Shared Lane Marking Study

FINAL REPORT
JUNE, 2011

LADOT BIKE PROGRAM

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Acknowledgements

The LADOT Bicycle Program would like to thank the following individuals and organizations for their support and contribution to this study.

Mayor

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District 1: Ed Reyes
District 2: Paul Krekorian
District 3: Dennis P. Zine
District 4: Tom LaBonge
District 5: Paul Koretz
District 6: Tony Cardenas
District 7: Richard Alarcon
District 8: Bernard Parks
District 9: Jan Perry
District 10: Herb J. Wesson, Jr.
District 11: Bill Rosendahl
District 12: Greig Smith
District 13: Eric Garcetti
District 14: Jose Huizar
District 15: Janice Hahn

Organizations

Los Angeles County Bicycle Coalition
Southern California Association of Governments
The David Bohnett Foundation

Individuals

Dorothy Le, LACBC
Ramon Martinez, LACBC
Jessica Meaney, SCAG
Marcel Porras, Council District 13
Rita Robinson, retired, LADOT
Aurisha Smolarski, LACBC
Jill Sourial, Council District 1
Alan Thompson, SCAG

Riders/Bicyclists

Colin Bogart
Derek Boonstra
Madeline Brozen

Donna Chazanov
Bradley Cleveland
Megan Dean
Terry E. DeWolfe
Mason Dille
G.H. Ian Elder
John Evans
David Fener
Jennifer Gill
Jose Byron Gonzalez
Maurice Grants
Howard Hackett
Dennis Hindman
Kathleen Hopkins
Niall Huffman
Woodson Joseph-Sandberg
Alexis Lantz

Andrew K. Lee
Alejandro Martinez
Patrick Miller
Taylor Nichols
Keefe O'Brien
Michele O'Brien
Elizabeth Oakes
Patrick Pascal
David Pulsipher
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Executive Summary

Shared Lane Markings (SLMs) are pavement markings installed to direct bicyclists where to ride on roadways shared with motor vehicles. The SLM is typically used along corridors with insufficient width for bike lanes. The marking is intended to direct bicyclists in terms of positioning, provide guidance to motorists for awareness of bicyclist presence, and reduce the chance of bicyclists striking abruptly opened doors of motor vehicles on a shared roadway with on-street parking.

The goal of the study is to determine where the SLM would work best in the City of Los Angeles by performing trials at locations with characteristics representative of roadways throughout the City. Upon completion of the study, the City plans to prioritize installation locations of SLMs based on performance characteristics.

The initial phase ("Before" study) measured driver response to bicyclists without pavement markings, at all six locations where the SLM was to be installed. The second phase ("After" study) took place approximately one month after SLM installation and measured the impact of the markings on driver-bicyclist interactions. Data were measured through field observations as well as later analysis of videofiles of the interactions.

After completing the study, the City has found the SLM to be effective on most streets in increasing the distance between motorists and bicyclists when motorists are passing bicyclists on their left. In addition, motorist behavior was found to be less aggressive after the SLMs were installed. In summary, the following recommendations for usage are presented:

- Placement of SLMs not less than 12 feet from the curbface
- Markings should be aligned in such a manner as to encourage bicyclists to ride in a straight line and to discourage weaving
- SLM implementation in conjunction with "Bicycles May Use Full Lane" sign, upon adoption by CA MUTCD
- In the City of Los Angeles or cities with comparable characteristics, to prioritize installation of the marking on two-lane roadways with lower posted speed limits
- Application with paint not recommended – instead, thermoplastic with appropriate friction coefficient and reflectivity is recommended

The LADOT also recommends, for prioritization of future Los Angeles SLM installations, the following:

- To provide gap closures in the Class II (Bike Lane) network
- To enhance Class III (Bike Route) Bikeways
- To prioritize installation on two-lane roadways with dashed centerlines


Western
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Introduction

Shared Lane Markings (SLMs) are pavement markings installed to direct bicyclists where to ride on roadways shared with motor vehicles. The SLM is typically used along corridors where there is not sufficient width for bike lanes, but where there is a need to offer guidance to bicyclists in terms of positioning, and awareness to motorists in terms of bicyclist presence. In addition, the marking is intended to reduce the chance of bicyclists striking abruptly opened doors of motor vehicles on a shared roadway with on-street parallel parking. Initially developed in Denver, various agencies have been using some version of the SLM for many years. The City of San Francisco first studied the SLM, refined its configuration and brought it to the attention of the California Traffic Control Devices Committee (CTCDC). In 2005, the California Department of Transportation (Caltrans) approved the Shared Lane Marking as an official traffic control device in the State of California. The marking was also approved by the Federal Highway Administration in the Federal 2007 Manual of Traffic Control Devices (MUTCD).

The roadway network in the City of Los Angeles is very different from the streets that were examined and tested as part of San Francisco's study. In Los Angeles, traffic volumes and speeds are typically higher and driver behavior tends to be more aggressive. As such, and to supplement San Francisco's efforts with a more Los Angeles-specific analysis, the Los Angeles Department of Transportation (LADOT) undertook this pilot study of the SLM.

Purpose

The goal of the study is to determine where the SLM would work best in Los Angeles by performing trials at locations with different characteristics. The study assumes, based on the San Francisco data, that the marking inherently offers either a neutral or positive impact on bicycle-motorist interactions, but aims to determine the level of performance associated with locations with varying characteristics. In this study, performance of the SLM was considered to be based on factors associated with motorist behavior when passing a bicyclist (the bicyclist being a control element of the study). Upon completion of the study, the City plans to prioritize installation locations of SLMs based on performance characteristics.

Figure 1
Councilmember Eric Garcetti assists in shared lane marking installation

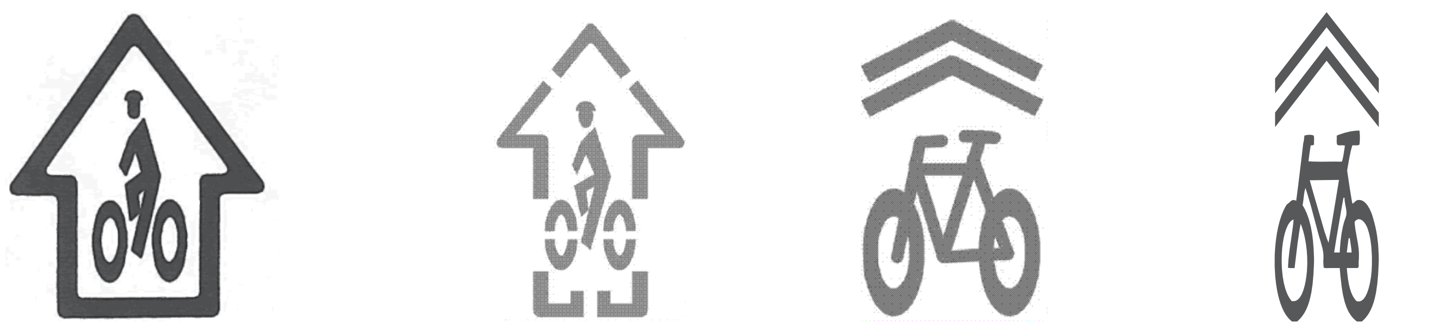
Background

As early as 2005, LADOT began meeting with the Los Angeles County Bicycle Coalition (LACBC) to discuss the use of the SLM in Los Angeles. Initially, the LACBC conducted an online survey of their membership to seek recommendations for streets in Los Angeles where they would most like to see SLMs installed by the City. These roadways were considered in the initial selection of streets for the study by City staff. It was determined that the study conducted in San Francisco could not be readily transferred to Los Angeles and that a variety of types of roadways and conditions needed to be considered to truly gauge the effectiveness of the marking in Los Angeles. Given the requirements set by the California Manual of Traffic Control Devices (CA MUTCD) and very different roadway conditions (widths, speeds, and most importantly intersection treatments), LADOT decided to conduct its own study to determine how the marking could best be used in Los Angeles given the size, traffic volumes, and motor vehicle speeds in the City.

