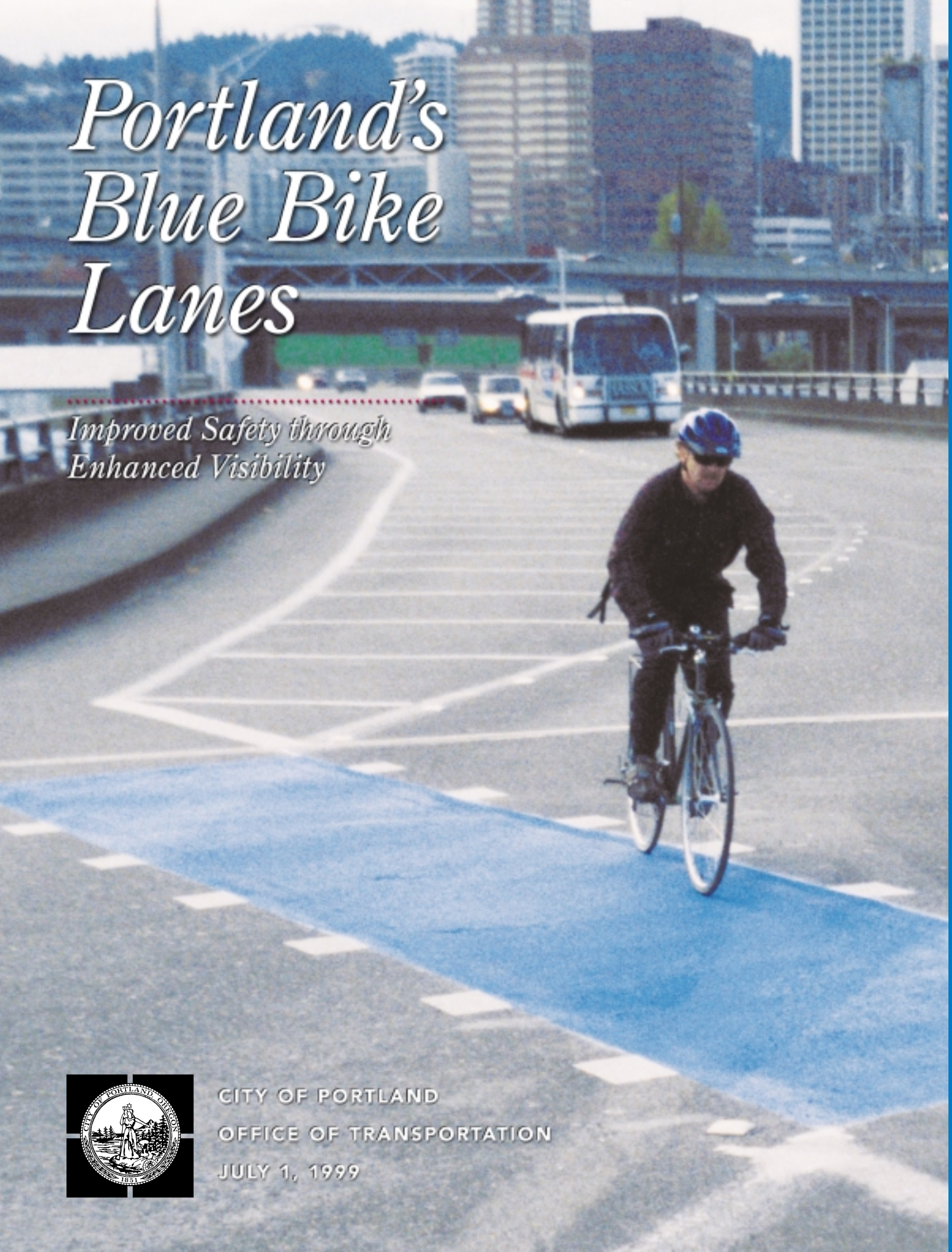

Portland's Blue Bike Lanes

Improved Safety through Enhanced Visibility

CITY OF PORTLAND
OFFICE OF TRANSPORTATION

JULY 1, 1999

CITY OF PORTLAND,
OFFICE OF TRANSPORTATION

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This project was funded through a grant from the Oregon Department of Transportation Bicycle and Pedestrian Program. Special thanks to the German Marshall Fund Environmental Fellowship Program, which funded Bicycle Program Manager Mia Birk's 1996 research tour of bicycle-friendly European cities.

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INTRODUCTION

The City of Portland has over 100 miles of bicycle lanes; most were installed within the last decade. As a result of this and other factors, many more residents are riding bicycles for all types of trips. For example, in 1975 about 200 cyclists rode the Hawthorne Bridge daily; today, that number is over 2400. Staff have recorded similar increases throughout the City, especially in areas with new bicycle lanes.

Bicycle lanes provide enormous benefits to all transportation users. They define a space in which to ride, eliminating the need to weave in and out of traffic or parked cars. They help novice cyclists feel more confident and increase cyclist visibility. Bicycle lanes also help motorists predict where to expect cyclists. However, motorists are often unaware that they must yield to cyclists when crossing a bicycle lane. As a result, many cyclists worry about the safety of these crossing areas.

Many European cities use colored markings at bicycle-motor vehicle crossings to reduce conflicts. The colors range from red (the Netherlands, Germany, Sweden, Denmark, Switzerland, Belgium and others) to blue (Denmark), yellow (Switzerland), and green (Germany and France). Thus far, American cities have not used this technique.

To determine whether such colored markings help improve safety at bicycle-motor vehicle crossings, the City of Portland has been experimenting with blue pavement markings to delineate selected conflict areas. The University of North Carolina Highway Safety Research Center (UNCHSRC) — under contract to the Federal Highway Administration — analyzed the project data.

Other studies

Evidence shows that the use of colored pavement helps improve safety. References for these studies are listed at the back of this report.

Offenberg, Germany
Photo by Eric Stachon

- A Swedish study found the use of colored markings increased safety per bicyclist by 20 percent.
- Denmark found the use of blue markings reduced bike-motor vehicle collisions by 38 percent and fatalities and serious injuries by 71 percent.
- Studies in England showed colored markings to be effective at reducing conflicts.

