Bicycle-Bus Conflict Area Study

SEPTA
City of Philadelphia

DELAWARE VALLEY
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REGIONAL
PLANNING COMMISSION

2009

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Executive Summary

Increasing bicycle use and bus ridership are both desirable policy goals from a sustainability standpoint, and a great deal of planning work in Philadelphia aims to accomplish both. On city streets, however, these two modes of transport are in several ways natural enemies: while occupying opposite ends of the size and weight spectrum, they often operate in the same space (the right side of the street) and at roughly the same speeds over significant stretches of road.

This report includes a review of PennDOT crash data and an analysis of videologs along Walnut Street in University City, with an aim of documenting and highlighting the precise nature of this conflict in Philadelphia. After reviewing how other locales have dealt with these conflicts, this report proposes two specific strategies to address the problems that were observed:

Street design change: install left-side bike lanes on one-way streets where significant transit conflicts exist. Left-side bike lanes could be implemented quickly (and without an FHWA experiment application) where bike lanes do not currently exist, or where the entire multi-block length of a right-side bike lane is replaced. This should be the most typical circumstance, since instances where a left-side lane becomes a right-side lane (or vice versa) should preferably be avoided. However, when circumstances dictate that a left-side lane must connect with a right-side lane, a bike box at the intersection to permit a safe transition for bicyclists (see Figure 13) should be installed, which would require an FHWA experiment application.

Policy change: pursue a citywide "yield/courtesy pyramid" to clarify roles and responsibilities (whether legislated or advisory). The complex multimodal conflicts around transit stops are one acute example of a broader citywide challenge: as city streets are increasingly used for more than vehicular throughput, "border skirmishes" increasingly occur between the territories assigned (or left to) the various modes. With this in mind – along with an increasing policy emphasis on sustainability – the city should seek to clarify a simple set of "deference ground rules" or "rules of the road" (and of the sidewalk). A suggested yield/courtesy pyramid is illustrated in Figure 16 (page 28).

CHAPTER 1

Introduction and Background

Purpose

Increasing bicycle use and bus ridership are both desirable policy goals from a sustainability standpoint, and a great deal of planning work in Philadelphia aims to accomplish both. On city streets, however, these two modes of transport are in several ways natural enemies: while occupying opposite ends of the size and weight spectrum, they often operate in the same space (the right side of the street) and at roughly the same speeds over significant stretches of road.

This can lead to a variety of conflicts: between buses and bicycles, between bicycles and bus passengers, and between bicycles and general traffic (where one of the prior two conflicts sends a bicyclist leftward into traffic flow). With the broad aim of enhancing safety and comfort for both of these desirable modes of travel, this report explores these unique conflicts, focusing on one of the areas where they are most acute: at bus stops, where a curbing bus crosses a bicyclist's path or a non-curbing bus places boarding/alighting passengers in conflict with bicyclists. Most specifically, the focus here is where bike lanes abut bus stops.

This report reviews how other locales have dealt with these conflicts, and proposes specific solutions to the problems observed.

Background and Project Approach

Since spring 2006, DVRPC staff have been working with staff from SEPTA, the Philadelphia Streets Department, the Bicycle Coalition of Greater Philadelphia, the University City District, and others in order to explore improvements that might improve safety at locations where curbside bus stops conflict with bicycle lanes in the City of Philadelphia, requiring buses to cross bicycle lanes in order to curb. Where conflicts occur, bicyclists may engage in improper passing while bus operators may fail to yield to bicyclists, resulting in collisions or near-collisions.

This cooperative process resulted in a preliminary pavement marking design that was proposed to be tested in University City. However, as this would be an experimental marking, using a symbol that does not appear in the Manual of Uniform Traffic Control Devices (MUTCD), an application would need to be made to FHWA for approval before an experimental pavement marking can be tested. An FHWA experiment application requires a comprehensive analysis to document the nature and extent of the problem, explain the proposed solution(s), and propose performance measures to evaluate the proposed solutions following the test. The approach for this project was to conduct these broad tasks, but without a predetermined outcome.

DVRPC received a research grant for this effort from PennDOT, which presented an opportunity to thoroughly explore this issue from a variety of perspectives. The analysis would be appropriate for an FHWA experiment application, but if best practices and the data suggested alternate strategies that would not include non-standard pavement markings or signage, and consequently not require an FHWA experiment application, those alternate strategies would be pursued. This project explores this conflict throughout Philadelphia, with a study area focus on Walnut Street in University City. This is a corridor with bicycle lanes, clearly marked curbside bus zones, and relatively high levels of bicycle and bus traffic.

