

Final Report

UCSC Base of Campus Transportation Network Improvements

March 16, 2020

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ENVS-196

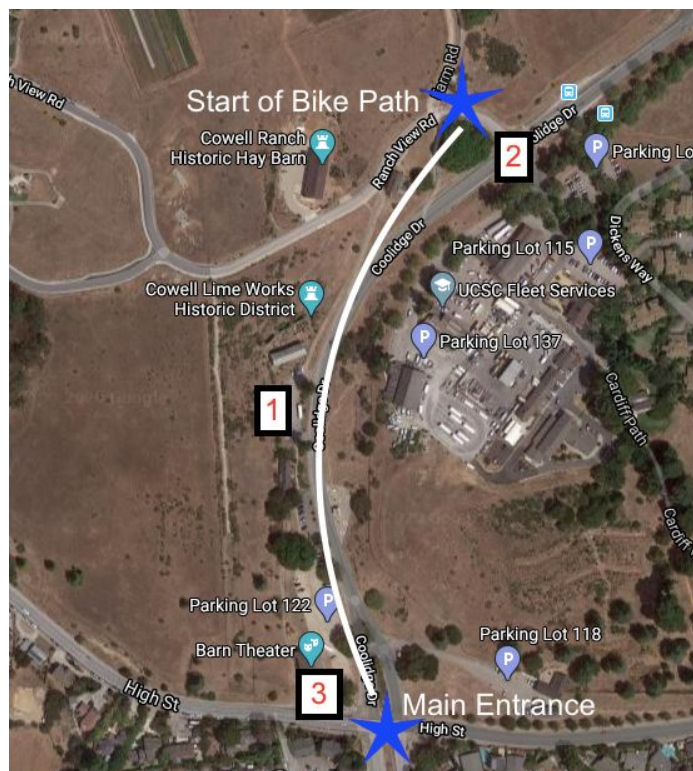
Main Entrance Final Report

Executive Summary

The UC Santa Cruz main entrance expects over 14,000 vehicles per day with little to no infrastructure protecting pedestrians or bicyclists, creating an unsafe atmosphere for individuals looking to commute through a sustainable mode of transportation. The entrance to campus is car-oriented with a total of five car lanes and two mere 5.5 feet wide unprotected bike lanes with zero pedestrian walkway. The intersection itself is large, exposing pedestrians to long crosswalks which could be shortened with better infrastructure that would simultaneously protect pedestrians and cyclists navigating the intersection. The lack of adequate infrastructure causes conflict between cyclists and cars/pedestrians, acting as a deterrent for potential cyclists.

Here, we have summarized our field observations- from photos of desire lines that pedestrians have made due to the lack of sidewalk, alternative bike-lane options, analysis of the current roadway in terms of bicyclist safety (Level of Traffic Stress/speed limit), and street data (width of the different car and bike lanes along Coolidge, traffic volumes, accidents/injury).

From these observations, we recommend the following:



1) Coolidge Drive

- ❖ Implement a bidirectional bicycle lane along the West side of Coolidge Drive with a landscaped divider that extends from Ranch View Road to High Street.
- ❖ Widen the bicycle path that connects Coolidge Drive to the Great Meadow Bike Path to accommodate bidirectional bike traffic.
- ❖ Addition of a pedestrian path next to the bidirectional bicycle path.
- ❖ Establish sidewalk and stairs on the East side of Coolidge to accommodate the desire lines of pedestrians.

2) Ranch View Rd. and Coolidge Dr. Intersection

- ❖ Implement a crosswalk on the West side of the intersection to link the Coolidge Dr. bidirectional bicycle path to the existing bicycle path on Ranch View Road towards Hagar Drive.

3) Bay Dr. and High St. Intersection

- ❖ Tighten the intersection using corner islands, median islands, pedestrian islands, bicycle waiting areas, and car setback infrastructure.
- ❖ A single-lane, 120 ft roundabout in place of the proposed two-lane roundabout by the city of Santa Cruz.

4) Short Term Recommendations

- ❖ Add bike lockers at the campus entrance for individuals who bike to the entrance and catch the Loop to the main campus.
- ❖ Quick fixes may be implemented at the Cardiff Path to provide bicyclists and pedestrians a vehicle separated path towards the Great Meadow Bike Path or Lower Campus through pavement, replacing the entry gate with bollards, and intersection safety infrastructures.

1. Introduction

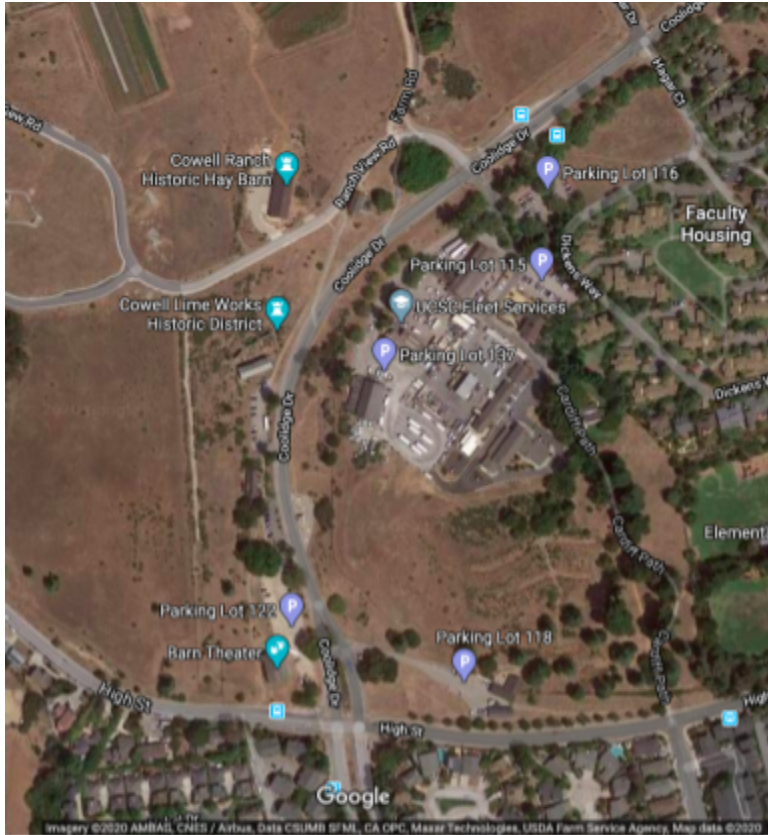


Figure 1.1: Overhead view of area in discussion from the Bay Dr. and High St. intersection to the Coolidge Dr. and Ranch View Rd. intersection

To improve bicycle and pedestrian access to the main entrance/the intersection of Bay Dr. and High St., we have compiled data on all relevant current existing infrastructure. Currently, the only existing separate bike path on campus remains the Great Meadow Bike Path which may be difficult to access as it is found further along the main entrance.

The UC Santa Cruz campus is working on a new Long Range Development Plan (LRDP) to determine future development on campus into 2040. The LRDP is the Campus' general plan which guides specific areas designated for certain uses to provide infrastructure required for the longevity of the campus. Current plans from the LRDP suggest the

construction of new pathways to increase mobility and accessibility. Due to the large hills on campus, our team has identified opportunities for developing physical improvements for individuals to reach the campus in a safe and secure manner.

In order for UCSC to meet its Vehicle Miles Traveled (VMT) and other sustainability goals by 2022, the campus will have to start prioritizing other modes of sustainable transit, such as biking and walking. Biking allows more accessibility for low-income students who may not be able to purchase a parking pass, but also provides a healthier, more sustainable community. Studies show that often what prevents people getting on a bike is safety concerns. Current infrastructure for cyclists entering and exiting campus is not only unsafe, but it also actively discourages less confident cyclists from using cycling as their primary mode of transit onto campus.

The goal of this report is to propose a plan that makes the main entrance more bike and pedestrian-friendly, specifically in the Bay & High intersection as well as up along Coolidge Dr

until the Great Meadow Bike Path. To do so, more pedestrian and bicycle infrastructure is needed.

In this report, we will present our field observations—from photos of desire lines that pedestrians have made due to the lack of sidewalk (which we will base our recommendations on), alternative bike lane options, analysis of the current roadway in terms of bicyclist safety (Level of Traffic Stress/speed limit), street data (width of the different car and bike lanes along Coolidge, traffic volumes, accidents/injury).

2. Planning Context

The campus' most recent sustainability plan, revised in 2019, outlined the following as its main goals:

“Reduce commute travel mode impacts relative to a 2017 baseline by: reducing Scope 3 commuter greenhouse gas emissions 10 percent by 2022; reducing commute vehicle miles travelled (VMT) five percent by 2022; and reducing per capita parking demand 10 percent by 2022” (Campus Sustainability Plan – 2019 update – UCSC Campus Sustainability, n.d.).

With a sub-strategy being:



Figure 2.1: Map of the historic district at the main entrance of the UC Santa Cruz campus

“Develop an outreach strategy to promote sustainable transportation culture and prioritize human-powered on-campus travel at UC Santa Cruz.”

