EVALUATION OF SHARED-USE FACILITIES FOR BICYCLES AND MOTOR VEHICLES

FINAL REPORT

Prepared For:

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Transportation
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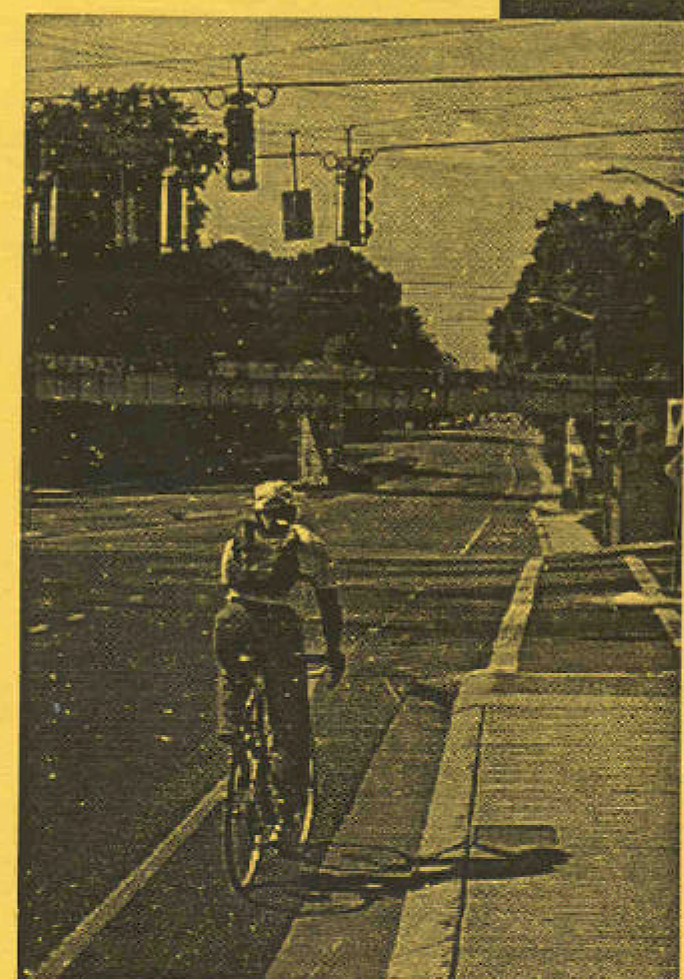

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Evaluation of Shared-Use Facilities for Bicycles and Motor Vehicles in Florida

EXECUTIVE SUMMARY

The Florida Department of Transportation has a variety of shared-use facilities for bicycles and motor vehicles in place throughout the State. Facility types range from roadways with wide curb lanes to those with bicycle lanes or paved shoulders.

While wide curb lanes are still in place throughout the state, the FLDOT presently discourages such facilities from their new roadway designs and builds only roadways with bicycle lanes or paved shoulders for shared-use facilities.

The missing element from the FLDOT design guidelines, as well as other documents suggesting specific geometric designs, are results indicating which types of facilities provide the greatest benefit to bicyclists and motorists by making it more comfortable for both modes, where comfort is defined as reducing unpredictable or potentially unsafe movements by either motorists or bicyclists and minimizing the risk of a conflict or crash. This research effort was undertaken to develop such results.

Research Approach

The objective of this study was to evaluate the safety and utility of shared-use facilities in order to provide engineers and planners comprehensive results that can be used in planning and designing roadways to be shared by motorists and bicyclists.

The research approach used to meet this objective was an observational comparative analysis study which included all three facility types with a range of speed limits, lane widths, and lane configurations. More than 1500 interactions of bicyclists being passed by motorists were recorded on videotape and 35 mm slides. From these media, several measures of effectiveness (MOE's) were acquired including: 1) separation distance between the motorist and bicyclist, 2) distance between the bicyclist and the edge of the roadway, 3) change in lateral position of the motorist while passing the bicyclist, and 4) motor vehicle encroachments while passing the bicyclist.

Bicycle lanes and paved shoulders result in more predictable maneuvers by bicyclists and motorists, enhancing the comfort level for both groups.

Summary of Results

The principal findings from the analysis of the data are as follows:

- The separation distance between bicylists and motorists did not vary greatly by facility type, ranging from 6.4 ft for wide curb lanes to 6.2 ft for paved shoulders to 5.9 ft for bicycle lanes.

- The distance between the bicyclist and the edge of the roadway was considerably less on wide curb lane facilities (1.4 ft) compared to paved shoulder and bicycle lane facilities (2.6 ft).

- Motor vehicles moved to the left when passing a bicyclist by a much greater distance on wide curb lane facilities (2.4 ft) compared to paved shoulder and bicycle lane facilities (1.0 ft).

- The percentage of motor vehicles encroaching into the adjacent left lane when passing a bicyclist was much higher on wide curb lane facilities (22.3 %) compared to paved shoulder and bicycle lane facilities (3.4% and 8.9%, respectively).

- An analysis of bicycle lane width showed the 3-ft lane to produce a separation distance between the motor vehicle and bicyclist, on average, of 5.5 ft. This MOE ranged from 6.0 ft to 6.5 ft on lane widths of 3.5 ft to 5 ft. The 3-ft lane also resulted in the smallest distance between the bicyclist and the edge of the roadway (2.3 ft) while for the other lane widths, the values ranged from 2.7 to 3.0 ft. The change in lateral position of the motorist as a bicyclist was being

Motorists encroached into the adjacent lane to the left when passing a bicyclist much more often on wide curb lane facilities than on roadways with bicycle lanes or paved shoulders.

passed was the same (1.1 or 1.2 ft) regardless of the bicycle lane width.

Conclusions

The primary issues addressed in this study were:

Which type of bicycle facility (wide curb lane vs. marked bicycle lane vs. paved shoulder) provides the most comfortable environment for bicyclists and motorists?

What are the primary differences between the facility types with respect to motor vehicle and bicycle operations?

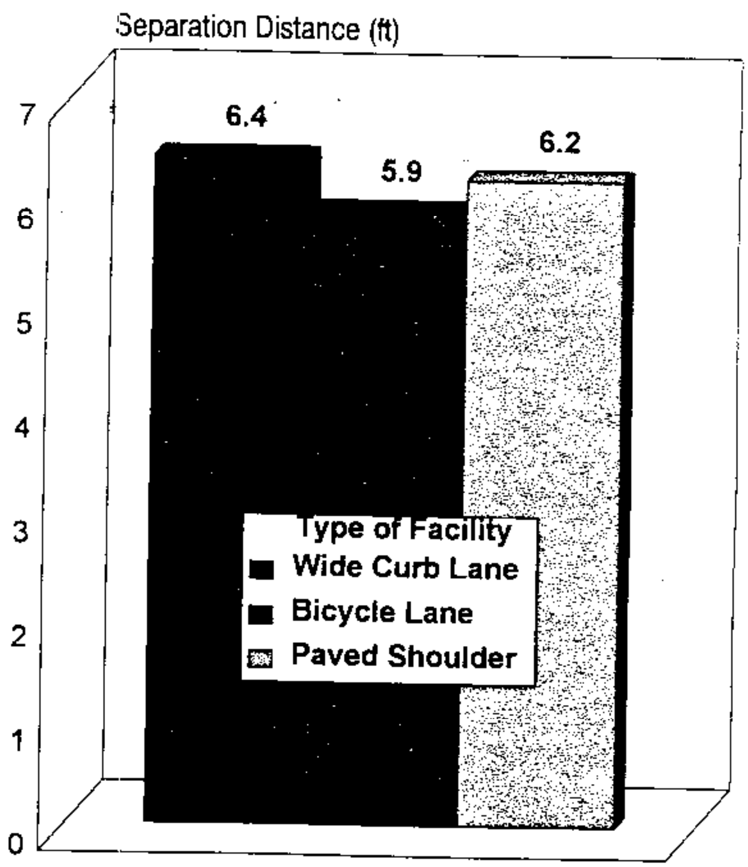
Examining the findings above, it is apparent that the type of facility does not have a large effect on the separation distance between motor vehicles and bicyclists. In general, the motorist positioned their vehicle, on average, between 5.9 ft (bicycle lane) and 6.4 ft (wide curb lane) from the bicyclist as the passing maneuver was initiated. Since this distance is obviously controlled by the motorist, it appears that a distance of approximately 6 ft to 6.5 ft is the spacing with which the motorist is most comfortable. It also appears that the motorist is willing, on average, to accept a slightly smaller separation distance when there is a stripe on the roadway designating two distinct spaces for the bicyclist and motorist.

It is also apparent from the findings that bicycle lane facilities and paved shoulder facilities generally result in similar interactions between motorists and bicyclists, and when compared to wide curb lanes, offer three distinct advantages:

1) Motorists are much less likely to encroach into the adjacent lane when passing a bicyclist on facilities with paved shoulders or bicycle lanes.

2) Motorists have less variation in their lane placement when passing a bicyclist on a paved shoulder or bicycle lane facility.

3) Bicyclists are more likely to ride further from the edge of the roadway in a bicycle lane or on a paved shoulder than they are in a wide curb lane. This increased distance from the roadway edge only marginally reduces the separation distance between the bicyclists and motorists, but significantly increases the distance to the right of the bicyclist which can be used, if needed, as "escape" space. The increased distance from the roadway edge also offers other advantages for the bicyclist. First, their sight distance



Motorists were consistent passing a bicyclist at a separation distance of approximately 6 ft regardless of the type of facility.

