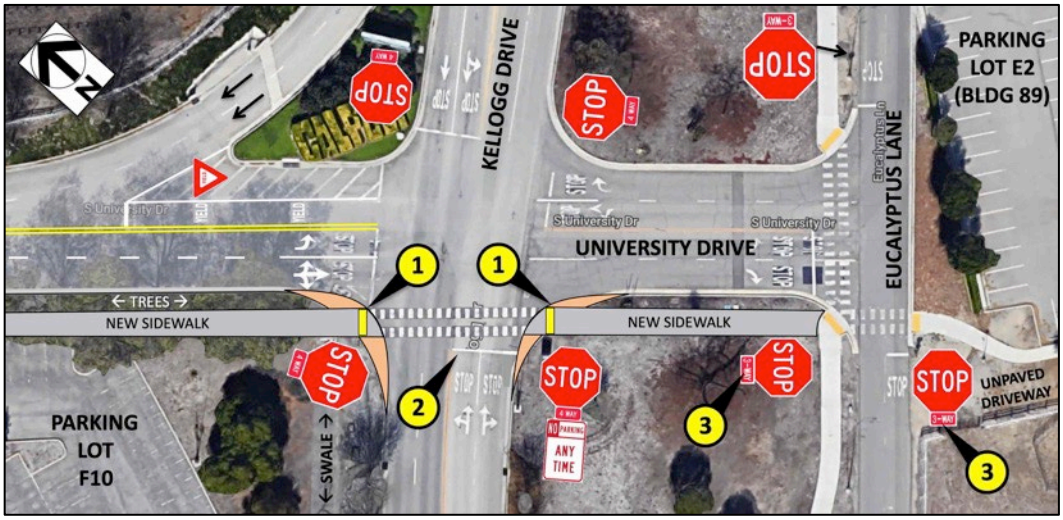


Figure 3-29: University at Kellogg and Eucalyptus – Sidewalk & Crosswalk Concept

Transforming the intersection to improve performance and safety, and support development

The University / Kellogg intersection is the last major junction on the northbound route to Interstate 10, both for campus motorists and for through traffic from South Campus Drive. Motorists at this intersection experience substantial vehicle delays and queue lengths especially in the PM peak period when the eastbound (University) and northbound (Kellogg) approaches are busiest. The two-lane approaches create hesitation as to when it is safe to enter.

The University staff informed the evaluators that there are future plans to signalize this intersection. However, such an all-way STOP controlled intersection with two-lane approaches can often be comfortably replaced with a single-lane roundabout because vehicles can enter simultaneously from all legs of a roundabout. The result typically reduces or eliminates vehicle delays and queuing, and greatly reduces crash frequency and severity. A roundabout also significantly improves pedestrian safety by greatly reducing crossing distances and providing median refuges that replace simultaneous multiple-direction decisions with two shorter single-direction decisions that can be separated in time. The elimination of multi-lane crosswalk approaches also eliminates the "multiple-threat" vehicle-pedestrian crash mode.

If the University / Kellogg intersection became a roundabout, the existing southbound-to-westbound dual slip lane could remain because that movement — which is heavy at AM peak period — does not need to enter the main intersection. A roundabout also creates a landscape opportunity on its center island, which could support the intersection's "campus gateway" function. Because all legs of a roundabout have splitter islands that serve as median refuges for pedestrians, a roundabout would also support potential future development on all quadrants by creating safe crosswalks on all legs. If the roundabout concept is pursued, it is suggested to coordinate with the planned improvements at the Kellogg Drive / East Campus Drive intersection to ensure adequate intersection spacing.

The US Federal Highway Administration (FHWA) has an excellent roundabout resource website, https://safety.fhwa.gov/intersection/roundabouts. It links to many Outreach and Education Resources, plus two Top Resources – the video "Modern Roundabouts: A Safer Choice" (English and Spanish), and the publication containing current U.S. roundabout practice: Roundabouts: An Informational Guide, Second Edition. The Guide's introductory chapters are accessible for planners and decision makers, and subsequent chapters provide engineers with details of selecting, sizing, configuring, signing, marking, operating and maintaining roundabouts of all types across the rural-to-urban and low-to-high traffic volume spectra.