Key Tasks:

- **Collect data to identify and document the nature of the problem:**
    - **PennDOT crash data:** Explore the volume and geographic distribution of all crashes involving bicycles and both bicycles & buses over the last five (5) years in Philadelphia.
    - **Study area videologging:** Record video at several bus stop locations adjacent to bike lanes in order to explore and summarize conflicts that do not result in crashes.
- **Explore national and international "best practices" for similar conflicts:**
    - **Summarize current practice and policy in Philadelphia**
    - **Literature review:** Survey electronic and print sources to assess the ways in which such conflicts are addressed internationally and in the United States, in order to establish whether any appropriate strategies for Philadelphia emerge.
- **Based on the results of the tasks above, recommend local solutions:** These may be location-specific strategies or suggested citywide policies.
- **Propose data plan for "post test" review of the experiment(s):** if one or more of the strategies resulting from the analysis would involve an FHWA experiment test, propose performance measures that would assist in evaluating the experiment's success.

CHAPTER 2

Defining the Problem: Data Analysis

PennDOT Crash Data

DVRPC's PennDOT crash database includes the records of all reported crashes beginning in 2003. Reported crashes are those involving significant damage and/or injuries. Two sets of data were extracted and summarized from the crash database:

- **The volume and geographic distribution of all crashes involving bicycles over the last five (5) years in Philadelphia.**
  For the purpose of this project a 2003-2007 dataset was used.

- **The volume and geographic distribution of all crashes involving both bicycles and buses over the last five (5) years in Philadelphia.**
  Combined with the above, this will indicate the proportion of all serious (reported) bicycle crashes in which buses were involved.

It bears noting that in our experience, non-motorized crash data is often mislabeled in the database, introducing some degree of uncertainty.

According to PennDOT records[1] over the five year period from 2003-2007, in Philadelphia there were:

- **1,757** total bus-involved crashes (resulting in 25 fatalities, 46 major injuries, and at least 3,677 other injuries)

- **2,515** total bike-involved crashes (resulting in 20 fatalities, 75 major injuries, and at least 2,515 other injuries)

- **46** total reported crashes involving both bikes and buses (resulting in 3 fatalities, 2 major injuries, and at least 52 other injuries)

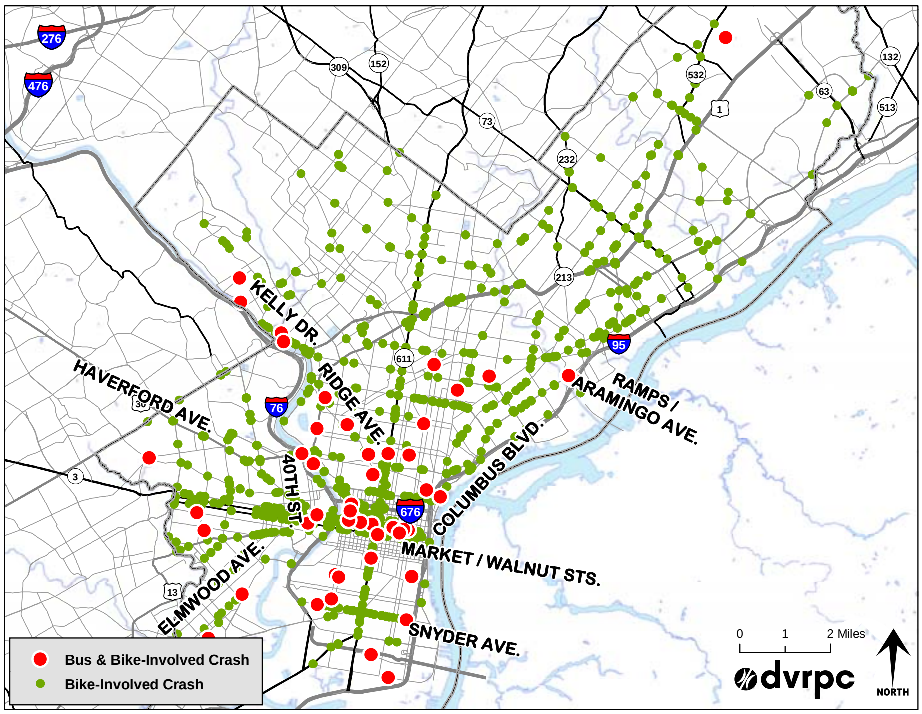
This means that just 2.6 percent of all recorded bus crashes involved bicycles, and 1.8 percent of all recorded bicycle crashes involved buses.