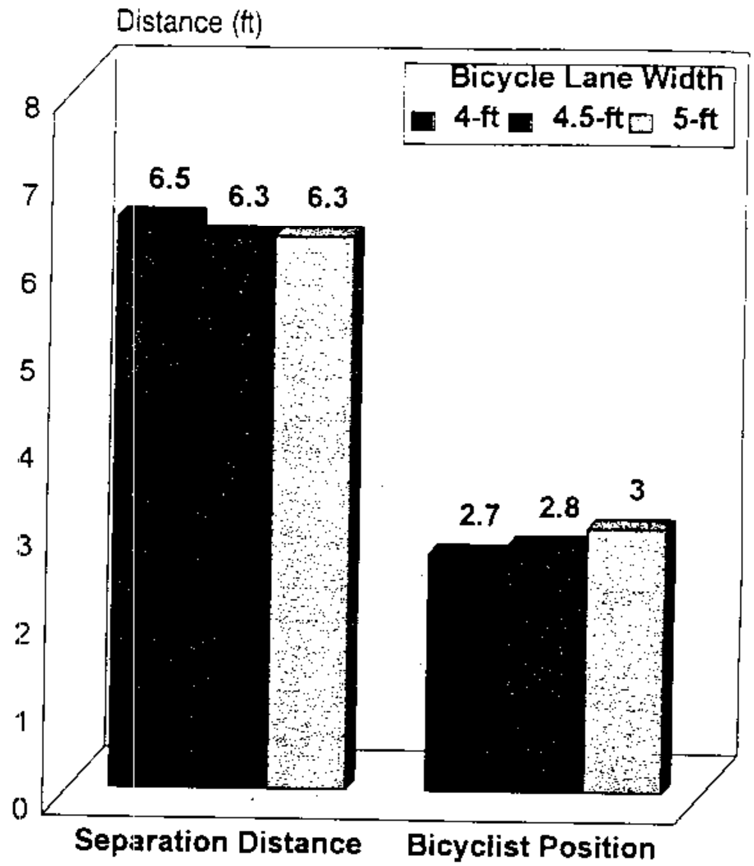
is improved along roadways with trees or other obstructions adjacent to the curb. Second, by being further from the edge of the roadway, they may be more visible to overtaking motorists, motorists on side streets or driveways, and oncoming motorists (who may be turning left). Finally, being further from the roadway edge provides the bicyclist with slightly more time to react to drivers pulling or backing into the street from a driveway or side street.
In general, the presence of the stripe separating bicyclists from motor vehicles results in fewer erratic maneuvers on the part of motorists and enhances the comfort level for all roadway users.

With respect to bicycle lane width, only the 3-ft wide lane produced a separation distance of less than 6 ft. However, this was the only practical difference between the 3-ft wide facility and the other facilities examined (which included 3.5 ft, 4 ft, 4.5 ft, and 5 ft wide lanes). Considering this lack of differences, particularly with respect to change in lateral position of the motorist and the few number of encroachments, it appears that bicycle lane widths as narrow as 3 ft can provide sufficient space for motorists and bicyclists to safely interact.

The results also showed very little change in any of the MOE's for bicycle lane widths of 4 ft, 4.5 ft, and 5 ft. Thus, a 4-ft wide bicycle lane or paved shoulder will optimize operating conditions for motorist and bicyclists, and at the same time, minimize the paved surface and right-of-way required. It should be noted, however, that these results are based on interactions between passenger vehicles and bicycles. On roadways with significant large truck traffic, widths greater than 4-ft may be required for sufficient operations, particularly on high-speed facilities where wind blast may be a factor.

Authors

This research study was conducted by Mr. David L. Harkey and Dr. J. Richard Stewart of the University of North Carolina Highway Safety Research Center. For more information, contact Mr. Dan Burden, Pedestrian/Bicycle Coordinator for the Florida Department of Transportation, at (904) 487-1200.



For bicycle lane widths of 4 ft or greater, there is very little change in the position of the bicyclist and motorist during the passing maneuver.

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CHAPTER 1 - INTRODUCTION

The Florida Department of Transportation (FLDOT) has a variety of shared-use facilities for bicycles and motor vehicles in place throughout the State. Facility types range from roadways with wide curb lanes to those with bicycle lanes or paved shoulders. While wide curb lanes are still in place throughout the State, the FLDOT presently discourages such facilities from their new roadway designs and builds only roadways with bicycle lanes or paved shoulders for shared-use facilities. In addition, a practice of retrofitting current roadways which are considered insufficient for bicyclists is also in place. This practice includes converting wide curb lane facilities in urban areas to roadways with bicycle lanes or paved shoulders.

The missing element from the FLDOT design guidelines, as well as other documents suggesting specific geometric designs, are results indicating which types of facilities provide the greatest benefit to bicyclists and motorists by making it more comfortable for both modes, where comfort is defined as reducing unpredictable or potentially unsafe movements by either motorists or bicyclists and minimizing the risk of a conflict or crash. This research effort was undertaken to develop such results.

OBJECTIVE AND SCOPE

The objective of this study was to evaluate the safety and utility of shared-use facilities in order to provide engineers and planners comprehensive results that can be used in planning, designing, and constructing roadways to be shared by motorists and bicyclists. The results were developed from the analysis of observations of bicyclists and motorists interacting on different types of roadways. The evaluation included roadways with wide curb lanes, bicycle lanes, and paved shoulders. Locations from both rural and urban environments were included and ranged in motor vehicle speeds, traffic volumes, lane widths, and number of lanes.

RESEARCH METHODOLOGY

The research methodology for meeting the objective of this study was designed to answer the following questions:

- *Which type of bicycle facility (wide curb lane vs. marked bike lane vs. paved shoulder) provides the most comfortable environment for bicyclists and motorists?*

- *What are the primary differences between the facility types with respect to motor vehicle and bicycle operations?*

The research approach used to answer these questions was an observational comparative analysis study in which data were collected on a variety of roadways where "bicycle friendly" designs have and have not been implemented. Sites selected for observation included a range of conditions in order to make this effort a comprehensive study. The sites contained a range of geometrics (e.g., lane width) and traffic operations variables (e.g., motor vehicle speed).

The operational measures of effectiveness (MOE's) used in evaluating the different types of facilities should reflect relative risk to the bicyclist and the motorist. The risk to the bicyclist when being passed by a motorist is either being struck by the passing motor vehicle or being run off the road by the passing motor vehicle. The risk to the motorist when passing a bicyclist is being struck by the bicyclist, or weaving into the adjacent left-lane and striking another vehicle (head-on collision on a two-lane road or sideswipe, rear-end, or angle collision on a multilane facility). Thus, the MOE's thought to be related to these risks for bicyclists and motorists which were collected and analyzed in this study included:

- Lateral placement of the bicyclist.
- Lateral placement of the motor vehicle.
- Separation distance between the bicycle and the motor vehicle.
- Encroachments by the motorist and/or bicyclist during the passing maneuver.

CHAPTER 2 - LITERATURE REVIEW

A literature review was conducted of prior research and operational studies in which the interactions between bicyclists and motor vehicles had been evaluated. Only three such studies were found. The first effort was conducted by Jilla in Indiana in 1974.[1] The second study was conducted by Kroll and Ramey in Davis, California in 1977,[2] and a third effort was undertaken by McHenry and Wallace in Maryland in 1985.[3] A brief summary of each of these efforts is provided below.

Jilla (1974)

Jilla examined the operational characteristics of four streets with bike lanes, concentrating on the effects of bicyclists on passing motorists. On narrow roads, the motor vehicle's speed dropped and displacement toward the center line occurred when the motorist encountered a bicyclist in the bike lane. Motor vehicles in the opposing lane had less of an effect on speed and displacement of the motorist than did the bicyclist. The author recommended specific geometric recommendations based on the results of the observed interactions which ranged from 11-ft travel lanes with 3-ft bicycle lanes on low volume streets and 14- ft travel lanes with 6-ft bicycle lanes on high volume streets.

Kroll and Ramey (1977)

Kroll and Ramey examined how the presence of a bicycle lane affects driver and bicyclist behavior. They observed a confederate cyclist riding on ten streets with bicycle lanes and ten streets without bicycle lanes. On three of these streets, data were collected before and after bicycle lanes were installed. Finally, the authors observed real (as opposed to confederate) cyclists on six streets, five of which had bicycle lanes.

The results showed the mean separation distance between bicycles and cars to largely be a function of the motorist's available travel space (the distance between the bicyclist and the center line), and not whether or not a bicycle lane was present. Also, the installation of bicycle lanes did not change the mean separation distance between bicycles and cars. However, drivers did exhibit fewer wide swerves or close passes when passing cyclists on streets with bicycle lanes, and the variability in the separation distance was less when bicycle lanes were present. Auto displacement toward the center line also decreased on two streets after bicycle lanes were added. Based on these findings, Kroll and Ramey suggested that bicycle lanes are desirable on streets where the available travel space is less than 15 ft to reduce the incidence of center line violations, wide swerves, and close passes.

McHenry and Wallace (1985)

This research study was conducted in a suburban area north of Baltimore with an objective of determining how adequate varying wide curb lanes were for shared use by motor vehicles and bicycles. The research approach consisted of collecting and analyzing the differences in lateral positioning data for motorists and bicyclists interacting on four different multilane roadways. Three of the sites had wide curb lanes with widths of 12.5 ft, 13.8 ft, and 17.5 ft. The fourth location had a curb lane width of 10.5 ft and a designated bicycle lane of 3.75 ft.