Suggestions

Table 3-10: Suggestions for Kellogg Drive at University Drive

#	Location	Item	Suggestion
1	South side of University	Sidewalk	Install a landscape-buffered sidewalk. Consider making it 10' wide to support shared use by bicycles.
2	Southwest and southeast corner at Kellogg	Corner radii	Consider reconstructing with smaller radii to shorten the south-leg crosswalk and enable the northbound limit line to be shifted to the north, closer to University's curb line.
3	South leg at Kellogg	Crosswalk	Install a marked crosswalk using the Triple-Four pattern that is present at Eucalyptus.
4	Intersection control	Alternatives analysis	Consider evaluating the feasibility of replacing University / Kellogg's all-way STOP control with a single-lane roundabout.

3.2.8. FOCUS AREA #8: Kellogg Drive / Innovation Way Roundabout

Overview

Kellogg Drive intersects Innovation Way at a three-leg modern roundabout midway between its intersections with South Campus Drive and Valley Boulevard.

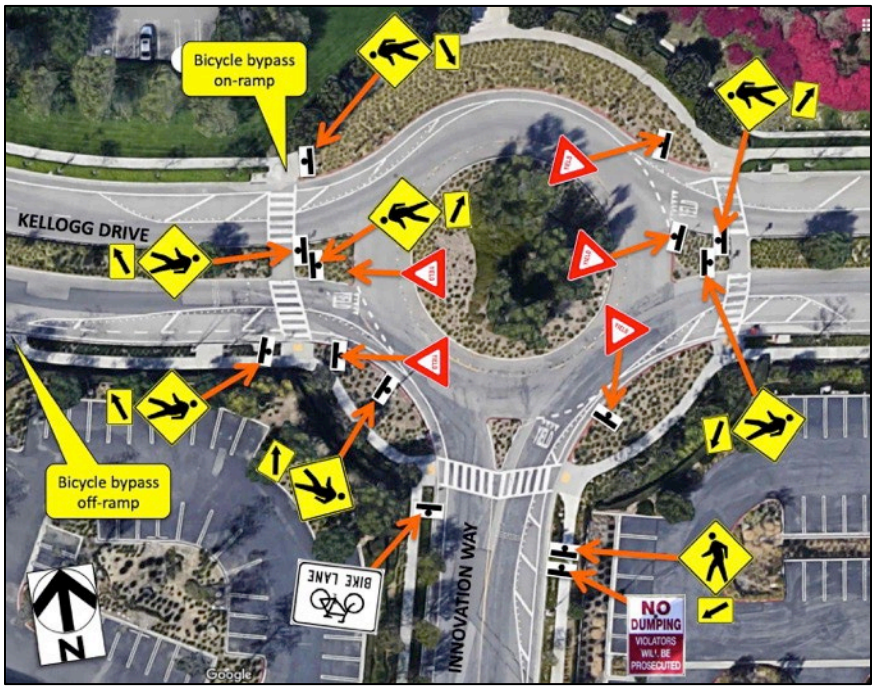


Figure 3-30: Kellogg Drive at Innovation Way – Roundabout Signs And Markings

Observations and Analysis

Circulatory Roadway Raised Markers

The one high-priority safety observation is that the large half-round markers that define the inner (truck apron) and outer (shoulder) edges of the circulatory roadway are an immediate loss-of-control hazard to any single-track vehicle (motorcycle, bicycle, inline scooter).

The evaluator was driving the roundabout in the evening in a rental car and happened to be the first vehicle behind a westbound motorcyclist as she proceeded through on Kellogg Drive. She apparently attempted to “apex” the ring by hugging the truck apron, but her wheel struck one of the half-round markers and her bike went down. **These markers should be replaced with safe alternatives.**

Truck aprons are typically low raised (often 3” high) concrete areas that are recognized (as a curb) and avoided by motorcyclists, yet are mountable by big-rig trailers. Figure 3-31 shows an example in Davis, California.