In order to be compliant with these goals, bicycle and pedestrian infrastructure is necessary to cut down emissions and move to “human-powered” travel, with single-occupancy vehicles being a dominant form of transit as of now. It is also important to acknowledge the already-existing infrastructure plans and limitations to development such as UC Santa Cruz’s 2040 Long Range

Development Plan (LRDP 2040) the Historic District near the Barn Theater, depicted below in Figure 2.1.

The historic district at the base of campus is on the National Register of Historic Places. This means there are certain restrictions on what can be done within the bounds of the historic region and, therefore, any recommendations must take this into account. With that said, Figure 2.2 illustrates the proposed Long Range Development Plan for the campus. Since this plan is still in the process of being finalized and approved, there is flexibility within the plan to add provisions for cycling infrastructure. It is also important to note the proposed housing, shown in brown in Figure 2.2, around the main entrance which will increase the need for improved transportation infrastructure around this area.

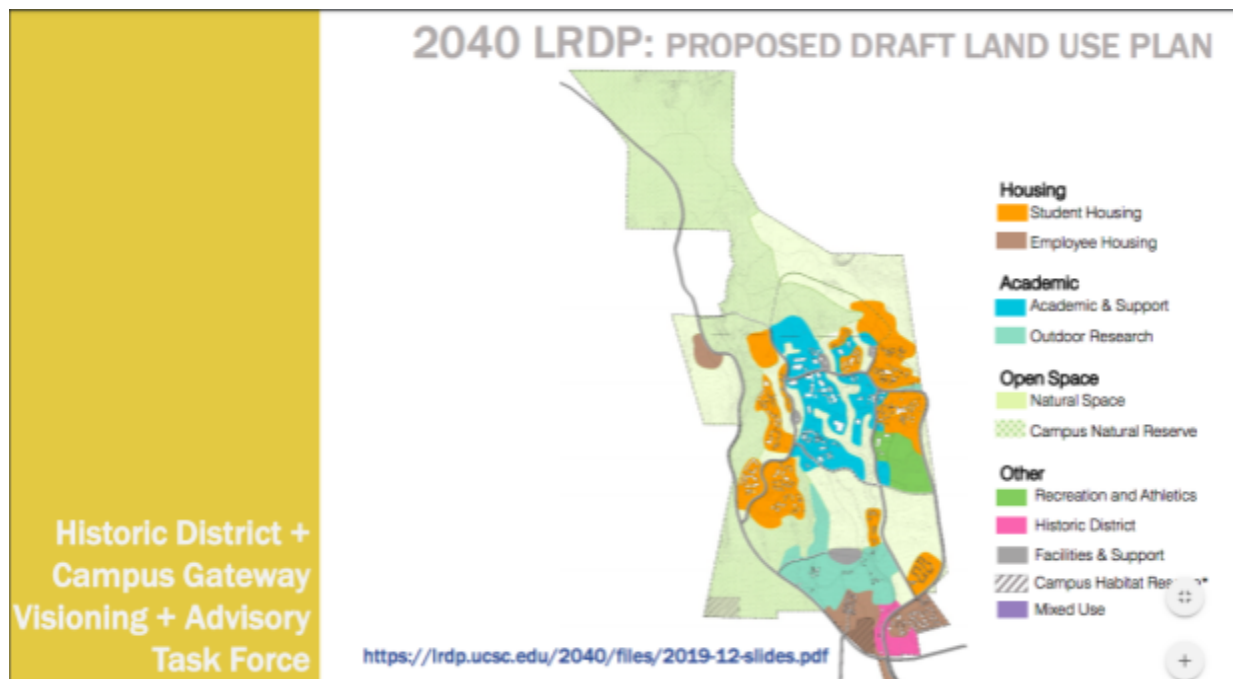


Figure 2.2: Map of proposed land use plans stated in the UC Santa Cruz LRDP 2040

3. Existing Conditions

The Existing Conditions compile our data collection and analysis to get a sense of the current state of roads, bike lanes, and our recommended short-term bike pathways (this is discussed further in Recommendations section, but here we look at its current state). We have taken street measurements to determine if implementing wider bike lanes on already-existing roads is possible, photos of current unpaved pathways that proves that better infrastructure is needed, data on car speed limits to determine bicyclist safety, and used a method called Level of Traffic Stress (LTS) to analyze comfort level of cyclists on streets. Also, we have data on traffic volumes that show that bicyclists make a significant percentage of transportation methods on-campus, accidents/injury to prove the urgency of safer road infrastructure, street slopes to base our bike lane recommendations on and formed a survey to assess comfort of current cyclists on roads, alternatives to Coolidge Dr.

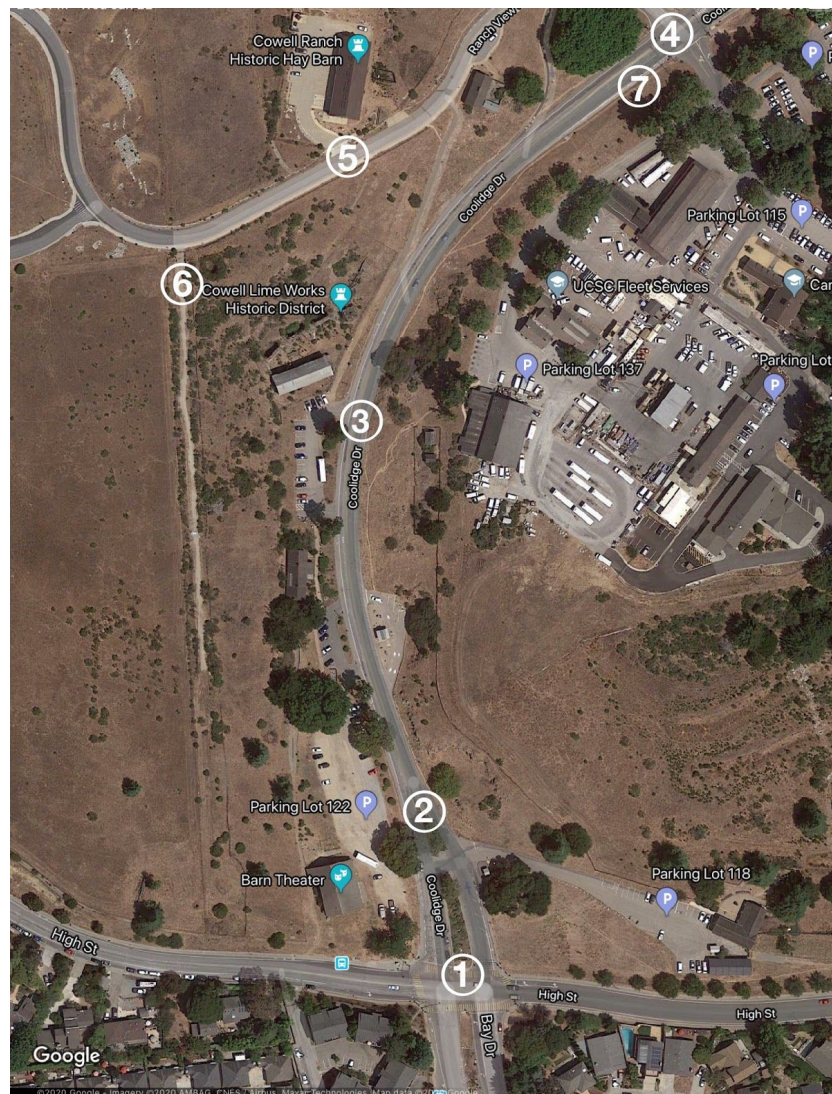


Figure 3.1. Map outlining points of interest with numbers corresponding to the street widths shown in Table 3.1.1

3.1 Street Widths

Coolidge Drive generally consists of two 50 foot vehicle lanes and a 5'-5'6" foot bicycle lane in each direction. There is no sidewalk along most of the road. In general, there is ample width to expand the right of way, although this would require cutting into grassed areas, a planting strip with mature trees and/or parking lots. Coolidge Drive generally consists of two 5' to 5.5' bicycle lanes and two 12.5' car lanes. There is no sidewalk along most of the road; although there is some width to expand the right of way, this would require cutting into grassed areas, parking lots, and/or a planting strip with mature trees. At its narrowest point (3), the constraints of historic buildings and a cliff leave a maximum width of about 36 feet.

UCSC Campus Street Widths			
#	Location	Total Width	Bike Lane Width
1	Main Entrance Crosswalk	108'6" total 25' median	11' southbound bike lane 5' 6" northbound bike lane
2	Lower Coolidge	60' total 12' median	5'6" southbound bike lane 5' northbound bike lane
3	Coolidge Halfway Point	36' total	5'6" north-south bike lane
4	Coolidge-Ranch View Intersection	50' total	5'6" north-south bike lane
5	Ranch View Road	23' total	
6	Utility Corridor	20' total	
7	Northbound Upper Coolidge Bike Lane		7'6" northbound bike lane

Table 3.1.1: Location and lengths of street widths including bicycling lanes.