Troisdorf, Germany
Photo by Eric Stachon

- A 1996 study in Montreal, Quebec found the use of blue markings at five intersections resulted in a small but significant decrease in conflicts. The study also found that cyclists exercised greater caution after the installation of colored markings and significantly increased the number of cyclists following the delineated path.

Why blue?

- *Conflicting meanings for other colors* Throughout the American transportation system, yellow is used for centerline stripes. Red and green both have very distinct meanings: red signifies "do not go here" and green means "go". The only meaning for blue is disabled parking stalls.

- *Color blindness* Many people have a limited ability to differentiate colors. In particular, many color blind or impaired individuals find it difficult to see red and other earth tones, as well as green. In low light and wet conditions, blue shows up relatively well.

- *Public support* Prior to the start of the project, Bicycle Program staff presented the color options to dozens of local community groups, including neighborhood and business associations, transportation professionals, bicycle advisory committees in Oregon and Washington, and bicycling and other interested community groups. Participants overwhelmingly preferred blue.

Copenhagen, Denmark
Photo by Eric Stachon

- *Evidence from Denmark and Montreal* Studies in Denmark and Montreal demonstrate the benefits of using blue markings.

PROJECT GOAL

The project goal is to investigate the effectiveness of colored pavement markings in reducing bicyclist-motorist conflicts at designated crossing areas.

Staff designed the study to answer the following:

1. *Did motorists appear to yield more frequently to cyclists after the pavement was colored blue?*
2. *Did motorists appear to look for cyclists before crossing the bike lane more frequently than before?*
3. *Did motorists modify their behavior in any significant ways?*
4. *Did cyclists tend to look more frequently for motorists before proceeding through the painted area?*
5. *Did cyclists modify their behavior in any significant ways?*
6. *Did the number of conflicts, near conflicts, and reported crashes change?*

Test sites selection and characteristics

Staff selected ten conflict areas with a high level of cyclist and motorist interaction, as well as a history of complaints. All of the sites are locations where the cyclist travels straight while the motorist crosses the bicycle lane. Sites with similar characteristics are grouped as follows:

GROUP ONE (Sites 1-4): *Exit ramp*

The cyclist travels straight ahead and the motorist crosses the path of the cyclist to exist a roadway, such as an off-ramp situation. These sites are Broadway/Williams; Beaverton-Hillsdale/Bertha; Multnomah/Garden Home; and the Hawthorne Bridge eastbound.

GROUP TWO (Sites 5-8): *Right-turn lane*

The cyclist travels straight and the motorist crosses over the cyclist path to enter a right turn lane. These sites are Madison/Grand; 7th/Morrison; Broadway/Larrabee; and Terwilliger/I-5.

GROUP THREE (Sites 9-10): *Entrance ramp*

The cyclist travels straight and the motorist crosses the bicycle lane to merge onto a street from a ramp. These sites are Broadway/ Interstate and Weidler/Victoria.

Site descriptions can be found in *Table 1* and the schematics and photos of each site found on pages 6-11.

Table 1. *Blue bike lane sites*

GROUP 1: Exit ramps

SITE	CONFLICT AREA	AVERAGE DAILY TRAFFIC	SITE DESCRIPTION: EXIT RAMP	PHASE 1	PHASE 2
1	NE Broadway, westbound at Williams (I-5 northbound entrance ramp)	35,000	Bicyclist heading west. Motorist crosses bicycle lane to access I-5 northbound entrance ramp.	•	•
2	SW Beaverton-Hillsdale Highway eastbound at Bertha	14,500	Bicyclist heading east. Motorist crosses bicycle lane while veering off to Bertha Blvd.	•	•
3	SW Multnomah Blvd, eastbound at Garden Home Rd	10,000	Bicyclist heading east. Motorist crosses bicycle lane while veering off to Garden Home Rd.		•
4	The Hawthorne Bridge, east end, eastbound at the McLoughlin off-ramp	13,200	Bicyclist heading east. Motorist exiting Hawthorne Bridge eastbound viaduct onto McLoughlin Blvd.	•	

GROUP 2: Right-turn lanes

SITE	CONFLICT AREA	AVERAGE DAILY TRAFFIC	SITE DESCRIPTION: RIGHT-TURN LANE	PHASE 1	PHASE 2
5	SE Madison, eastbound, between Sixth and Grand	10,500	Bicyclist heading west. Motorist crosses bicycle lane into right-turn only lane onto northbound Grand Ave.	•	
6	SE 7th, southbound at Morrison	8,300	Bicyclist heading south. Motorist crosses bicycle lane into right-turn only lane onto SE Morrison.		•
7	East end of the Broadway Bridge, eastbound at Larrabee	15,200	Bicyclist heading east comes off sidewalk of Broadway Bridge onto roadway bicycle lane. Motorist crosses bicycle lane into right-turn only lane onto NE Larrabee.	•	•
8	SW Terwilliger, northbound at I-5 entrance ramp	<7,000	Bicyclist heading north. Motorist crosses bicycle lane into right-turn only lane onto I-5.		•

GROUP 3: Entrance ramps

SITE	CONFLICT AREA	AVERAGE DAILY TRAFFIC	SITE DESCRIPTION: ENTRANCE RAMP	PHASE 1	PHASE 2
9	East end of the Broadway Bridge, westbound at Interstate	32,000	Bicyclist heading west from roadway bicycle lane onto Broadway Bridge sidewalk. Two lanes of motorists from N. Interstate cross bicycle lane to use Broadway Bridge westbound.	•	•
10	NE Weidler, eastbound at Victoria (I-5 north bound off-ramp)	40,300	Bicyclist heading east. Motorist exits I-5, crosses bicycle lane as she/he enters eastbound NE Weidler St.	•	•

BLUE MARKING INSTALLATION

The sites had previously been defined with white dashed lines as well as, in most cases, signs directing motorists to yield to cyclists.