Other SLM Installations and Studies

Previous studies have examined driver and bicyclist behavior and interaction distances under a variety of circumstances.

Most SLM studies have tested how well the markings improve interactions between drivers and bicyclists, with San Francisco pioneering the first study in 2004. The San Francisco study looked at SLMs placed on streets with different characteristics to determine ideal conditions for SLMs (San Francisco Department of Parking & Traffic 2004). This study also compared different iterations of the marking itself. Through video-tape analy-



Bike-in-house (Pioneered in Denver, CO) | Modified bike-in-house | SLM | CA MUTCD SLM

Tested by San Francisco

Figure 2
Variations of shared lane markings

sis, San Francisco determined that the marking: increased bicyclists' distance from parked cars; increased vehicle passing distance by 2 feet; caused no change in negative behavior from drivers; and resulted in less sidewalk bicycling (San Francisco Department of Parking & Traffic 2004).

While Denver pioneered the used of the SLM with the bike-in-house design, Bellevue, Washington was the first municipality to make use of SLMs for limited roadway space (Latt 2009). Bellevue used their bike plan to determine which roads would be designated for SLM installation. Some placements occurred on streets without on-street parking—something not then authorized in the Federal MUTCD. The bulk of the analysis focused on bicycle and vehicle volumes through counts made via road tubes and video recording. The roadway area used by bicyclists was also recorded to review passing interactions. Even though this study occurred five years after San Francisco's, Bellevue found similar results. Overall, Bellevue found the average lateral distance between bicyclists and parked cars increased after SLM installation. They also found reduced numbers of undesirable behaviors between drivers and bicyclists. The study also mentions dynamic changes in weather, adding a level of uncertainty in the overall study results.

One study in Cambridge, Massachusetts conducted a before-and-after evaluation of bicyclists and drivers with 10-foot SLM spacing from the curb with parallel parking (Hunter et al. 2011). Investigators conducted this study to determine whether 10-foot spacing acts as a suitable substitute for the 11 feet indicated by the MUTCD. Through video recording, surveys noted the following motor vehicle characteristics: vehicle proximity, lane changes and passing behavior. For bicyclists the following behaviors were noted: SLM proximity, bicycle position, bicyclist taking full lane, and interactions with parked vehicles. The Cambridge study resulted in statistically significant findings

Agency	Multiple Sharrow Corridors	Type of Sharrow	Type of Roadway	Posted Speed	Curb Lane Width	Distance from Curb Face	Corridor Length	Materials	Comments
Glendale Public Works Department	N	CAMUTCD	Collector	25 mph	18 ft	11 ft	1.2 mi	Thermo-plastic	N/A
Hermosa Beach PW Department	N	CAMUTCD	Secondary Highway	30 mph	20 ft	11 ft	1.5 mi	Paint	Used SLM w/ "May Use Full Lane" Sign
Pasadena Department of Transportation	Y	CAMUTCD	Secondary Highway	35 mph	20 ft	11 ft	0.7 mi	Paint	Plans for more with new Bike Blvd Project
Thousand Oaks PW Department	Y	CAMUTCD	Secondary Highway	35 mph	20 ft	11 ft	2.7 mi	Thermo-plastic	N/A
Long Beach Public Works Department	N	CAMUTCD + green lane	Collector	25 mph	18 ft	14 ft	0.6 mi	Paint	Designed to get bikes off sidewalk
Santa Monica Department of Planning and Community Development	N	CAMUTCD	Collector	30 mph	20 ft	14 ft	0.25 mi	Paint	500 feet between each marking
San Francisco	Y	Bike-in-house, Chevron	Varies	Varies	16 ft to 20 ft	11 ft	Varies	Paint	Pioneered study of SLM

Table 1
Summary of SLM installations in California

that included fewer bicyclists taking the lane, more bicyclists moving safely, fewer bicyclists yielding to vehicles, safer overtaking from drivers, decreases in lane changes, and decreases in motor vehicle speed. This study found 10-foot spacing to improve safety.

Table 1 is a summary of SLM installations conducted in California. Although a variety of studies and installations have been conducted throughout California to analyze the effectiveness of the SLM, the City of Los Angeles determined that conducting its own study would provide a more comprehensive and extensive analysis, and would also tailor to the defining and varying characteristics of the megalopolis to best determine prioritization for installation of the marking.

Standards

The State of California was the first to adopt standards for the installation of the SLM. Standards for the use of the marking are as follows:

> *The shared roadway bicycle marking shall only be used on a roadway (Class III Bikeway (Bike Route) or Shared Roadway (No Bikeway Designation) which has on-street parallel parking. If used, shared roadway bicycle markings shall be placed so that the centers of the markings are a minimum of 3.3 m (11 ft) from the curb face or edge of paved shoulder. On State highways, the shared roadways bicycle marking shall be used only in urban areas.*
>
> Section 9C.103(CA), CA MUTCD

When the SLM was adopted for use in California it was anticipated that the marking would be almost simultaneously approved at the national level in the Federal 2003 MUTCD. While the marking was reviewed, recommended for inclusion by the bicycle committee, and considered by the membership, it was ultimately rejected for inclusion in the 2003 Manual. However, when the manual was revised in 2007 the marking was included. In addition, the installation of the marking is now allowed on roadways without on-street parking for jurisdictions that have adopted the federal manual.

Site Selection

In developing locations for the study, LADOT evaluated multiple locations per the CA MUTCD guidance and sought to select up to ten (10) but no less than five (5) roadway segments. The selected segments were required to include permanent curbside parking, have a speed limit no higher than 35 MPH, and be selected from a cross-section of the wide variety of street types in the City in terms of the following factors:

1. Geographic Location
2. Roadway Classification
3. Parking Demand
4. Speed Limit
5. Motor Vehicle Volume

Table 2 shows the final six (6) test locations. In addition to selecting these locations based on the variance of the aforementioned characteristics, some other elements played a role in the selection process. Fountain Avenue was part of the original Council Motion put forth by Council District 13, which directed LADOT to conduct the study. Adams Boulevard and Westholme Avenue are adjacent to the campuses of the University of Southern California and the University of California, Los Angeles, respectively. 4th Street is designated as a future Bicycle Friendly Street (BFS) per the 2010 Los Angeles Bicycle Plan. Abbot Kinney Boulevard is a popular cycling route in bicycle-friendly Venice. Finally, Reseda Boulevard has the unique characteristic of being a wide boulevard with little-used on-street parking. Corridors were selected from locations across thr city, each of which has its own driver and cycling characteristics, as well as demographic makeup. Table 3 provides more detailed characteristics of the SLM test locations and Figure 3 displays them graphically.