Data were collected at a designated location at each of the four sites and consisted of three 35mm photographs taken as a motorist passed a bicyclist. The first photograph was of the car prior to reaching the bicyclist, the second of the car as the passing maneuver was being made, and the third of the car after the passing maneuver was completed. From these photographs, lateral positioning and encroachment data were obtained for the car before, during and after the passing maneuver and for the bicycle during the maneuver.

The results showed that the 12.5 ft outside lane was not wide enough for lane sharing. Instead, bicycles acted as lateral obstructions, and displaced most overtaking motorists to the point that they encroached into the adjacent lane. A few motorists maintained their lane position and squeezed past the bicyclist at a close distance. A curb lane width of 13.8 ft was an improvement but was still too narrow for lane sharing, particularly for less experienced bicyclists and roadways where there are considerable numbers of large trucks. On the other hand, a 17.6 ft wide curb lane was excessive. Vehicle lane placement was considerably more variable with motorists sometimes driving two abreast at intersections. Based on the observed interactions between motorists and bicyclists, the authors suggested that a lane width of approximately 15 ft as optimal for lane sharing on a major collector or minor arterial with a posted speed limit of 40 mi/h.

The bicycle lane facility, when compared to the three roadways without bicycle lanes resulted in several advantages. First, the percentage of encroachments by the motorist into the adjacent lane to the left decreased. There was also less variation in the lateral position of the bicycle and the car in their respective lanes, and the motor vehicle showed the least amount of displacement when passing the bicyclist on the bicycle lane facility.

CHAPTER 3 - DATA COLLECTION AND REDUCTION

SITE SELECTION

The sites selected for this study included the full range of facility types (wide curb lane vs. bicycle lane vs. paved shoulder), motor vehicle speeds, and lane widths that would allow for a thorough evaluation. More than 40 sites in six metropolitan areas were examined before selecting the 13 locations for field data collection. The distribution of these 13 sites by type of facility and rural/urban designation is shown in table 1. A complete description of each site, including all geometric and operational characteristics, is provided in the appendix.

Table 1. Number of study sites by facility and area type.

Type of Facility	Type of Area	
	Urban	Rural
Wide Curb Lane	3	0
Bicycle Lane	5	2
Paved Shoulder	2	1

FIELD DATA COLLECTION

The field data collection consisted of following traffic stream vehicles along each of the selected sites and videotaping and taking slides of the interactions between each motor vehicle followed and any bicyclists passed along the route. This effort required a two-person data collection crew, a driver and a camera operator. The driver's responsibilities included selecting the vehicle to be followed and maintaining a constant following distance behind each vehicle. The camera operator was responsible for turning the video camera on and off at the beginning and end of each run, taking 35 mm slides of the bicycle/motor vehicle interactions along the route, and recording descriptive information about the vehicle.

The equipment required for this effort was minimal and included: 1) 35mm camera with a 100-300mm zoom lens, 2) S-VHS video camera with zoom lens, 3) heavy duty tripod with stabilizing equipment for mounting in the van, 4) battery powered monitor for the video, 5) videotapes and 35mm slide film, and 6) extra batteries for all equipment.

Prior to beginning data collection at a site, the field crew established starting and ending points within the length of the site selected such that length of each run was between one and two miles. Locations approximately 0.25 to 0.5 miles upstream of the starting points on both ends were also identified and referred to as "catch" points. It was at these locations that the driver decided which traffic stream vehicle to follow, then pulled out behind the vehicle and accelerated to catch the vehicle prior to reaching the start of the section.

Once the starting, ending, and catch points were established at a given site, the data collection began. The driver positioned the van at one of the catch points and waited for a traffic stream vehicle to follow. The vehicles were randomly selected, but had to be a car, pickup, sport utility vehicle, minivan or van (no large trucks were included in the study). The selected vehicles were also predominantly "free-flowing," i.e., not following another vehicle closely enough to inhibit their speed. Once the driver selected a vehicle to follow, he pulled onto the roadway and closed to the appropriate following distance prior to reaching the starting point.

Before reaching the start point, the camera operator turned the video camera on and began recording. A monitor within the data collection van allowed the operator to determine if the camera needed to be adjusted. The primary purpose of the video recording was to obtain encroachments by either the motorist or bicyclist as a passing maneuver was taking place; thus it was critical that the video recording include both the vehicle and bicycle, the lane or center line to the left of the vehicle, and the edge of the roadway to the right of the bicycle. At the end of the run, after passing the established end point, the video camera was placed in the pause mode until the next run was made.

Within a section, the camera operator watched for upcoming bicycles on the roadway which were going to be passed by the motorist being followed. As the motorist passed the bicyclist and the rear of the vehicle was even with the rear of the bicycle, a 35mm slide was taken (*see figure 1*). Once the motorist had passed the bicyclist and readjusted their lane positioning (if at all), a second slide was taken (*see figure 2*). These steps were repeated for each bicyclist passed in each run.

At the end of each run, the driver turned the van around at the catch point and waited for a traffic stream vehicle going in the opposite direction to follow. The camera operator recorded the make and color of the vehicle which was just followed (*see example of a completed form in appendix*) and checked the quantity of the film and videotape to ensure it was adequate for the next run.

DATA REDUCTION

Reducing the data from the slides and the videotape consisted of two steps. The first step was to record data from the videotapes for each site. Each run was examined to identify any encroachments by either the motor vehicle or bicycle which occurred immediately before, during, or after the passing maneuver was made. These events were simply recorded as yes/no events with respect to whether either party encroached over a line or roadway edge to the right or left (*see example of a completed form in appendix*). The other critical measure recorded from the videotape was the presence of vehicles in the adjacent lane which would have prevented the passing motorist from encroaching into that lane. Again, this was recorded as a simple yes/no.

Also recorded were any erratic maneuvers or braking applications which took place during the passing maneuver; these events were extremely rare and were not included in the analysis due to the small number. The final task undertaken as the video was examined was properly ordering, numbering, and preparing the slides for data reduction. As each bicycle was passed, the sound of the 35mm camera shutter opening and closing could be heard on the videotape. This step ensured that the correct encroachment data from the videos were matched with the correct lateral placement data from the slides.

Figure 1. Example of a slide taken as the motorist passes the bicyclist.

The second step in reducing the data was to record data from the slides. The measures recorded from each slide depended on the type of slide and the type of facility. As shown in figure 3, there were two measures recorded when the facility was a bicycle lane or paved shoulder and there was a bicycle in the slide (Slide 1 or the interaction slide). In this case the measures were the distance from the outside of the right rear tire of the car to the edge line (MDTE) and the distance from the rear bicycle tire to the edgeline (BDTE). When there was no bicycle in the slide (Slide 2 or the post-interaction slide) on this type of facility, only the measurement for the motor vehicle (MDTE) was recorded. Also shown in the figure are the other variables included in the analysis which were either measured in the field or calculated from the measured variables.

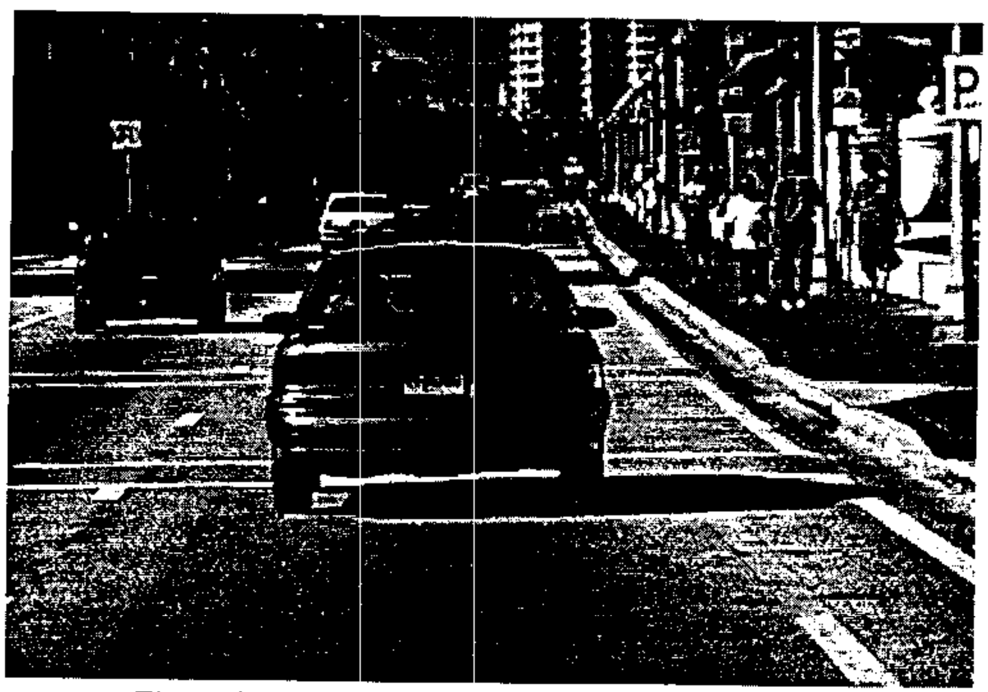

Figure 2. Example of a slide taken after the passing maneuver is completed.