3.2 Field Observations

As shown in Figures 3.2.1 and 3.2.2, the current infrastructure for cyclists is degrading (both figures discussed further in Utility Corridor & Cardiff Path sections). In Figure 3.2.3 on Coolidge Dr, a narrow 5.5 feet long bike lane exists on the side of the road, which meets the minimum width requirement but has no physical barrier protecting cyclists from cars. There is also a lack of pedestrian infrastructure leading to potential pedestrian-cyclist conflict since pedestrians create desire lines or utilize the bike path as a walkway as shown in Figure 3.2.3 as well.



Figure 3.2.1: Existing Utility Corridor conditions



Figure 3.2.2: Image of poor asphalt conditions along Cardiff Path



Figure 3.2.3: Desire lines created by pedestrians on Coolidge Dr. due to the lack of sidewalk and pedestrian infrastructure.



Figure 3.2.4: Southbound bike lane connecting the Great Meadow Bike Path to Coolidge Dr.

Figure 3.2.4 displays the expanse of the Bay and High St. intersection. As shown in the photo, cyclists must cross the large intersection with cars when making a left turn. This maneuver can leave cyclists vulnerable to cars and create an unsafe atmosphere.

Vehicles volumes at the base of campus may inhibit bicycle and pedestrian accessibility. Indicated vehicle speed limits in the area, typically 25-30mph, are often surpassed but with the

addition of sidewalk streets and buffered roads could be made more accommodating for bicycle and pedestrian traffic.

3.3 Level of Traffic Stress & Speed

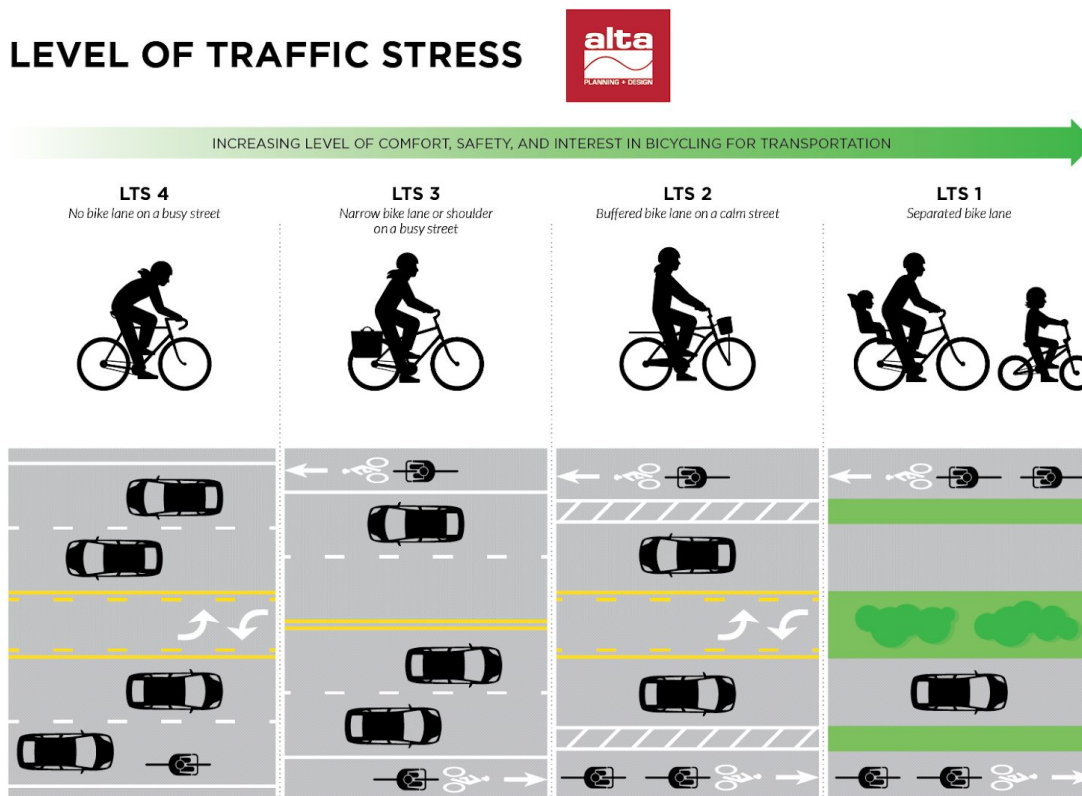


Figure 3.3.1 Level of Traffic Stress Visual

We are analyzing this data with a metric called, Level of Traffic Stress (LTS). Figure 3.3.1 is an objective, data-driven approach to evaluating bikeways by matching up roadway design, traffic volumes, and car speeds to determine bicyclist comfort. LTS 1 represents the lowest stress and 4 represents the highest stress and discomfort. Currently, Coolidge Dr meets a Level of Traffic Stress 3 level (according to Figure 3.3.1), described as having a narrow bike lane/shoulder on a busy street with most cars going around 35 mph. Ideally, we would want to improve the infrastructure to meet LTS 1 standards. At speeds of up to 35 mph, Level of Traffic Stress would suggest a level 4 Level of Stress, meaning cyclists must be “strong and fearless” in order to feel comfortable riding on the current infrastructure. To create a safer cycling experience, it is important to create street networks that take into account both cycling and pedestrian needs and connectivity to other areas of campus.

UCSC Base of Campus Speed Limits		
Average Daily Traffic: 14,000		
Street Name	85th Percentile	Speed Limit
Coolidge Drive	35 mph	25 mph
Bay Dr	N/A	30 mph
High St	N/A	30 mph

Source: University Engineering and Traffic Surveys, 2018

Table 3.3.2 Traffic speed and volume by UCSC base of campus.

Street Width			
Speed Limit or Prevailing Speed	2-3 lanes	4-5 lanes	6+ lanes
Up to 25 mph	LTS 1* or 2*	LTS 3	LTS 4
30 mph	LTS 2* or 3*	LTS 4	LTS 4
35+ mph	LTS 4	LTS 4	LTS 4

* Use lower value for streets without marked centerlines and with ADT ≤ 3000; use higher value otherwise.

Figure 3.3.3. LTS Criteria for Mixed Traffic Segments (*Level of Traffic Stress Criteria – Peter G Furth, n.d.*)

Coolidge Dr. presents an LTS 3 because of the speed and number of lanes. According to Peter Furth’s Level of Traffic Stress Criteria, an LTS 3 would only be appropriate for “enthused and confident” cyclists, excluding a large portion of the populace who may not feel as confident on a bike.

The National Association of City Transportation Officials (NACTO) has laid out guidelines and recommendations for implementing safe, efficient, and bicycle-friendly roads and intersections. Regarding bicycle lanes, NACTO has set the minimum rideable surface width at 3 feet, while stating that the ideal width would be at least 4 feet of traversable surface with a total of 6 feet of space between the curb face and the edge of the bicycle lane. While this minimum applies to any road according to NACTO, many transportation officials, like Mikael Colville-Andersen of *Copenhagenize*, advocate for protected or buffered bicycle lanes on streets whose average vehicle speed exceeds 25 MPH or has high traffic volumes. For protected bicycle lanes, NACTO recommends at the very least separating traffic from the bicycle lane with white painted lines

spanning 3 feet in width. Traffic pylons and other forms of protection can also be installed for reinforcement.

3.4 Traffic Volumes

Main Entrance/Coolidge Inbound Vehicle Percentages

Data collected between 7:00 AM and 6:30PM on 05/22/2019

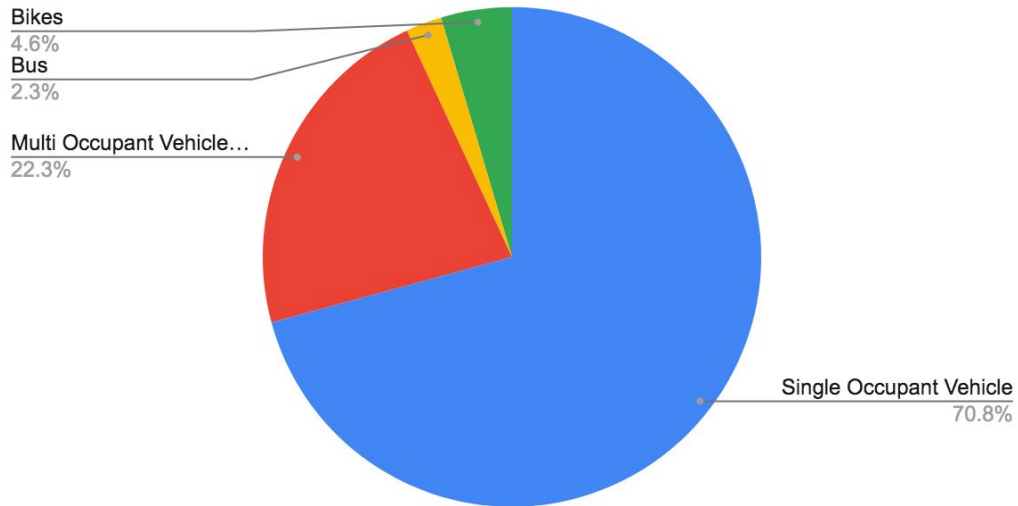


Figure 3.4.1. Pie chart depicting total quantities of single-occupant vehicles, multiple occupant vehicles, busses, and bikes that traveled inbound through the main entrance of the UC Santa Cruz Campus between the hours 7:00 AM and 6:30 PM on May 22, 2019. Single-occupant vehicles counted: 3739/5283, Multi-Occupant: 1178/5283, Bikes: 243/5283, Bus: 123/5283