Figure 3-31: Low Raised Truck Apron at Roundabout – Davis CA (Anderson & Alvarado)

Until the truck apron is reconstructed as a concrete ring, consideration could be given to delineating it with radial markings thick enough to provide strong tactile feedback without diverting the front wheel of a motorcycle, bicycle or scooter. Radial markings crossed in the transverse direction are just bumps, and the circumferential marking defining the apron perimeter should not be thick enough to divert a front wheel if encountered tangentially. Figure 3-32 shows radial apron markings at the same Davis, California roundabout as originally constructed 20 years ago, before the truck apron was reconstructed in concrete.

Figure 3-32: Truck Apron Using Radial Markers – Davis CA 2002 (Anderson & Alvarado)

Crosswalk Warning Sign Assemblies

Several of the crosswalk warning sign assemblies (W11-2 Pedestrian Symbol + W16-7p Downward Pointing Arrow plaque) are not located at their respective crosswalks, as they should be in order to communicate the crosswalk's precise location to approaching traffic. These should be relocated to their respective crosswalks.

Street Name Signs

The Cal Poly Pomona campus has street name signs throughout, mounted on sign posts near intersection corners. Such signs are present at this intersection but are too small to be recognized and comprehended before entering the roundabout. This could be remedied by installing two types of signs:

- Low-mounted signs on the splitter islands, stating the name of the street being approached (Kellogg or Innovation) in large text
- Graphical signs that depict the through or turning movement needed, and state the street name associated with each exit

The City of Portland, Oregon uses such graphical signage at its center-island intersections (Figure 3-33). At the Kellogg / Innovation roundabout the Portland R5500A, R5500B and R5500C would be appropriate, respectively (in left-to-right order below), for the east (westbound Kellogg), south (Innovation), and west (eastbound Kellogg) approaches. A street name would be added at each arrowhead.

R5500A R5500B R5500C

Figure 3-33: Portland "Flight Of Arrows" roundabout signs

Non-Standard Speed Limit Sign

There is a non-standard speed limit sign on the Innovation Way departure.

Bicycle Bypass Ramps And Signs

Bicycle bypass ramps give bicyclists the choice of using the sidewalk instead of traversing the circulatory roadway in line vehicular traffic. A bicycle bypass consists of a diagonal off-ramp on the approach, upstream of the leg's splitter crosswalk, and a (typically in-line) off-ramp on the departure, downstream of the crosswalk. Providing bicycle-specific bypass ramps avoids having bicyclists conflict with pedestrians on the splitter crosswalk's curb ramps. The orientations of the bypass ramps (off-ramp: diagonal, on-ramp: in-line) eliminate the need for bicyclists leaving or re-entering the street to make 90-degree turning movements as would be required at the pedestrian curb ramps.

The Kellogg Drive legs have bicycle bypass off- and on-ramps. The Innovation leg does not.

It is unusual for a roundabout to incorporate a right-turn bike lane around the corner, inboard of the splitter crosswalks, but this intersection has such striping for the Kellogg-to-Innovation and Innovation-to-Kellogg bicycle right turns. However, an approaching bicyclist unfamiliar with roundabouts may mistakenly assume that they should continue on the bike lane beyond the crosswalk to turn left (from Innovation) or proceed through (from eastbound Kellogg) — but doing so would set up a conflict at the roundabout exit they are about to cross.

Providing a guide sign just before the bypass ramp (upstream of the crosswalk) on these legs could help to clarify bicyclists' three choices: merge, continue straight in the bike lane, or bypass onto the sidewalk. Using the Innovation approach as an example, the intended messages would be:

- To turn left, either merge (i.e., move diagonally left into the traffic lane) or use the sidewalk bypass ramp (diagonally right)
- To turn right, continue in the bike lane (straight ahead)