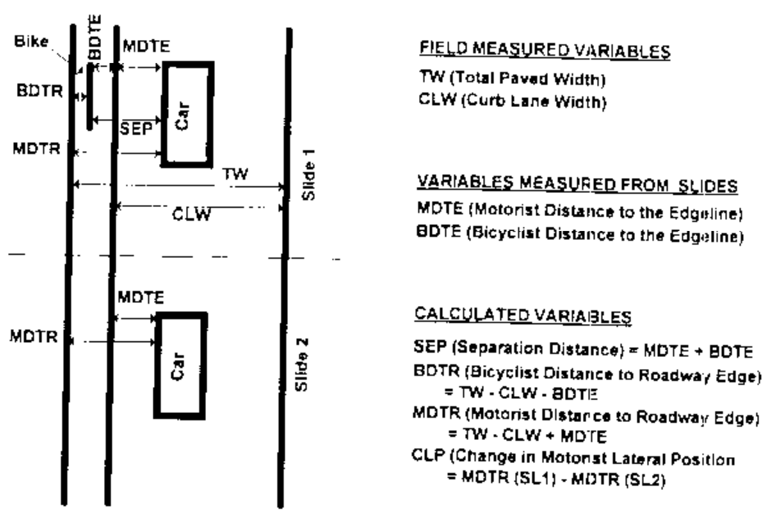

Figure 3. Measured and calculated variables for bicycle lane and paved shoulder facilities.

When the facility was a wide curb lane (*see figure 4*), the recorded measures changed since there was no longer an edge line. For the interaction slide (Slide 1), the distance between the outside of the right rear tire of the motor vehicle and the rear tire of the bicycle (MDTB) was recorded. Also recorded from this type of slide was the distance from the rear tire of the bicycle to the edge of the paved surface (BDTR). The edge of the paved surface was either the joint between the pavement and the gutter pan or the curb face, depending on the presence of a gutter pan. The additional measured and calculated variables for wide curb lane facilities are also shown in figure 4.

Regardless of the facility or slide type, the process of recording the measures was the same. Each slide was projected onto a wall and adjusted to fit a pre-established scale. The constant in each slide which was used to scale from was the vehicle license plate which is one foot wide. Once the slide was adjusted so that the license plate fit the one-foot wide space on the scale, the appropriate measures were made and recorded.

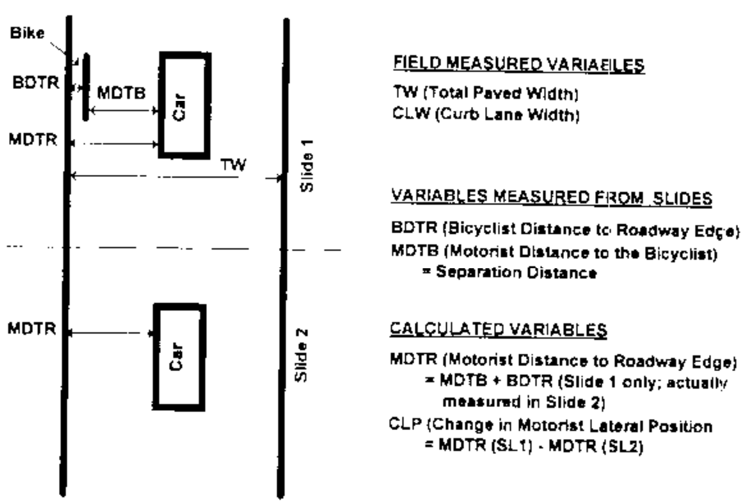

Figure 4. Measured and calculated variables for wide curb lane facilities.

All measures from the video and slides were recorded on a data reduction form; an example of a completed form is in the appendix. These data were entered into a computer data base and checked for accuracy and completeness. Once the data had been thoroughly cleaned, they were combined with the roadway data which contained all of the geometric and operational data associated with each of the 13 sites. The total number of bicycle/motor vehicle interactions included in the analysis was 1583, which ranged from a low of 46 interactions at a site to a high of 175 interactions.

CHAPTER 4 - DATA ANALYSIS

As previously noted in chapter 1, the objective of the study was to evaluate the interactions between motorists and bicyclists on different configurations of shared-use facilities. The three types of facilities included wide curb lanes, bicycle lanes, and paved shoulders. To achieve the study objective, the analysis was conducted in two parts. In the first set of analyses, data from all sites were combined, and comparisons between facility types were made using Analysis of Covariance (ANCOVA). Only covariates (e.g., total width) that had a statistically significant effect on a dependent measure (e.g., separation distance between the motorist and bicyclist) at a level of 0.05 or less were retained in the models. The dependent variables and covariates included in the ANCOVA are shown in table 2. The second set of analyses focused on specific geometric characteristics (e.g., bicycle lane width), and comparisons were made between specific pairs or groups of sites with similar geometric and operational characteristics, with the exception of the variable being analyzed.

Shown in figure 5 are the mean values and ranges for each of the dependent variables across all study sites. These values are unadjusted for any differences in the geometric and operational characteristics among the different types of facilities or among the individual sites. However, these values do indicate some general trends in the data which even after adjustments are made in the ANCOVA remain true. One of the trends is the fact that bicycle lanes and paved shoulders tend to result in very similar operations by motorists and bicyclists, and that wide curb lanes tend to result in different operating patterns compared to the other two facility types. The distance from the bicycle to the roadway edge and the motorist change in lateral placement are perfect examples of this trend. Another trend that is found in the unadjusted means is that the separation distance between the motorist and bicyclist is practically the same (6.0 to 6.2 ft), irrespective of facility type.

COMBINED ANALYSIS

Lateral Position of the Bicyclist

The first variable examined was the lateral position of the bicyclist when being passed by a motorist. This measure of effectiveness (MOE) was measured as the distance from the rear bicycle tire to the roadway edge (**BDTR**). The roadway edge was either the curb face when no gutter pan was present, the seam between the gutter pan and the road surface, or the edge of the paved shoulder. An ANCOVA was performed to estimate the effects of facility type and the covariates on BDTR. Facility type was entered into the model as a class variable having three levels. The model was formulated by taking the third level (bicycle lanes) as a base line and including two dummy variables to indicate the other two types. Thus, the estimates β_1 and β_2 represent differences between bicycle lanes and wide curb lanes, and bicycle lanes and paved shoulders, respectively. The variables which were significant along with their corresponding p-values are shown in table 3 and included facility type, vehicle presence, rural/urban, number of lanes, speed limit, and total width.

Table 2. Dependent and independent variables included in the analysis.

Variable Name	Description
Dependent Variables	
BDTR	Distance between the rear tire of the bicycle and the edge of the paved roadway, where the edge of the roadway is either the edge of the paved shoulder, the seam between the gutter pan and the roadway surface, or the curb face when no gutter pan is present.
SEP	Separation distance between the right rear tire of the motor vehicle and the rear tire of the bicycle.
ENC	Percentage of motor vehicle/bicycle interactions in which the motorist encroached into the adjacent lane to the left.
ENCV	Percentage of motor vehicle/bicycle interactions in which the motorist encroached into the adjacent lane to the left when a vehicle was present in that lane.
CLP	Change in lateral position of the motor vehicle, defined as the lateral position when passing the bicyclist minus the lateral position downstream of the bicyclist.
Independent Variables	
TYPE	Type of facility (wide curb lane vs. bicycle lane vs. paved shoulder)
SPLIM	Posted speed limit.
NLNS	Number of through travel lanes.
CLW	Width of the curb (outside) motor vehicle lane; measured from the center of the lane line or center line to the motor-vehicle side of the edge line
BLW	Width of the bicycle lane: measured from the seam between the gutter pan and the road surface (or from the curb face when no gutter pan was present) to the motor-vehicle side of the edge line.
SHW	Width of the paved shoulder; measured from the outside edge of the paved shoulder to the motor-vehicle side of the edge line.
GPP	Indication of whether a gutter pan was present at a location.
GPW	Width of the gutter pan; measured from the seam between the gutter pan and road surface to the curb face.
TPW	Total paved width including the width of the curb lane and the width of the bicycle lane or paved shoulder.
TW	Total width available including the total paved width and the gutter pan width.
AREA	Indication of whether the site was located in a predominately rural or urban area.
VPR	Indication of whether a vehicle was present in the adjacent lane when a motorist was passing a bicyclist, potentially preventing the motorist from encroaching into the adjacent lane.

