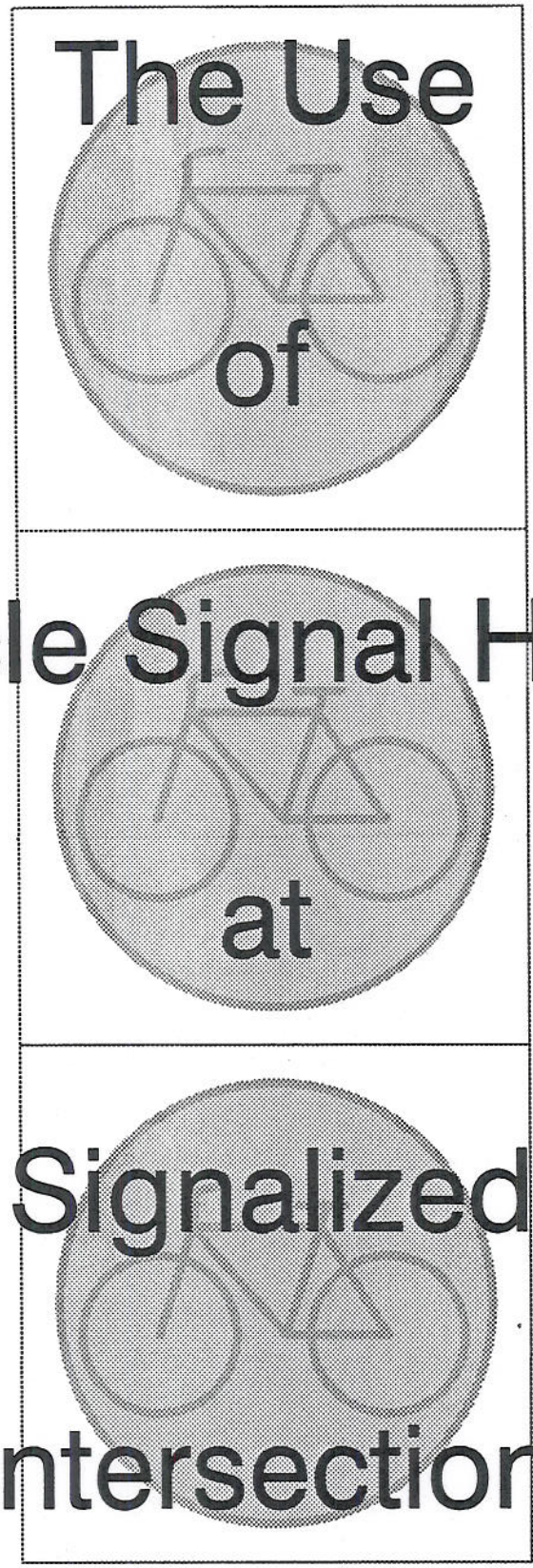
The Use of Bicycle Signal Heads at Signalized Intersections



Davis
California

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The Use of Bicycle Signal Heads at Signalized Intersections

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Executive Summary

The City of Davis submitted a proposal to the California Traffic Control Devices Committee (CTCDC) in 1990 for approval of a demonstration project. This project involved the use of bicycle signal heads in combination with the standard green yellow and red balls and arrows of a "typical" intersection. This concept has been used in Europe for a number of years.

The City of Davis undertook this project to install bicycle heads at a signalized intersection due to the volumes of bicycles interacting with motor vehicles. The intersection, Russell Boulevard at Sycamore Lane, consisted of a tee intersection and a three-phase signal. Sycamore Lane extends north from Russell Boulevard, and the UC Davis campus perimeter begins along the south side of the intersection. A 12-foot wide bicycle/pedestrian path parallels Russell Boulevard along the UC perimeter This location serves a large volume of college student traffic to and from UC Davis, primarily from Sycamore Lane southbound, onto campus. Peak hour volumes for bicycles are in the magnitude of 1,100 bicycles per hour while motor vehicle traffic for Russell Boulevard is about 18,500 vehicles per day (vpd) and 7,500 vpd for Sycamore Lane.

The bicycle signal heads were installed for northbound and southbound traffic to provide bicyclists a separate signal phase for movements through the intersection. Prior to modifications, the existing north/south signal phase provided for bicyclists and motor vehicles to operate concurrently. A typical result was motor vehicle and bike traffic winding their way around each another in an attempt to get through the intersection.

The project included installation of additional Type 1-B standards for southbound traffic and installation of a mast arm mounted signal for northbound traffic. Southbound traffic signal heads consisted of standard red, yellow and green balls and the addition of red, yellow and green bike indications. Northbound signal heads were installed with bike indications only.

The signal phasing was modified to accommodate a fourth phase, for northbound and southbound bicycle and pedestrian traffic only. This phase was placed before the southbound vehicle green to clear the majority of all bicyclists from the intersection.

Before and after questionnaires were completed to gather data on the perception of both bicyclists and motorists of traveling through this intersection. A marked increase in safety was noted by most respondents who had traveled through the intersection in both before and after conditions. Most of the respondents who had not experienced the "before" condition perceived that the intersection was safer than other signals where they interact with motor vehicles.

Accident history showed that in the three years before modification fourteen collisions occurred in the intersection. Over half involved either pedestrians or bicyclists. In the sixteen months since implementation, two collisions have occurred, neither of which involved a pedestrian nor a cyclist.

The City of Davis Public Works Department regards the use of bicycle signals as an important element in safe, orderly and efficient movement of all people through intersections. They should, however, be installed on a case by case basis when configured with vehicle head indications as intersection dynamics vary.

Various locations may merit the use of bicycle signal heads. These include tee intersections where a major bicycle movement is along the top of the tee, the confluence of a separated bicycle path with a signalized intersection, and separated bicycle paths that are parallel to arterial streets.

INTRODUCTION

It is estimated that in Davis, CA, there is approximately one bicycle per resident in this city of 53,000. As such, bicycles are an integral part of the transportation system. In 1990, the city proposed the installation of bicycle signal heads at various intersections to the California Traffic Control Devices Committee (CTCDC) [Figure 1]. The purpose of these signals was to give bicyclists sufficient information to facilitate their movements through intersections. Initially, five intersections received approval for modification with bicycle signal heads. These intersections, all tee intersections for motor vehicles (hereinafter vehicles), provided red, yellow and green bicycle indications for those approaches only seen by pedestrians and bicyclists. Two additional signals were installed where the indications were seen by vehicle traffic. One intersection had bike signals installed along the top of a tee intersection while the other intersection, at Russell Boulevard and Sycamore Lane, had bike signal indications positioned in the view of all approaches to the intersection. This paper analyzes the Russell Boulevard/Sycamore Lane site.

The Russell Boulevard/Sycamore Lane intersection is a tee intersection in the west side of the city, along the northern perimeter of the University of California at Davis (UCD). This intersection provides access to various on and off-campus housing areas and provides a major access route from central west Davis to north Davis. An elementary school is also located along Sycamore Lane, in the northern segment. Both UCD and West Davis Elementary School serve as attractors along Sycamore Lane while the residential neighborhood, and in particular, the high density student housing, provides a high generator of bicycle traffic. Most of the bike trips generated are inbound to the campus in the morning, outbound in the evening and equally split during the midday.

The Russell Boulevard/Sycamore Lane intersection was a three-phase signal providing phasing for left turning eastbound traffic, east and westbound through traffic and southbound traffic (Figure 2). During the southbound vehicle phase (phase 3), bicyclists and pedestrians along both sides of the street were given green ball indications and walking phases. Peak hour volumes for bicycles are in the magnitude of 1,100 bicycles per hour while vehicle traffic for Russell Boulevard is about 18,500 vehicles per day (vpd) and 7,500 vpd for Sycamore Lane. Peak hour vehicle volumes for the intersection average about 2,300 vph. During this peak, approximately 200 pedestrians can cross Russell Boulevard. This traffic composition and volume provided for a complex set of maneuvers for bicyclists, pedestrians and motorists during this southbound motor vehicular phase. A typical phase would result in bicycles scattered throughout the intersection proceeding straight and turning from various locations within the intersection (Figure 3). Pedestrians would