Methodology

Preliminary Assessment

A preliminary assessment was conducted at each prospective SLM location to determine lateral placement of the SLMs—a factor that would remain constant for all installations in the study. Staff conducted sample rides with markings placed at 11, 12, and 13 feet from the curb. Staff tested comfortability of these placements beside a parked wide vehicle with an open door. Finally,

Table 2
Final SLM test locations

Location Name	Limits
1. Fountain Ave	Western Ave to Vermont Ave
2. Adams Blvd	Vermont Ave to Figueroa St
3. Westholme Ave	Santa Monica Blvd to Hilgard Ave
4. 4th St	Wilton Pl to Commonwealth Ave
5. Abbot Kinney Blvd	Venice Blvd to Main St
6. Reseda Blvd	Vanowen St to Nordhoff St

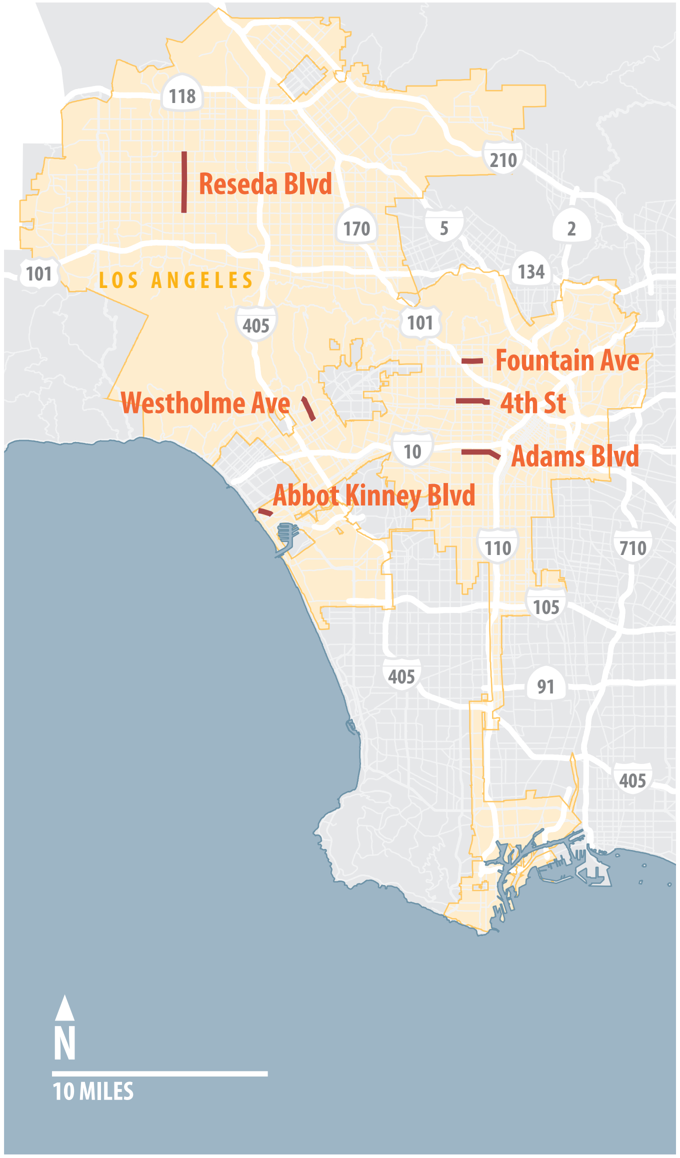


Figure 3
Map of the six selected study locations

Location	Council District	Classification	Length of Sharrow Treatment	Curb Lane Width (with Parking Lane)	Parking Demand	Posted Speed Limit
Fountain Ave	13	Secondary Hwy	1.00 mi	20 ft	High	30 mph
Adams Blvd	8	Scenic Major Highway – Class I	1.40 mi	20 ft	Med/High	35 mph
Westholme Ave	5	Collector St	1.20 mi	18-20 ft	High	25 mph
4th St	4	Collector St	1.60 mi	20 ft	Low/Med	25 mph
Abbot Kinney Blvd	11	Secondary Hwy	0.70 mi	20-21 ft	High	30 mph
Reseda Blvd	3	Major Hwy – Class II	3.00 mi	21-24 ft	High	35 mph

Table 3
Detailed SLM test location description

it was determined that 12 feet would be the most appropriate constant lateral placement for all locations for the purposes of the pilot study.

Field Staff and Equipment

Staff participated in the before and after studies for each study location in a variety of roles:

- Two female and two male bicyclists alternated for car-bicyclist interactions as bicyclist controls
- One data recorder, inside the lead vehicle observed interaction characteristics
- One data recorder, inside the lead vehicle operated recording equipment

Figure 4
Adams Blvd SLM installation with orange markings to help guide video analysis measurements

- An additional observer in the follow van operated recording equipment
- One coordinator facilitated bicyclist movement through the Zone of Interaction (ZOI)

The following equipment was utilized in the study:

- Two LADOT vans
- Five street-legal standard bicycles with computers (all bicyclists wore helmets)
- Two video cameras
- Two camera tripods
- Four radios (one for each staff member)
- One measuring wheel used to measure curb-lane width and the Zone of Interaction (ZOI)
- Two cans of orange mark out paint to mark bicyclist curb-width during Before studies and the Zone of Interaction (see Figure 4)
- Safety cones
- Sunscreen
- Refreshments
- Measuring tape
- Volunteer release forms (Appendix A)

Materials

Various materials were researched for use with the installation of the SLM. Paint, Thermoplastic, and Methyl Melacrylate were all considered in the application of the marking for the pilot study. Methyl Melacrylate was removed from consideration due to its toxicity and the fact that the City's field crews no longer utilize the material. While most locations were installed with poured thermoplastic on a stencil cut to CA MUTCD requirements, one location – Reseda – was installed with paint to determine how long a marking installed with paint would last on a roadway with relatively high traffic volumes. Unfortunately the markings installed with traffic paint were virtually indistinguishable within six months.

While the markings in thermoplastic have proved to be durable with motor vehicle traffic, the thickness of the material does provide a bump when being ridden over by sensitive bicycle wheels. In future applications, the City will test pre-cut SLM stencils and SLMs installed into the asphalt for durability and a more cohesive roadway surface.

Field Setup

At all six study locations the City carried out trials before and after the installation of the SLMs. Each trial involved runs and data collection in both the morning and evening peak-hours with a goal of collecting 100 interactions during each trial period. Through the recording of videotaped car-bicyclist interactions, field observations included vehicle type, braking, lane encroachment, and other behavioral responses.

The initial part of the study ("Before" study) measured driver response to bicyclists without pavement markings, at the location the SLM was to be installed. The second stage ("After" study) took place approximately one month after SLM installation at the same six locations. The "After" study measured the impact of the pavement markings on driver-bicyclist interaction as well as possible motor vehicle with motor vehicle interaction. Data was measured through field observations and note taking, as well as later analysis of videofiles of the interactions.

At each location, the bicyclist starting point was located just after an intersection, roughly 50′ before the LADOT study van and the Zone of Interaction (ZOI) between oncoming motorists and bicyclists but at least ¼ mile after the start of the markings. To obtain interactions, bicyclists rode from the start point to just past the ZOI endpoint

Figure 5
Adams Blvd before (top) and after (bottom) shared lane marking application

pavement marking at the direction of the observer/data recorder in the LADOT vans placed before and after the ZOI. The bicyclists were instructed to ride at a constant 12 mph, along guide markings 12 feet from the curb face where SLMs were to be installed for the "After" study.

City staff observed the interactions from inside the LADOT vans, next to the video camera but out of sight of approaching vehicles. During the study, observers used radios to communicate, coordinate speed and coordinate interactions.

Interaction Process

The LADOT SLM study team studied one location per day and conducted a set of data collection for both AM and PM peak motor vehicle volume periods. Each peak hour study took between two and four hours to set up, conduct, and videotape. The City conducted the "Before" and "After" studies at approximately the same time of day and on the same day of the week at each location, with the "After" study taking place at least one month after installation of the SLMs.

At each location, a group primarily composed of LACBC volunteers alternated bicycling within the ZOI to induce car-bicyclist interactions with motor vehicle traffic in the corridors. The City defined an interaction as a vehicle moving beside a bicyclist and either laterally sharing the lane with the bicyclist, passing the bicyclist, or staying behind the bicyclist within the ZOI. The driver's behavioral response was also noted, such as braking, lane encroachment, speed variations, honking, and/or yelling at bicyclists.