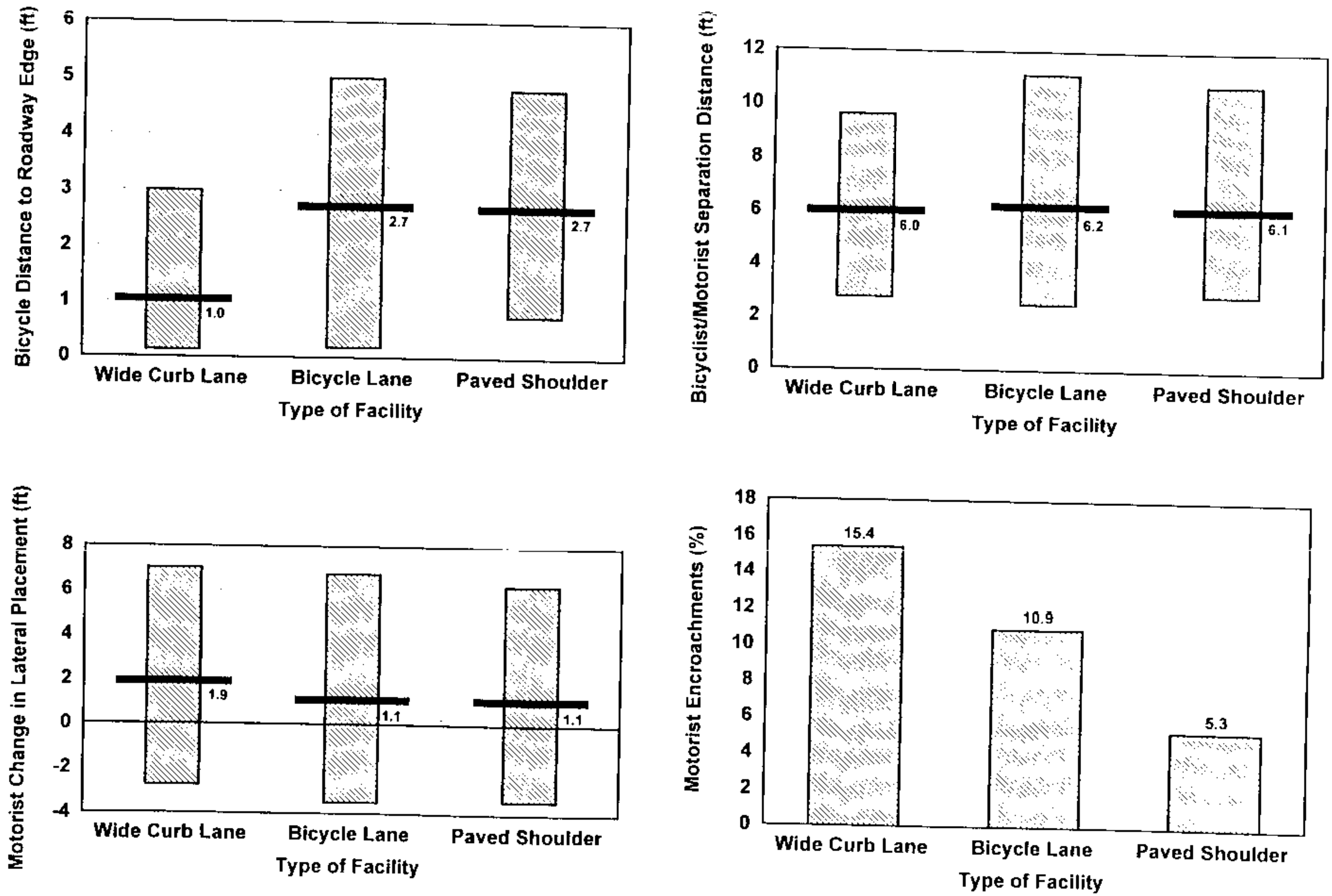

Figure 5. Unadjusted means and ranges for each dependent variable across all study sites.

Table 3. ANCOVA results for estimating differences in bicycle distance to edge of roadway (**BDTR**).

ANCOVA Results				
Source of Variation	Degrees of Freedom	Mean Square	F-value	P-value
Facility Type	2	105.93	310.40	.0001
Vehicle Presence	1	1.52	4.45	.0351
Area Type	1	9.04	26.50	.0001
No. of Lanes	1	21.06	61.71	.0001
Speed Limit	1	10.80	31.64	.0001
Total Paved Width	1	63.84	187.08	.0001
Estimated Effects of Significant Covariates				
Parameter		Estimate	Standard Error	
Wide Curb Lane vs. Bicycle Lane		-1.185	.376	
Paved Shoulder vs. Bicycle Lane		.049	.047	
Vehicle Presence		.067	.032	
Area Type		-.303	.059	
No. of Lanes		.142	.018	
Speed Limit		-.030	.005	
Total Paved Width		.454	.033	

Table 4. Adjusted means for bicyclist distance to roadway edge by facility type.

Adjusted Means			Pairwise Comparisons	
Facility Type	Mean	Std. Error	Comparison	P-value
1. Wide Curb Lane	1.40	.044	1 vs. 2	.0001
2. Paved Shoulder	2.63	.031	1 vs. 3	.0001
3. Bicycle Lane	2.59	.029	2 vs. 3	.3063

Also shown in the table are the estimated effects on the MOE associated with each of these covariates. The largest effect is associated with facility type, specifically when focusing on wide curb lanes vs. bicycle lanes. The model predicts a decrease in the distance between the bicycle and the roadway edge of 1.19 ft, on average, when the facility type is a wide curb lane rather than a bicycle lane. Another covariate showing a large effect on this MOE was total width; as the total width of the roadway increases, so does the distance of the bicyclist to the roadway edge.

Using the five significant covariates, adjusted mean distances were computed for each of the facility types and are shown in table 4. The adjusted means account for the differences in geometrics and operations among the sites and predict what the mean values would be if the significant covariates were equivalent across all sites. The adjusted mean distances for the wide curb lane, bicycle lane, and paved shoulder facilities were 1.40 ft, 2.59 ft, and 2.63 ft, respectively. The difference between the paved shoulder facilities and the bicycle lane facilities was not significant, indicating that the bicyclist position on these two types of facilities is equivalent. However, the differences between the wide curb lane and the other two facility types were significant and showed that bicyclists, on average, tend to

Table 5. ANCOVA results for estimating differences in the separation distance between the bicyclist and passing motorist (**SEP**).

ANCOVA Results				
Source of Variation	Degrees of Freedom	Mean Square	F-value	P-value
Facility Type	2	13.29	11.65	.0001
Vehicle Presence	1	43.10	37.78	.0001
Gutter Pan Pres.	1	18.75	16.43	.0001
No. of Lanes	1	6.97	6.11	.0135
Total Paved Width	1	143.83	126.07	.0001

Estimated Effects of Significant Covariates		
Parameter	Estimate	Standard Error
Wide Curb Lane vs. Bicycle Lane	.509	.105
Paved Shoulder vs. Bicycle Lane	.263	.083
Vehicle Presence	.351	.057
Gutter Pan Presence	.259	.064
No. of Lanes	-.080	.033
Total Paved Width	.406	.036

Table 6. Adjusted means for separation distance between bicyclist and passing motorist (**SEP**) by facility type.

Adjusted Means			Pairwise Comparisons	
Facility Type	Mean	Std. Error	Comparison	P-value
1. Wide Curb Lane	6.44	.074	1 vs. 2	.0033
2. Paved Shoulder	6.19	.054	1 vs. 3	.0001
3. Bicycle Lane	5.93	.051	2 vs. 3	.0016

be approximately 1.2 ft closer to the roadway edge on a wide curb lane compared to bicycle lanes and paved shoulders.

Separation Distance between the Motorist and Bicyclist

The next variable examined was the separation distance between the motorist and the bicyclist (**SEP**). The results of the ANCOVA, shown in table 5, indicate that the significant covariates affecting this MOE were facility type, vehicle presence, gutter pan presence, number of lanes, and total width.

The estimated effects of the covariates on this MOE are also shown in the table. A large effect is associated with a change in facility type, specifically from a wide curb lane to a bicycle lane. If the facility type was a wide curb lane rather than a bicycle lane, the separation distance increased. Similarly, as the total width of the roadway increased, the mean separation distance also increased. Finally, when there was no vehicle present in the lane to the left of the passing motorist, the separation distance increased.

Using the five significant covariates, adjusted mean separation distances were computed for each of the facility types as shown in table 6. Wide curb lanes resulted in the largest separation distance of 6.44 ft. Paved shoulders resulted in a slightly smaller separation

Table 7. ANCOVA results for estimating differences in the change in lateral position of the motorist (**CLP**).

ANCOVA Results				
Source of Variation	Degrees of Freedom	Mean Square	F-value	P-value
Facility Type	2	73.71	60.37	.0001
Gutter Pan Pres.	1	40.54	33.20	.0001
Area Type	1	41.25	33.78	.0001
No. of Lanes	1	9.84	8.06	.0046
Speed Limit	1	21.49	17.60	.0001
Total Paved Width	1	14.84	12.16	.0005
Vehicle Presence	1	30.75	25.19	.0001

Estimated Effects of Significant Covariates		
Parameter	Estimate	Standard Error
Wide Curb Lane vs. Bicycle Lane	1.479	.172
Paved Shoulder vs. Bicycle Lane	.042	.096
Gutter Pan Pres.	-.724	.126
Area Type	-1.140	.196
No. of Lanes	.098	.034
Speed Limit	-.049	.012
Total Paved Width	.272	.078
Vehicle Presence	.306	.061

distance of 6.19 ft, and bicycle lanes resulted in the smallest separation distance of 5.93 ft. The differences between each pair of facility types were significant. However, the practicality of these differences between facility types (0.5 ft maximum) is not clear.

Change in Motorist Lateral Position

The next variable examined was the change in lateral position of the motorist (**CLP**). This MOE was defined as the difference between the position of the motorist at the time the bicyclist was passed and the position of the motorist downstream of the bicyclist. The distance measured at these two locations was from the right rear tire of the motor vehicle to the roadway edge. Results from the ANCOVA are shown in table 7 and indicate that the significant covariates affecting this measure were facility type, gutter pan presence, area type, number of lanes, speed limit, total width, and vehicle presence.

The estimated effects of the covariates are also shown in table 7. As with the two previous MOE's, one variable with a large effect is the change in facility type from a wide curb lane to a bicycle lane. The change in lateral position increases as the facility type changes from a bicycle lane to a wide curb lane. Another covariate which was shown to have a large effect on this MOE was the area type variable. The change in lateral position was shown to be much smaller in urban areas compared to rural areas. Finally, the presence of a gutter pan was shown to have a negative effect on the change in lateral position, i.e., the presence of a gutter pan resulted in a smaller change in lateral position.

Adjusted mean changes in lateral position were computed using the six significant covariates and are shown in table 8. The means for the paved shoulder and bicycle lane facilities

Table 8. Adjusted means for change in lateral position of the motorist (**CLP**) by facility type.

Adjusted Means			**Pairwise Comparisons**	
Facility Type	Mean	Std. Error	Comparison	P-value
1. Wide Curb Lane	2.43	.120	1 vs. 2	.0001
2. Paved Shoulder	0.99	.058	1 vs. 3	.0001
3. Bicycle Lane	0.95	.067	2 vs. 3	.6632

were almost identical (0.99 and 0.95 ft, respectively). The mean change in lateral position for the wide curb lane was 2.43 ft and was significantly different from the other two facility types.