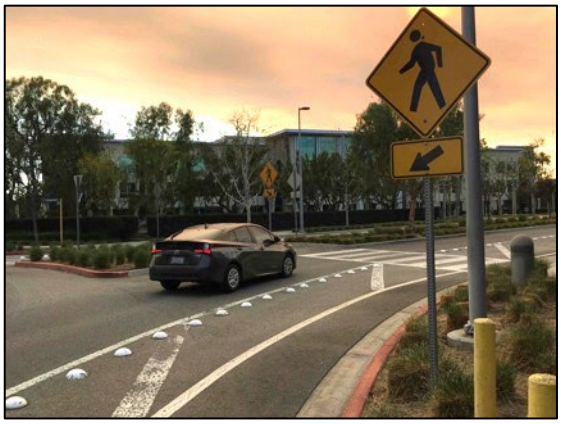
A sign that graphically depicts these choices and the respective maneuver directions with minimal text seems feasible, using the Portland "Flight Of Arrows" signs for inspiration.

a) Eastbound approach – merge decision point.
Left-side "walker" symbol should preferably walk *toward* the approach conflict.

b) NB approach -- merge / bike lane / bypass decision point (no bypass off-ramp)

c) Street name signs distract from Yield and from warning signs (which is upstream of its crosswalk)

d) NB approach – warning sign upstream of crosswalk. No Dumping sign distracts.



e) WB departure – warning sign upstream of crosswalk (relocate to crosswalk)

Figure 3-34: Signs And Markings – Issues And Opportunities

Suggestions

Table 3-11: Suggestions for Kellogg Drive / Innovation Way Roundabout

#	Location	Item	Suggestion
1	Circulatory roadway	Large half-round markers	The large half-round markers that define the inner (truck apron) and outer (shoulder) edges are hazardous to motorcyclists, scooter operators and bicyclists, and should be replaced with safe alternatives. [HIGH PRIORITY]
2		Unused sign post	There is an unused sign post by the north curb, midway between the east and west legs. Remove it.
3	South leg (Innovation Way)	Crosswalk	The outer splitter island is only paint, which does not protect crossing pedestrians. Install a raised island.
4		Crosswalk warning sign assemblies	The right-side assembly is not at the crosswalk. Relocate it.
5			Install left-side assembly on new raised splitter island, preferably with its “walker” walking rightward.
6		Bicycle bypass	Install a bicycle bypass ramp to give approaching bicyclists the option to use the sidewalk.
7			In advance of the bicycle bypass, install a guide sign informing left turning bicyclists to either merge (to circulate with vehicle traffic) or use the bypass and the sidewalks.
8		Bike lane line beyond crosswalk	A bike lane line is striped around the northeast corner to guide right-turning bicyclists. It is too close to the gutter for comfortable riding (42” to face of curb). 48” is the minimum standard asphalt-plus-gutter width for a bike lane. Remove and replace (48” - 16” gutter = 32” of rideable asphalt).
9		Yield sign	There is no Yield (R1-2) sign on the splitter island. Install one.
10		Non-standard speed limit sign	Downstream of the departure there is a non-standard yellow 25 MPH speed limit sign. Remove it or replace it with a standard regulatory (black on white) speed limit sign
11		Crosswalk warning sign assembly	The midblock crosswalk south of the roundabout (not the splitter island crosswalk) has no W16-7p Downward Arrow plaque below the W11-2 Pedestrian Symbol sign. Add one.
12		Crosswalk warning sign	The existing right-side sign assembly facing traffic exiting the roundabout onto Innovation Way is mounted to the streetlight pole, which is not at the crosswalk. Relocate this sign assembly to a new sign post at the crosswalk.
13		No Dumping sign	This sign does not need to be at its current location, where it could detract from comprehension of the safety-related signs. Relocate it away from the intersection.

#	Location	Item	Suggestion
14	East leg (Kellogg)	Crosswalk warning sign	Add a crosswalk warning sign assembly facing traffic approaching the roundabout.
15		Crosswalk markings	Refresh faded markings
16		Detectable warning	Currently there is no detectable warning strip on the north ramp of the crosswalk. Install one.
17		Right-side Yield (R1-2) sign	The right-side Yield sign on the approach does not appear to face approaching traffic. Rotate the sign to address this.
18	West leg (Kellogg)	Street name signs	The existing street name signs around the intersection are too small to be legible at approach speeds and distances. Consider adding larger low-mounted street name signs on the all splitter islands just before the crosswalks, facing inbound traffic.
19		Crosswalk warning sign	The existing right-side sign assembly facing westbound exiting traffic is not at the crosswalk, as it should be (the downward arrow should point at the crosswalk). Relocate this sign assembly to the crosswalk.
20		Detectable warning	Currently there is no detectable warning strip on the north ramp of the crosswalk. Install one.
21		Bicycle bypass signage	In advance of the bicycle bypass, install a guide sign informing left turning bicyclists to either merge (and circulate with vehicle traffic) or use the bypass and the sidewalk.