Main Entrance/Coolidge Outbound Vehicle Percentages

Data collected between 7:00AM and 6:30PM on 05/22/2019

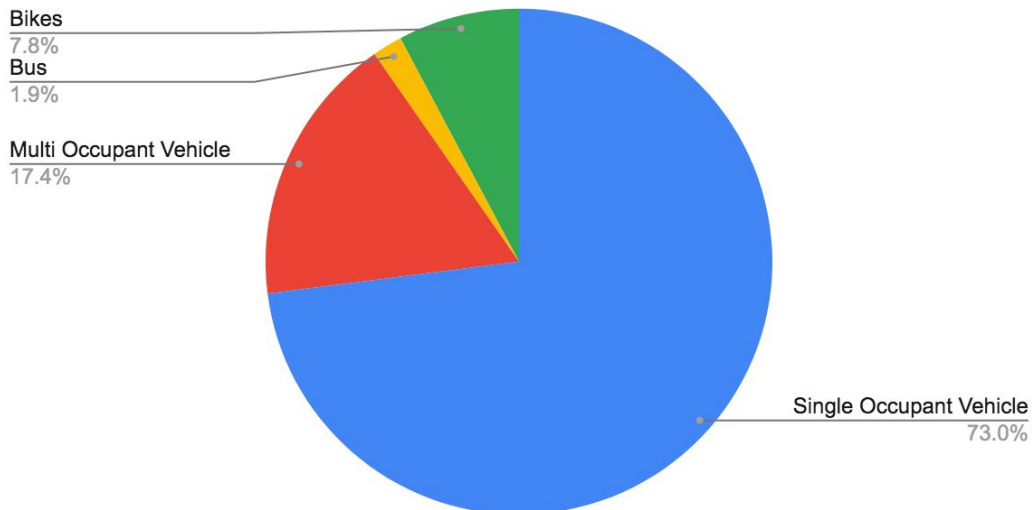


Figure 3.4.2. (above on last page) Pie Chart depicting total quantities of single-occupant vehicles, multiple occupant vehicles, busses, and bikes that traveled inbound through the main entrance of the UC Santa Cruz Campus between the hours 7:00 AM and 6:30 PM on May 22, 2019. Single-occupant vehicles counted: 3239/4438, Multi-Occupant: 770/4438, Bikes: 344/4438, Bus: 85/4438.

Figure 3.4.1 and Figure 3.4.2 make it clear that the car is the dominant mode of transportation for students and faculty at UC Santa Cruz. For inbound commuters on May 22, 2019, cars made up 93.1% of the total vehicles that entered campus, while cars made up 90.4% of the outbound vehicles on the same day. While bus usage is hard to gauge from this data, as it represents the quantity of busses but not riders, these numbers are still overwhelming, especially regarding the relationship between car and bicycle usage.

3.5 Bicycle Shuttle Ridership

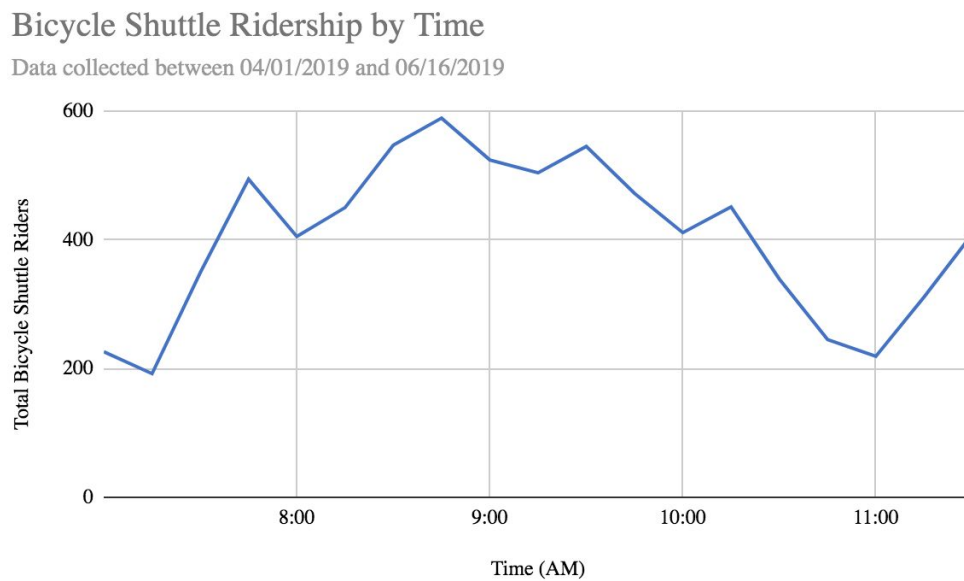


Figure 3.5.3. Total bicycle shuttle ridership by time between the dates April 1, 2019, and June 16, 2019.

Bicycle Shuttle Daily Average Ridership by Time

Data collected between 04/01/2019 and 06/16/2019

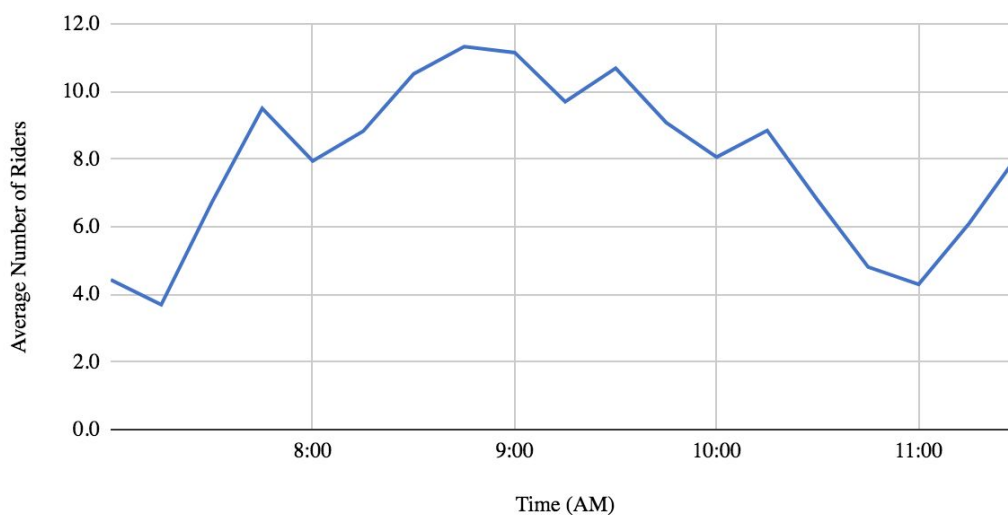


Figure 3.5.4. Average bicycle shuttle ridership by time between the dates April 1, 2019 and June 16, 2019.

Figure 3.5.3 and Figure 3.5.4 provides insight into rush hour times for bicyclists commuting to the UC Santa Cruz campus. Both the average and total ridership show 9:00AM as the height of bicycle shuttle usage, however it is also important to note that ridership is on the rise at and after 11:00AM, just as the shuttle stops running.

3.6 Accidents/Injury

According to Berkley's Transportation Injury Mapping System, there have been 10 incidents of bicycle collisions occurring at the our surveyed site from 2008-2018. Collisions occurring here have all been the faults of the motorists. Reducing speeds or increasing safe bike infrastructure may be incorporated to reduce collisions.

UCSC Base of Campus Collisions					
Bay Dr. and High St.					
Date	Time	Movement	Injury	Gender	Age
02/11/2008	5:53 PM	Making Left Turn	Suspected Minor Injury	Female	19
02/16/2010	7:20 PM	Proceeding Straight	Suspected Minor Injury	Female	23
12/01/2010	3:37 PM	Proceeding Straight	Suspected Minor Injury	Female	21

04/27/2016	3:15 PM	Not Stated	Suspected Serious Injury	Male	19
High St. & Cardiff Pl.					
Date & Time		Movement	Injury	Gender	Age
01/18/2008	6:21 PM	Proceeding Straight	Suspected Minor Injury	Female	24
02/12/2008	5:11 PM	Making Left Turn	Suspected Minor Injury	Female	23
08/11/2009	5:45 PM	Proceeding Straight	Possible Injury	Male	51
05/01/2011	1:31 PM	Proceeding Straight	Possible Injury	Female	22
03/13/2014	6:30 PM	Proceeding Straight	Possible Injury	Female	26
Empire Grade Merging Into High St.					
Date & Time		Movement	Injury	Gender	Age
04/20/2017	7:49 AM	Proceeding Straight	Suspected Minor Injury	Male	16
<i>Source: TIMS SWITRS GIS Map, 2008-2018.</i>					

Table 3.6.1. Bicycle collisions are located by streets at the UC Santa Cruz base of campus.

3.7 Survey

In our survey, we asked students about their comfort level biking on campus roads, frequency of cycling to campus, and suggestions on how to make the road safer. Students and faculty on social media indicated that the majority of survey-takers feel uncomfortable and unsafe riding on Coolidge Dr. which could potentially discourage future cycling.