Motorist Encroachments

The final MOE examined was the percentage of encroachments by motorists into the adjacent lane to the left when passing bicyclists (**ENC**). An encroachment was defined as occurring when the left rear tire of the motor vehicle crossed the lane line or center line and entered the lane to the left of the motorist. Results from the ANCOVA are shown in table 9 and indicate that the significant covariates were facility type, vehicle presence, area type, and gutter pan presence.

The estimated effects of the covariates, also shown in table 9, indicate that the area type variable had a relatively large effect on the percentage of encroachments. The percentage of encroachments decreased in urban areas compared to rural areas. The presence of a gutter pan was also shown to result in a decrease in the percentage of encroachments. The presence of a wide curb lane resulted in an increase in the number of encroachments compared to other facility types.

Adjusted means for the percentage of encroachments by motorists were computed using the significant covariates and are shown in table 10. The paved shoulder facilities resulted in the smallest percentage of encroachments (3.4 %) with bicycle lane facilities producing a slightly higher number (8.9%). Wide curb lane facilities, however, resulted in a much higher percentage of encroachments (22.3%) compared to the other facility types. While the differences between each pair of facility types is significant, it is the difference between the wide curb lanes and the other locations that stands out as being practically different.

SITE-SPECIFIC ANALYSIS

Type of Facility

One of the site-specific analyses conducted examined the effects of different facility types (wide curb lanes vs. bicycle lanes vs. paved shoulders) on the operations and interactions of motor vehicles and bicycles. Three of the sites included in this research study had the same total paved width of 14 ft and 16-in to 18-in gutter pans. These locations were four-lane divided

Table 9. ANCOVA results for estimating differences in motor vehicle encroachments (**ENC**).

ANCOVA Results				
Source of Variation	Degrees of Freedom	Mean Square	F-value	P-value
Facility Type	2	5.02	29.24	.0001
Vehicle Presence	1	3.03	35.31	.0001
Area Type	1	2.94	34.29	.0001
Gutter Pan Pres.	1	2.53	29.53	.0001

Estimated Effects of Significant Covariates		
Parameter	Estimate	Standard Error
Wide Curb Lane vs. Bicycle Lane	.134	.023
Paved Shoulder vs. Bicycle Lane	-.055	.017
Vehicle Presence	.095	.016
Area Type	-.181	.031
Gutter Pan Presence	-.143	.026

Table 10. Adjusted means for motor vehicle encroachments (**ENC**) by facility type.

Adjusted Means			**Pairwise Comparisons**	
Facility Type	Mean (%)	Std. Error	Comparison	P-value
1. Wide Curb Lane	22.33	1.86	1 vs. 2	.0001
2. Paved Shoulder	3.36	1.41	1 vs. 3	.0001
3. Bicycle Lane	8.89	1.09	2 vs. 3	.0014

facilities with speed limits of 30 to 35 mi/h. The only difference between the locations with respect to geometrics and operations was the lane configuration; one site had a 14-ft wide curb lane, the second had an 11-ft curb lane and 3-ft bicycle lane, and the third had an 11-ft curb lane and 3-ft paved shoulder.

Results from an analysis of the data associated with these three locations is shown in figure 6. These results indicate that the paved shoulders and bicycle lanes essentially produce similar operations with respect to motor vehicle/bicycle interactions. Only the wide curb lane produces differences which are practically different from the other facility types. The motorist in a wide curb lane is, on average, more likely to provide slightly more distance between his vehicle and the bicyclist, 0.4 to 0.6 ft more compared to the paved shoulder and bicycle lane locations, respectively. The motorist in the wide curb lane is also more likely to move further away from the bicyclist during the passing maneuver by a greater amount (1.3 to 1.4 ft more when compared to the bicycle lane and paved shoulder locations, respectively. The bicyclist in a wide curb lane is also more likely to ride closer to the edge of the roadway (1.0 to 1.3 ft closer when compared to the bicycle lane and paved shoulder locations, respectively). These results confirm the previous findings from the ANCOVA.

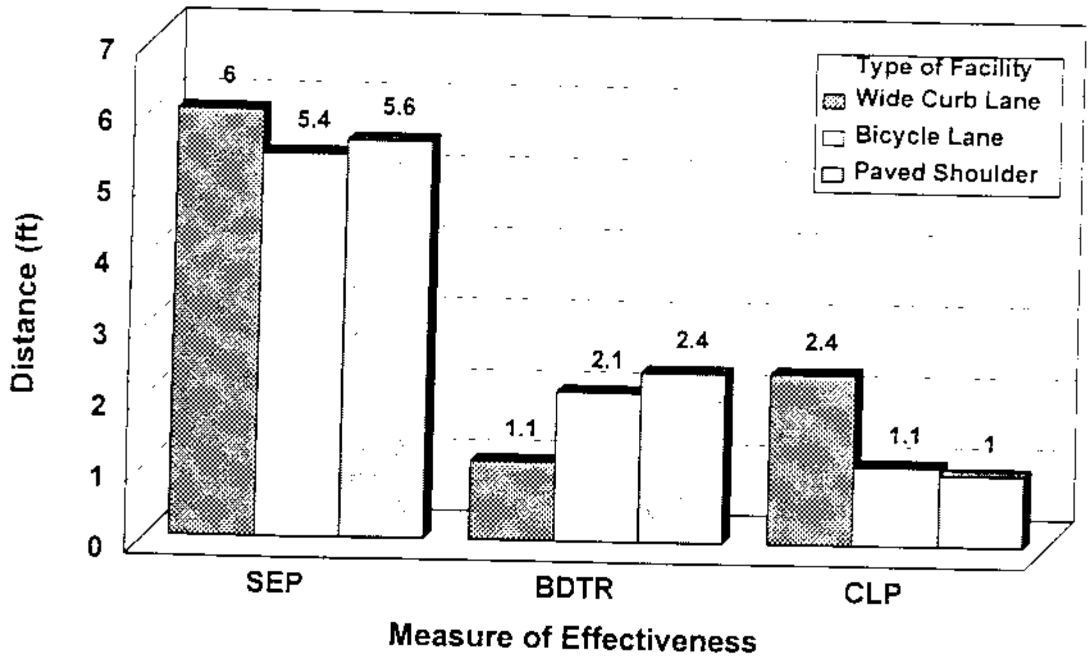

Figure 6. Mean distances by facility type for bicycle/motor vehicle separation distance (SEP), bicyclist distance to edge of roadway (BDTR), and change in motorist lateral position (CLP).

Bicycle Lane Width

Another site-specific analysis was the examination of bicycle lane width. Since it was discovered in the ANCOVA that bicycle lanes and paved shoulders generally result in similar operations on behalf of motorists and bicyclists, both types of facilities were included in this analysis. Shown in figure 7 are the mean values across sites for each of the MOE's associated with bicycle lane or paved shoulder widths ranging from 3 ft to 5 ft. Overall, the 3.5-ft to 5-ft wide bicycle lanes and paved shoulders result in very similar operations with separation distances between the motorist and bicyclist which range from 6.0 ft to 6.5 ft and distances between the bicyclist and roadway edge which range from 2.7 ft to 3.0 ft. Only the 3-ft bicycle lane results in practically smaller distances, with a separation distance between the motorist and bicyclist of 5.5 ft and a distance between the bicyclist and the edge of the roadway 2.3 ft. However, even these smaller distances for the 3-ft bicycle lane does not seem to affect the comfort of the motorist; the change in lateral position of the motorist is virtually the same across all lane widths and the percentage of encroachments into the adjacent lane in the presence of another vehicle is small for all widths and does not appear to be consistently related to lane width.

Speed Limit

The final variable examined using site-to-site comparisons was speed limit. Two pairs of sites were examined. The first pair included multilane locations with 14-ft wide curb lanes and 16- to 18-in gutter pans. The primary difference between the two sites was the speed limit; one

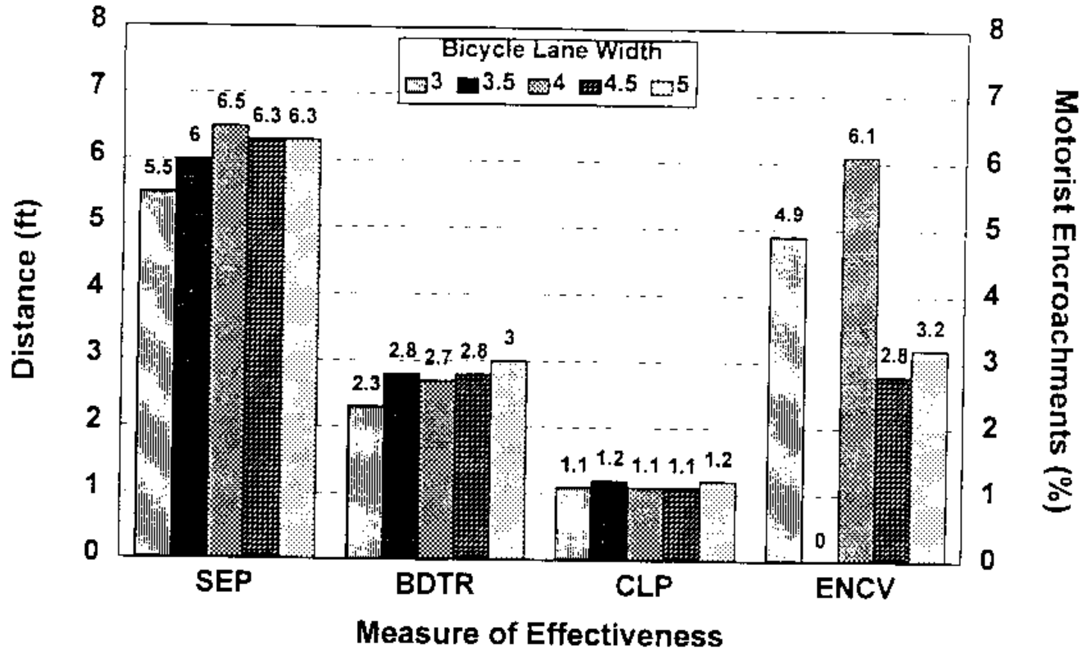

Figure 7. Mean values by bicycle lane width for bicycle/motor vehicle separation distance (SEP), bicyclist distance to edge of roadway (BDTR), change in motorist lateral position (CLP), and motor vehicle encroachments when a vehicle was present in the adjacent lane (ENCV).

was posted at 35 mi/h and the other at 45 mi/h. Comparing the MOE's for the two locations (*see figure 8*), the only difference is in the percentage of encroachments occurring when there is a vehicle present in the adjacent lane. The location with the higher speed limit resulted in 6.3% of the passing motorists encroaching into the adjacent lane while the lower speed limit location had no encroachments.