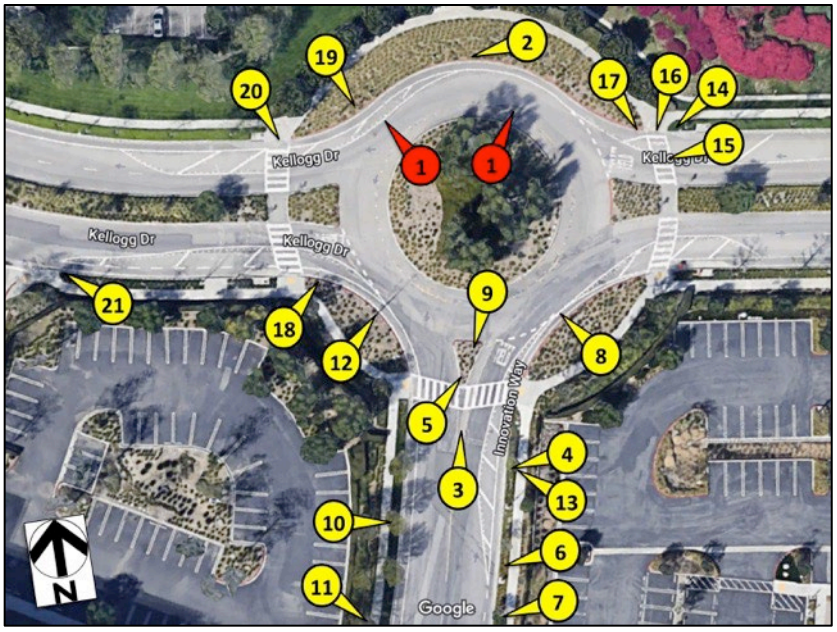


Figure 3-35: Kellogg Drive at Innovation Way – Numbered Suggestions

3.3. GENERAL SUGGESTIONS

The following general suggestions for physical enhancements may be appropriate campus-wide or in the focus areas. These are discussed in detail below.

Table 3-12: General Suggestions for Physical Enhancements

Pedestrian	Details
Advance Limit Lines	Install 4’ in advance of the limit line or first crosswalk line on STOP and signal-controlled approaches, to deter motorists from encroaching into the crosswalk or blocking sightlines to low pedestrians such as wheelchair users.
Corner curb extensions	Enable pedestrians to make a starting decision where they can see and be seen. Calm inbound right turns by reducing the physical radius. Shorten crosswalks.
Interim curb extensions	Consider Painted Safety Zone / Interim Curb Extension treatments at locations where the need is current but hardscape curb extensions are subject to future funding.
Crosswalk markings	At uncontrolled crosswalks, incorporate wide longitudinal elements (e.g. “ladder rungs”) to enable approaching drivers to recognize the crosswalk earlier.
Leading Ped. Interval	Display WALK phase (typically) 3 seconds before same-direction green indication, so pedestrians can occupy the curb lane.
RRFB warning lights	If motorist yielding behavior is deemed inadequate at an uncontrolled crosswalk that has the standard passive warning sign assemblies in place, consider installing pedestrian-activated Rectangular Rapid Flashing Beacon (RRFB) light bars to the sign assemblies.
Center islands on side streets	Calm inbound turns. May enable bicyclists preparing to turn left or proceed through to wait further forward than they otherwise would.
Left-side warning signs: symbol orientation	Pedestrian symbol (W11-2) or trail crossing signs (W11-15) installed on the left side of street may depict users approaching, just as the W16-7p Downward Pointing Arrow always points into the approach. (MUTCD 2A.06 Design of Signs specifically allows mirror-imaging. However, sign catalogs may not designate a unique product code.)
Left-side signs on medians	At uncontrolled locations where it is feasible to add a raised median to protect a sign, do this so that each approach sees a pair of warning signs on its side of the street.
Upstream sightlines	Prohibit parking for at least 1 car length upstream of crosswalk, to keep sightlines open to approaching traffic. A curb extension can ensure compliance and is a good place for crosswalk warning signs. “Bike corrals” (in-street racks) can also utilize this area.
Yield Lines	Install on multi-lane approaches to uncontrolled crosswalks, 20’-50’ before the crosswalk.
Directional curb ramps	Provide 2 ramps per corner, aligned with sidewalks, rather than diagonal ramps.
Accessibility	Ensure that signal actuation is ADA compliant, including pushbutton height.
Centerline	Install no-passing (double yellow) centerline 50’ back from crosswalk.