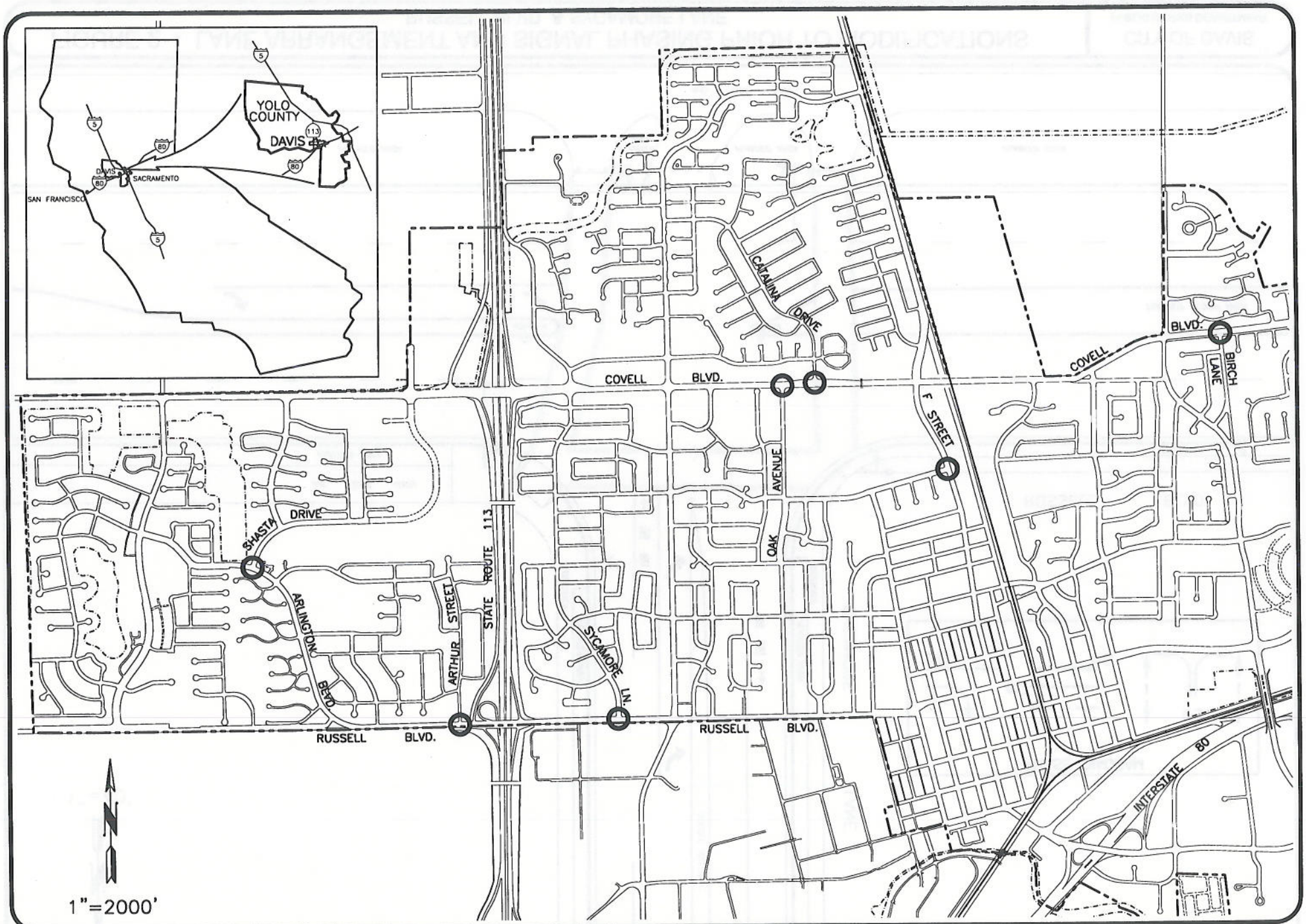

FIGURE 1 - LOCATION MAP

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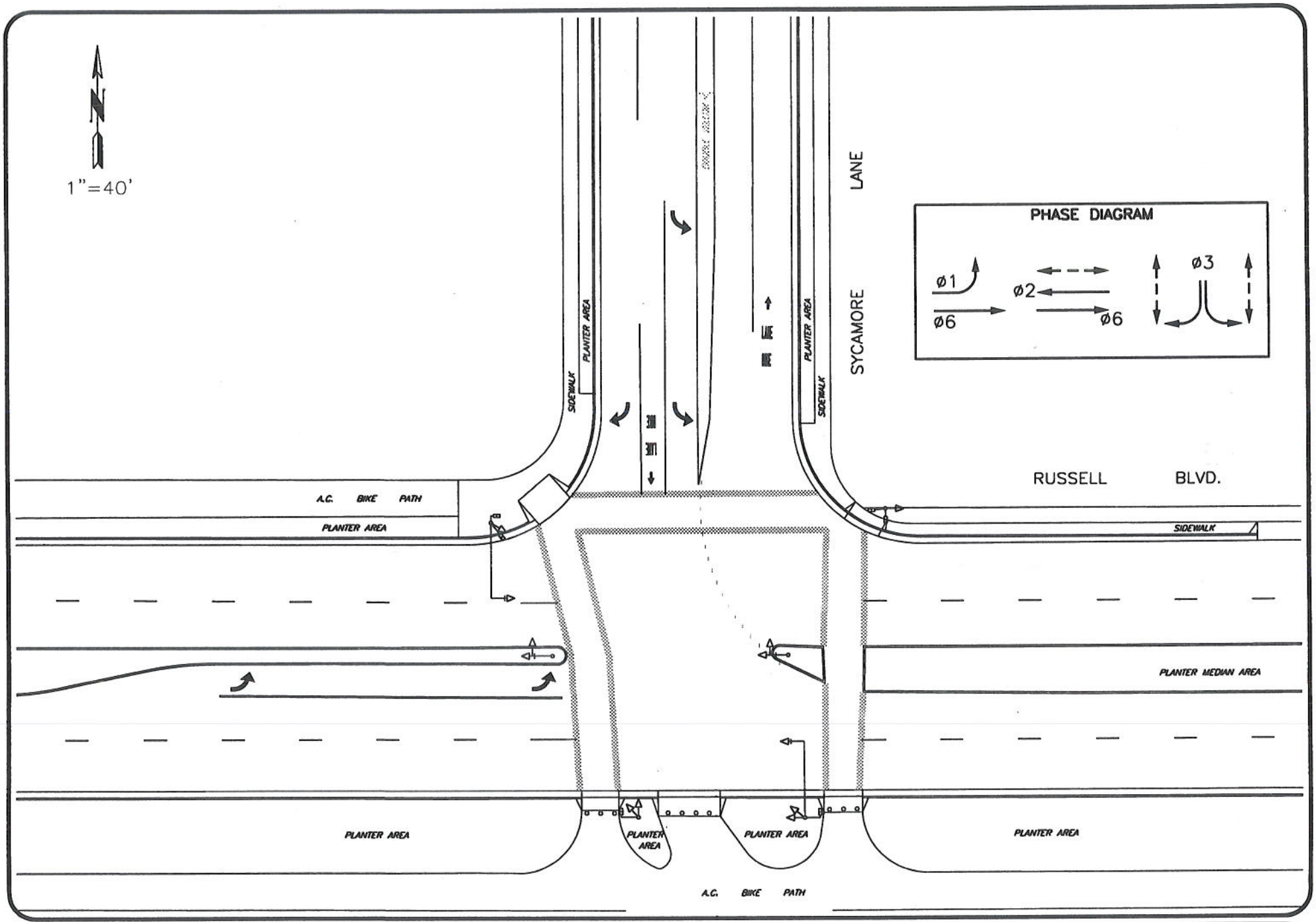

FIGURE 2 - LANE ARRANGEMENT AND SIGNAL PHASING PRIOR TO MODIFICATIONS

RUSSELL BLVD. & SYCAMORE LANE

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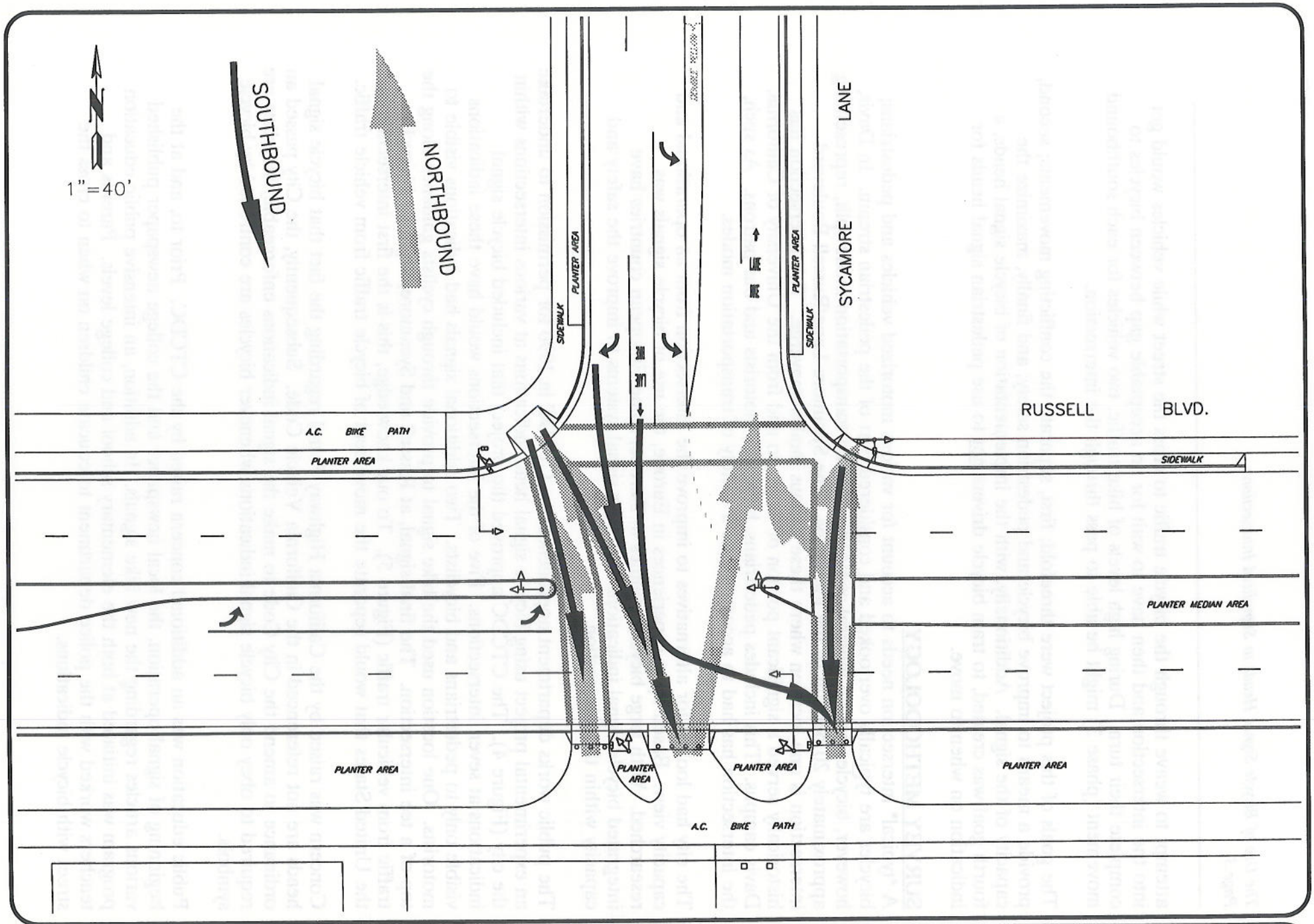

FIGURE 3 - BICYCLE MOVEMENTS PRIOR TO MODIFICATIONS

RUSSELL BLVD. & SYCAMORE LANE

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attempt to weave through the bicycle traffic to cross the street while vehicles would get into the intersection and then have to wait for an acceptable gap between bicycles to complete their turn. During high levels of bike traffic, two vehicles for each southbound movement (phase 3) might be able to pass through the intersection.