The second pair of sites were multilane locations with 11-ft curb lanes. One location had a 4-ft bicycle lane while the other had a 4.5-ft paved shoulder. The speed limits at the two locations were 35 mi/h and 45 mi/h. Comparing the MOE's for this pair (*see figure 8*) again shows the only practical difference to be between the percentage of encroachments occurring when a vehicle is present in the adjacent lane. For this pair, however, the percentage of encroachments is greater for the lower speed location (10.0%) rather than the higher speed location (2.0%). The other variable showing a difference was the distance of the bicyclist to the edge of the roadway (3.3 ft for the high-speed site vs. 2.8 ft for the low speed site). However, this 0.5-ft difference is offset by the fact that the location with the larger value is also 0.5 ft wider.

Overall, it does not appear from this site specific analysis that speed limit is a major factor with respect to any of the MOE's evaluated in this effort. This result confirms what was previously found in the ANCOVA with all sites. Speed limit was found not to be a significant factor with respect to separation distance between the motorist and bicyclist and percentage of encroachments. It was a significant factor with respect to bicyclist distance to the edge of

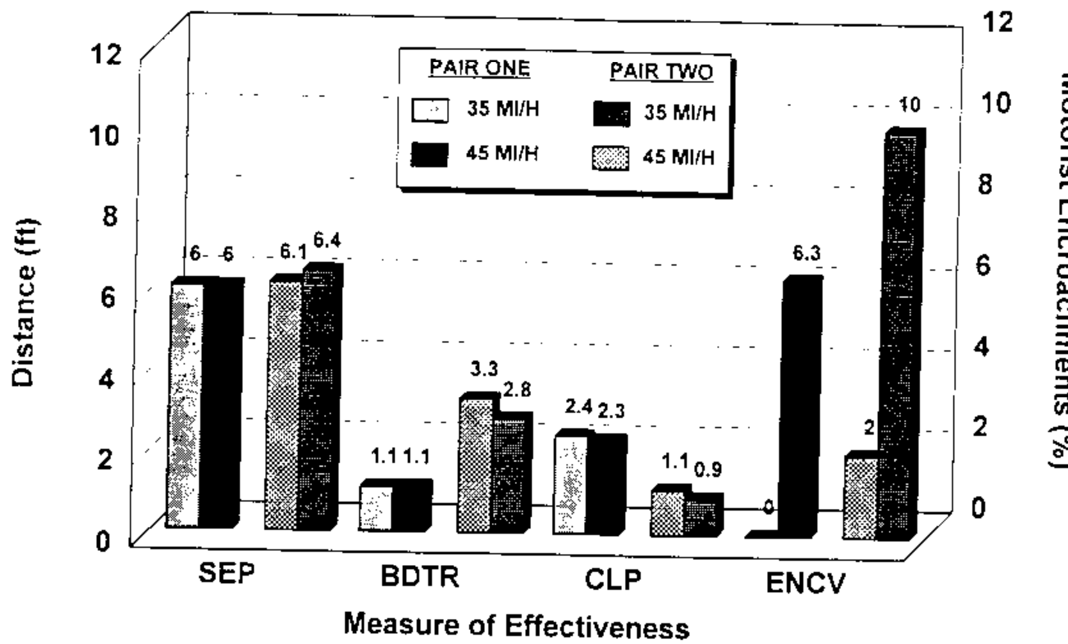

Figure 8. Mean values by speed limit for two pairs of sites for bicycle/motor vehicle separation distance (SEP), bicyclist distance to edge of roadway (BDTR), change in motorist lateral position (CLP), and motor vehicle encroachments when a vehicle was present in the adjacent lane (ENCV).

roadway and change in lateral position of the motorist. However, the effect of speed limit on each of these MOE's was relatively small.

CHAPTER 4 - SUMMARY AND CONCLUSIONS

SUMMARY OF RESULTS

The objective of this study was to evaluate the utility of various configurations of shared-use facilities by exploring the differences in bicycle and motor vehicle interactions and operations. The MOE's examined as part of this evaluation included lateral position of the bicyclist, separation distance between the bicyclist and motorist, and encroachments into the adjacent lane by the motorist. Each of these measures were recorded at the time of the passing maneuver by the motorist. Another MOE was the change in lateral position of the motorist, or the difference between the position at the time of the passing maneuver and the position downstream of the maneuver. Below is a summary of the results pertaining to each of the MOE's examined.

- Lateral position of the bicyclist - In the combined analysis (i.e., including all sites), the position of the bicyclist from the edge of the roadway was virtually the same on facilities with bicycle lanes and paved shoulders (2.59 vs. 2.63 ft, respectively). On wide curb lane facilities, however, the bicyclist, on average, was positioned only 1.40 ft from the edge of the roadway. The covariates having the largest effect on this MOE were facility type and total paved width (included the width of the curb lane and bicycle lane or paved shoulder). Similar results were found from the site-specific analysis in which type of facility was examined for three locations, each with a total paved width of 14 ft. The position of the bicyclist from the edge of the roadway on the wide curb lane facility was 1.1 ft. On the bicycle lane and paved shoulder facilities, the distances were 2.1 and 2.4 ft, respectively.

- Separation distance between the motorist and bicyclist - In the combined analysis, the wide curb lane facilities resulted in the largest average separation distance of 6.44 ft. Paved shoulder facilities were very similar with an average separation distance of 6.19 ft, and bicycle lane facilities produced the smallest average separation distance of 5.93 ft. The covariates having the largest effect on this MOE were facility type, total paved width, and presence of a vehicle in the adjacent lane to the left of the motorist. The site-specific analysis produced similar differences between the facility types, again with the wide curb lane facility producing the largest average separation distance of 6.0 ft. The average separation distances for the paved shoulder and bicycle lane facilities were 5.6 ft and 5.4 ft, respectively.

- Change in motorist lateral position - The change in lateral position of the motorist between the point at which the bicyclist was passed and a point downstream of the passing maneuver in the combined analysis showed bicycle lane facilities and paved shoulder facilities to result in almost identical behaviors on the part of the motorist (0.95 ft vs. 0.99 ft, respectively). The wide curb lane facilities, however, resulted in a much larger change in position of 2.43 ft. The most significant covariates for this MOE were type of facility, presence of a gutter pan, and area type (rural vs. urban). The results from the site-specific analysis were almost identical. The bicycle lane and paved shoulder facilities resulted in average changes in lateral position of 1.1 ft and 1.0 ft, respectively while the wide curb lane facility resulted in an average distance of 2.4 ft.

• Motorist encroachments - In the combined analysis, encroachments by the motorist into the adjacent lane to the left were much greater on wide curb lane facilities (22.3 percent) compared to bicycle lane facilities (8.9 percent) and paved shoulder facilities (3.4 percent). As with the change in lateral position of the motorist, the most significant covariates were facility type, gutter pan presence, and area type.

Also examined in the site-specific analyses was the effect of bicycle lane width on the MOE's. This particular analysis included bicycle lane and paved shoulder facilities with lane widths ranging from 3 ft to 5 ft. The smallest average separation distance between the motorist and bicyclist was 5.5 ft and occurred on the 3-ft wide facilities. On roadways with 3.5-ft facilities, this separation distance increased to 6.0 ft, and on roadways with 4-ft to 5-ft wide facilities, the separation distance ranged from 6.3 to 6.5 ft. The smallest average distance between the bicyclist and the roadway edge was 2.3 ft and also occurred on the 3-ft wide facilities. For the other widths, there was very little difference in this MOE, ranging from 2.7 ft to 3.0 ft. Finally, the change in lateral position of the motorist was essentially the same (1.1 ft to 1.2 ft) across all widths, and encroachments by motorists into the adjacent lane were few and showed no pattern that could be attributed to lane width.

CONCLUSIONS

The primary issues addressed in this study were:

- *Which type of bicycle facility (wide curb lane vs. marked bicycle lane vs. paved shoulder) provides the most comfortable environment for bicyclists and motorists?*

- *What are the primary differences between the facility types with respect to motor vehicle and bicycle operations?*

Examining the findings above, it is apparent that the type of facility does not have a large effect on the separation distance between motor vehicles and bicyclists. In general, the motorist positioned their vehicle, on average, between 5.9 ft (bicycle lane) and 6.4 ft (wide curb lane) from the bicyclist as the passing maneuver was initiated. Since this distance is obviously controlled by the motorist, it appears that a distance of approximately 6 ft to 6.5 ft is the spacing with which the motorist is most comfortable. It also appears that the motorist is willing, on average, to accept a slightly smaller separation distance when there is a stripe on the roadway designating two distinct spaces for the bicyclist and motorist.