Advance Limit (Stop) Lines

On approaches to crosswalks that are controlled by signals or STOP signs, installing an advance limit line a short distance (typically 4 feet) before the crosswalk can remind motorists to stop far enough back that their vehicle's front end does not encroach into the crosswalk. Such encroachment can be a safety issue at multi-lane approaches when the front end of a vehicle waiting can hide a low pedestrian (child or wheelchair user) approaching across another lane.

MUTCD Section 3B.16 Stop and Yield Lines applies. Guidance Paragraph #10 states:

> *10 If used, stop and yield lines should be placed a minimum of 4 feet in advance of the nearest crosswalk line at controlled intersections, except… at mid-block crosswalks.*

Corner Curb Extensions

At intersections with conventional corners and no curb extensions, pedestrians preparing to cross a street typically make their crossing decisions before stepping off the curb, i.e., while on the sidewalk. Due to substantial corner radii at most intersections, this places them over 10 feet outside of the first travel lane they will enter. Corner curb extensions (bulb-outs) enable pedestrians to safely make their decision near the outside travel lane, where they are more visible to approaching motorists and also have a considerably shorter distance to cross. Raised curb extensions also enable crosswalk warning sign assemblies to be installed closer to the travel lanes where they are more visible to motorists. One resource for curb extensions is NACTO's Urban Street Design Guide section:

https://nacto.org/publication/urban-street-design-guide/street-design-elements/curb-extensions/

Curb extensions attached to the street's existing curb can be expensive to construct because they must preserve drainage along the street and provide accessible slopes and curb ramps. However, the same safety benefits can be obtained with less expense and without modifying drainage if the extension area is segmented into "floating" islands between which pedestrians including wheelchair users travel at existing street grade.

"Temporary Traffic Calming Curbs" (Calgary, AB)

Figure 3-36: Segmented Floating Corner Island Treatment

Interim Curb Extensions

Many cities are now deploying treatments consisting only of painted lines, colored paint or epoxy fill, and tubular delineators to rapidly and inexpensively create corner-bulb installations in advance of funding availability for hardscape versions (Figure 3-37). These go by various names such as "Painted Safety Zones" (San Francisco), "Painted Curb Extensions" (Pasadena), "Painted Bulbouts" (Denver) and "Interim curb bulbs" (Seattle).

San Francisco MTA writes:

> Painted safety zones are painted road areas that wrap around sidewalk corners to make pedestrian crossing intersections more visible to people driving. Painted safety zones are often flanked by delineators (white posts) and encourage people who drive to slow down, especially when making turns.
>
> https://www.sfmta.com/getting-around/walk/pedestrian-toolkit

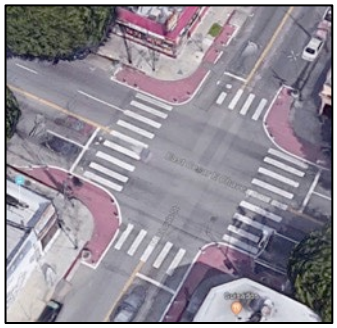
Seattle DOT (SDOT) writes:

> Interim curb bulbs may be appropriate in locations where there is a safety need and a permanent solution is not feasible in the short term, and/or where there is a planned capital improvement within 5 years. At intersections with curb and gutter, an interim curb bulb can only be done [where] there are existing curb ramps. In some cases, curb bulbs may also be integrated with bioretention to manage storm water runoff from the right-of-way.
>
> https://streetsillustrated.seattle.gov/urban-design/adaptive-design/intersection-treatments/

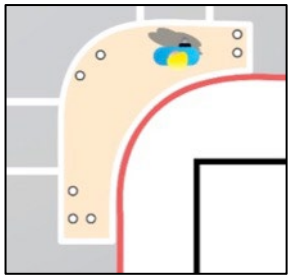
Crosswalk Marking Patterns – High Visibility And Contrast Edge

The standard crosswalk-marking scheme at controlled approaches has 2 transverse lines and no fill pattern. Many cities use the standard pattern at controlled approaches and a high-visibility pattern at uncontrolled approaches. The following description from San Francisco MTA's crosswalk design guidelines describes the safety advantages of high-visibility markings:

> *Because of the low approach angle at which drivers view pavement markings, the use of longitudinal stripes in addition to or in place of the standard transverse markings can significantly increase the visibility of a crosswalk to oncoming traffic. While research has not shown a direct link between increased crosswalk visibility and increased pedestrian safety, high-visibility crosswalks have been shown to increase motorist yielding and channelization of pedestrians, leading the Federal Highway Administration (FHWA) to conclude that high-visibility pedestrian crosswalks have a positive effect on pedestrian and driver behavior.*



Los Angeles (Cesar Chavez & St Louis)



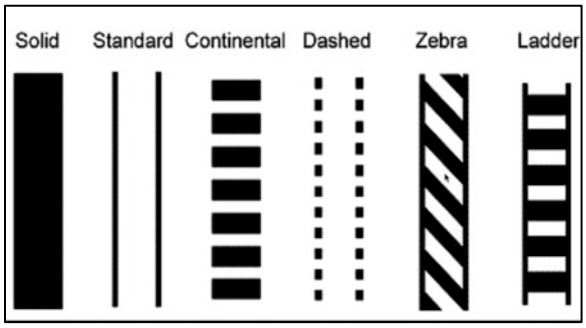
Pasadena Street Design Guide

Los Angeles – Pico & Curson

San Francisco (16th St & Kansas St)

Seattle (Burke-Gilman Trail & 40th Ave NE & NE 52nd Pl)

Figure 3-37: Paint-and-Delineator Curb Extensions



(Figure 12 from FHWA report HRT-04-100, "Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations Final Report and Recommended Guidelines")

Figure 3-38: Crosswalk Marking Patterns (FHWA)

Table 3-13 lists suggested treatments for several crosswalk elements.

Table 3-13: Suggested Crosswalk Treatments

	Approach	Controlled		Uncontrolled	
Elements	**Median**	**None or painted**	**Raised**	**None or painted**	**Raised**
Crosswalk markings		2-line		High-visibility (ladder)	
Warning signs at crosswalk		None		Curbside, 2-sided ("2-sign")	Curbside: 1-sided Median: 2-sided ("4-sign")
RRFBs on crosswalk signs		None		If needed	
Advance markings & signs		Advance limit line 4' upstream		Yield line 20'-50' upstream R1-5 Yield Here signs at yield lines	
Advance warning signs		None		If needed, per MUTCD	

Low-vision pedestrians (persons who are not completely blind) benefit from a continuous "contrast edge" for guidance when crossing streets. The solid transverse lines in the "solid", "standard", "zebra" and "ladder" patterns provide this; the "continental" and "dashed" patterns do not. For all crosswalks at uncontrolled approaches that currently use the continental pattern, it is suggested to add two solid transverse lines to create a ladder pattern.

In prior decades, "artistic" crosswalks were constructed in which the transverse border was a wide cast concrete strip with no retroreflective white marking (12-inch line). Over time the contrast between these strips and the middle of the crosswalk is reduced so the strips no longer provide an effective contrast edge for low-vision pedestrians. 12-inch transverse lines (white for non-school crosswalks, yellow for school crosswalks) may always be incorporated.