On a scale of 1-5 (5 being extremely comfortable), how comfortable/safe do you feel riding on Coolidge Dr.?

Answered: 14 Skipped: 13

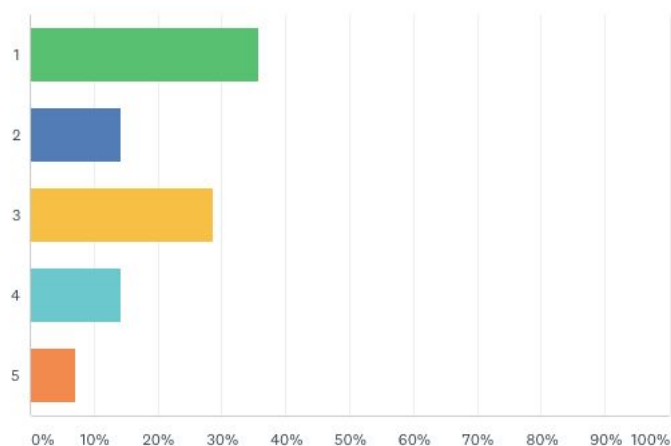


Figure 3.7.2. Results from survey show that the majority feel discomfort riding on Coolidge Dr.

3.8 Alternatives to Coolidge Drive

Besides Coolidge Drive, paths that may be potentially utilized for bicyclists include Cardiff Path found by the east of the school entrance or the Utilities Corridor found in the middle of Faculty Housing and the Haybarn. This will be further discussed in our Recommendations section.

3.9 Cardiff Path

At the intersection between High St. and Cardiff Pl., the path, Cardiff Path, may be taken by pedestrians or bicyclists to reach the lower campus facilities in 0.2 miles as shown in Figure 3.10.1 (on next page). Examining the current conditions of the Cardiff Path, obstacles that may deter individuals from access includes fencing, poor infrastructure, and difficulties reaching the path. Cyclists may find it difficult to reach the Cardiff Path from the intersection as it favors vehicle movement. While the road may offer a crosswalk for pedestrian movement, there are no stop or yield signs present at the intersection. At the entrance of the path, individuals may be dissuaded from entering due to the presence of a large fence blocking the road. However, individuals who are not intimidated by the fence and access the path may find that the road is difficult to traverse due to poor pavement and large slopes. In looking at Table 3.10.2 (also on next page), the slopes found on this path indicate that this may be the least bike-friendly of the areas examined, presenting an average grade of 9.2 feet. Furthermore, visibility infrastructure is not present on this path which may further deter usage especially for individuals reaching school at night or early morning. While this existing path may be separated from traffic, obstacles present may discourage access.

3.10 Utility Corridor

In addition to the Cardiff Path, another path that may be utilized for bicyclists looking to reach the Great Meadow Bike Path can be found in between Ranch View Terrace faculty housing and the Hay Barn on Ranch View Road. On this road, a path restricted by a gate is used to host utility cables underground. The conditions of this corridor may be comparable to Cardiff Path due to the lack of infrastructure and difficulties accessing. Looking at Table 3.10.2, this corridor presents an overall steepness that may be more favorable compared to Cardiff Path but significant slopes are present at the entrance shown in Figure 3.10.1. To show discontinuity that occurs in our path, we have separated the path based on “Upper” where the path is relatively symmetrical while the “Lower” section captures unpaved land. In separating the corridor to Upper and Lower, we are able to distinguish where the existing path may have been developed. In the Upper portion of the Utility Corridor, we find that the path averages at a slope of 7.54 feet whereas the Lower portion has an average slope of 11.89 feet. In addition, the Utility Corridor does not connect to any infrastructure at the base of campus. Due to the lack of connectivity, a sharp change in slope is present by High Street with a grade of 51.55 feet. Utilizing the Utility Corridor for bicyclists reaching the path at the base of campus may be difficult due to the proximity of the intersection of Bay Drive and High Street. Due to the proximity of the intersection, slowing down vehicles again to accommodate bicyclists reaching the corridor may cause tensions from motorists. Due to existing conditions, the realization of this corridor may be infeasible.

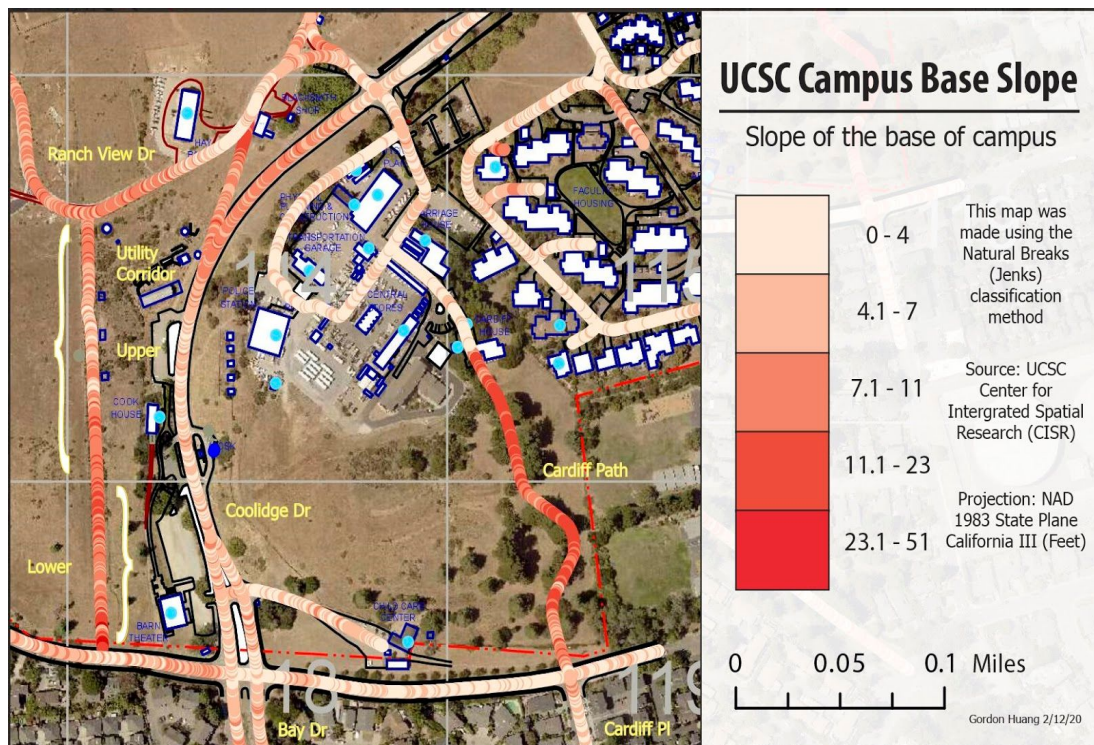


Figure 3.10.1. Map exploring the slope of existing bike or pedestrian pathways at the UCSC base of campus.

	Utility Corridor (Whole)	Utility Corridor (Upper)	Utility Corridor (Lower)	Cardiff Path	Coolidge Dr	Ranch View Rd	High St
Mean	9.36	7.54	11.89	9.20	5.27	5.96	4.68
Minimum	0.95	0.95	4.16	0.42	0.54	0.42	0.26
Maximum	51.55	13.59	51.55	21.97	12.83	14.06	4.68
Standard Deviation	5.39	2.59	7.02	5.08	2.54	2.69	2.15
Count	1065	619	444	383	575	574	789

Note: Counts represent cells measured by 1x1 feet.

Table 3.10.2. Slopes of streets and paths located on the UCSC campus.

3.11 NACTO-recommended Intersection Treatments

Regarding intersections, NACTO has a host of treatments that can be used to mitigate common issues that intersections cause for cyclists and pedestrians. Among these are bike boxes, median refuge islands, intersection crossing markings, and bulb-outs. For the purpose of addressing issues with the UC Santa Cruz main entrance intersection, bulb-outs and median refuge islands are relevant. Bulb outs extend the sidewalk corners of an intersection out into the street, either entirely, or through disconnected islands. Bulb outs slow down traffic turning, as they have to navigate a sharp, large corner more carefully than a curved, sweeping one. They also cut down the distance between sidewalks, making pedestrian and cyclist crossing shorter, less exposed and therefore safer. Lastly, they provide a waiting area for pedestrians and cyclists that is projected further into the street, while also being protected so that pedestrians and cyclists are more visible to vehicles on the road while remaining safe. Median refuge islands have a similar goal, except they are placed in the center of long crosswalks. They are a protected waiting place for pedestrians or cyclists who could not cross the entire length of the crosswalk in time. Additionally, they create more obstacles for vehicles, and consequently slow them down and force drivers to be more aware.

3. 12 Roundabout/Alternative Intersection



Figure 3.12.1. 2030 Roundabout Geometrics with improved crosswalks.



Figure 3.12.2. Current crosswalk at Bay & High Intersection.

The City of Santa Cruz Public Works Department has proposed a roundabout in the Bay & High intersection to accommodate the predicted rush hour traffic of 3,000 vehicles in the year 2030, which would increase Level of Service (LOS) from the expected future LOS F score to LOS B. While it is true that roundabouts stabilize car speeds and allow them to move smoothly with no stops, the City Department has not taken into account the impact this will have on other street-users, such as bicyclists.