It is also apparent from the findings that bicycle lane facilities and paved shoulder facilities generally result in similar interactions between motorists and bicyclists, and when compared to wide curb lanes, offer three distinct advantages:

1) Motorists are much less likely to encroach into the adjacent lane when passing a bicyclist on facilities with paved shoulders or bicycle lanes.

2) Motorists have less variation in their lane placement when passing a bicyclist on a paved shoulder or bicycle lane facility.

3) Bicyclists are more likely to ride further from the edge of the roadway in a bicycle lane or on a paved shoulder than they are in a wide curb lane. This increased distance from the roadway edge only marginally reduces the separation distance between the bicyclists and motorists, but significantly increases the distance to the right of the bicyclist which can be used, if needed, as "escape" space. The increased distance from the roadway edge also offers other advantages for the bicyclist. First, their sight distance is improved along roadways with trees or other obstructions adjacent to the curb. Second, by being further from the edge of the roadway, they may be more visible to overtaking motorists, motorists on side streets or driveways, and oncoming motorists (who may be turning left). Finally, being further from the roadway edge provides the bicyclist with slightly more time to react to drivers pulling or backing into the street from a driveway or side street.

In general, the presence of the stripe separating bicyclists from motor vehicles results in fewer erratic maneuvers on the part of motorists and enhances the comfort level for all roadway users.

With respect to bicycle lane width, only the 3-ft wide lane produced a separation distance of less than 6 ft. However, this was the only practical difference between the 3-ft wide facility and the other facilities examined (which included 3.5 ft, 4 ft, 4.5 ft, and 5 ft wide lanes). Considering this lack of differences, particularly with respect to change in lateral position of the motorist and the few number of encroachments, it appears that bicycle lane widths as narrow as 3 ft can provide sufficient space for motorists and bicyclists to safely interact.

The results also showed very little change in any of the MOE's for bicycle lane widths of 4 ft, 4.5 ft, and 5 ft. Thus, a 4-ft wide bicycle lane or paved shoulder will optimize operating conditions for motorist and bicyclists, and at the same time, minimize the paved surface and right-of-way required. It should be noted, however, that these results are based on interactions between passenger vehicles and bicycles. On roadways with significant large truck traffic, widths greater than 4-ft may be required for sufficient operations, particularly on high-speed facilities where wind blast may be a factor.

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2. Kroll, Bonnie and Melvin R. Ramey, "Effects of Bike Lanes on Driver and Bicyclist Behavior," *Transportation Engineering Journal*, March 1977.

3. McHenry, Steven R. and Michael J. Wallace, *Evaluation of Wide Curb Lanes as Shared Lane Bicycle Facilities*, Report No. FHWA/MD-85/06, Maryland Department of Transportation, Baltimore, MD, August 1985.

APPENDIX

Included in this appendix are the following:

1) A table containing descriptive geometric and operational characteristics associated with each of the sites where data were collected in the study.

2) Example of a completed field data collection form.

3) Example of a completed data reduction form for roadways with bicycle lanes or paved shoulders.

4) Example of a completed data reduction form for roadways with wide curb lanes.

FIELD DATA COLLECTION FORM

SITE: High Road PAGE 1 OF 6

CITY: Tallahassee

CREW: Lex / David

DATE: 6/20/95

RUN NO.	SLIDE ROLL NO.	VIDEO TAPE NO.	DIR. OF TRAVEL	VEHICLE DESCRIPTION		NO. OF SLIDES
				COLOR	BODY STYLE	
1	1	1	N	RED	CAMARO	4
2			S	BLUE	SEDAN	6
3			N	BLACK	PICKUP	6
4			S	SILVER	MERCEDES	2
5			N	RED	MONTE CARLO	4
6			S	WHITE	MINIVAN	6
7			N	BLUE	PICKUP	4
8			S	GRAY	ACCORD	4
9			N	BROWN	TEMPO	6
10			S	BLACK	TAURUS	4
11			N	RED	PRELUDE	2
12			S	WHITE	VAN	4
13			N	PURPLE	PICKUP	2
14			S	SILVER	SEDAN	6
15			N	GREEN	TAURUS	4
16			S	GOLD	LEXUS	5
17			N	RED	PICKUP	6
18			S	BLUE	SEDAN	3
19			N	GREEN	CIVIC	4

Table 11. Geometric and operational characteristics of the study sites.

Variable	Site Number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Type of Facility (**W**ide Curb Lane/**B**icycle Lane/**P**aved Shoulder	W	W	P	W	P	B	B	B	B	B	B	B	P
Area Type (**R**ural/**U**rban)	U	U	U	U	U	U	U	U	U	U	R	R	R
(**D**ivided/**U**ndivided)	U	U	U	U	U	D	U	U	U	U	D	U	U
Posted Speed Limit (mi/h)	35	35	35	45	45	35	35	30	45	45	50	40	45
Number of Travel Lanes	4	4	4	6	6	2	4	4	4	4	2	4	4
Curb Lane Width (ft)	15	14	11	14	11	11.5	11	11	13	12	12	11	11.5
Gutter Pan Width (ft)	0	1.5	1.3	1.3	1.3	1.3	1.3	1.3	0	1.3	0	0	0
Bicycle Lane Width (ft)	0	0	0	0	0	3.5	4	3	6.5	4.5	5	5	0
Paved Shoulder Width (ft)	0	0	3	0	4.5	0	0	0	0	0	0	0	4.5
Total Paved Width (ft)	15	14	14	14	15.5	15	15	14	19.5	16	17	16	16
City: **B**oca Raton, **C**learwater, Ft. Lauderdale, **G**ainesville, **O**rlando, **T**allahassee													

FLORIDA TYPICAL SECTIONS STUDY - DATA REDUCTION FORM FOR ROADS WITH BIKE LANES OR PAVED SHOULDERS

SITE: Federal Highway (US 1) CITY: Boca Raton PAGE 1 OF 16

VEH NO.	TAPE NO.	TAPE TIME	MOTORIST ENCROACHMENT		VEHICLE PRESENCE	BICYCLIST ENCROACHMENT		SLIDE NO.	PAIR NO.	TYPE OF SLIDE	MOTORIST DISTANCE TO THE EDGELINE	BICYCLIST DISTANCE TO THE EDGELINE
			LEFT	RIGHT		LEFT	RIGHT					
1	1	:35	N	N	Y	N	N	1	1	B	4.5	1.75
		:39	N	N	N			2	1	Y	3.875	
		:48	N	N	N	N	N	3	2	B	3.875	2.0
		:53	N	N	N			4	2	Y	2.875	
		1:09	N	N	Y	N	N	5	3	B	3.125	1.875
		1:14	N	N	Y			6	3	Y	3.625	
		1:22	N	N	Y	N	N	7	4	B	3.875	2.50
		1:25	N	N	Y			8	4	Y	2.0	
2		2:07	N	N	N	N	N	9	5	B	5.125	2.125
		2:11	N	N	N			10	5	Y	2.125	
		2:20	N	N	Y	N	N	11	6	B	3.875	2.0
		2:23	N	N	Y			12	6	Y	2.50	
		2:32	N	N	Y	N	N	13	7	B	3.50	2.625
		2:36	N	N	N			14	7	Y	2.375	
3		2:58	N	N	Y	N	N	15	8	B	3.50	2.0
		3:02	N	N	Y			16	8	Y	3.125	
		3:09	N	N	Y	N	N	17	9	B	2.875	1.75
		3:14	N	N	Y			18	9	Y	2.375	

FLORIDA TYPICAL SECTIONS STUDY - DATA REDUCTION FORM FOR ROADS WITH WIDE CURB LANES

SITE: BELCHER ROAD CITY: CLEARWATER PAGE 1 OF 13

VEH NO.	TAPE NO.	TAPE TIME	MOTORIST ENCROACHMENT		VEHICLE PRESENCE	BICYCLIST ENCROACHMENT		SLIDE NO.	PAIR NO.	TYPE OF SLIDE	MOTORIST DISTANCE TO THE BICYCLE	BICYCLIST DISTANCE TO THE ROAD EDGE
			LEFT	RIGHT		LEFT	RIGHT					
1	1	:00	N	N	N		N	1	1	B	4.50	1.75
		:08	N	N	N			2	1	V	4.375	
		1:42	N	N	N		N	3	2	B	6.250	1.125
		1:46	N	N	N			4	2	V	4.375	
2		2:03	N	N	N		N	5	3	B	5.75	1.0
		2:08	N	N	N			6	3	V	5.125	
		3:06	N	N	N		N	7	4	B	5.0	1.5
		3:09	N	N	Y			8	4	V	4.125	
3		3:42	Y	N	N		N	9	5	B	6.875	1.25
		3:45	N	N	N			10	5	V	4.875	
		4:28	N	N	N		N	11	6	B	5.25	1.50
		4:33	N	N	N			12	6	V	5.0	
4		4:53	N	N	N		N	13	7	B	5.125	1.625
		4:58	N	N	N			14	7	V	4.5	
5		5:38	N	N	N		N	15	8	B	4.875	1.375
		5:45	N	N	N			16	8	V	5.125	
		6:48	Y	N	N		N	17	9	B	5.625	1.25
		6:54	N	N	N			18	9	V	5.125	