Leading Pedestrian Interval

Leading Pedestrian Interval (LPI) traffic signal phasing displays the pedestrian signal's WALK indication for 3-7 seconds before the green indication for same-direction traffic. LPI gives pedestrians a head start to occupy the crosswalk before turning vehicles. A 2000 study by the Insurance Institute for Highway Safety (IIHS) found that LPI reduces conflicts between turning vehicles and pedestrians.

> *Field Evaluation of a Leading Pedestrian Interval Signal Phase at Three Urban Intersections*. Van Houten, Retting, Farmer, Van Houten. Transportation Research Record (TRR) 2000.

It is suggested that the City of Pomona consider implementing LPI at signals with high pedestrian activity, prohibiting right-turn-on-red as needed per recent research findings.

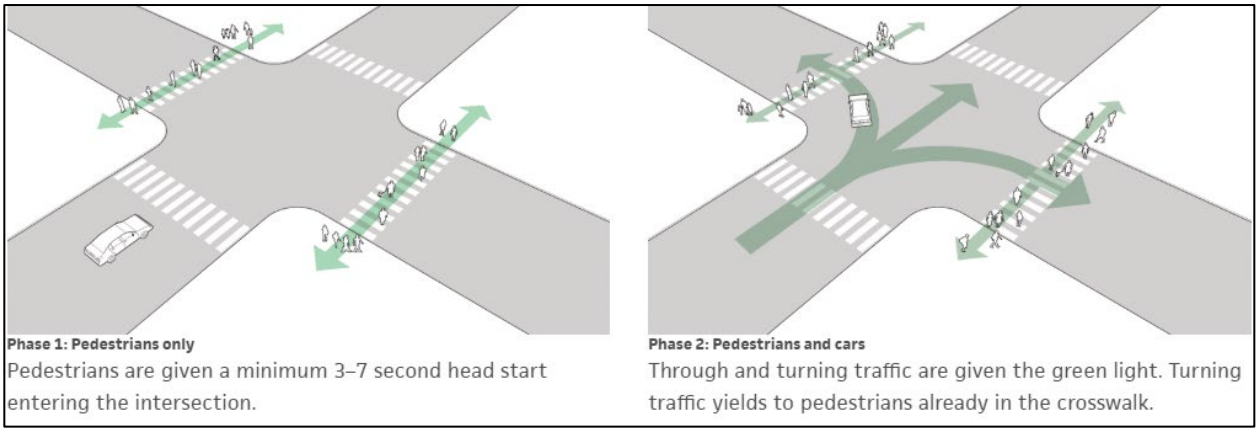


Figure 3-39**: Leading Pedestrian Interval phases**

Center Islands On Side Streets

Adding pill-shaped center islands just behind the crosswalks side streets at some intersections can improve safety in several ways:

- Calm right turns from the major street
- Calm left turns onto the major street
- Calm through movements on the side street
- Provide a modest refuge for pedestrians crossing the side street, especially slow ones
- Enable the limit lines to be moved forward for better sightlines
- Provide a sheltered place for bicycle users approaching on the side street to prepare to cross or enter the major street

Figure 3-40 shows such an island on a 40-foot residential street in Sunnyvale CA (Canary Drive, at Inverness Way). The island is 6 feet wide and 20 feet long.

Figure 3-40: Median Island On Residential Street (Canary at Inverness, Sunnyvale CA)

Berkeley SafeTREC

SAFE TRANSPORTATION RESEARCH AND EDUCATION CENTER

(SAFETREC)

UNIVERSITY OF CALIFORNIA, BERKELEY

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Founded in 2000, SafeTREC is part of the University of California, Berkeley, affiliated with the School of Public Health and the Institute of Transportation Studies, with additional partnerships with the Department of City and Regional Planning, Public Policy, and Transportation Engineering. SafeTREC helps the California Office of Traffic Safety (OTS) administer its Community Pedestrian and Bicycle Safety Training workshops and support various safety initiatives from other California agencies, including the California Department of Transportation (Caltrans), by providing programs such as:

- Community Pedestrian and Bicycle Safety Program
- Complete Streets Safety Assessments
- Global Road Safety
- Tribal Road Safety
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