The goals of this project were threefold; first, separate the conflicting movements; second, provide a means to improve bicycle and pedestrian safety; and finally, maximize the capacity of the signal. Additionally, with the implementation of bicycle signal heads, a fourth goal was created, to train bicycle drivers not to use pedestrian signal heads for indication on when to move.

SURVEY METHODOLOGY

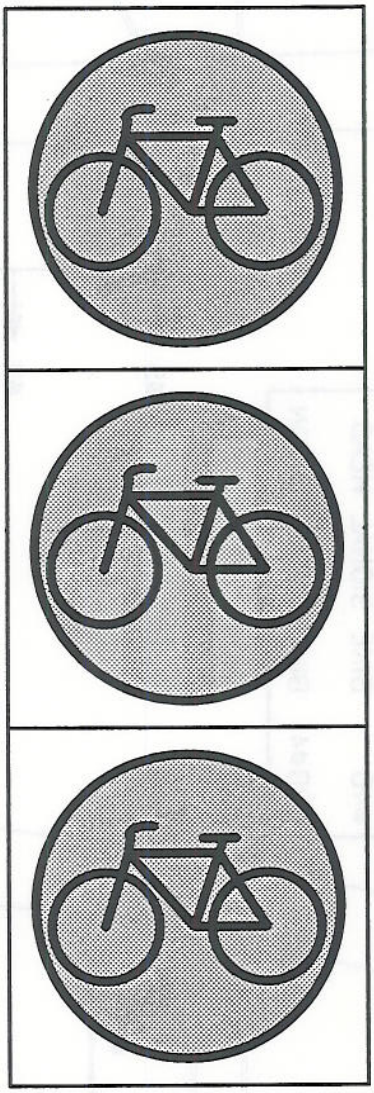
A "typical" intersection needs to account for various motorized vehicles and pedestrians; bicycles are typically overlooked and considered part of the pedestrian stream. In Davis, however, bicycles are an integral component of the transportation mode split, representing approximately 20 percent of the total trips. The Sycamore Lane/Russell Boulevard intersection is one location where these various modes converge. This intersection has historically served a significant portion of trips to and from the University of California, Davis campus. This includes pedestrians, bicyclists, motorists and bus patrons. As such, the intersection has had to accommodate a variety of transportation modes.

The city had looked for alternatives to improve the intersection from an operational and capacity view. Based upon experiences in Europe, the use of bicycle signals was researched. With large bicycle volumes in Europe, some European countries have integrated bicycle signal indications into their signal systems to improve the safety and capacity within the intersection.

The public works department approached the CTCDC in 1990 for permission to undertake an experimental project using bicycle signal head indications at various intersections within the city (Figure 4). The CTCDC approved the project that included bicycle signal indications at seven intersections. Five of the intersections would have these indications visible only to pedestrians and bicyclists. Two additional signals had indications visible to motorists. One location used the bike signal to provide through cyclists guidance along the top of a tee intersection. The final signal, at Russell and Sycamore, separated bicycle traffic from vehicular traffic (Figure 5). To our knowledge, this is the first intersection in the United States that would separate the movement of bicycle traffic from vehicle traffic.

Concern was raised by the California Highway Patrol regarding the fact that bicycle signal heads are not referenced in the California Vehicle Code. Subsequently, the City passed an ordinance to amend the City Code to make the signal indications enforceable; bicyclists are required to obey only bicycle signal indications whenever bicycles are controlled by bicycle symbols.

Public education was an additional concern raised by the CTCDC. Prior to, and at the beginning of signal operation, the local newspaper and the college newspaper published various articles regarding the new bike signals. In addition, an intensive public education program was initiated at both the elementary school and college levels. Parents and teachers worked with the police department to educate children on when to cross the street with bicycle indications.



12" RED

12" YELLOW

12" GREEN

FIGURE 4 - BICYCLE SIGNAL HEAD

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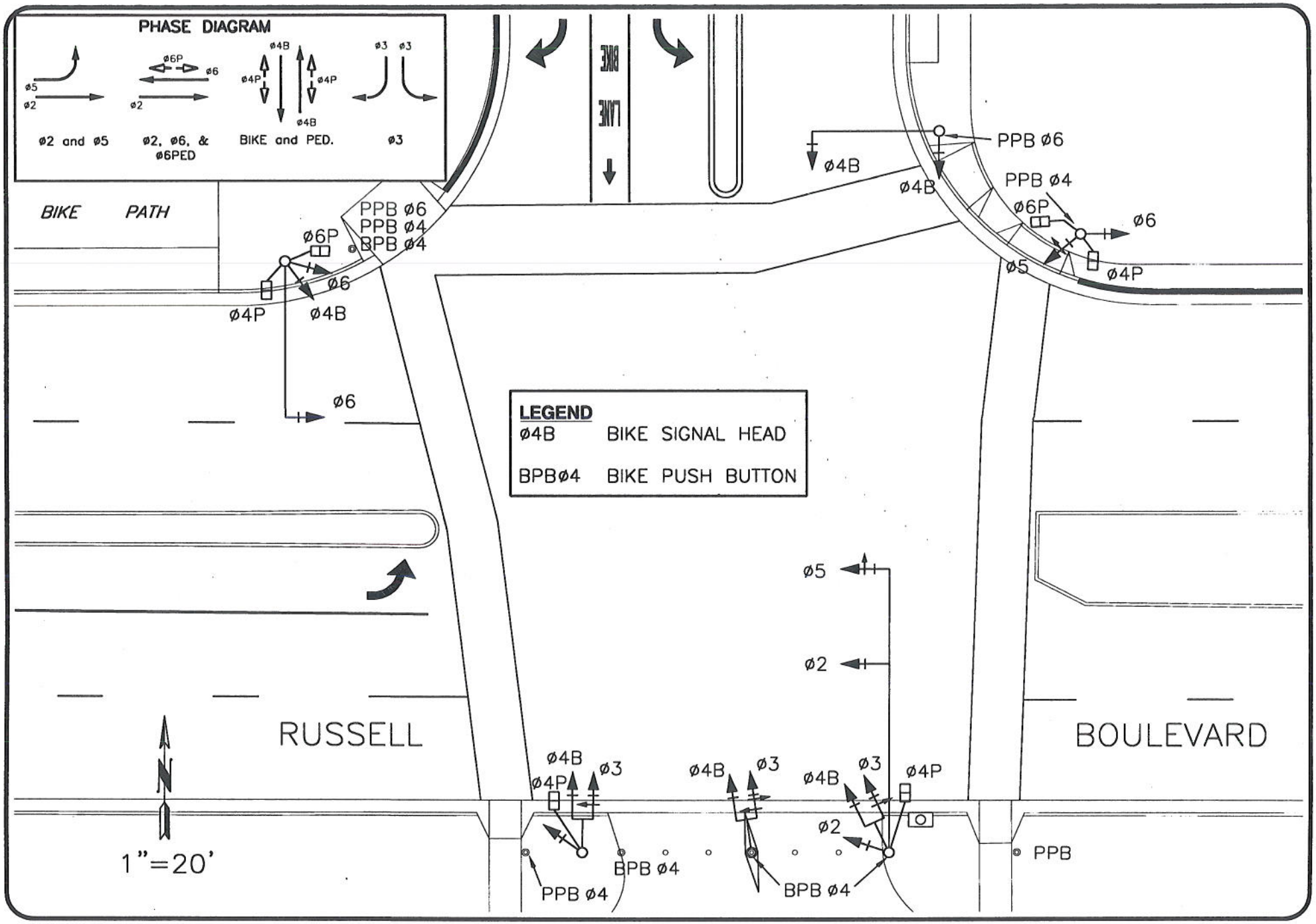

FIGURE 5 - SIGNAL INDICATIONS AND PHASING - AFTER MODIFICATIONS

RUSSELL BLVD. AND SYCAMORE LANE

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"Before" Signal Configuration

The traffic signal at the Russell Boulevard/Sycamore lane intersection before implementation of the project consisted of a three-phase semi-actuated signal with full pedestrian access. The intersection is a tee intersection for vehicles while providing a four-way intersection for bicyclists. A protected left turn phase was provided for eastbound traffic (Figure 2). Traffic signal indications existed for eastbound, westbound and southbound movements while northbound traffic (bicycles and pedestrians) was dependent upon pedestrian signals only. Additionally, the east side crosswalk bisected the existing median. As such, pedestrians and bicyclists using this crossing were obscured by the Type 1-B pole for eastbound left turning vehicles.

Prior to modification of the existing signal, before surveys were conducted to develop baseline data of the then current conditions. In late June and early July 1994, 230 surveys were completed by bicyclists regarding the ease or difficulty bicyclists had in negotiating the intersection. A copy of the survey, "Form 'A'," can be found in Appendix A. The surveys included questions to determine a "typical" cyclist. These included the type of school attended to find age groups, the time of day that cyclists typically passed through the intersection and the type of cyclist passing through the intersection. The results of this data are shown in Tables 1 through 3.

Table 1
What term best describes your cycling?

	Commuter	Fitness/Recreation	Casual Recreation	Primary Travel Mode
Response	85	29	21	94
Percentage	37%	13%	9%	41%

Table 1 identifies 78% of cyclists surveyed at this intersection are daily users who commute either to work or school or use a bike as their primary travel means. In other words, these cyclists are familiar with the intersection dynamics and would most likely notice signal modifications, such as separated phasings. Table 2 provided us with a more refined look to define our typical cyclist using the intersection further. Of the cyclists riding through the intersection 80% were college students. Of the remaining 20 percent 12% were not students. This may include parents riding with their children to school, faculty/staff at UCD, cyclists commuting to work, cyclists riding for fitness, or someone riding to the University Shopping Mall, adjacent to the intersection.

Table 2
What school do you attend?