[1] The crash data used in this report was provided by the Pennsylvania Department of Transportation for the Delaware Valley Regional Planning Commission's traffic safety related transportation planning and programming purposes only. The raw data remains the property of the Pennsylvania Department of Transportation, and its release to third parties is expressly prohibited without the written consent of the Department.

Crash Distribution

Figure 1 below depicts the distribution of reported bicycle crashes throughout the city of Philadelphia between 2003 and 2007. The small green dots represent all bike crashes recorded in this time period, while the larger red ones represent the 46 documented crashes involving both bicycles and buses. It bears noting that the dataset does not differentiate between transit buses and school buses (or other types of buses).

Figure 1: Geographic Distribution of Bicycle Crashes 2003-2007



Source: DVRPC 2009

As evidenced in Figure 1, the largest concentration of bicycle crashes (as well as bike/bus crashes) took place in Center City, Philadelphia. This is to be expected, as the largest concentration of bike and bus traffic occurs here. Only one bike/bus crash took place in this project's most specific study area, Walnut Street in University City. Other streets that had a large number of bike crashes include major east-west streets such as Spring Garden, Girard, Lehigh, and Allegheny avenues and arterials such as Frankford and Aramingo avenues. Broad Street also had a large number of bicycle crashes but relatively few bike/bus incidents. Ridge Avenue, which extends into northwest Philadelphia, also had a significant number of crashes. Of the 46 bike/bus crashes that took place between 2003 and 2007, 10 (or roughly 22 percent) of the crashes took place on streets with bicycle lanes.

Collision Types

Of particular importance to this study are the crash types of the incidents involving buses and bikes. Table 1 below depicts different crash types and the corresponding number of bike/bus incidents in Philadelphia between 2003 and 2007.

Table 1: Bike/Bus Collision Types, 2003-2007

Collision Type	Crashes	Percentage
Sideswipe (same direction)	21	45.7%
Angle	15	32.6%
Hit pedestrian	5	10.9%
Rear-end	2	4.3%
Head-on	2	4.3%
Sideswipe (opposite direction)	1	2.2%
Total	**46**	**100.0%**

Source: PennDOT 2008

As depicted in Table 1, roughly 46 percent of all bike/bus crashes were identified as “sideswipe (same direction)”, 33 percent of the bike/bus crashes were defined as “angle” crashes, and 11 percent of the crashes as “hit pedestrians.” Only 9 percent of the crashes were defined as either “rear-end” or “head-on” crash types. One incident (or 2 percent) was defined as “sideswipe (opposite direction).”

As noted above, only 22 percent of all bike/bus crashes took place on streets with bicycle lanes. This would seem to indicate that the presence of a bicycle lane is not a primary contributor in bike/bus incidents. However, the most common crash type (sideswipe same direction) is consistent with the types of conflicts that would occur in bike lanes, and which are the focus of this study. Further, a certain portion of the next-most-frequent crash type (angle) may also involve same-direction crashes from similar conflicts. The next section takes a closer look at the conflicts that exist between buses and bikes on streets with bicycle lanes.

Walnut Street Video Logs

In order to document the degree of conflict between SEPTA buses and bicycles in bike lanes, it was important to consider not just number of actual collisions, but also the number of "near misses," or instances of conflict where either bicyclists or buses need to take action to avoid collision.

To this end, DVRPC conducted AM peak and midday videologs at three study area intersections along Walnut Street: 33rd Street, 34th Street, and 38th Street. At each intersection, DVRPC staff recorded video of all westbound approaching buses during one peak (7AM – 10AM) and midday (11AM – 2PM) period. These recordings were conducted mid-week (Tues, Wed, Thurs) in March of 2009. Each recording was reviewed and tabulated for the number of buses, bicycles, occasions where both arrive in the same timeframe, and the number of various types of conflicts or "near misses."