A great deal of research went into the blue marking material selection. The aspects considered included cost, durability, and color availability. These aspects are discussed in *Table 2*.

The utility of the blue markings was tested in two phases. In Phase 1, October 1997, crews painted seven of the conflict areas (sites 1, 2, 4, 5, 7, 9, 10). Two sites (4, 5) were subsequently dropped due to the year-long closure of the Hawthorne Bridge. Phase 1 sites were marked with paint. As expected, the paint wore off quickly during the subsequent winter.

In Phase 2, August 1998, crews applied thermoplastic[1] to mark eight conflict areas, of which five had been included in Phase 1 (sites 1, 2, 7, 9, 10) and three were new sites (3, 6, 8). As of this writing, the plastic has been in place for almost a year and is holding up well at six of eight sites. Of the remaining two, one is in fair and the other is in poor condition; the disintegration of the plastic is likely due to incorrect installation. Although the blue appears quite bright, it is not as visible as anticipated in low light conditions. Cyclists are pleased, however, with the texture; it is not slippery.

At each site, crews mounted an accompanying sign depicting the conflict situation (see *Figure 1* for sign examples). The blue area and its accompanying sign are intended to remind motorists that they are crossing a bicycle lane and need to yield to through cyclists.

Table 2. *Materials considerations**

MATERIAL	KNOWN VENDORS	APPROXIMATE MATERIALS COST (NOT INCLUDING INSTALLATION)	DURABILITY	AVAILABILITY OF COLORS
Paint	Local paint supply stores	$.04-$.10/ lineal foot	Poor	Wide variety
Thermoplastic	Flint Trading (Premark®)[1] 336-475-6600	$2.66/sq.ft	Good. Withstands significant volume & turning movements	Blue, red, yellow, white
Methyl methacrylate-based marking	Morton Traffic Markings (Dura Stripe®) 800-835-3357	$.50-$.60/ lineal foot	Potentially good	Yellow, white, red
Cold plastic	3M (Stamark®) 800-362-3455	$4.50 sq.ft.	Durable with inlay, not as good with existing asphalt; unlikely to hold up to heavy turning volumes	Blue, red, yellow, white
Dyed asphalt	Asphacolor® 800-258-7679	Very costly. Must apply fresh, treated asphalt.	Excellent	Earth-tones
Imprinted and sealed asphalt	Integrated Paving Concepts (Street Print) 800-688-5652	Costly. Must apply fresh asphalt.	Unknown	Earth-tones
Colored acrylic coating	Traffic Safety Systems (Zebraflex®) 407-348-2624	Unknown	Potentially good	Blue, green, red, yellow

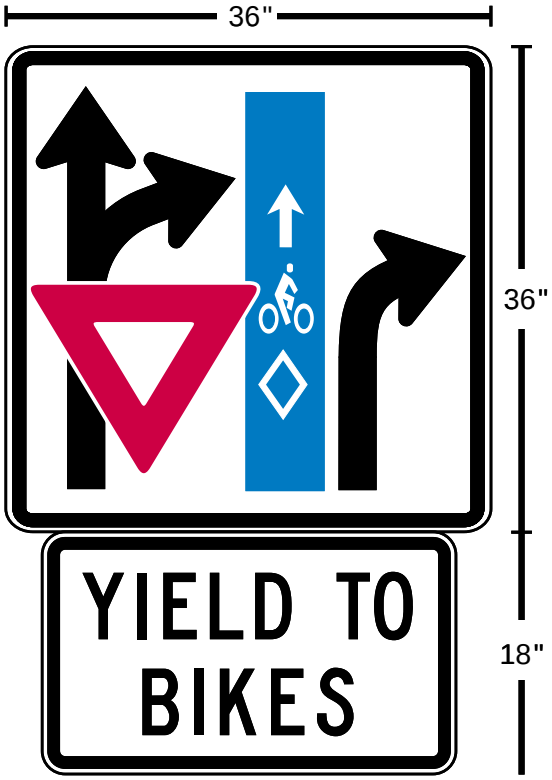
** All statements on this table are based on research for this project. Actual costs may vary widely depending on quantities, etc. Installation costs are not included. Other vendors may sell similar products.*

[1] The specifications for the thermoplastic are: Blue Premark 20/20 Flex 125 mil. Highly skid resistant. 60 BPN. Material suppled by Flint Trading Inc. P.O. Box 160, Thomasville NC 27361-0160. Phone: 336-475-6600.

■ Figure 1. *Accompanying signs*

GROUP 1: Right-turn exit ramps

- Motorists yield to cyclists as they turn right to exit roadway.

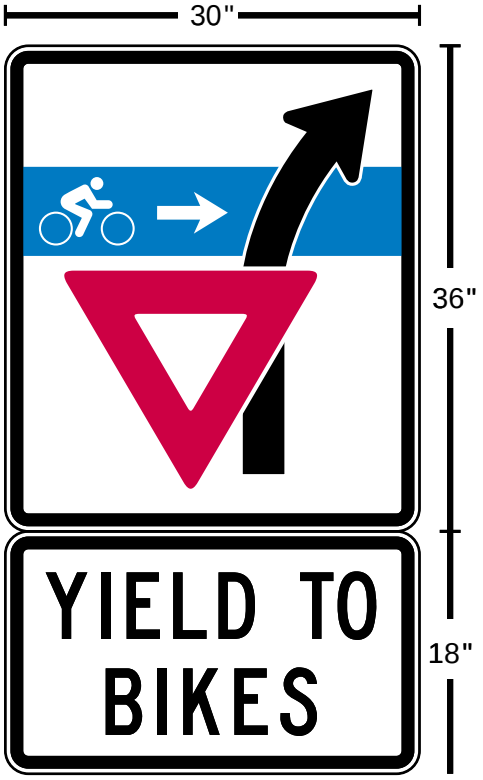


GROUP 1: Right-turn exit ramps

- Unique sign for Broadway/Williams.

GROUP 2: Right-turn lanes

- Motorist entering right-turn lane yields to cyclist.