	Elementary	Jr. or Sr. High School	College	Not a student
Response	1	17	170	25
Percentage	0%	8%	80%	12%

Most of the cyclists ride during three time periods, the morning and evening peak periods and throughout the day between peak periods. The midday cyclists are typically students who commute to campus before and after classes. The two peak periods would suggest that a combination of students and workers are on the facility during this time.

Table 3
When do you typically ride through this intersection?

	Before 7:30 a.m.	7:30 a.m. - 9 a.m.	9 a.m. - 4 p.m.	4 p.m. - 6 p.m.	After 6 p.m.
Response	20	40	104	46	21
Percentage	9%	17%	45%	20%	9%

"After" Signal Configuration

The Russell Boulevard/Sycamore Lane signal was modified in November 1994. Modifications included removal of the left-turn 1-B signals in the Russell Boulevard median, installation of left turn signals on the mastarm and far side pole, installation of new bicycle signal heads for northbound and southbound traffic, including a mastarm installation for northbound traffic, removal of the median island in the east side of the intersection, and installation of a "no turn on red" LED sign. Figure 5 shows the signal layout after changes were completed.

As noted, the island formerly containing a 1-B pole was removed. This island, and equipment located within it, previously obscured pedestrians and bicyclists from vehicles turning east from southbound Sycamore Lane. After removal, visibility of the entire intersection was improved for all transportation modes. Other improvements included construction of a wider throat for bike access at the south side of the intersection. This widening provides for a larger volume of bikes to enter and exit the bike path to campus. Advance signing was also installed for southbound Sycamore Lane traffic about 200 feet in advance of the signal. The signing included the approaching lane arrangement (a left turn lane, a bike through lane and a right turn lane) and a sign informing motorists and bicyclists of the impending bicycle signal (Figure 6).

The traffic signal was modified to a four-phase signal with the inclusion of the bicycle/pedestrian phase for northbound and southbound traffic. The phasing modified the north-south approach to a lead-lag phasing, with the "northbound" phase consisting of northbound and southbound bike/ped traffic. The phasing was arranged so that the bike phase would be actuated first to clear the waiting bicycle and pedestrian traffic. This was done because of the bicycle queue that develops in peak hours. This southbound queue can extend beyond the limit of the bike lane, and a vehicle phase first would require merging vehicles to go through bikes to get to the intersection. In addition, depending on the phase sequence used, the phase following the bike phase could be either eastbound and westbound traffic or southbound vehicle traffic. It was viewed that the southbound vehicle phase would present a safer condition for bicyclists, especially those that enter intersection during the yellow clearance interval.

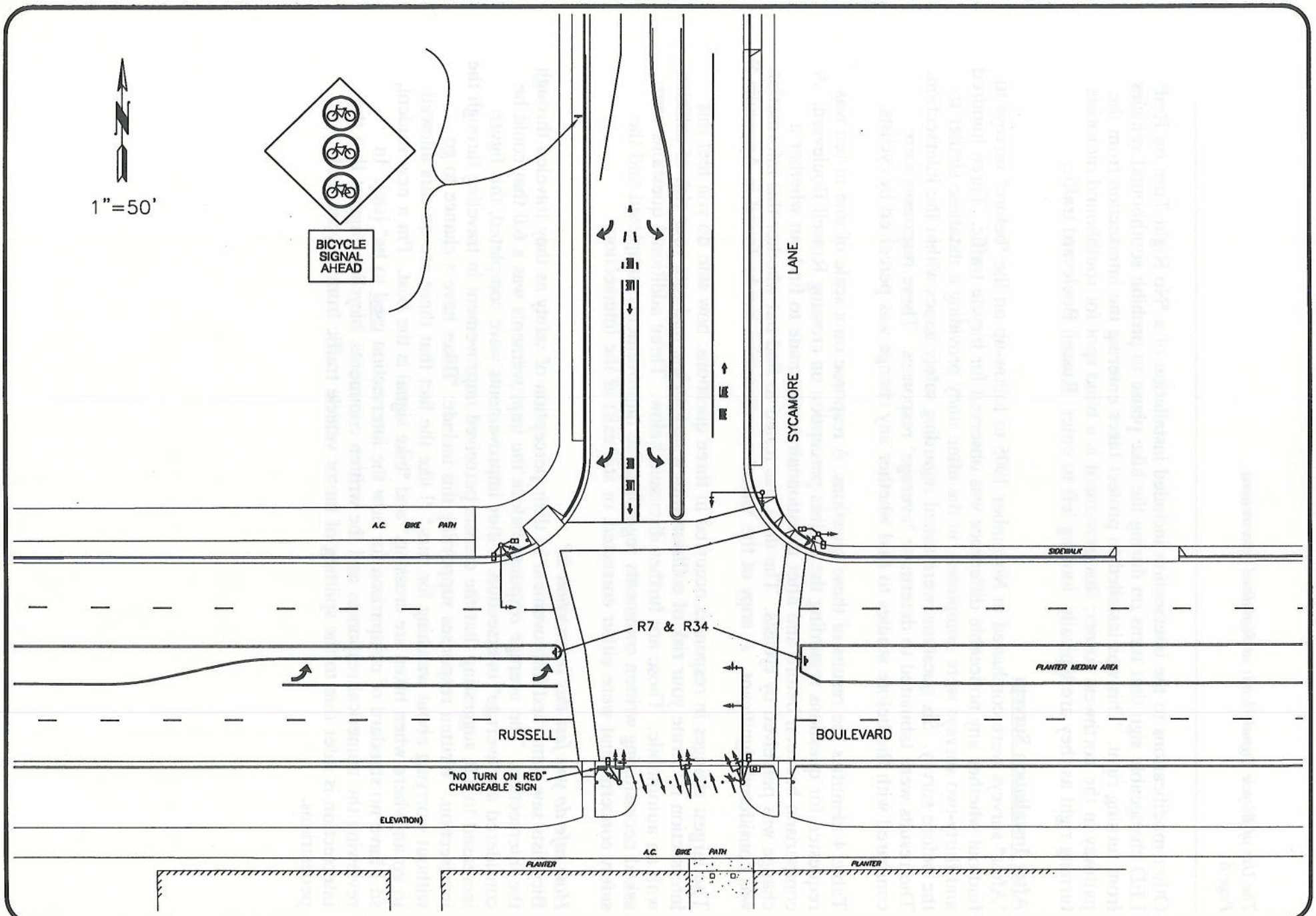

FIGURE 6 - SIGNING AND STRIPING AFTER MODIFICATIONS
RUSSELL BLVD. AND SYCAMORE LANE

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Other modifications to the intersection included installation of a "No Right Turn on Red" LED changeable sign that turns on during the bike phase to prohibit southbound vehicles from turning right. This was installed to protect bikes entering the intersection from the pathway in the northwest corner; this movement is a blind spot for southbound motorists turning right as they are typically looking left to enter Russell Boulevard traffic.

After Installation Surveys

"After" surveys were conducted in November 1995 to follow-up on the "before" surveys to find out whether any noticeable difference was observed for bicycle traffic. Three hundred and thirty-two surveys were completed in the after study providing a database similar to the before survey. Six questions were asked regarding safety issues within the intersection. The results were tabulated to determine "average" responses. These responses were compared with the before studies to find whether any change was perceived by cyclists.

Table 4 identifies the results of these questions. A response on a scale of one to ten was requested for questions regarding the cyclists perception on crossing Russell Boulevard. A comparison between before and after questionnaires was made to find out whether a change was perceived by cyclists. The data was tested to find out whether this information was considered significant. A copy of the "after" questionnaire can be found in Appendix B.

The largest changes in responses occurred in three questions: how safe do you feel this intersection is? ; rate your risk of collision with a pedestrian; and rate your risk of collision with an automobile. These are further discussed below. Three additional questions were asked necessitating written comments regarding the improvements completed and the safety concerns that were either corrected, or still exist at the intersection.

How safe do you feel this intersection is?

Bicyclists saw a marked improvement in their perception of safety as they traveled through the intersection. The average response before the improvements was a 6.0 that could be considered an "average" intersection. After improvements were completed, this figure increased to 8.0, suggesting that the cyclists perceived improvement in traveling through the intersection. Written responses supporting this include: "Bikes have a chance to go without worrying about watching for cars," "I like the fact that there are no cars allowed to go anywhere when bikes are crossing," and "bike signal is the best. I'm a new student, so I have no standard of comparison for how the intersection used to be" [sic]. In reviewing the numerical responses and the written comments, bicyclists suggest that the intersection is safer due to the splitting of motor vehicle traffic from bicycles and pedestrians.

Table 4 - Bicycle Questionnaire Results

Question	"Before" Average	"After" Average	"Before" Std. Deviation	"After" Std. Deviation	"Before" 95% Confidence Limits	"After" 95% Confidence Limits	Significant/ Not Significant
1) On a scale of 1 to 10 (10 being the best), do you feel a cyclist can figure out when to cross?	7.1	7.8	2.3	2.0	6.8 / 7.4	7.6 / 8.1	Significant
2) On a scale of 1 to 10 (10 being the best), how safe do you feel this intersection is?	6.0	8.0	2.1	1.6	5.7 / 6.2	7.8 / 8.2	Significant
3) On a scale of 1 to 10 (10 being the highest), rate your risk of collision with another cyclist:	6.0	6.0	2.8	2.6	5.7 / 6.4	5.7 / 6.3	Not-Significant
4) On a scale of 1 to 10 (10 being the highest), rate your risk of collision with a pedestrian:	4.3	2.9	2.5	2.1	4.0 / 4.6	2.7 / 3.2	Significant
5) On a scale of 1 to 10 (10 being the highest), rate your risk of collision with a fixed object:	3.5	2.8	2.5	2.3	3.2 / 3.8	2.6 / 3.1	Significant
6) On a scale of 1 to 10 (10 being the highest), rate your risk of collision with an automobile:	5.4	3.0	2.7	2.2	5.1 / 5.8	2.8 / 3.3	Significant

Rate your risk of collision with a pedestrian on a scale of 1 to 10 (10 being the worst). Respondents perceived that the potential collision with a pedestrian has decreased with the installation of the bike phase. This is because the cyclists do not have to worry about vehicle traffic and can concentrate solely on bicycle and pedestrian traffic. Bicyclists raised concerns regarding the queuing locations for cyclists and pedestrians. The one location identified as a concern was the northwest quadrant of the intersection where cyclists and pedestrians queue together. During peak hours there is a large volume of traffic, both on bikes and on foot, in this location. Many cyclists felt that, although this location was a cause for concern, other cyclists were more of a concern than pedestrians. This remark was noted on many surveys, however, the overall rating for a collision with another cyclist was 6.0 both before and after modification.