Table 2 (below) depicts the total number of bicycles and buses that passed through these locations during these hours. Bike Count refers to the number of bikes in or around the bicycle lane. Bus Count refers only to buses that stopped at that given intersection. 'Incidents' refer to the number of instances where the presence of a bus in the bicycle lane hindered the bicycle's ability to move through the intersection cleanly. It is important to note that these are not actual crashes between the bus and bicycle, but instances of conflict. Table 2 lists the camera locations and corresponding number of bicycles, buses, and incidents.

Table 2: Walnut Street videolog incident breakdown

Street	Time Period	Bike Count (in lane)	Bus Count (stopping at intersection)	Incidents
33rd	AM	390	34	18
33rd	Midday	157	20	13
34th	AM	172	21	7
34th	Midday	118	17	4
38th	AM	45	22	2
38th	Midday	84	17	3
Total		**966**	**131**	**47**

Source: DVRPC 2009

As evidenced in Table 2, the three locations had a total of almost 1,000 bicyclists and approximately 130 buses stopped during the selected time period (roughly 6 hours per intersection). The intersection of 33rd and Walnut saw the highest numbers, with almost 550 bicycles and 55 buses stopping. This accounts for a sizable volume of right-turning bicyclists moving north on 33rd Street towards Drexel University. Almost 300 bicycles and 40 buses were recorded at 34th Street. 38th Street saw the lightest activity, with roughly 130 bicycles and 40 buses being counted during the filming.

There were 47 total incidents noted at the three intersections. Almost every occasion when a bicycle and bus were at an intersection at the same time resulted in an incident or conflict. It is important to note that not all of the incidents necessarily reflected unsafe passings.

Generally speaking, there were two types of incidents, both caused by the bus' inability (or failure) to curb at the bus stop and consequently coming to rest in the bike lane.

Merging into the traffic lane:

These were instances where the bicycle merged into the traffic lane (sometimes suddenly) to the left of a bus. This is an accepted action on the part of the bicyclist, but sometimes the cyclist is forced to maneuver into traffic quickly. Twelve of the 47 incidents were the result of this conflict.

Cutting between the bus and the curb:

The remaining incidents (35) occurred when the bicycle moved to the right of the bus and attempted to maneuver through disembarking passengers between the bus and the curb. The greatest danger seemed to exist between the cyclist and passengers crossing the parking lane/bus zone.

Figure 2: Videolog incident type illustrations

Source: DVRPC 2009

Figure 2 depicts the two types of incidents described above. The first photograph depicts a bus stopped at the intersection, a passenger disembarking, and a cyclist leaving the bicycle lane and merging into the traffic lane. Note that the bus is not curbed despite a technical obligation to do so, and that even if it wanted to curb, the presence of vehicles in the bus zone make it impossible to do so.

The second photograph depicts a bus stopped in the bicycle lane, a passenger disembarking, and two bicycles passing between the bus and the curb. In this picture, there is sufficient room for the bus to curb, but the operator chose not to do so, likely to avoid delays in re-entering traffic.

As noted previously, nearly every occasion where a bicycle and stopped bus were at the same intersection resulted in an incident or near-miss worth documenting. While each of these occasions reflected a clear conflict, it bears noting there was no incident among the 47 over 18 hours of videologging that we would qualitatively characterize as acutely dangerous. They were, however, compellingly illustrative of the complex conflicts between buses, bicyclists, and bus passengers (pedestrians).

C H A P T E R 3

Bike Lanes at Bus Stops: Survey of Best Practice Solutions

With a focus on bus/bike/pedestrian conflicts at bus stops, this chapter first reviews the current state of the practice in Philadelphia, and explores how other cities have attempted to address these unique conflicts.

Current Practice in Philadelphia

Pennsylvania Vehicle Code

The Pennsylvania Vehicle Code specifies that cars must yield to bicyclists when crossing bike lanes, but the issue of buses in bike lanes is not specifically addressed. Accordingly, general "rules of the road" apply with regard to yielding: neither vehicle has universal priority, and the vehicle being overtaken has the right of way. This means that buses should not accelerate around a bicycle only to "cut them off" and curb in front of them; similarly, bicyclists should not overtake a bus as it approaches an intersection and expect the bus to yield.

While this chapter focuses on conflicts in and around bike lanes, this general rule applies to roadways without bike lanes as well. The vehicle code also instructs bicycles operating at "slower than prevailing speeds" to use the right side of the road (i.e., the general space that would be typically occupied by a bike lane).