GROUP 3: Entrance ramps

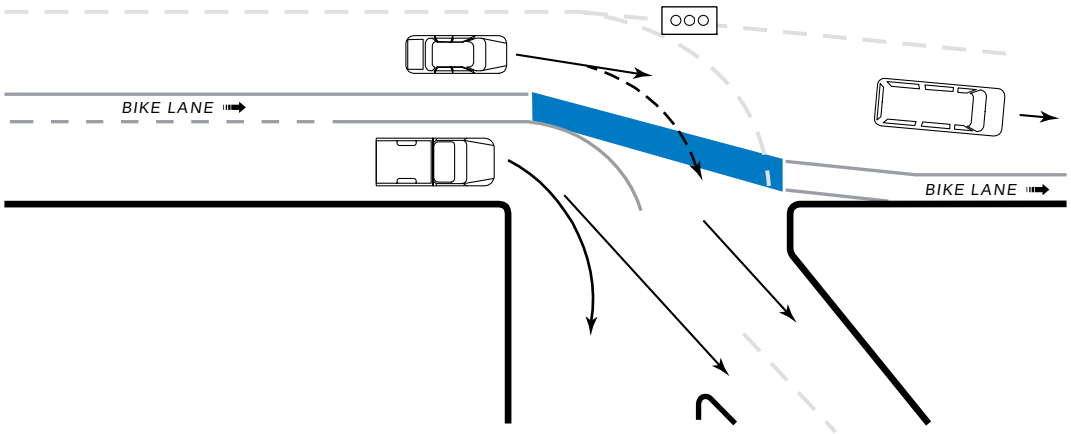
- Motorist yield to cyclists as they turn right to enter roadway.

GROUP 1:
Exit ramps

Motorists can either turn right as they exit the roadway or continue straight from the right lane. Right-turning exiting vehicles cross the bicycle lane.

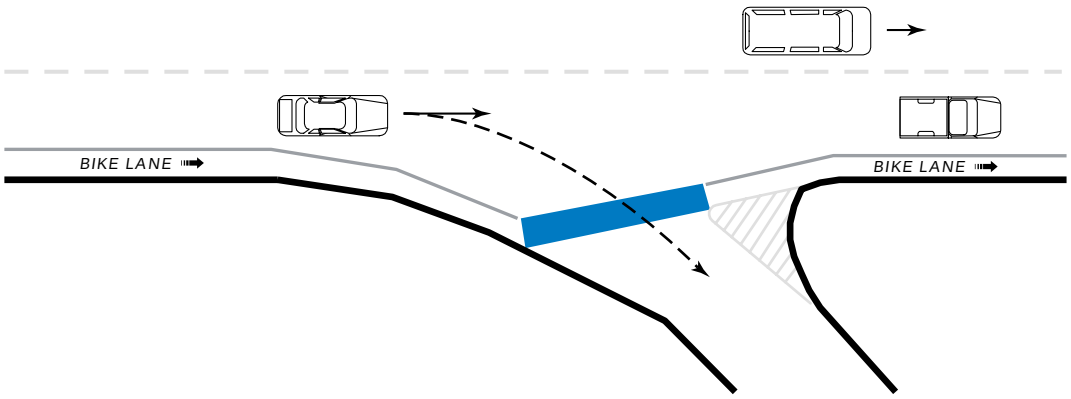
SCHEMATICS
(not to scale)