The modification of the intersection provided separate access points for bicyclists and pedestrians. Pedestrian push buttons and bicycle push buttons were positioned so that the interaction of cyclists and pedestrians at entry points would be minimized. The position of the bike heads, separate from the walk/don't walk indications, and beside the motor vehicle indications, required "retraining" of cyclists to focus on the bike indications, rather than the pedestrian indications, for direction on when to enter the intersection.

Rate your risk of collision with an automobile on a scale of 1 to 10 (10 being the worst). This question showed the largest change in "average" response. After modification of the intersection, the perceived risk of a collision with an automobile dropped significantly from 5.4 to 3.0. The bike phase gave cyclists a phase independent of vehicle traffic with which to cross Russell Boulevard. This was supported with written comments provided by the respondents. Some comments included, "Bikes have a chance to go without worrying about watching for cars," "I like the fact that there are no cars allowed to go anywhere when bikes are crossing," and "I really like the fact that no cars are leaving where [sic] bike traffic is moving."

The bike signal has evidently improved flow and safety for bicyclists, however, one concern that is apparent is that bicyclists have a tendency to relax because they are now "protected" by a bicycle signal. One comment above noted that bikers do not have to "worry" about watching for cars. Installation of bicycle signals should be installed knowing that some bicyclists may perceive their obligation of ensuring their individual safety can be lessened because of a bike signal phase.

ACCIDENTS

Before Bicycle Signal Head Implementation

Accident data was collected and analyzed using the Statewide Integrated Traffic Records Systems (SWITRS). Accident records were categorized between January 1992 and November 1994, just before implementation of the bicycle signal program. Data was tabulated by type of accident, violation type, parties involved, party at fault, primary collision factor and location within intersection. The reports were also examined to figure out whether the various collision(s) could have been prevented with installation of a bicycle signal phase. Table 5 provides a synopsis of the collisions that occurred before the signal modification. Fourteen collisions within the intersection were noted including one property damage only (PDO) collision and thirteen injury collisions having police reports.

Of the fourteen reported collisions, ten involved bicycles and one involved a pedestrian. Most of the types of collisions involved failure to yield or right turns on red. Failure to yield collisions were determined to be primarily the faults of the bicyclists (4 of 6). Review of the police reports indicated that a primary cause of the collisions involves cyclists entering the intersection during the end of a green phase and attempting to "beat" the yellow or red clearance intervals. Many cyclists also enter the intersection without looking to see if it is safe. This latter condition has a tendency to exist as bicycles and pedestrians enter an intersection because "they" have the green, despite whether motor vehicles are present.

The secondary collision type consisted of vehicles turning right on red. The party at fault in all these collisions was the motorist. Again, after reviewing the police reports, apparently right turning motorists were generally looking toward oncoming traffic (to the left) prior to entering the cross traffic stream. As they continued into the intersection, cyclists were entering the crosswalk from the bike path along the north side of the intersection (from the right) and were subsequently struck by the motor vehicle. Other collision factors included inattention by motorists, particularly in rear-end collisions and riding on the wrong side of the road by bicyclists.

Of the fourteen collisions noted during this period, seven possibly could have been avoided with a bicycle signal phase in place. Five other collisions may also have been avoidable while two, both auto-auto collisions, probably still would have occurred.

<u>After Bicycle Signal Head Implementation</u>
Accident data was collected between December 1994 and March 1996. Table 6 provides a listing of collisions after installation of the bike signal. During this sixteen-month period, only two collisions were reported to the police department; neither collision was bike related.

Construction and implementation of the bicycle phase caused a noted decrease in collisions in the intersection. This is due to several changes made in the intersection. The three primary changes as previously noted included:

- Bicycles and pedestrians having a phase separate from motor vehicles;
- The southbound Sycamore Lane motor vehicle green phase starts after the northbound/southbound bicycle/pedestrian phase;
- The installation of a "no right turn on red" indication activated only during the bicycle/pedestrian phase.

Table 5
Reported Collisions Prior to Signal Modifications (January 1992 - November 1994)

Type	Violation	Parties Involved	Party at Fault	Primary Collision Factor	Location	Correctable by Signal Modifications
1) Rear End*	Basic Speed Law (§22350)	Auto 1/Auto 2	Auto 2	Inattention	WB Russell Boulevard	No
2) Rear End*	None Issued	Auto 1/Auto 2	Auto 2	Inattention	EB Russell Boulevard	No
3) Rear End	None Issued	Auto 1/Auto 2	Auto 2	Inattention	EB Russell Blvd. @ west X-walk	Possible
4) Failure to Yield	Entry onto Highway (§21804a)	Auto 1/Bicycle 1	Bicycle 1	Failure to yield entering intersection	in intersection @ east X-walk	Yes
5) Failure to Yield	Circular Green (§21451b)/Bicycle operation on a highway (§21202a)	Auto 1/Bicycle 1	Auto1/Bicycle 1	Auto - Failure to yield Bicycle - Traveling against traffic	in intersection @ west X-walk	Possible
6) Failure to Yield	Entry onto Highway (§21804a)	Auto 1/Bicycle 1	Bicycle 1	Failure to yield entering intersection	in intersection, northwest quadrant, west X-walk	Yes
7) Failure to Yield	None Issued	Auto 1/Bicycle 1	Undetermined	Undetermined	NW quadrant @ X-walk	Possible
8) Failure to Yield	None Issued	Auto 1/Bicycle 1	Bicycle 1	Failure to yield entering intersection	in intersection, east X-walk	Yes
9) Failure to Yield	Right of Way at Crosswalks(§21950a)	Auto 1/ Pedestrian 1	Auto 1	Failure to yield to pedestrian at crosswalk	in intersection, east X-walk	Yes
10) Right Turn on Red	Circular Red (§21453b)	Auto 1/Bicycle 1	Auto 1	Failure to stop at red light	SB Sycamore Ln to WB Russell Blvd	Yes
11) Right Turn on Red	Circular Red (§21453b)	Auto 1/Bicycle 1	Auto 1	Failure to yield	SB Sycamore Ln to WB Russell Blvd	Yes

Table 5
Reported Collisions Prior to Signal Modifications (January 1992 - November 1994)

Type	Violation	Parties Involved	Party at Fault	Primary Collision Factor	Location	Correctable by Signal Modification
12) Right Turn on Red	Circular Red (§21453b)	Auto 1/Bicycle 1	Auto 1	Failure to stop at red light	WB Russell Blvd to NB Sycamore Ln	Possible
13) Entering Intersection on Red	Circular Red (§21453a/§21650)	Auto 1/Bicycle 1	Bicycle 1	PCF - Entering intersection on red/SCF - riding on wrong side of street	in intersection, north X-walk	Possible
14) Wrong side of road	Bicycle Operation on Roadway (§21650.1)	Auto 1/Bicycle 1	Bicycle 1	Riding SB in east X-walk	in intersection, east X-walk	Yes

* - Signal modifications under construction
† - Contributing factor - bike rolled into intersection
SCF - Secondary Collision Factor

Table 6
Reported Collisions After Signal Modifications (December 1994 - March 1996)

Type	Violation	Parties Involved	Party at Fault	Primary Collision Factor	Location	Correctable by Signal Modifications
1) Hit & Run (Parked Car)	Duty where property damaged (§20002a)	Auto 1/Auto 2	Auto 2	Hit & Run	100 feet north of Russell Blvd	No
2) Rear End*	Basic Speed Law (§22350)	Auto 1/Auto 2	Auto 2	Speed	WB Russell Blvd, leaving intersection	No

These changes:

- allow bicycles and pedestrians to move during their own phase, eliminating motor vehicle conflicts from most directions. This has reduced the failure to yield collisions because bicycles now have their own phase and are not mingling with motor vehicles.

- allow bicycles to clear the intersection before southbound motor vehicle traffic. This provides for southbound bicycles not observing the signal phase change to travel in the same direction as motor vehicles; The city enacted an ordinance that states that bicycles must obey only bicycle signals when they exist in an intersection. (Appendix C)

- eliminate the turning conflicts that previously existed in the northwest quadrant. Although some motorists may not abide by this sign, most drivers are aware of the sign and provide bicyclists the opportunity to cross without conflict.

There is no indication that the physical changes made in the intersection, widening the bike approach in the south and removing the nose island on the east, have reduced the collision rates within the intersection; however, they have provided better access and visibility through the intersection.

Before implementation of the bicycle signal, the collision rate along Russell Boulevard in the segment between State Route 113 (west of Sycamore Lane) and Anderson Road (east of Sycamore Lane) was 1.45 accidents per million vehicle miles (acc/mvm). Since installation, the collision rate has dropped to 0.45 acc/mvm (Table 7). The collision rates between bicycles and motor vehicles have decreased from 1.03 acc/mvm to 0 acc/mvm.

Discussions were conducted with the Davis police department, the UC police department and the UC Transportation and Parking Services (TAPS) staff to find out their perceptions of the effectiveness of the bike signals. The consensus was that the bike signal has reduced the number of collisions at the intersection. Officers from the city police department noted that before the bike signal installation they were responding to numerous collisions. One watch commander noted, "I can't recall the last time I responded to an incident at that intersection." U.C. police commented, "As much as I hate to admit it the intersection minimizes contact with motor vehicles, and it does work." U.C. police, noted, that the bike signal makes a distinction between bicycles and vehicles, contrary to the vehicle code.