A target of 100 car-bicyclist interactions at each site for each trial period ensured a valid sample size. To account for error and/or missed interaction opportunities, a maximum of 150 interactions were recorded. Counted interactions had to occur within the camera view, or during the designated location's ZOI. The observer/data recorder and

In-the-Field Collection	Videofile Analysis
Vehicle type/color	Car-bicyclist distance (ruler-measured lateral distance between the car and bicyclist)
Platoon (Y/N)	Curb-lane width (ruler-measured to verify scale)
Lane encroachment (L/M/H)	Bicyclist height in video (ruler measured)
Breaking (Y/N)	Other motor vehicles' location during interaction (in adjacent/opposite lane, ahead or behind)
Time of day	Platoon number
Bicyclist height (for video analysis)	Lane encroachment level (low, medium, high)
Other observations (honking, aggressive behavior, etc.)	Verification of data collected in the field
Curb-lane width	
LADOT van location	
Video camera location	
Posted speed limit	
Presence of pedestrians and other bicyclists	

Table 4
Items recorded in data collection

camera operators determined eligibility of interaction for analysis.

Data Collection

The data for the study was collected in the field and analyzed during videofile review following the field collection. Table 4 summarizes the factors and parameters recorded for both data collection processes.

Defining Variables

The following actions by motorists were observed during the data collection segment of the pilot study:

Braking: Braking was recorded when it occurs before and during an interaction

Lane encroachment: Lane encroachment was considered to occur only when a tire from the car completely crosses over the lane line. If the car's tire is on the line, then no encroachment is considered. The levels of encroachment were determined as follows:

a) *Low encroachment:* 1+ tire crosses over into the adjacent/opposite lane
b) *Medium encroachment:* Nearly half of the car crosses over into the adjacent/opposite lane
c) *High encroachment:* Half or more of the car crosses over into the adjacent/opposite lane

Platoon: A platoon is defined as a group of cars traveling together and in the same direction from a signalized intersection, as well as when cars simply follow each other in the same lane.

Videofile Review

Review of video of the "Before" and "After" studies verified written observations and allowed the City to record other measurements, such as lateral vehicle-bicyclist distance. To do this, staff paused and reviewed the video. Staff reviewed the video twice per interaction to ensure accurate lateral distance measurements.

The ZOI was established at a location within the future SLM installation area, far enough beyond the beginning of the markings for drivers to recognize and process the meaning of the markings, once installed. Staff parked the "lead" LADOT van roughly 100 to 200 feet beyond the start of the ZOI, but still within it. The "follow" van was located at the beginning of the ZOI. The video cameras mounted atop the tripods inside the LADOT vans were out of sight of approaching vehicles but in line with the driver's seat. The view from the video cameras captured distances roughly 125 to 150 feet away. Orange mark-out paint marked the points on the pavement to help bicyclists identify the desired line of travel during the "Before" interactions. Points marked at 8, 10, 12 and 14 feet from the curb every 250 feet (with higher frequency in the ZOI directly in front of the video camera) facilitated distance measurements between car and bicyclist during video review. These markings were not easily visible to motorists as Figure 4 displays.

For the "After" study, all six locations had SLMs installed per CA MUTCD standard, located approximately every 250 linear feet at 12 lateral feet from the curb face. The observer/data recorder did not record observations for interactions that occurred past the ZOI and outside of the video camera recording envelope.

Videotape Data Analysis

During the review of raw video data, staff paused the video at the closest point of lateral interaction and measured[1]:

1) Distance between vehicle and bicyclist in inches with a ruler on a computer monitor from the vehicle's rear right tire to the bicyclist's back tire.
2) Curb-lane width.
3) Bicyclist height, using the ratio between actual curb-lane width (feet) and ruler-measured curb-lane width (inches), distance in inches was converted to feet. The ratio of the bicyclist's measured and actual height verified this measurement.

1. Recorded measurements taken to the nearest 1/4 of an inch.

Examples of excluded interactions are as follows:

A. Complete deletion:
Eligible for full deletion from the dataset:

1) Interaction does not occur within video camera view.
Reason: Unable to laterally measure car-bicyclist distance.

2) Interaction not entirely visible when reviewing (i.e. interaction too far away or too close-up on the video)
Reason: Increase in error, unable to laterally measure car-bicyclist distance.

B. Distance not measured:
Eligible for deletion of distance measurements from the dataset:

1) Driver slows down and avoids interaction within the ZOI.
Reason: No interaction to measure.

"Before" and "After" Study Statistics

Results compiled from data collection and observations were statistically analyzed to determine the performance levels of the SLMs. Statistics were graphed for visualization and are presented on the following pages.

Findings

Passing Distance

Most streets in the study experienced statistically significant increases in passing distances after SLM installation - Abbot Kinney Boulevard being the exception. Fountain Avenue and 4th Street experienced an increase of approximately one lateral foot in average passing distance after installation of the SLMs. Fountain Avenue experienced the highest percent change, with an approximate 28% increase in average lateral passing distance. Although Abbot Kinney Boulevard did not experience a significant increase in passing distance after the SLM installation, the "Before" data support the assumption that motorists on Abbot

Street	Before Average Passing Distance (ft)	After Average Passing Distance (ft)	Percent Change
Fountain Ave	3.89	4.97	27.6%
4th St	5.09	6.06	18.9%
Adams Blvd	5.26	5.83	10.7%
Reseda Blvd	5.06	5.61	10.9%
Westholme Ave	5.29	5.46	3.2%*
Abbot Kinney Blvd	6.17	5.78	-6.3%

**Due to low traffic volumes, less than 100 samples were collected during each study period*

Table 5
Changes in "Before" and "After" passing distance

Kinney were already accustomed to the presence of bicyclists and were already passing them with a comfortable lateral distance, before the installation of the SLMs. Table 5 and Figure 6 summarize the changes in the average "Before" and "After" passing distance.

Further analysis on passing distance includes a look at the passing distance in the aggregate sense of those passing with less than 4 feet or 4+ feet. Figure 7 illustrates the number of vehicles passing within these two categories. Figure 8 shows the distribution of passing distances across all study locations, as well as at Fountain Ave, where the most dramatic changes were observed.

Fountain Avenue experienced a decrease from 50% to approximately 25% in vehicles passing bicyclists with less than 4 feet after the SLM installation.

Driver Behavior

Looking at all sites collectively, non-passing vehicles typically:

- Increased their safe following distance from motor vehicles

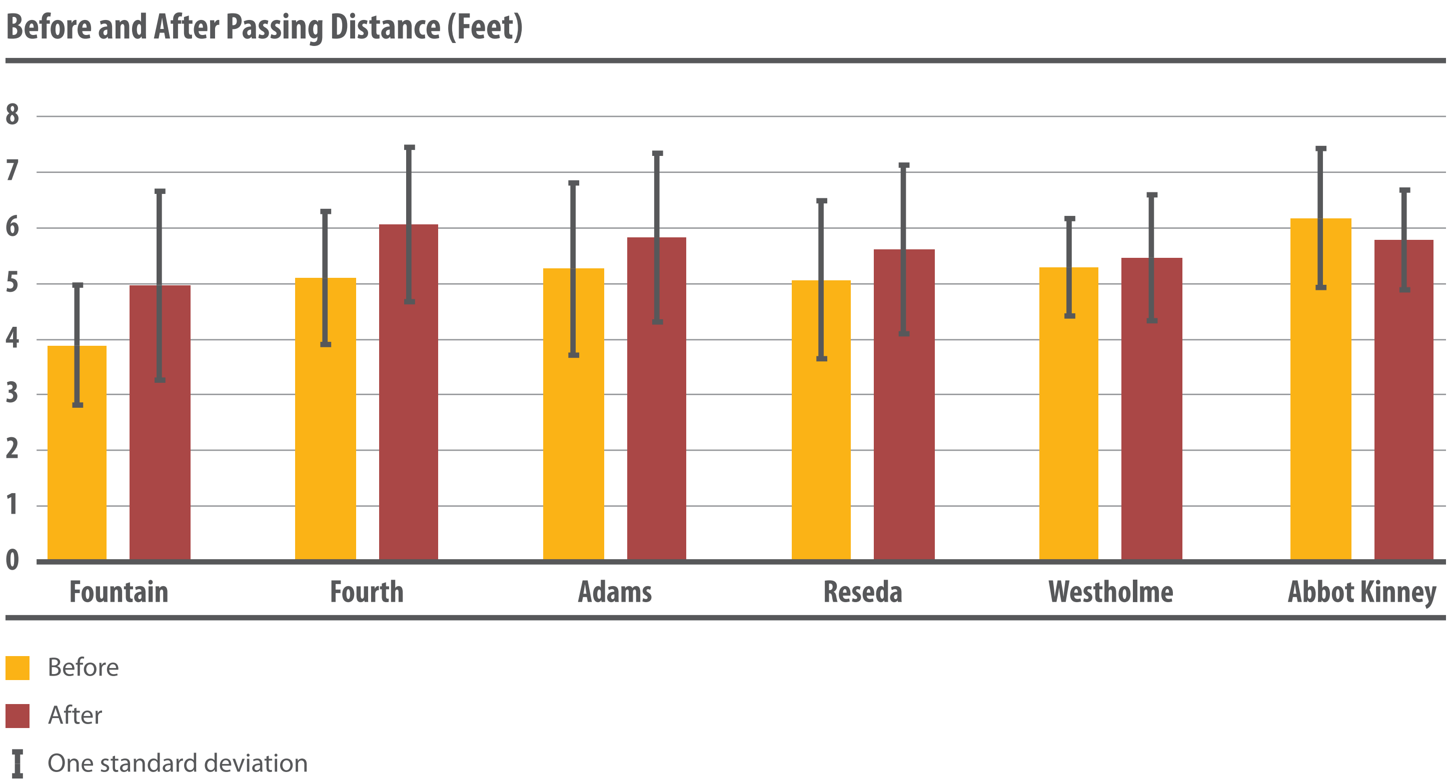


Figure 6
Changes in "Before" and "After" passing distance

- Tailgated less
- Made fewer lane changes, when applicable
- Exhibited less aggressive behavior

Figure 9 shows how the behavior of non-passing vehicles changed between the "Before" and "After" studies. Behavior changes on specific corridors before and after SLM installations do not yield any significant differences except in one category: decreased lane changes on Reseda Ave (significant at the 0.002 level).

Before and After Passing Distance (Percent)

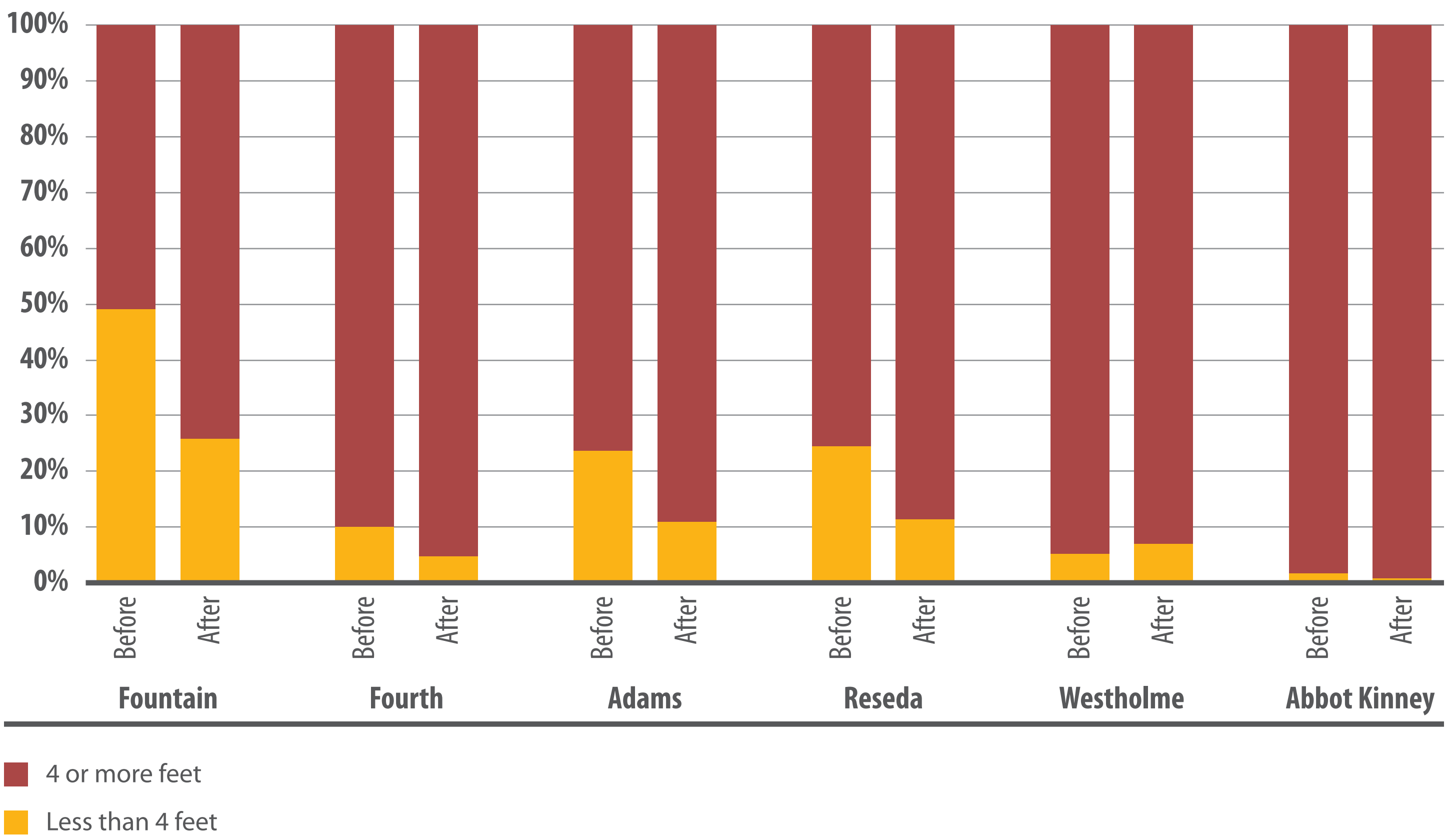
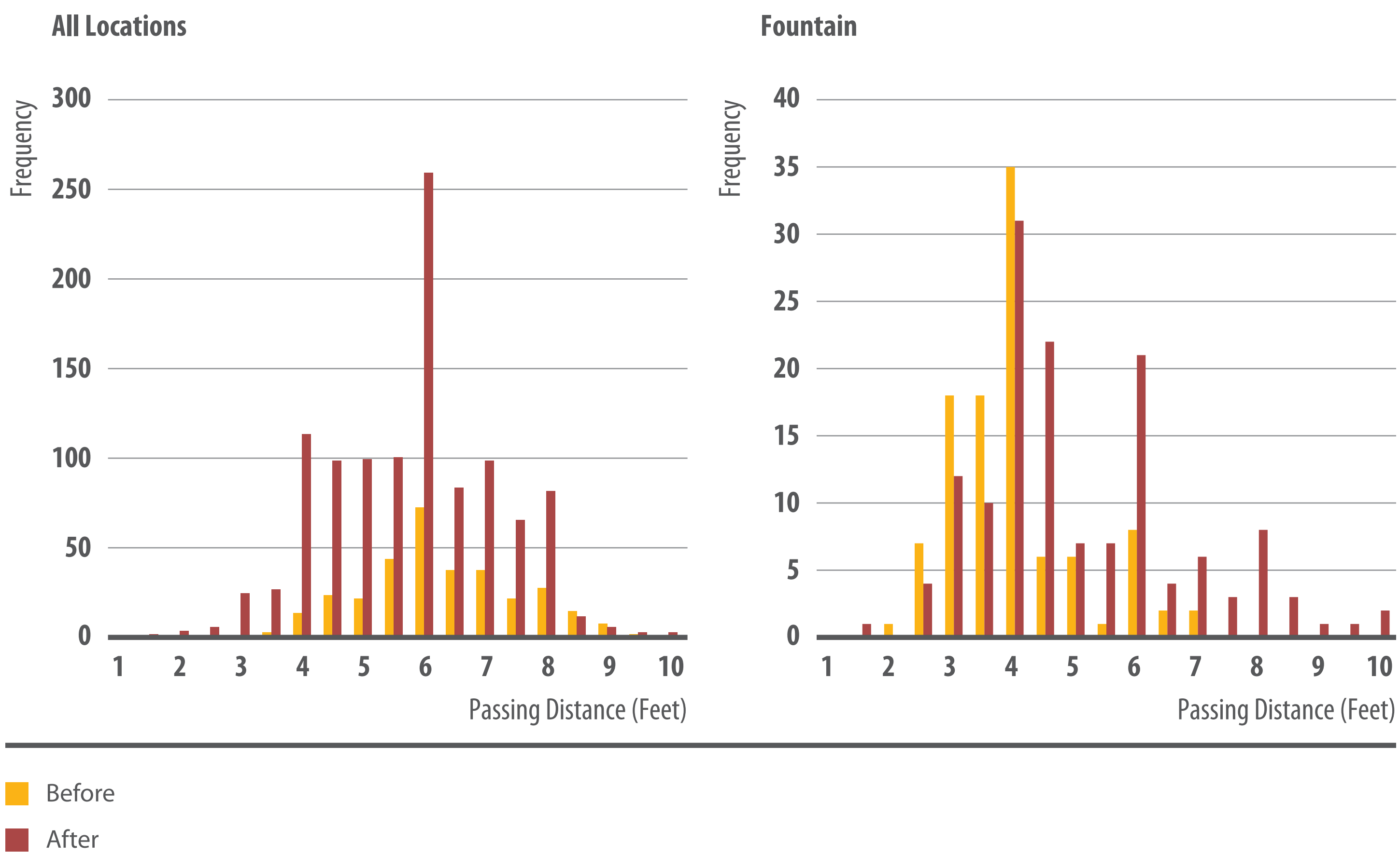