Bike Lanes and Transit Stops in Philadelphia

Given the large number of bus, trolley, and trackless trolley routes across Philadelphia, as well as the large and increasing number of bike lanes, there are many locations throughout the city where right-side bike lanes are adjacent to curbside bus zones. SEPTA policy is for all buses to curb when stopping for passengers, to keep passengers out of the roadway and make boarding and alighting safer and easier. This also keeps buses out of the travel lanes while stopped, which helps prevent queuing of general traffic behind stopped buses. In many cases, even a complete curbing will still result in the bike lane being partially blocked. Further, if the curbside bus zone is blocked by a parked vehicle or the bus driver is otherwise unable to (or simply does not) fully curb, this often results in a diagonal bus completely blocking the bicycle lane. In the case of complete and proper curbing, the bus conflicts with bicyclists in the bike lane while crossing the lane to curb, and while exiting the bus zone to re-enter traffic. In the case of in-line stopping (where no attempt to curb is made), the bus conflicts with moving bicyclists (who typically pass on either the right or left, as indicated in Chapter 2), and bicyclists are put into conflict with boarding or alighting bus passengers.

The typical street design for bike lanes adjacent to bus zones is illustrated in the figure below.

Figure 3: Lane striping where bike lanes abut bus zones in Philadelphia

34th and Walnut

Turning traffic makes a left; bike lane striping is unbroken where bus crosses

33rd and Walnut

Bike lane striping broken for right-turning traffic

Source: DVRPC 2009

Notably, the condition where a transit vehicle running adjacent to a bike lane does not curb at stops (placing bicyclists in conflict with boarding passengers) – theoretically atypical for buses given the curbing policy – is actually a necessary condition elsewhere in the city: at trolley stops adjacent to bike lanes where there are no curb extensions or passenger islands to permit curbed boardings. This is the case, for example, with the Route 34 trolley along east and westbound Baltimore Avenue in University City and West Philadelphia, shown in Figure 4 below.

Figure 4: Route 34 trolley with bicyclist in bike lane

Source: DVRPC 2009

Figure 4 depicts the Route 34 Trolley in University City. While there are no passengers alighting, the figure illustrates the built-in conflict between the stopped trolley and bicyclists: boarding/alighting passengers will always cross the bike lane.

Two other exceptions to the standard Philadelphia condition illustrated in Figure 5 are 11th Street between Spring Garden Street and Girard Avenue and 12th Street between Cecil B. Moore and Girard avenues in North Philadelphia, where the bike lanes are located on the left side of the street. This is a unique circumstance in Philadelphia; bicyclists are placed in conflict with left-turning traffic rather than right-turning traffic, but the conflict with transit vehicles (in this case the Route 23 bus) and boarding passengers is completely removed.

Figure 5: Left-side bicycle lanes on 11th Street

Source: DVRPC 2009

Figure 5 above depicts the left-side bicycle lanes on 11th Street in North Philadelphia. Left-side lanes along 11th and 12th streets help to mitigate the hazards that street rails present for bicyclists.

National and International Solutions

There have been a variety of strategies implemented worldwide to address either the specific bike/bus/passenger conflict at issue here or related conflicts where similar solutions may be applicable. Some of these would require an FHWA experiment application to be tested in Philadelphia, and others would not.

Strategy 1: Colored bike lanes in conflict hotspots, including transit stop areas

A number of cities have used colored lane treatments in bike lanes, particularly where vehicles cross and conflicts are most likely. In Philadelphia, blue pavement has been somewhat widely used where bike lanes are shifted leftward around right-turn lanes (Walnut Street Bridge, 6th Street near Market Street, others), and the city has expressed an interest in continuing and perhaps expanding this practice, but with a shift to green bike lanes due to an emerging consensus that blue treatments should be reserved for ADA-related facilities. It bears noting that any colored lane treatment (including blue) would require an FHWA experiment application.