No problems were noted over the long term, however, during the initial operation of the signal, a short term learning curve was required as motorists would go during the green bike phase. The installation of the LED "No right turn on red" changeable sign provided additional safety by prohibiting motor vehicles from conflicting with bike and pedestrian traffic during the bike phase. Research of traffic citations did not suggest the running of green bike signals by motorists, nor did it indicate that the running of green arrows by cyclists occurred. In addition, no traffic citations were found for right turn on red infractions once the changeable sign was installed for southbound Sycamore traffic. This would suggest that most drivers understand and comply with the operation of the bike signal.

CONCLUSIONS

The City of Davis and California Traffic Control Devices Committee bicycle signal head experimental project has shown that bicycle signals can play an effective role in channelizing bicycle and motor vehicle traffic. The study showed that:

- bicycle signals enhance safety by separating bicycles and motor vehicle traffic;
- once the signal has become operational the signal is easy to understand by both cyclists and motorists;
- user perception of the signalized intersection is enhanced with regard to safety because of the separate movements;
- bicycle signal heads should be used on a case-by-case basis.

Table 7
Collision Rates along Russell Boulevard in vicinity of Sycamore Lane
(accidents per million vehicle miles)

	Prior to Bicycle Signal Installation	After Bicycle Signal Installation
All Collisions	1.45 acc/mvm	0.45 acc/mvm
Bicycle Collisions	1.03 acc/mvm*	0 acc/mvm*

** accident rate using bicycle collisions and motor vehicle ADT*

To date, in the sixteen months since the bicycle signal has been in operation at the Sycamore Lane/Russell Boulevard intersection the collision rate has decreased significantly.

Implementation of bicycle signals in locations that allow motorists to view them has resulted in a clear understanding of the bicycle signal head. Advance signing has been installed with the signal modification that warns users that bicycle signal heads are in use at the intersection. This signage is placed only along the approaches that use the bicycle phase. One phenomenon noted is that during the "break in" period of the modified signal, some motorists are not attentive to the changes and go on the bicycle green. This has not been different from other signals that the city has installed that results in motorists stopping or going because they have not acclimated to the new conditions. This is not considered significant as all users are still familiarizing themselves with the new signal and typically go with caution. The installation of the "no right turn on red" LED changeable sign and the familiarization with this sign has minimized motorists traveling during the bicycle green.

User perception of the bicycle signal head program has been overwhelmingly positive. Until the signal was modified, bicyclists, motorists and pedestrians had to be concerned about each other's potential movements. Bicyclists are concerned with the movements of other cyclists and pedestrians. The "guessing" of where opposing bicyclists are headed is the primary concern of cyclists now traveling through the intersection. Numerous complaints of near misses between motorists and pedestrians and bicyclists, particularly in the northwest quadrant where right turns on red were allowed, have been curtailed. While cyclists approve of the new configuration, there is a tendency to "forget" that cyclists are "subject to all of the provisions applicable to the driver of a vehicle" (CVC §21200). One of the most astute comments made by a cyclist stated, "I think it's most important that the bicyclist obey the traffic laws and treat themselves as a moving vehicle rather than a pedestrian on a bike. So, I think informing cyclists of the traffic laws is important."

Additional delay within the intersection has been incurred for motorists, however, this is minimal. While a new phase has been introduced into the signal cycle the intersection operates as if it had a minor leg lead-lag phasing sequence. The current signal phasing provides for a minimum bicycle green time of 12 seconds and a maximum green time of 25 seconds. Additionally, a two second all-red interval is provided at the end of this phase as opposed to one-second at the end of the other phases. Pedestrian cycle times are five seconds of walk and 18 seconds of pedestrian clearance.

The use of bicycle signal heads, integrated into a standard signal, should be considered on a case-by-case basis. This study has shown that where heavy bicycle demand exists with motor vehicle traffic, the use of these signals improves safety for bicyclists, pedestrians and motorists. This location is a tee intersection for motor vehicles while providing access from four approaches for bicycles. We have also looked at other applications for bicycle signals with standard signal heads. The following applications could be considered for implementation, however, additional analyses should be conducted to examine the intersection dynamics.

- Tee intersection with major bicycle movement along the tee - Currently, bicyclists at a signalized tee intersection have to stop during the red phase along the major street. Cyclists, traveling along the top of the tee, however, do not conflict with any movements (Figure 7a). This situation occurs at various locations in Davis, and in particular, at the eastbound off-ramps at Interstate 80. This location is in a 6 percent downgrade, and most cyclists do not stop at the signal because of the downgrade. Installation of a bike green would allow cyclists to continue through the intersection. A bicycle red indication would be required if the tee leg includes a perpendicular pedestrian phase.

- Confluence of a separated bicycle path with a signalized intersection - Davis has a bicycle network that integrates bicycle lanes and bicycle paths. In certain intersections, it may be beneficial to operate a bike phase that provides cyclists coming from the bike paths to go through the intersection (Figure 7b).

- Separated bicycle paths parallel to arterial streets - Davis has separated bicycle paths that pass through signalized intersections. The typical location of the signal heads is to the left of the bicycle path. The state vehicle code states that traffic control devices shall be placed on the right-hand side of the traffic lane to which it applies. In these situations, the signal is to the left. Installation of a bicycle signal with the motor vehicle green phase will clarify how and when cyclists are to cross the intersecting street (Figure 7c). This location is common at freeway diamond off-ramps where all exiting vehicles are signal controlled.

Installation of bike signals along these paths will help train cyclists to respond to signals that aid them in crossing the street. Pedestrian signals, which cyclists may observe, have constraints for bike use; bicyclists have no advance warning when a pedestrian signal phase is ending; and, bicycle drivers should be responding to signal indications since they are not pedestrians.

These applications represent unique situations with potentially unpredictable conflicts. The use of bicycle signals should be dependent on the volumes of both motor vehicles and bicycles that would preclude safe turning movements by either of these transportation modes. The city is constantly evaluating the bike signals, however, given the bicycle volumes in this city, their use has helped to improve the transportation network by establishing right-of-way for bicycles at key intersections.

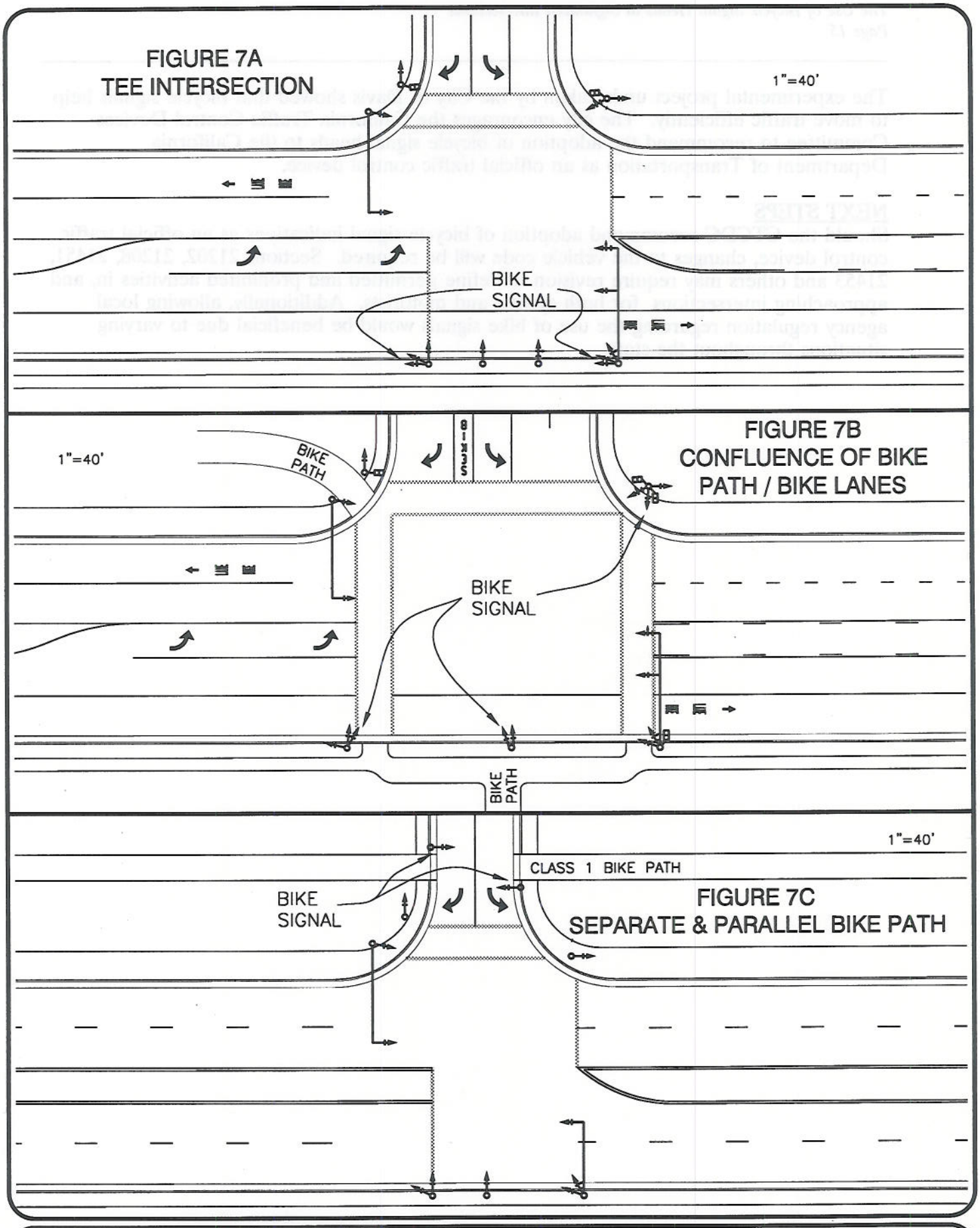

FIGURE 7 - ALTERNATIVE LOCATIONS FOR BICYCLE SIGNALS

CITY OF DAVIS
PUBLIC WORKS DEPARTMENT

The experimental project undertaken by the City of Davis showed that bicycle signals help to move traffic efficiently. The city encourages the California Traffic Control Devices Committee to recommend the adoption of bicycle signal heads to the California Department of Transportation as an official traffic control device.