Site 1 *Broadway / Williams / I-5 entrance*

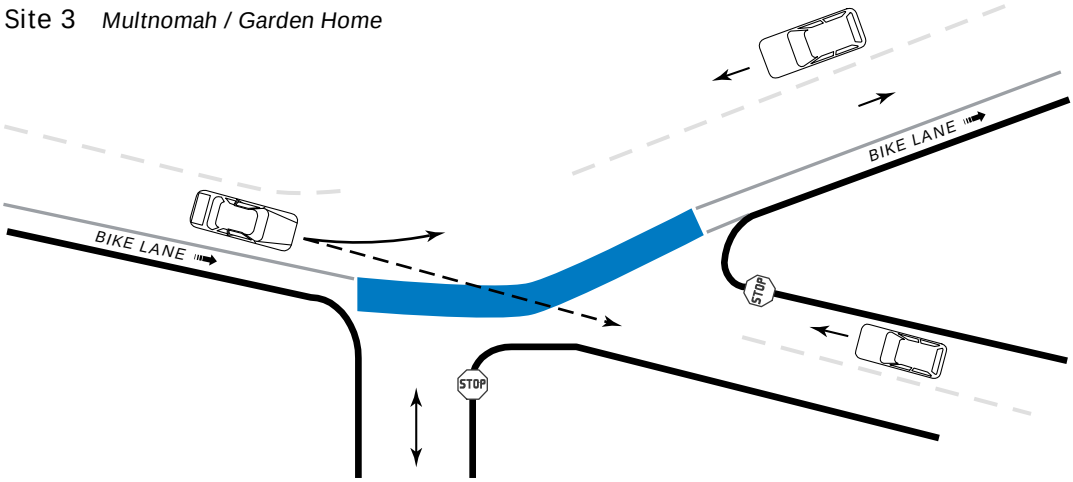


Site 2 *Beaverton-Hillsdale Highway / Bertha*

Site 4 *Hawthorne Bridge / McLoughlin off-ramp*



Site 3 *Multnomah / Garden Home*



GROUP 1:
Exit ramps

SITE PHOTOS

BEFORE | AFTER

Site 1

NE Broadway, westbound at Williams

Site 2

SW Beaverton-Hillsdale Highway, eastbound at Bertha

Site 3

SW Multnomah Blvd, eastbound at Garden Home Road

photo not available

Site 4

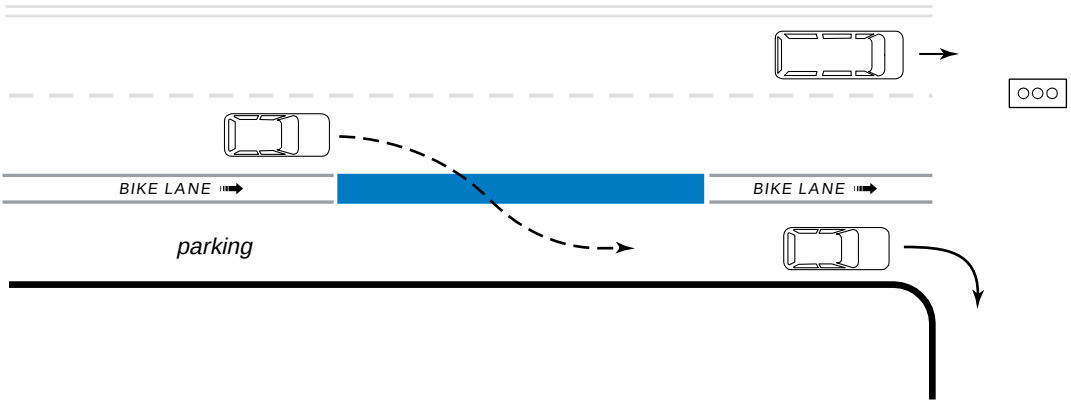
The Hawthorne Bridge, east end, eastbound at the McLoughlin off-ramp

GROUP 2:
Right-turn lanes

Motorists cross the bicycle lane as they turn to enter the right-turn only lane. The bicyclist proceeds straight in the bicycle lane, to the left of the right-turn lane.

SCHEMATICS
(not to scale)

Sites 5–8 *SE Madison / Grand, SE 7th / Morrison, east end of Broadway Bridge / Larrabee, and SW Terwilliger / I-5 entrance*



GROUP 2:
Right-turn lanes

SITE PHOTOS

BEFORE AFTER

Site 5

SE Madison, eastbound,
between Sixth and Grand

Site 6

SE 7th, southbound at Morrison

Site 7

East end of the Broadway
Bridge, eastbound at Larrabee

Site 8

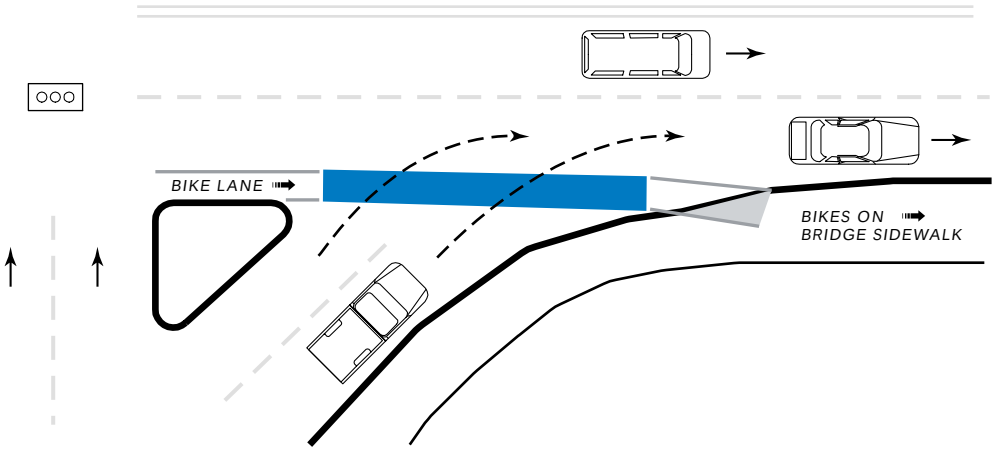
SW Terwilliger, northbound
at I-5 entrance ramp

GROUP 3:
Entrance ramps

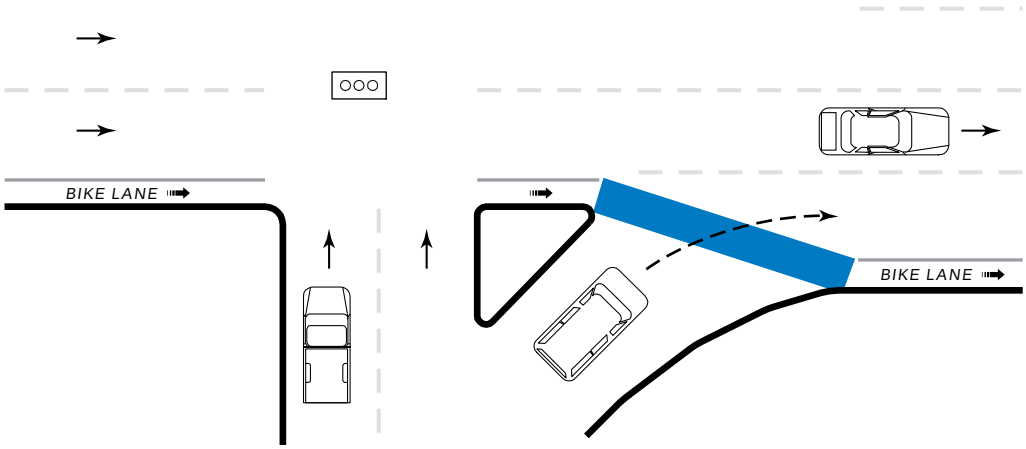
Motorists cross the bicycle lane as they turn right to enter the roadway from a ramp.

SCHEMATICS
(not to scale)

Site 9 *Broadway Bridge / Interstate Ave.*



Site 10 *NE Weidler / Victoria / I-5 off ramp*



GROUP 3:
Entrance ramps

SITE PHOTOS

	BEFORE	AFTER
Site 9 East end of the Broadway Bridge, westbound at Interstate	*photo not available*	
Site 10 NE Weidler, eastbound at Victoria (I-5 northbound off-ramp)		

DATA COLLECTION

At each site, a videographer taped cyclist-motorist interactions both before and after the blue application. At all 10 sites, she taped bicyclist-motorist interactions for two hours before the blue marking application. The taping was done from seven to nine a.m., or four to six p.m., depending on peak directional flow. As noted in *Table 1,* she taped five sites once after the blue application (for two hours, same time of day as the before taping) and five sites twice after the blue application. The total time for videotaping before the blue marking was 10 hours; after videotaping totaled 30 hours. In the before period, the videotapes captured 846 bicyclists; in the after period, 1021.