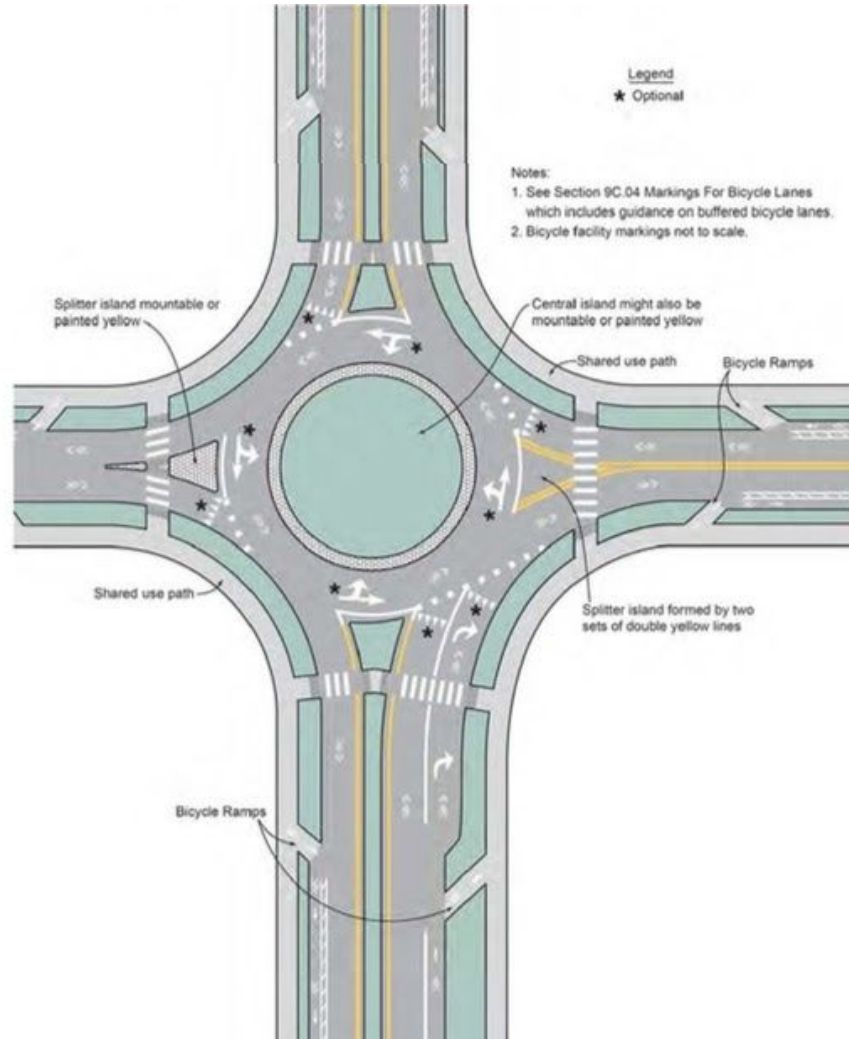
According to the visual the Committee has provided, it is clear that the roundabout would provide an easier crossing experience for pedestrians, providing mini-islands and breaks in between. This is a big improvement from the current infrastructure, which has zero breaks and could benefit from an island.

However, there seems to be no design compatible for cyclists who need to either get on campus through the main entrance or get across High St. As the updated 2018 Intersection Redesign plan states, this roundabout fails to meet the needs of cyclists who make up 10% of non-vehicular UCSC commuters. To fix this, 1) the roundabout must have a smaller radius to lessen traffic speeds or 2) there must be a separate bike lane altogether.

Assuming that cyclists ride the roundabout in the same way as car drivers, accidents may occur when cars and bikes exit/enter simultaneously: cars can fail to yield or slow down. This is a question of traffic law and how it will be implemented: whether bikes or cars will have the right of way. In a case study of roundabouts in Denmark, it was found that 81% of people injured/killed in roundabout accidents were cyclists or moped riders. In these incidents, the most common conflict was a cyclist circulating the roundabout with a car exiting or entering, in which cars failed to give way.

In the events that the city implements the proposed roundabout, we recommend a single-lane roundabout since according to Table 3.3.2 (also in Existing Conditions), there is an average traffic of only 14,000 per day; a single lane will be sufficient in dealing with these numbers. The recommended diameter is 120 ft to control traffic speeds, which is between the 90-150 ft range recommended by the National Cooperative Highway Research Program for a B-40 design vehicle, which includes the Metro and Loop buses.

A roundabout can coexist with the recommended infrastructure down on Coolidge, so bicyclists can choose whether to ride with cars or on a separate lane (Figure on next page).



3.12.3: Single lane roundabout visual

4. Recommendations and Next Steps

Based on the data analyzed, we will be preparing a set of recommended actions and designs to make the base of campus a cycling and pedestrian-friendly environment. These recommended actions may range from physical bike & pedestrian infrastructure (new bike paths, protected lanes, etc.). After evaluating the existing conditions, we found that improving the bicycle network on Coolidge Drive and Cardiff Path are the most feasible in the short-term since they already have existing infrastructure and do not include any grading of slopes. We are including the recommendations of the Utility Corridor as an option for a long-term project, as it would significantly improve cycling at UCSC but may require more resources.

4.1 Quick Fixes

Although implementing infrastructure on Coolidge Dr. may yield better results for safety and accessibility, quick fixes may be employed to save time and money. Infrastructure may be implemented at ease with relatively low significant changes at the Cardiff Path to provide a separated bike path. The Cardiff Path is located between the intersection of Cardiff Place and High Street and may be utilized as an alternative path to the campus bike lanes at the Great Meadow Bike Paths. These fixes may include the replacement of the fence with bollards, road repavement, street lighting, and intersection safety infrastructure.

To promote individuals to use the Cardiff Path, the campus must work to remove the barrier fencing the entrance. The fence presents an obstacle from pedestrians and bicyclists who are seeking to reach the Lower Campus facilities or to connect to the Great Meadows Bike Path. By replacing the fence with bollards, individuals looking to utilize the path would not be discouraged by the large barrier. In addition, bicyclists traveling through the bollards would not lose momentum compared to crossing of the fence. Bollards are recommended over the full removal of the fence to prevent vehicles attempting to use the path.



Figure 4.1.1: Removal of the fence at Cardiff Path.

In addition, the Cardiff pathway presents barriers of unpaved roads which may deter usage. Current conditions indicate that the path presents steep slopes that may be unfriendly towards bicyclists and pedestrians. To correct for slopes, pavement across the path is necessary. Moreover, the path may be under utilized during the night or early mornings due to the lack of lighting infrastructures. Thus, implementing lighting such as lamps and street lights may be necessary to make this path safe and usable.



Figure 4.1.2: Cardiff Path with pavement and lighting.

Although the Cardiff Path may be better utilized by individuals living on the east side of campus, long term infrastructures that would support the viability of the Cardiff Path must be implemented. To legitimize this intersection, the additions of pedestrian crosswalks, stop signs, and street lights must be made. Currently, individuals looking to access the Cardiff Path from High Street may find it difficult to enter as traffic travels at 30 mph without any yield or stop signs. The implementation of stop signs may be preferred over stop lights as the momentum from cars are put to a halt, giving bicyclists an opportunity to reach the separated path. If this path is to

be realized, new infrastructure must include bicycle route indicators along with stop signs at each corner of the intersection.



Figure 4.1.3: Intersection of Cardiff Place and High Street with additional stop signs and crosswalks.

5. Long Term Development Proposals

While developing infrastructure at Cardiff Path may promote bicycle usage, the location is relatively steep and may cater most to individuals living on the East side. Thus, improving infrastructure on Coolidge Drive is imperative for improving the transportation networks at UCSC and making cycling more accessible.

5.1 Coolidge Dr.

When considering cycling routes, it is important to consider paths of least resistance. Based on the existing conditions, remedying Coolidge Dr. is the most feasible option and of high priority for a more comprehensive network on campus.



Coolidge Dr. at its narrowest point is 36' in width. As demonstrated in Figure 5.1.1, this provides plenty of space for a bidirectional bike way buffered with a planting strip along Coolidge Dr. The current infrastructure provides no actual security for cyclists since there is no physical boundary preventing collisions. As previously stated in Section 3.3 (Level of Traffic Stress & Speed)-although the posted speed limit is 25 mph on Coolidge Dr., 85% of drivers travel 35 mph or lower according to the 2018 UCSC Engineering and Traffic Survey. At speeds of up to 35 mph, Level of Traffic Stress would suggest a level 4 Level of Stress, meaning cyclists must be “strong and fearless” in order to feel comfortable riding on the current infrastructure.

Figure 5.1.1: A depiction of how a bidirectional, buffered bike way might spatially look on Coolidge Dr. based on current measurements.

Separated bikeways have proven to be the safest bike infrastructure and make cyclists feel the most comfortable as emphasized in Level of Stress research. A bidirectional protected bike lane on Coolidge Dr. resolves current issues of conflict because of the physical separation.