NEXT STEPS

Should the CTCDC recommend adoption of bicycle signal indications as an official traffic control device, changes to the vehicle code will be required. Sections 21202, 21208, 21451, 21453 and others may require revision to define permitted and prohibited activities in, and approaching intersections for both cyclists and motorists. Additionally, allowing local agency regulation regarding the use of bike signals would be beneficial due to varying situations throughout the state.

APPENDIX A

Article VI. Bicycle Traffic Control Signals.

Sec. 5-40. Bicycle traffic subject to bicycle traffic control signals.

(a) Whenever bicycle traffic is controlled by traffic control signals showing colored lighted bicycle symbols, only the colors green, yellow and red shall be used, and those lights shall apply to bicyclists and pedestrians as provided in this article. At those intersections bicyclists shall obey such traffic control signals and no others. Any bicyclist eighteen years of age or older who fails to obey such traffic control signals shall be guilty of an infraction, punishable as provided by California Government Code section 36900. Any bicyclist under the age of eighteen years who fails to obey such traffic control signals shall be subject to the provisions of section 5-4 of the Davis Municipal Code.

(b) At signalized intersections controlled in part by bicycle signals, bicyclists shall make their approach to the intersection from a bike lane or bike path. The city traffic engineer may authorize placement of signs on the approaches to these intersections directing bicycle movements. (Ord. No. 1666, § 2(part).)

Sec. 5-41. Green bicycle signal.

(a) A bicyclist facing a green bicycle signal shall proceed straight through, or turn right, or left, or make a U-turn unless a sign prohibits a U-turn. Any bicyclist, including one turning, shall yield the right-of-way to other traffic and to pedestrians lawfully within the intersection or an adjacent crosswalk.

(b) A bicyclist facing a green bicycle signal shown in conjunction with a green arrow shall enter the intersection only to make the movement indicated by that green arrow or any other movement that is permitted by other indications shown at the same time. A bicyclist shall yield the right-of-way to pedestrians lawfully within the intersection or an adjacent crosswalk.

(c) A pedestrian facing a green bicycle signal, unless prohibited by sign or otherwise directed by a pedestrian control signal as provided in section 21456 of the California Vehicle Code, may proceed across the roadway within any marked or unmarked crosswalk, but shall yield the right-of-way to traffic lawfully within the intersection at the time that signal is first shown. (Ord. No. 1666, § 2(part).)

Sec. 5-42. Yellow bicycle signal.

(a) A bicyclist facing a yellow bicycle signal is warned that the green bicycle signal is ending or that a red bicycle signal will be shown immediately.

(b) A pedestrian facing a yellow bicycle signal, unless otherwise directed by a pedestrian control signal as provided in section 21456 of the California Vehicle Code, is, by that signal, warned that there is insufficient time to cross the roadway and shall not enter the roadway. (Ord. No. 1666, §2(part).)

Sec. 5-43. Red bicycle signal.

(a) A bicyclist facing a steady red bicycle signal shall stop at a marked limit line, but if none, before entering the crosswalk on the near side of the intersection, or if none, then before entering the intersection, and shall remain stopped until an indication to proceed is shown, except as provided in subdivision (b).

(b) Except when a sign is in place prohibiting a turn, a bicyclist, after stopping as required by a subdivision (a), facing a steady red bicycle signal, may turn right, or turn left from a one-way street onto a one-way street. A bicyclist making such a turn shall yield the right-of-way to pedestrians lawfully within an adjacent crosswalk and to traffic lawfully using the intersection.

(c) A bicyclist facing any color of bicycle signal shown in conjunction with a red arrow shall not enter the intersection to make the movement indicated by the red arrow and, unless entering the intersection to make a movement permitted by another signal, shall stop at a clearly marked limit line, but if none, before entering the crosswalk on the near side of the intersection, or if none, then before entering the intersection, and shall remain stopped until an indication permitting movement is shown.

(d) Unless otherwise directed by a pedestrian control signal as provided in section 21456 of the California Vehicle Code, a pedestrian facing a red bicycle signal shall not enter the roadway. (Ord. No. 1666, § 2(part).)

Sec. 5-44. Relation of bicycle signals to vehicles.

A driver of any vehicle, other than a bicycle, facing a bicycle signal shall be controlled only by the circular or arrow traffic control signals at the intersection pursuant to sections 21450 through 21454 of the California Vehicle Code. (Ord. No. 1666, § 2(part).)

Question #8: How do you know when it is safe to cross?				
Possible Responses	**a) watch others**	**b) ped. signal**	**c) traffic signal**	**d) the "cu-koos"**
Number of people who chose this response	14	101	100	13
Percent of total who chose this response	4.2%	30.4%	30.1%	3.9%

Question #9: On a scale of 1 to 10, 10 being the easiest, 5 the average, how easily do you feel that a cyclist who is alone can figure out when to cross, and when not to cross?											
Possible Responses	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**
Number of people who chose this response	2	4	8	15	45	18	22	44	28	45	23.1
Percent of total who chose this response	0.6%	1.2%	2.4%	4.5%	13.6%	5.4%	6.6%	13.3%	8.4%	13.6%	7.0%

Question #10: On a scale of 1 to 10, 10 being the safest, how safe do you feel this intersection is?											
Possible Responses	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**
Number of people who chose this response	2	12	11	29	47	25	35	28	13	14	21.6
Percent of total who chose this response	0.6%	3.6%	3.3%	8.7%	14.2%	7.5%	10.5%	8.4%	3.9%	4.2%	6.5%

Question #11: On a scale of 1 to 10, 10 being the highest, rate your risk of collision with...											
a) Another cyclist	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**
Number of people who chose this response	21	12	12	14	34	14	23	43	20	23	21.6
Percent of total who chose this response	6.3%	3.6%	3.6%	4.2%	10.2%	4.2%	6.9%	13.0%	6.0%	6.9%	6.5%
b) A pedestrian	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**
Number of people who chose this response	42	29	21	20	40	24	17	17	8	4	22.2
Percent of total who chose this response	12.7%	8.7%	6.3%	6.0%	12.0%	7.2%	5.1%	5.1%	2.4%	1.2%	6.7%
c) A fixed object	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**
Number of people who chose this response	65	28	32	16	18	15	15	12	4	3	20.8
Percent of total who chose this response	19.6%	8.4%	9.6%	4.8%	5.4%	4.5%	4.5%	3.6%	1.2%	0.9%	6.3%
d) An automobile	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**
Number of people who chose this response	23	17	15	24	32	20	28	32	11	14	21.6
Percent of total who chose this response	6.9%	5.1%	4.5%	7.2%	9.6%	6.0%	8.4%	9.6%	3.3%	4.2%	6.5%

B. This section refers to you as a driver approaching this intersection in the southbound direction (approaching on Sycamore Lane).

Question #13: When you have a green light, and you are turning left or right onto Russell Boulevard, you...					
Possible Responses	**a) Go fast to make the light**	**b) Yield to pedestrians**	**c) Yield to bikes**	**d) Go slow because you're not sure**	**e) don't remember**
Number of people who chose this response	14	82	77	27	3
Percent of total who chose this response	4.2%	24.7%	23.2%	8.1%	0.9%

Question #14: Did you know that drivers are supposed to yield to all other pedestrians and other vehicles (including bikes) that are legally in the intersection at this, and all other "T" intersections?		
Possible Responses	**Yes**	**No**
Number of people who chose this response	136	13
Percent of total who chose this response	41.0%	3.9%

SYCAMORE & RUSSELL BICYCLISTS SURVEY

FORM "A"

A. THIS SECTION REFERS TO YOU AS A CYCLIST GOING THROUGH THIS INTERSECTION.

1. What following terms best describe your cycling? (circle all that apply)
   a) commuter b) fitness recreation c) casual recreation d) primary travel mode

2. If you are a student, which school do you attend?
   a) Elementary b) Intermediate c) Sr. or Jr. High d) College e) not a student

3. Do you feel comfortable riding in the dark? yes no

4. About how many times per week do you ride through this intersection? a) 5 or less b) 5-10 c) 10-20 d) 20 or more

5. When are you here? (circle all that apply) a) before 7:30a, b) 7:30-9a, c) 9a-4p, d) 4p-6p, e) after 6p

6. Think back to when you first rode your bike through this intersection....how did you know when it was safe to cross?
   a) watched other cyclists b) obeyed the pedestrian signal c) obeyed the traffic signal d) don't remember

7. How long have you been crossing here regularly? a) less than a year b) 1-2 years c) 3 + years

8. How do you know when it is safe to cross?
   a) watch others b) ped. signal c) traffic signal d) the "cu-koos" (audible signal for the blind)

9. On a scale of 1 to 10, 10 being the easiest, 5 the average, how easily do you feel that a cyclists *who is alone* can figure out when to cross, and when to not cross?_____

10. On a scale of 1 to 10, 10 being the safest, how safe do you feel this intersection is? _____

11. On a scale of 1 to 10, 10 being the highest, rate your risk of collision with....

    a) another cyclist _____
    b) a pedestrian _____
    c) a fixed object (ie: pole, curb, tree, etc.) _____
    d) an automobile _____

12. What are your most important traffic/safety concerns (if any) at this intersection? (use the back if you wish)

_____

_____

_____

B. THE FOLLOWING QUESTIONS REFER TO YOU AS A *DRIVER* APPROACHING THIS INTERSECTION IN THE SOUTHBOUND DIRECTION (APPROACHING ON SYCAMORE LANE). *IF YOU DO NOT DRIVE, PLEASE SKIP TO SECTION "C".*

13. When you have a green light, and you are turning left or right onto Russell Boulevard, you (circle all that apply)...
    a) go fast to make the light, b) yield to pedestrians, c) yield to bikes, d) go slow because you're not sure, e) don't remember

14. Did you know that drivers are supposed to yield to all pedestrians and other vehicles (including bikes) that are legally in the intersection at this, and all other "T" intersections? yes no

15. Do you have any other concerns regarding this intersection from a driver's point of view? (use the back if you wish)

_____

_____

_____

C. Thank You for completing this form. Please print your name and mailing address so we can send you the followup survey after the project's construction. Your personal information will only be used to match up your "before" and "after" surveys (once they are stapled together, the bottoms of these forms will be removed). Thanks again for your help!!