Figure 7
Changes in "Before" and "After" passing distance

Figure 8
Changes in "Before" and "After" passing distances at all locations and Fountain Ave

Before and After Passing Distance (Frequency Distribution)



Before and After Driver Behavior

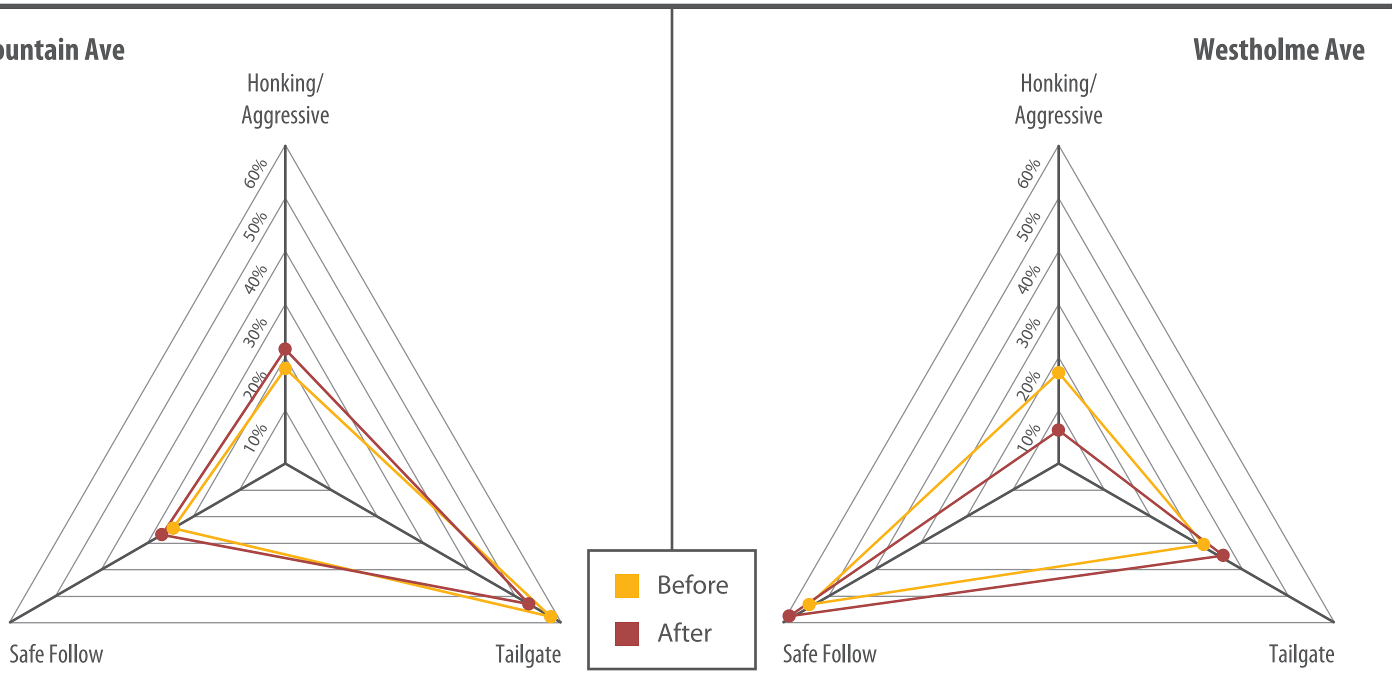


Figure 9
Changes in "Before" and "After" non-passing vehicle behavior

An additional observation was a significant drop in non-passing vehicles. Coupled with significant decreases in tailgating and other aggressive behavior, these observations suggest that motorists are more likely to stay safely behind bicyclists after SLM installation. However on Adams and Reseda Boulevard, roadways with multiple travel lanes, it could also mean that some of the motorists preferred to perform a lane change when given the opportunity rather than stay behind a bicyclist riding at 12 miles per hour in the number-two lane.