Cities in the US and around the world have used a variety of different colors for this purpose (Figure 6 below illustrates a few examples):

- Red: Germany, Denmark, Netherlands, United Kingdom
- Blue: Portland, Philadelphia
- Yellow: Switzerland
- Green: France, New York City

Figure 6: Examples of various colored bike lanes

Portland, OR **Victoria, BC, Canada** **United Kingdom**

Source: Portland Office of Transportation 1999, VICRoads 2005, Welsh Assembly Government Department of Transport 2008

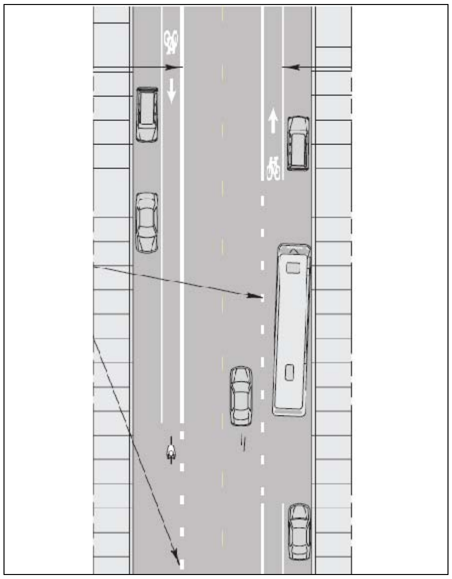
Portland, Oregon began a large-scale experiment with blue lane treatments in 1999, and selected blue over green and red because of the conflicting connotations of those colors (go/stop). As mentioned previously, green is an emerging United States standard because of the linkage between blue and ADA facilities.

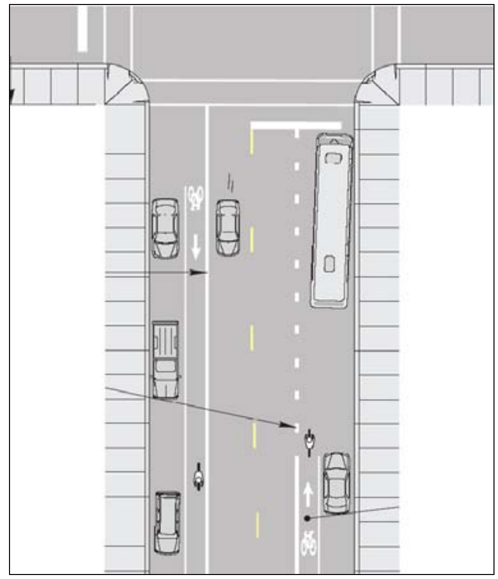
Strategy 2: Discontinue bike lanes at transit stops

Bike lanes are sometimes discontinued at bus stops, and in a variety of ways. Where the lane is discontinued, bicyclists are in some cases expected to stop while passengers board/alight, and in other cases to merge left into or toward general traffic. Figure 7 illustrates several examples from other cities/countries (note that these may not be the only practices in place in these locations – like Philadelphia, many places employ a variety of treatments).

Figure 7: Examples of discontinued bike lanes at bus stops

Chicago: bike lanes are broken, and bikes share space with buses at bus stops (left: midblock stop; right: nearside intersection stop).





United Kingdom: bus zone (red) interrupts bike lane (green); bicyclists are directed either to stop or to move into general traffic.

Denmark: Stop bar in bike lane; bicyclists expected to stop for boarding/alighting passengers

Source: AustRoads 2005, Chicago Department of Transportation 2002

Strategy 3: Physical re-routing of bike lane around stop location

While obviously much more capital-intensive, there are a number of examples where the bike lane is physically re-routed outside the main cartway, around the bus stop location. Figure 8 illustrates several of these.

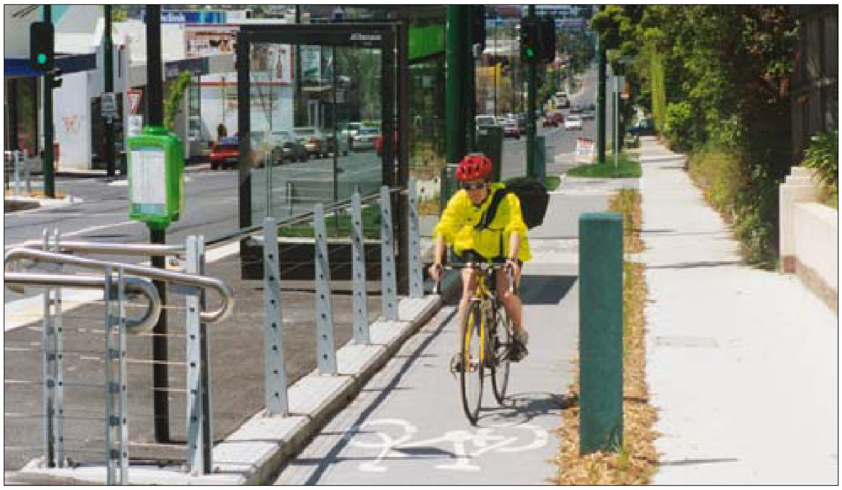
Figure 8: Examples of re-routing bicycle lanes around bus stops

United Kingdom: bike lane is routed outside traffic lane at bus/trolley zone, but still inside bus/trolley shelter location.