The videographer taped the seven Phase 1 intersections in September 1997 before the October 1997 blue paint application; Phase 1 after videotaping occurred on dry days from December 2nd to 12th, 1997. She recorded the three additional Phase 2 intersections in July 1998 before the blue plastic application in August 1998; Phase 2 after videotaping occurred on dry days from August 18th to September 3rd, 1998.

In addition, staff conducted a field survey of cyclists and a mail survey of motorists. Staff administered the cyclist survey on September 2nd and 23rd, 1998, collecting 216 surveys from cyclists who had just traveled through the Broadway/Larrabee site. Staff recorded license plate numbers of eastbound motorists driving through or past the Broadway/Larrabee site in late February 1999. They matched license plate numbers with Driver and Motor Vehicle Services (DMV) records and then mailed the motorist survey to approximately 1200 motorists, of which 222 returned surveys.

PROJECT RESULTS

The key results fall into five main areas: Motorist and cyclist behavior, motorist and cyclist viewpoints, and conflicts.

Analysts examined three levels of data to assess before to after changes in bicyclist and motorist behaviors. At the most aggregated level, they pooled the data over all sites. At an intermediate level, they analyzed data by site groupings (exit ramps, right-turn lanes, and entrance ramps). At the third level, they looked for significant behavior changes at each site.[2] A comparison of these analyses are presented in *Table 3.*

It is important to note that the word *"significant"* used here means that there is a low probability that the observed change was the result of chance. In other words, the change is likely the result of the blue marking and/or "yield to bikes" sign.

Table 3. *Summary of before-to-after changes in bicyclist/motorist behaviors from three levels of analysis.*

	LEVEL OF ANALYSIS		
BEHAVIOR	DATA POOLED OVER ALL SITES	DATA COMBINED INTO 3 GROUPS*	SITE-BY-SITE ANALYSIS**
Bicyclist followed indicated path	increase in percent following path	G1 – increase G2 – decrease G3 – decrease	increase at sites 4,10 decrease at sites 5,7 overall increase
Bicyclist turned head	decrease in percent turning head	G1 – decrease G2 – increase G3 – decrease	increase at site 7 decrease at sites 9,10 overall decrease
Bicyclist used hand gesture	decrease in percent using hand gesture	G1 – decrease G2 – non-significant G3 – non-significant	overall non-significant
Bicyclist slowed or stopped	decrease in percent slowing/stopping	G1 – decrease G2 – non-significant G3 – decrease	decrease at sites 7,10 overall decrease
Motorist used turn signal	decrease in percent using turn signal	G1 – non-significant G2 – increase G3 – no data	increase at site 5 overall non-significant
Motorist slowed or stopped	increase in percent slowing/stopping	non-significant	overall non-significant
Motorist yielded to bicyclist	increase in percent yielding	G1 – increase G2 – non-significant G3 – increase	increase at sites 7,10 overall increase

* *Group 1 (sites 1-4): Exit ramps*
Group 2 (sites 5-8): Right-turn lanes
Group 3 (sites 9-10): Entrance ramps
All noted increases or decreases were statistically significant.

***See Table 1 for site descriptions.*

[2] Contingency tables and x^2-tests were used to identify significant changes in behaviors for the first two levels of aggregation. For the third level, contingency tables were developed for each site. Significant behavior changes at a site were assessed by either a x^2-statistic or a Fishers exact test when cell frequencies were too small. A Cochran-Mantel-Haenszel (CMH) x^2-statistic was also computed to test for overall association across the tables. This test is particularly sensitive to consistency of relationships across the sites.

Figure 2. *Who yields?*

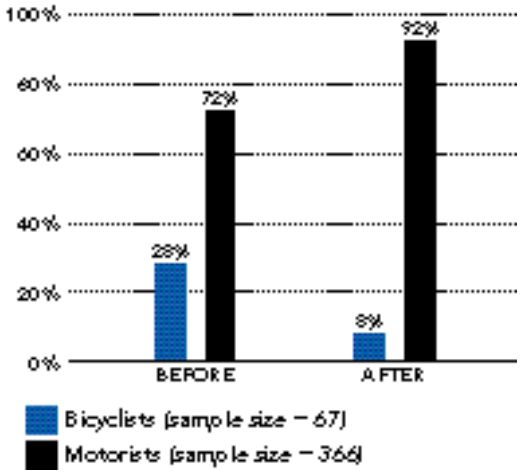
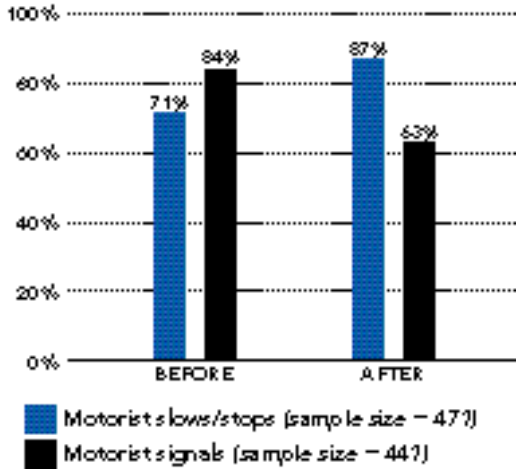


Figure 3. *Motorist behaviors*



Motorist behaviors:

In the before period, 72 percent of motorists yielded to cyclists while 28 percent of cyclists yielded to motorists. In the after period, the percentage of motorists yielding increased to 92 percent, a 27 percent increase (see *Figure 2*). The percentage of cyclists yielding decreased to eight percent. The increase in motorist yielding was consistent at all levels of analysis. Significant change was noted at Broadway/Larrabee and Weidler/Victoria.

Significantly more motorists slowed or stopped when approaching the blue area: 71 percent before and 87 percent after installation, a 23 percent increase (see *Figure 3)*. However, when analyzed at the group and individual levels, no significant changes were found. In contrast, 25 percent fewer motorists used a turn signal (84 percent before versus 63 percent after — see *Figure 3)*, with the exit ramp group experiencing an insignificant change and the right-turn lane group an increase in slowing or stopping.