Figure 5.1.2: The placement of the bidirectional bikeway on Coolidge Dr. linking up to the Great Meadow Bike Path and including a crosswalk along Ranch View Road

with placement of a bidirectional path, the transition onto Ranch View Road would be much easier for cyclists and would not require turning across oncoming traffic. In addition, the current bike path heading out of campus would easily feed into the bidirectional bike path as shown.

the current Great Meadow Bike path. This can be a risky and fear-inducing route as cyclists expose themselves to oncoming traffic. Figure 5.1.2 shows that

The bike pathway through the Great Meadow is heavily trafficked by cyclists looking to get to the heart of campus, therefore it is important to have an easy connection to and from that bikeway. As the infrastructure stands now, cyclists ride up the northbound bike lane and have to cross traffic to make a left turn onto Ranch View Road where they can then connect with

One of the goals is expanding and reinforcing bicycle networks. Therefore, there should be a crosswalk with paved waiting areas across Ranch View Road so that bikers may easily transition from the bidirectional path to the continued infrastructure up Coolidge.

In addition to the recommended bicycle infrastructure, there needs to be new pedestrian infrastructure along Coolidge as seen in Figure 5.1.3 & 5.1.4 in order to reduce the amount of pedestrians using bike lanes as a walkway. We suggest paving the current desire line and adding in stairs so pedestrians may easily access TAPS, the UCSC Police Station, and other essential offices, as well as potentially housing in the future.



Figure 5.1.3: Desire lines along Coolidge Road due to lack of pedestrian infrastructure.

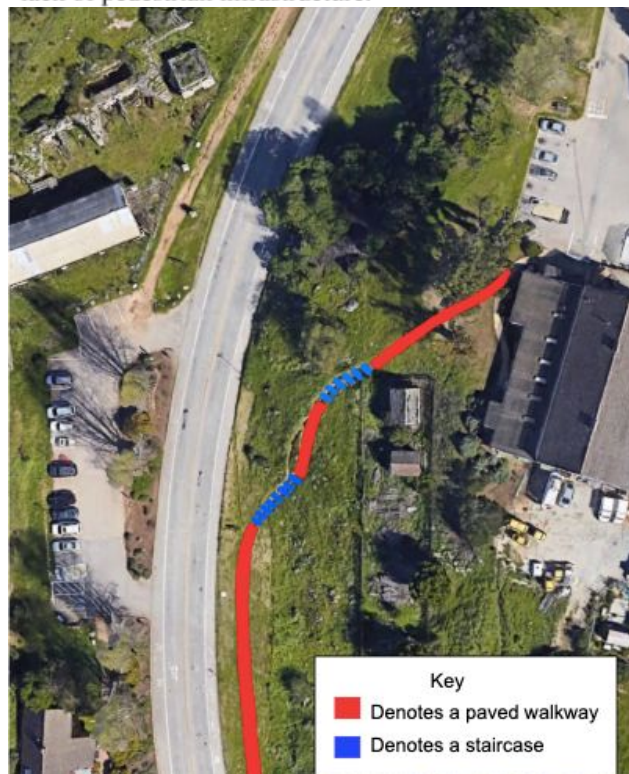


Figure 5.1.4. Proposed paved pedestrian pathway and staircases based on desire lines



Figure 5.1.5: The “before”: current situation of Coolidge Dr with 3 car lanes and desire line for nonexistent pedestrian walkway & northbound bicyclists

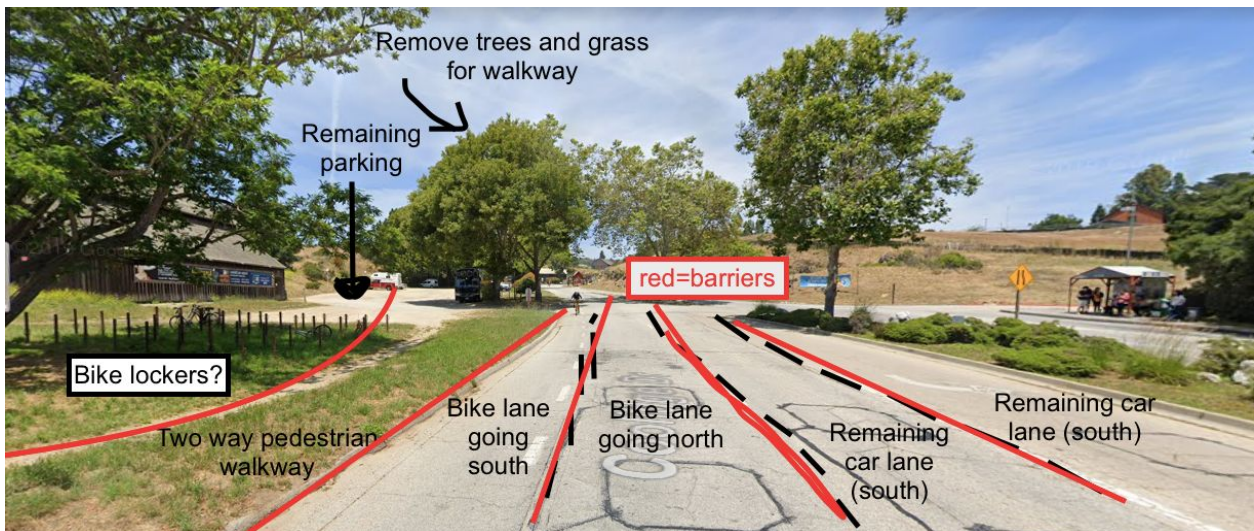


Figure 5.1.6: The proposed “after”: replacement of (looking from left to right) some parking near Barn Theater, grass/tree area, one bike lane, two car lanes into a two-way pedestrian walkway, two bike lanes (north and southbound), with remaining southbound car lane along with barriers to protect cyclists and pedestrians

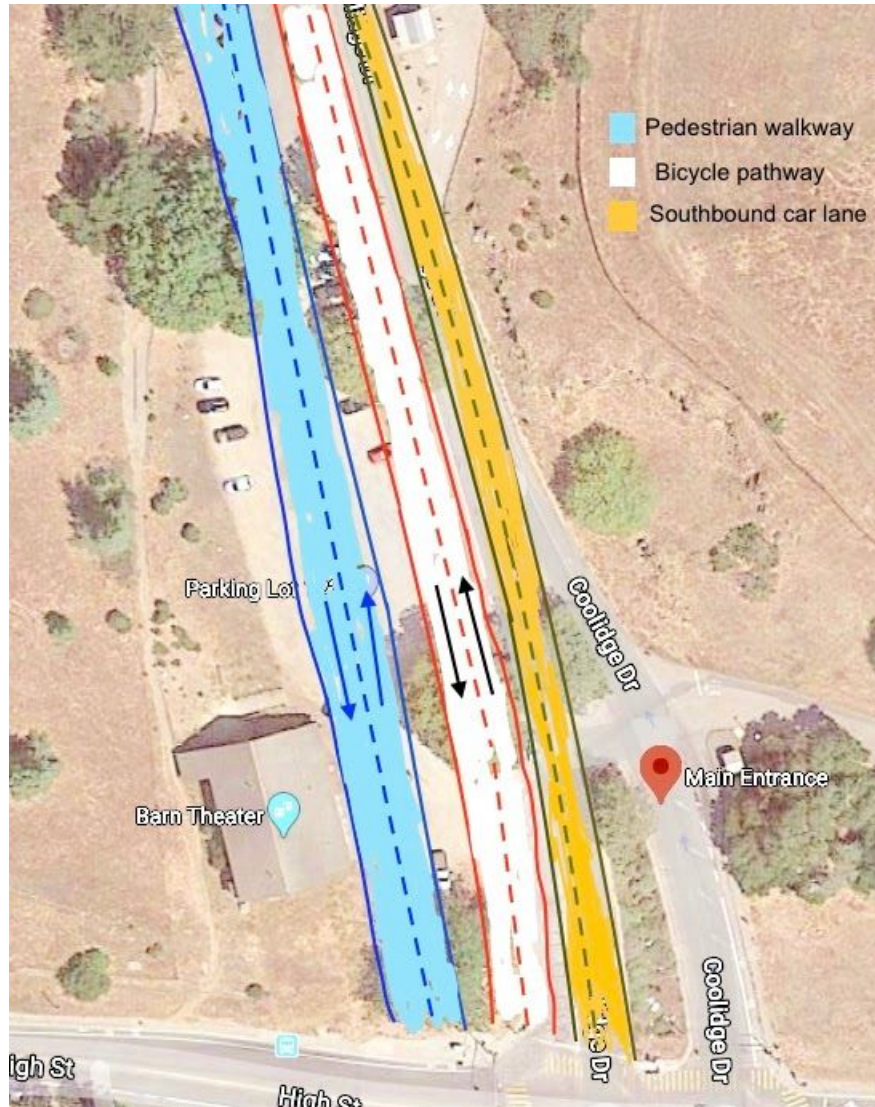


Figure 5.1.7. Aerial view of pedestrian walkway, bicycle pathway, and existing southbound car lanes with spaces in-between for physical barriers

Because of the narrow 5 to 5.5 foot bike lanes and the lack of a clear pedestrian walkway, we propose a road diet for the left section of Coolidge and use that space for bicyclists and pedestrians: this leaves one car lane behind and using the left car lane, part of the Barn Theater parking lot, the planting strip with trees to form a two-way pedestrian walkway on the left and a two-way bike lane to the right along with a physical barrier between the pedestrian and bike lane as well as between the bike and car lane. The conflicts that remain are: the downsizing of the Barn Theater parking lot, which does not pose a big issue since the lot is almost never full, as well as new infrastructure near the Historic District-the trees may or may not be of ecological importance to the campus.