Name_____

Street_____

Please fill in your name and mailing address and use the pre-stamped envelope to mail back your completed form.

City of Davis
Public Works Department
6/17/96

Sycamore Lane and Russell Boulevard Bicyclists Survey Results

Form "A"
Total number of questionaires evaluated = 230
Surveys taken on: 6/27/94, 7/6/94

A. This section refers to you as a cyclist going through this intersection.

Question #1: What following terms best describe your cycling?				
Possible Responses	**a) commuter**	**b) fitness recreation**	**c) casual recreation**	**d) primary travel mode**
Number of people who chose this response	85	29	21	94
Percent of total who chose this response	25.6%	8.7%	6.3%	28.3%

Question #2: If you are a student, which school do you attend?					
Possible Responses	**a) Elementary**	**b) Intermediate**	**c) Sr. or Jr. High**	**d) College**	**e) not a student**
Number of people who chose this response	1	2	15	170	25
Percent of total who chose this response	0.3%	0.6%	4.5%	51.2%	7.5%

Question #3: Do you feel comfortable riding in the dark?		
Possible Responses	**Yes**	**No**
Number of people who chose this response	173	50
Percent of total who chose this response	52.1%	15.1%

Question #4: About how many times a week do you ride through this intersection?				
Possible Responses	**a) 5 or less**	**b) 5-10**	**c) 10-20**	**d) 20 or more**
Number of people who chose this response	42	54	72	59
Percent of total who chose this response	12.7%	16.3%	21.7%	17.8%

Question #5: When are you here?					
Possible Responses	**a) Before 7:30 a**	**b) 7:30-9a**	**c) 9a-4p**	**d) 4p-6p**	**e) after 6p**
Number of people who chose this response	20	40	104	46	21
Percent of total who chose this response	6.0%	12.0%	31.3%	13.9%	6.3%

Question #6: Think back to when you first rode your bike through this intersection...how did you know when it was safe to cross?				
Possible Responses	**a) watched other cyclists**	**b) obeyed the pedestrian signal**	**c) obeyed the traffic signal**	**d) don't remember**
Number of people who chose this response	43	87	80	19
Percent of total who chose this response	13.0%	26.2%	24.1%	5.7%

Question #7: How long have you been crossing here regularly?			
Possible Responses	**a) less than a year**	**b) 1-2 years**	**c) 3+ years**
Number of people who chose this response	72	78	77
Percent of total who chose this response	21.7%	23.5%	23.2%

APPENDIX B

SYCAMORE & RUSSELL BICYCLISTS SURVEY

FORM "B" (AFTER CONSTRUCTION)

A. THIS SECTION REFERS TO YOU AS A BICYCLIST GOING THROUGH THE NEW AND IMPROVED INTERSECTION.

1. When you first approached this improved intersection, where were you?
   a) On the south (campus) side b) heading south on Sycamore c) heading East on bikepath d) other/don't remember

2. On a scale of 1 to 10 (10 being the easiest) 5 the average, how easy do you feel that a cyclists *who is alone and arriving here for the first time* can figure out when to cross, when to not cross?_____

3. Have you noticed that while the cyclists and pedestrians are allowed to cross, all autos must stop? yes no

4. On a scale of 1 to 10 (10 being the safest) how safe do you feel this intersection is for cyclists? _____

5. On a scale of 1 to 10, (10 being the highest) how well will cyclists obey this traffic control device? _____

6. Do you think that it might be a good idea to use the Bicycle Signals at other select intersections? yes no

7. On a scale of 1 to 10, (10 being the highest) rate your risk of collision with....

   a) another cyclist _____
   b) a pedestrian _____
   c) a fixed object (ie: pole, curb, tree, etc.) _____
   d) an automobile _____

8. All things considered, what improvements are the most appreciated or most important to you at this intersection?

_____

_____

_____

9. What are now your most important traffic/safety concerns (if any) at this intersection. (use the back if you wish)

_____

_____

_____

B. THE FOLLOWING QUESTIONS REFER TO YOU AS AN AUTOMOBILE DRIVER GOING SOUTH TOWARDS RUSSELL. IF YOU DON'T DRIVE, PLEASE SKIP TO Section C, AT THE BOTTOM OF THE FORM.

10. While driving south on Sycamore towards Russell, what differences have you noticed? (circle all that apply)
    a) bike only lane on right, b) fewer bikes in your way, c) Bicycle Symbol signals, d) "No Turn on Red" signs, e) Better cycling habits

11. Did you think that seeing the round red signal with the green bicycle signal is confusing to drivers? yes no

12. Do you now feel more or less likely to be involved in an accident with a bike? a) more b) less c) no change

13. Do you feel that your having to wait longer for a green light than before? a) yes b) no c) no change

14. Do you have any other concerns regarding this intersection from a drivers point of view? (use the back if you wish)

_____

_____

_____

C. Thank You for your help!! Please print your name in the space provided so that we can match your "before" and "after" surveys. Names and addresses will be removed once the two surveys are attached. Thanks again for your help!!

Name_____

Please fill in your name and use the postage paid envelope that is provided to mail back your completed form back to us. Thanks!

City of Davis
Public Works Department
6/17/96

Sycamore Lane and Russell Boulevard Bicyclists Survey

Form "B" (After Construction)
Total number of questionaires evaluated = 332
Surveys conducted 11/95

A. This section refers to you as a bicyclist going the new and improved intersection.

Question #1: When you first approached this improved intersection, where were you?				
Possible Responses	**a) on the south (campus) side**	**b) heading south on Sycamore**	**c) Heading East on bikepath**	**d) other/ don't remember**
Number of people who chose this response	75	124	30	101
Percent of total who chose this response	22.6%	37.3%	9.0%	30.4%

Question #2: On a scale of 1 to 10 (10 being the easiest) 5 the average, how easily do you feel that a cyclist *who is alone and arriving here for the first time* can figure out when to cross, when to not cross?											
Possible Responses	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**
Number of people who chose this response	3	1	10	10	25	23	40	78	54	85	32.9
Percent of total who chose this response	0.9%	0.3%	3.0%	3.0%	7.5%	6.9%	12.0%	23.5%	16.3%	25.6%	9.9%

Question #3: Have you noticed that while the cyclists and pedestrians are allowed to cross, all autos must stop?		
Possible Responses	**Yes**	**No**
Number of people who chose this response	317	14
Percent of total who chose this response	95.5%	4.2%

Question #4: On a scale of 1 to 10 (10 being the safest) how safe do you feel this intersection is for cyclists?											
Possible Responses	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**
Number of people who chose this response	0	1	4	5	28	13	44	97	79	60	33.1
Percent of total who chose this response	0.0%	0.3%	1.2%	1.5%	8.4%	3.9%	13.3%	29.2%	23.8%	18.1%	10.0%

Question #5: On a scale of 1 to 10, (10 being the highest) how well will cyclists obey this traffic control device?											
Possible Responses	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**
Number of people who chose this response	0	0	2	5	19	9	40	83	107	66	33.1
Percent of total who chose this response	0.0%	0.0%	0.6%	1.5%	5.7%	2.7%	12.0%	25.0%	32.2%	19.9%	10.0%

Question #6: Do you think that it might be a good idea to use the Bicycle Signals at other select intersections?		
Possible Responses	**Yes**	**No**
Number of people who chose this response	312	15
Percent of total who chose this response	94.0%	4.5%

Question #7: On a scale of 1 to 10, (10 being the highest) rate your risk of collision with...											
a) Another cyclist	1	2	3	4	5	6	7	8	9	10	Average
Number of people who chose this response	27	12	26	23	56	27	51	54	27	28	33.1
Percent of total who chose this response	8.1%	3.6%	7.8%	6.9%	16.9%	8.1%	15.4%	16.3%	8.1%	8.4%	10.0%
b) A pedestrian	1	2	3	4	5	6	7	8	9	10	Average
Number of people who chose this response	101	63	45	24	35	16	12	8	2	1	30.7
Percent of total who chose this response	30.4%	19.0%	13.6%	7.2%	10.5%	4.8%	3.6%	2.4%	0.6%	0.3%	9.2%
c) A fixed object	1	2	3	4	5	6	7	8	9	10	Average
Number of people who chose this response	144	52	37	16	32	12	19	6	7	2	32.7
Percent of total who chose this response	43.4%	15.7%	11.1%	4.8%	9.6%	3.6%	5.7%	1.8%	2.1%	0.6%	9.8%
d) An automobile	1	2	3	4	5	6	7	8	9	10	Average
Number of people who chose this response	121	49	47	21	45	13	16	10	3	3	32.8
Percent of total who chose this response	36.4%	14.8%	14.2%	6.3%	13.6%	3.9%	4.8%	3.0%	0.9%	0.9%	9.9%

B. The following section refers to you as an automobile driver going south towards Russell.

Question #10: While driving south on Sycamore towards Russell, what differences have you noticed?					
Possible Responses	a) Bike only lane on right	b) Fewer bikes in your way	c) Bicycle Symbol signals	d) "No turn on red signs"	e) Better cycling habits
Number of people who chose this response	66	53	122	125	33
Percent of total who chose this response	19.9%	16.0%	36.7%	37.7%	9.9%

Question #11: Did you think that seeing the round red signal with the green bicycle signal is confusing to drivers?		
Possible Responses	Yes	No
Number of people who chose this response	64	127
Percent of total who chose this response	19.3%	38.3%

Question #12: Do you now feel more or less likely to be involved in an accident with a bike?			
Possible Responses	a) More	b) Less	c) No change
Number of people who chose this response	11	149	28
Percent of total who chose this response	3.3%	44.9%	8%

Question #13: Do you feel that your having to wait longer for a green light than before?			
Possible Responses	a) Yes	b) No	c) No change
Number of people who chose this response	65	93	29
Percent of total who chose this response	19.6%	28.0%	9%

Percentages based on 332 responses