Cyclist behaviors:

Fewer bicyclists approaching the conflict area turned their head to look for a motor vehicle after the blue pavement was put in place (43 percent before versus 26 percent after — see *Figure 4)*. The exit ramp and right-turn lane groups also experienced a decreased in head turning, while the entrance ramp group experienced an increase. Among individual sites, an increase in head turning was noted at Broadway/Larrabee and a decrease noted at Broadway/Interstate and Weidler/Victoria.

Similarly, fewer bicyclists used a hand gesture to signal their movement through the conflict area after the blue marking application (11 percent before versus five percent after — see *Figure 4)*. Only the exit ramp group experienced a significant decrease; changes in the other two groups and at individual sites were not significant. However, cyclists are not required by law to use a hand gesture at any of the sites since the cyclist is making a through movement rather than a turn.

Figure 4. *Bicyclist behaviors*

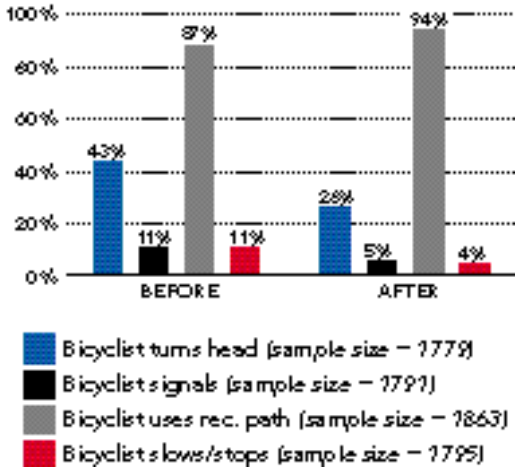
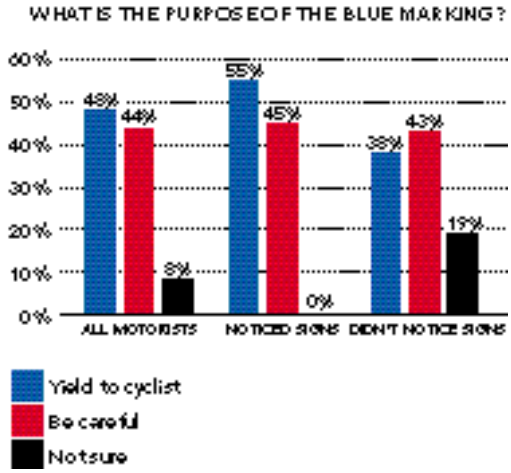


Figure 5. *Motorist survey*



Overall, more cyclists followed the recommended path after the blue marking: 87 percent before versus 94 percent after (see *Figure 4)*. At the group level, more cyclists did so in the exit ramp group, while fewer did in the right-turn and entrance ramp groups. Increased use of the recommended path was found at the Hawthorne Bridge and Weidler/Victoria, and decreased use at Madison/Grand and Broadway/Larrabee. When cyclists did not follow the recommended path, they usually opted for a straight rather than angled path at sites like the Hawthorne Bridge where the marked path is angled to shorten the conflict zone.

Additionally, fewer cyclists slowed or stopped when entering the blue pavement (11 percent before versus four percent after—see *Figure 4)*. Decreased slowing or stopping was found in both the exit and entrance ramp groups and at Broadway/Larrabee and Weidler/Victoria.

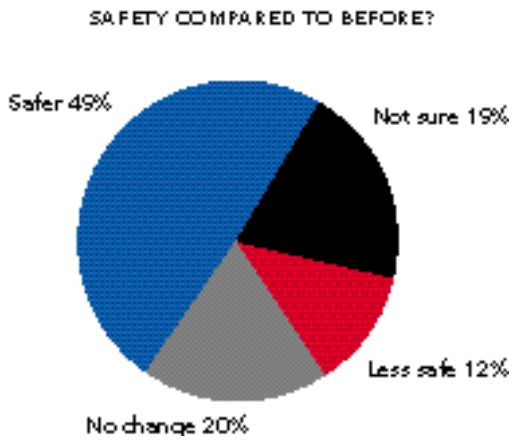
Motorist viewpoints:

The motorist survey respondents were 54 percent female with an average age of 46 years. Eighty-five percent said that they used this route regularly, to travel to work (52 percent), the store (17 percent), visit friends (four percent), and other places (six percent).

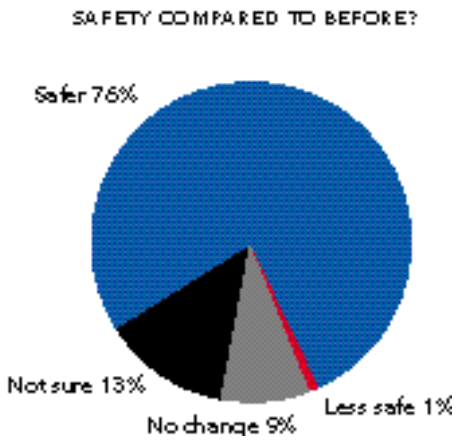
About 70 percent of the respondents noticed the blue areas and 59 percent noticed the accompanying sign. Of those on their regular route who noticed the blue area, 62 percent noticed the signs.

Of the respondents who noticed the sign, 55 percent said the blue area meant “yield to cyclist,” and 45 percent said it meant, “be careful.” Of those who did not notice the sign, only 38 percent said it meant “yield to cyclist,” and 43 percent “be careful” (see *Figure 5)*.

■ Figure 6. *Motorist survey*



■ Figure 7. *Cyclist survey*



Overall, almost 50 percent felt the areas were safer; another 40 percent said they were about as safe as before or were not sure *(Figure 6)*. Of those who noticed the signs, 55 percent felt the areas were safer.