This new infrastructure reinforces the desire lines that cyclists and pedestrians have already created (in the “before” figure).

5.2 Bay Drive and High Street Intersection

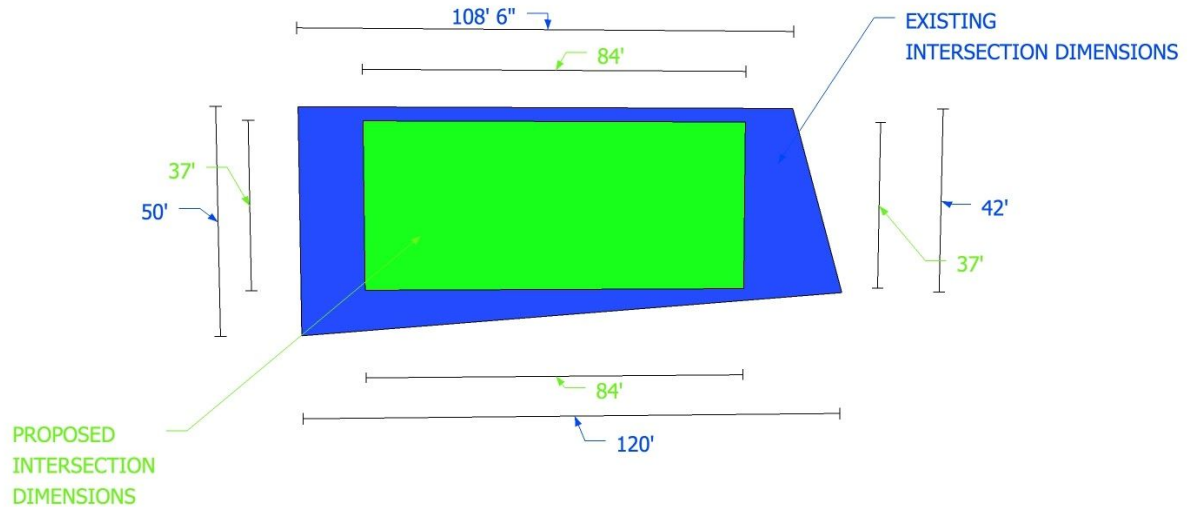


Figure 5.2.1: Proposed intersection dimensions in green versus existing intersection dimensions in blue.

High traffic volumes and critical speeds at the main entrance of UC Santa Cruz, where Bay Drive meets High Street, make clear the need for infrastructure that provides protection for pedestrians and cyclists navigating the intersection. The proposed design for a protected intersection will require a significant yet feasible downsizing of the space dedicated to vehicles in the intersection, shown in Figure 5.2.1. The blue area represents the current space dedicated to vehicles, while the green area represents the space that will be available to vehicles after implementing protection. This downsizing will not require the elimination of any current vehicle lanes in the intersection, however it will consistently reduce the width of these lanes to 11 feet. As shown in Figure 5.2.2, a breakdown of existing lane widths, 11 foot lanes are already in place at the intersection. The new design will only make this uniform.

The adjusted lane widths will have two benefits. First, thinner lanes will free up space for further bicycle and pedestrian protection. Second, they will require drivers to be more alert, and will often cause drivers to go slower than they would in wide, spacious lanes. This will create a safer intersection for drivers, cyclists, and pedestrians while maintaining sufficient space for all road users to move freely.



Figure 5.2.2 Current lane widths at main entrance intersection.

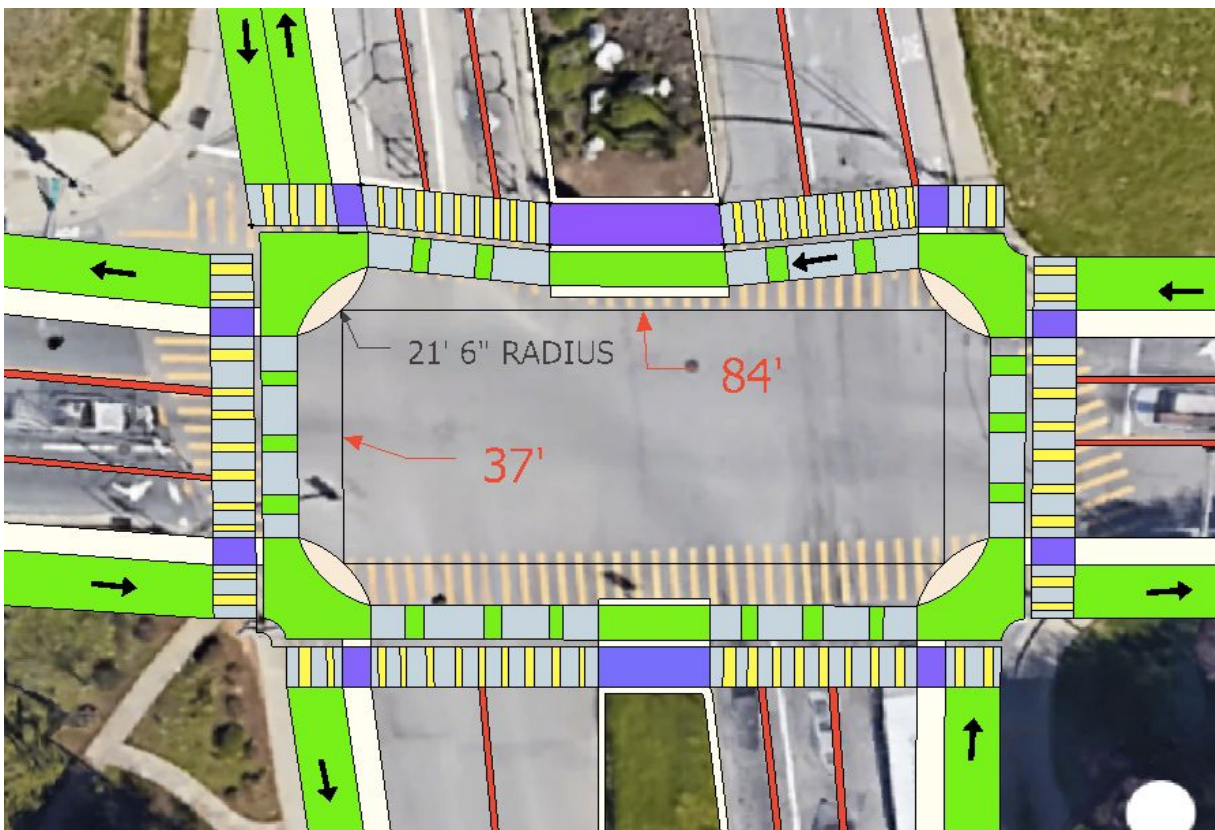


Figure 5.2.3: Proposed intersection design laid over Google Earth image of existing intersection (Pedestrian dedicated areas in purple and yellow, cyclist dedicated areas in green, and vehicle dedicated areas in red).

The proposed intersection design, shown in Figure 5.2.3, is inspired by recommendations from NACTO regarding protected intersections. An example of a protected intersection corner from NACTO can be seen in Figure 5.2.4. Our design includes median islands, pedestrian islands, bicycle waiting areas, car setbacks, and corner islands. These features provide a host of benefits to cyclists and pedestrians regarding safety.

Built out median islands with curbs for protection, shown in white in Figure 5.2.3, will provide a middle point along the longer crosswalks in which pedestrians and cyclists can stop and wait safely if necessary. Median islands are currently in place along the crosswalks, but they would be extended out to accommodate bicycle crossing as well. Although these crosswalks will be shortened, they will still be 84 feet long and median islands will be necessary to mitigate pedestrian and cyclist exposure.

The pedestrian islands and bicycle waiting areas reduce the length of crosswalks and therefore shorten the amount of time that pedestrians and cyclists are exposed to vehicles while navigating the intersection. This benefit is particularly important in the case of the Bay Drive and High Street intersection, because this intersection includes two massive crosswalks, being 120 feet and 108 feet long.

Additionally, pedestrian islands and bicycle waiting areas paired with car setbacks heighten visibility of pedestrians and cyclists. Figure 5.2.5, a depiction of the North West corner of the intersection, shows the 14 foot car set back line. This distance ensures that cars will have a clear view of pedestrians and cyclists waiting on their respective islands before even entering the intersection.

The corner island further contributes to heightened visibility. The corner islands will have a 21.5 foot radius, which ensures that cars turning right will have pivoted sufficiently to have a direct view of pedestrians and cyclists crossing. This eliminates the possibility that pedestrians and cyclists would be in a right turning vehicle's blind spot while crossing. This radius is tight enough that cars will also tend to slow down when making turns, however, it is still large enough that busses will be able to make right hand turns.



Figure 5.2.4: NACTO depiction of protected intersection