Study Limitations

The SLM study is limited by the scope of roadways included in the study treated with SLM. While the six study locations represent a significant percent-

Before and After Driver Behavior

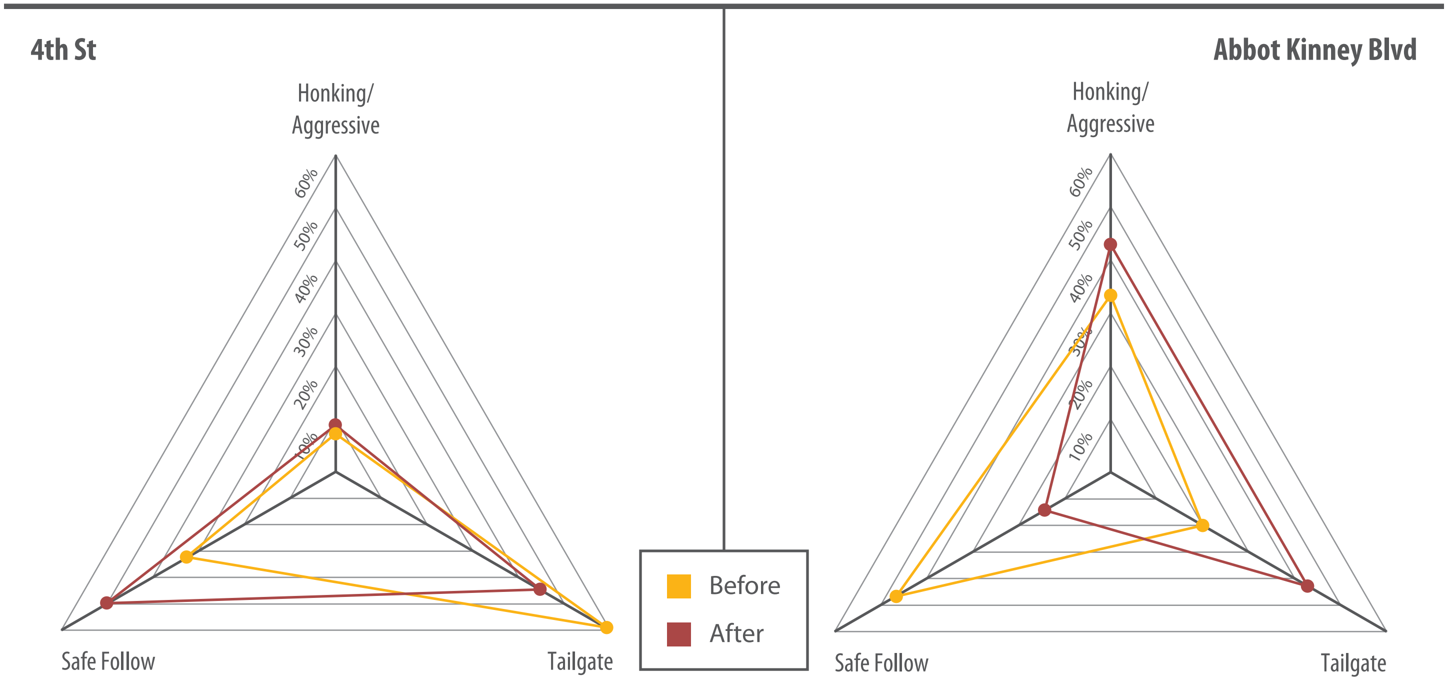


Figure 9 (continued)
Changes in "Before" and "After" non-passing vehicle behavior

age of street configurations throughout the City, there are still certain configurations that might benefit from the installation of markings.

Also, the video data collected in the "follow" van was not useful in the review of the bicyclists/motorist interactions. Often times, other vehicles that come into view of the video camera obscured a clear vision of the interactions. This data was ultimately disregarded.

Low traffic volumes also limited the number of samples, particularly on Westholme Avenue. On the other hand, traffic congestion on Abbot Kin-

Before and After Driver Behavior

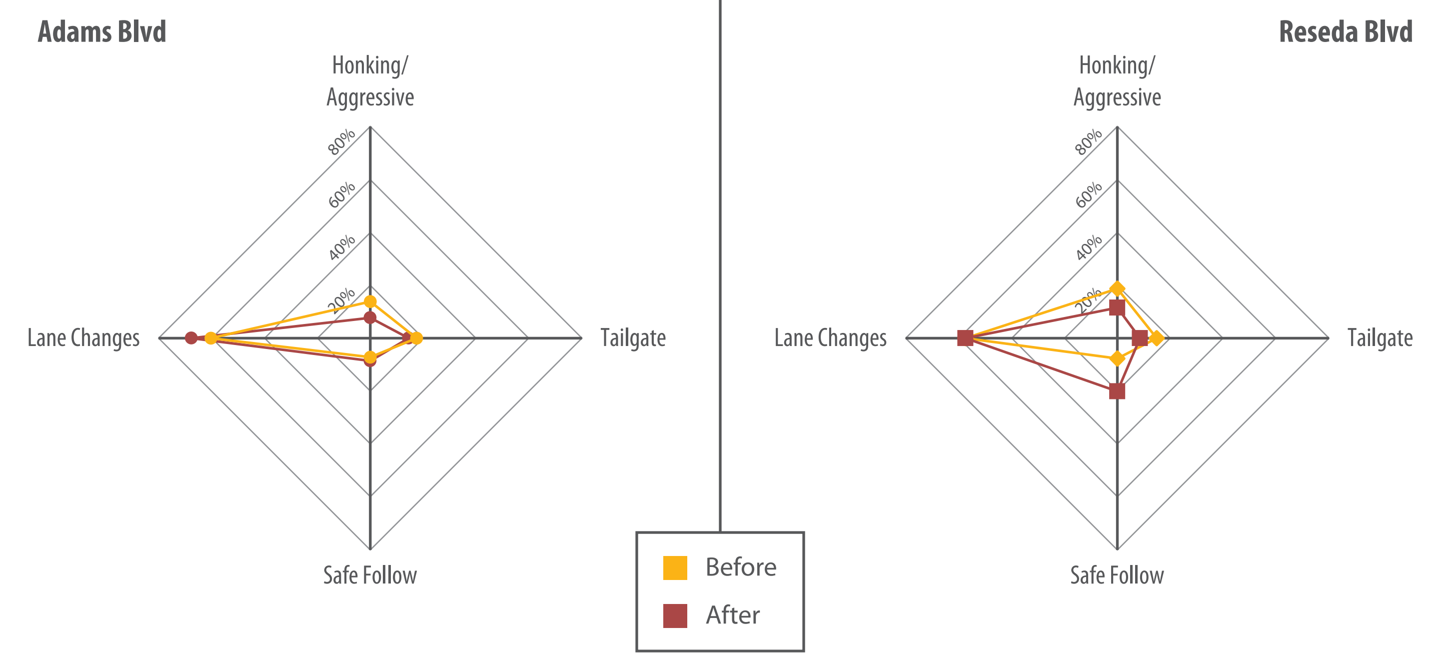


Figure 9 (continued)
Changes in "Before" and "After" non-passing vehicle behavior

ney Boulevard limited opportunities for bicyclist/ motorist interactions to occur, also resulting in a limited number of samples.

Due to a lack of resources this pilot study was unable to test the marking at multiple locations in the overall lane width. While it was determined that 11 feet distance often placed bicyclists within the "door zone," it would have added to the study to test multiple locations with the SLM at 13 or even 14 feet from the curb.

Conclusions and Recommendations for Future Work

The SLM can be interpreted as having two primary functions: first, it can be used along corridors with the purpose of guiding bicyclists along a specified route. In this case it supplements signage for guidance and way finding. This performance of the marking is less applicable because its intent is not primarily concerned with the lateral placement of the bicyclist, or even motorist behavior. The second function is to define the desired lateral positioning for bicyclists while increasing motorist awareness of bicyclist presence along a corridor. As such, the performance of the SLM along these corridors is key because the bicycle-motorist interaction is the target of effectiveness. For these applications, study results indicate that the SLM is most effective on a street such as Fountain Avenue, with narrow single lane operation in each direction separated by a dashed centerline. Though less dramatic, the SLM also proved effective along arterial roadways such as Reseda Boulevard and Adams Boulevard, and low-volume local streets and collectors such as Westholme Avenue and 4th Street. While the SLM did not have significant results along Abbot Kinney Boulevard, possibly due to geographic locations, the use of the SLM along corridors like Abbot Kinney can still be useful for the purposes of guidance, way finding, and closing gaps between bicycling facilities such as Class II Bike Lanes and Class III Bike Routes. Furthermore, it is recommended that complimentary signage, such as a "Bikes May Use Full Lane" sign, be used for additional way finding and awareness for roadway users to increase the effectiveness of the SLM installation.