Motorists had a variety of comments, ranging from, “this is a good idea,” to “needless expenditure.” Several thought the blue helped increase awareness, while others were concerned about creating a false sense of security. Several had concerns about the safety and design of the crossing area at Broadway/Larrabee.

Cyclist viewpoints:

The bicycle riders surveyed were 75 percent male, on average 35 years old and riding 59 miles per week. Almost 80 percent of the riders wore helmets and 72 percent considered themselves to be experienced bicycle riders.

The overwhelming majority (76 percent) felt that the locations were safer since the installation of blue pavement *(Figure 7)*.

Fifty-eight percent felt that motorists were yielding more than before, and 27 percent the same as before *(Figure 8)*.

There were a few negative comments, including one concern that bicyclists are lulled into a false sense of security. Typical positive comments were that the blue pavement made a big difference, that bicyclists were more visible to drivers and that drivers were more aware of bicyclists.

Figure 8. *Cyclist survey*

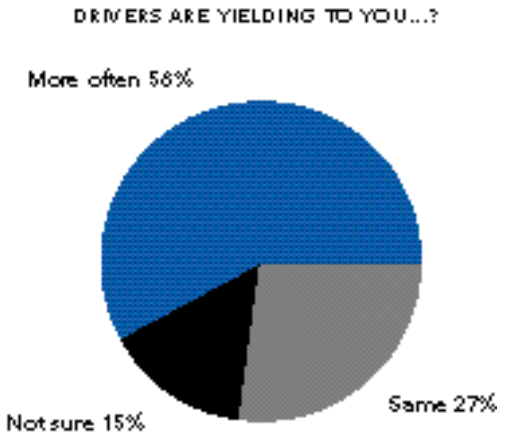
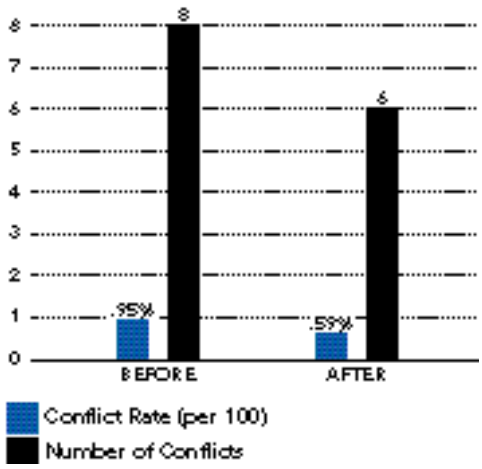


Figure 9. *Conflicts*



Conflicts:

There were no DMV reported bicycle-motor vehicle crashes during the five year period from 1992 to 1997 at any of the sites. DMV crash data subsequent to the installation of blue is not yet available.

On the videotapes, researchers noted conflicts — defined as interactions forcing at least one of the parties to make a sudden change in speed or direction. Conflicts were infrequent, with eight in the before period and six in the after period. Conflict rates were similarly small, decreasing from .95 per 100 to .59 per 100 *(Figure 9)*. Analysts judged all of the conflicts in the before period to be minor in nature, with one serious conflict in the after period. Five of the before conflicts occurred with bicyclists traveling eastbound on the Hawthorne Bridge. Four of the six after conflicts occurred at Weidler/Victoria, where motorists merge onto the street from a freeway off-ramp. Four of the eight before conflicts occurred in the uncolored bicycle lane, while five of the six after conflicts were in the blue pavement area.

Unfortunately, several cyclists have informed staff of recent crashes occurring at Broadway/Williams. Transportation engineers are investigating the potential problems and solutions.

CONCLUSIONS AND RECOMMENDATIONS

The blue bike lane study has had promising results. To recap, researchers found the following results:

1 *Did motorists appear to yield more frequently to cyclists after the blue pavement application?*

YES: a statistically significant increase in motorists yielding to cyclists.

2 *Did motorists appear to look for cyclists before crossing the bike lane more frequently than before?*

YES: a statistically significant increase in motorists slowing or stopping when approaching conflict areas.

3 *Did motorists modify their behavior in any significant ways?*

YES: in addition to the increased slowing, a statistically significant decrease in turn signal use.

4 *Did cyclists tend to look more frequently for motorists before proceeding through the painted area?*

NO: a statistically significant decrease in head turning and hand signaling.

5 *Did cyclists modify their behavior in any significant ways?*

YES: in addition to the decreased head turning and hand signaling, a statistically significant increased use of the recommended path and decreased slowing when entering the conflict areas.

6 *Did the number of conflicts and reported crashes change?*

YES, AND UNKNOWN: The number of conflicts decreased, although the numbers are small. Data on reported crashes subsequent to the blue markings is not yet available.

In addition, the overwhelming majority of cyclists and close to a majority of motorists felt the blue areas enhanced safety.

Most behavior changes were positive. In particular, significantly more motorists yielded to cyclists and slowed or stopped before entering the blue areas. The increased cyclist use of the recommended path is also encouraging, since it should be the safest route through a conflict area. However, coupled with and perhaps resulting from the perception of increased safety appears to be declining cyclist caution (fewer cyclists turning their heads and signaling). (The decrease in conflicts is based on such a small number that we cannot conclusively state a positive result.) While improving cyclist confidence is important to the City's goal of increasing the use of bicycles for transportation, it is also important to avoid creating a false sense of security.

These results are similar to those found by the City of Montreal in 1996. They found a small but statistically relevant decrease in conflicts, an increase in motorists yielding, and decreases in bicyclists slowing and turning their heads.

The accompanying sign appears to be a crucial part of conflict area design, given that substantially more motorists who noticed the sign correctly identified the meaning of the blue area. Some have suggested that the sign is in fact more important than the blue pavement, noting that the sign clarifies the regulatory message by clearing assigning priority right-of-way. This should be an area for more research, including additional surveys and analysis.

The City of Portland recommends that blue continue to be used to bring visibility to bicycle-motor vehicle conflict areas and that the blue areas be further monitored with additional videotaping and data analysis.

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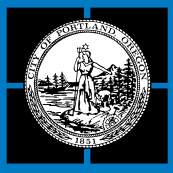

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