The City recommends the following measures for other agencies looking to implement Shared Lane Markings into the bike infrastructure toolbox:

- Placement of SLMs not less than 12 feet from the curbface
- Markings should be aligned in such a manner as to encourage bicyclists to ride in a straight line and to discourage weaving
- SLM implementation in conjunction with "Bi-

cycles May Use Full Lane" sign, upon adoption by CA MUTCD

- In the City of Los Angeles or cities with comparable characteristics, to prioritize installation of the marking on two-lane roadways with lower posted speed limits
- Application with paint not recommended – instead, thermoplastic with appropriate friction coefficient and reflectivity is recommended

The LADOT also recommends, for prioritization of future Los Angeles SLM installations, the following:

- To provide gap closures in the Class II (Bike Lane) network
- To enhance Class III (Bike Route) Bikeways
- To prioritize installation on two-lane roadways with dashed centerlines

Further research can be conducted to understand the impact of SLMs on motorist and bicyclist behavior. Such research might include the study of other materials for paint such as Methyl Melacrylate. Also, further studies are needed for variable distances greater than 12 feet from the curb, or the placement of markings measured from the center of the travel lane.

References

Brady, J. et al. (2011). Operational and Safety Implications of Three Experimental Bicycle Safety Devices in Austin, TX. *2011 Annual Meeting of the Transportation Research Board*.

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Latt, K. (2009). City of Bellevue Sharrows Project Pilot Study for 161st Ave SE. City of Bellevue, Transportation Department.

San Francisco's Shared Lane Pavement Markings: Improving Bicycle Safety. (2004). *San Francisco Department of Parking & Traffic*.

Appendix A: Shared Lane Marking Study (Sharrow) Waiver

THIS RELEASE FORM IS A CONTRACT WITH LEGAL CONSEQUENCES. PLEASE READ IT CAREFULLY BEFORE SIGNING

The City of Los Angeles, Department of Transportation (City) in conjunction with the Southern California Association of Governments (SCAG), and the Los Angeles County Bicycle Coalition (LACBC) is conducting a study of the Shared Lane Marking or Sharrow (Study) in order to best assess its use on roadways in the City. The Study will utilize volunteer bicyclists in a "before" and "after" data collection on the roadway with moving motor vehicle traffic to assess the best use of the Shared Lane Marking (Marking) in Los Angeles.

WAIVER

In consideration of the City's acceptance of my service as a volunteer bicyclist in the Study, I hereby freely agree to and make the following contractual representations and agreements:

I understand that the City, with the support of SCAG, and the assistance of the LACBC, will conduct a Study of the Marking.

I understand that as part of the Study, the City will use volunteer bicyclists to collect data and

determine, among other matters, whether and how the Marking affects motorists' behavior

towards bicyclists using the roadway following the path of the Markings.

I understand bicyclists who volunteer to participate in the Study are required to provide their own bicycle that meets the California Vehicle Code requirement for street legal bicycles, that no fixed gear bicycles will be allowed to participate, that riders must wear an approved helmet, and that bicycles must be equipped with a computer that will measure the rider's speed.

I desire to serve as a volunteer bicyclist in the Study, and understand that if the City selects me to serve as a volunteer bicyclist, I may terminate my services as a volunteer at any time and for any reason. I understand that if the City selects me to serve as a volunteer bicyclist, I will not be paid for my services.

I acknowledge that bicycle driving is an inherently dangerous activity, and I fully realize and assume the dangers and risks of serving as a volunteer bicyclist in the Study, which risks include by way of example and not limitation: the dangers and risks associated with and caused by pedestrians, vehicles, other bicycle drivers, and fixed and moving objects; the dangers and risks arising from surface hazards, equipment failure, inadequate safety equipment, and weather conditions; and the possibility of serious physical and mental trauma or injury associated with bicycle driving.

I hereby waive, release, discharge, and hold harmless, for myself, my heirs, executors, administrators, legal representatives, and successors in interest (collectively referred to as "Successors"), the City of Los Angeles, and any of its representatives, officers, employees and agents, and SCAG, and any of its representatives, officers, employees and agents, through or by which the Study will be conducted, from any and all rights, claims and causes of action that arise from my participation in the Study as a volunteer bicyclist. This waiver, release and discharge applies to all rights, claims and causes of action, including, without limitation, those that arise from the negligence of the City of Los Angeles or its representatives, officers, employees or agents, to the maximum extent permitted by law, which I may have or which may accrue to me or to my Successors.

I understand and agree that situations may arise during my services as a volunteer bicyclist that may be beyond the immediate control of the City of Los Angeles, and I must continually ride so as to neither endanger myself nor others. I accept responsibility for the condition and adequacy of my bicycle equipment. I also have no physical or medical condition which to my knowledge would endanger myself or others if I participate in the Study as a volunteer bicyclist, or would interfere with my ability to participate in the Study as a volunteer bicyclist.

I agree, for myself and my Successors, that the above representations are contractually binding, and that should I or my Successors assert a claim in contravention of this contract, the person or entity asserting the claim shall be liable for the expenses, including legal fees, incurred by the other party or parties in defending, unless the other party or parties are finally adjudged liable on such claim.

This contract may not be modified orally, and a written waiver of any provision shall not be construed as a modification of any other provision herein, nor as a consent to any subsequent waiver or modification.

Every term and provision of this contract is intended to be severable. If any one or more of the terms or provisions of this contract is found to be unenforceable or invalid, the remaining terms and provisions shall not be affected and shall remain binding and enforceable.

By signing this contract, I certify that I have carefully read this contract, that I understand what it means, and that by signing I am agreeing to be bound by the terms and provisions of the contract. This contract shall be binding on me and on my Successors.

Name
(print):____

Address:
____

E-Mail Address:
____

In case of emergency, notify:
__________________________________Phone:______________________________

SIGNATURE: ____

Date: ______________________________________

Appendix B: Shared Lane Marking Pilot Project BEFORE Study Site Descriptions

Location (Check one)

- [ ] Fountain
- [ ] Adams
- [ ] Westholme
- [ ] Fourth
- [ ] Abbot Kinney
- [ ] Reseda

Date: ________
Day: ____________
@ Site: Start time _________ Finish __________
@ Site: Total time ________

Weather

Camera Set-up # of tapes used ________ Camera time __________________________

Camera operator and location:

Bicyclists

	Name	Bike description	Seat Height	Overall Height
1	____________	_________________________	___________	______________
2	____________	_________________________	___________	______________

Site Description

Curb-lane width _________ Street parking? _____ # lanes each direction ______

Site notes:

Initial Traffic/Car Volume

Car Traffic: Heavy Moderate Low Speed limit ______

Car Parking Volume: Heavy Moderate Low Restrictions _____________

Other bicyclists? Y N Pedestrians? Y N

Other notes and/or non-ideal circumstances

Appendix C: Shared Lane Marking Pilot Project BEFORE Car-Bicyclist

Interactions

Location (Check one)

- ☐ Fountain
- ☐ Adams
- ☐ Westholme
- ☐ Fourth
- ☐ Abbot Kinney
- ☐ Reseda

Date: _______

Day: ___________

@ Site: Start time _______ Finish _______

@ Site: Total time ________

Bikers:

Interaction #	Car Type	Biker	Platoon?		Adj/Opp Lane	Lane Encroach	Distance (from Video)						Braking?		Comments	Video time	Delete?	Notes
	Type/Color		Platoon?	# of vehicles		No/Low/Med/High	Bicyclist Height (in.)	Bicyclist-car width (in.)	Curb-lane dist. (in.)	Bicyclist Height (ift.)	Bicyclist-car dist. (ft)	Bicyclist-car dist. error						