Australia: bike lane is routed onto sidewalk, outside bus stop/platform

Figure 8: Examples of re-routing bicycle lanes around bus stops (cont'd)

Denmark: bike lane routed around bus zone/shelter, adjacent to sidewalk



Source: AustRoads 2005

In addition to being relatively capital-intensive, this strategy would have limited applicability in Philadelphia given the city's typically narrow street rights-of-way. However, it may be appropriate in select locations where rights-of-way are wider and heavy bicycle traffic might justify the expense (for example, the proposed East Coast Greenway alignment along Spring Garden Street).

Strategy 4: Left-side bicycle lanes

Another method for reducing conflicts between bicycles and buses and between bicycles and parked cars is restriping streets to install bike lanes on the left side of the road, rather than the right side. The Guide for the Development of Bicycle Facilities (1999), published by American Association of State Highway and Transportation Officials (AASTHO), states:

> "Bike lanes on the left side are unfamiliar and unexpected for most motorists. This should only be considered when a bike lane on the left will substantially decrease the number of conflicts, such as those caused by heavy bus traffic or unusually heavy turning movements to the right, or if there are a significant number of left-turning bicyclists. Thus, left-side bicycle lanes should only be considered after careful evaluation."

The Federal Highway Administration (FHWA) similarly suggests that bike lanes on the left side of a roadway be considered only if that configuration would reduce conflicts. FHWA recommendations also allow for left-side bicycle lanes on one-way streets where there are frequent bus or trolley stops, unusually high numbers of right-turning motor vehicles, or if there is a significant number of left-turning bicyclists.

Even though the established guidelines approach left-side lanes with some trepidation, they have been installed on 11th and 12th Streets in Philadelphia (as mentioned previously) and more widely implemented in several other cities. This section summarizes the experience of these cities with some discussion of the criteria that they used to determine where left-side lanes would be appropriate.

Madison, Wisconsin

Madison, Wisconsin adopted a left-side bicycle lane several decades ago on a one-mile stretch of Johnson Street in downtown. In Madison, on a one-way street with more than one lane of traffic, bicyclists are permitted on either side of the street as long as they are moving in the same direction as traffic. While the designated striping is on the left side of the road, cyclists are also allowed on the right.

Roughly half of the length of the portion of Johnson Street with left-side bicycle lanes allows for parking on the right side of the street except during the PM peak (4:00PM to 5:30PM), during which time the parking lane becomes a third travel lane. Since a right-side bicycle lane in these blocks is not compatible with the need for this third travel lane, it was deemed more appropriate to move the bicycle lane to the left side of the road.

Minneapolis, Minnesota

Minneapolis began shifting some of its downtown bicycle lanes to the left side of the street in the early 2000s. These initial lanes were located on one-way arterial streets with heavy bus traffic, and this practice has since become the standard for bicycle lanes in downtown Minneapolis. Figure 9 depicts Park Avenue with a left-side bicycle lane.

Figure 9: Left-side bicycle lane in Minneapolis

Source: www.bicyclinginfo.org 2009

In changing its standards in this way, the city cited a number of reasons for choosing left-side bicycle lanes in the downtown. These include better visibility for drivers and cyclists, fewer rush hour parking restrictions, fewer truck conflicts, fewer “dooring” accidents (conflicts with parked cars, where bicyclists in bike lanes are struck by opening car doors), and fewer turn conflicts since there were generally fewer left-turn movements than right-turn movements.

While no study has yet examined crash data before and after the widespread installation of left-side bicycle lanes, engineers in Minneapolis are satisfied that they increase the safety of bicyclists and will continue to use them. Intersection treatments are currently being considered to better connect left-side bicycle lanes on one-way streets with the more traditional right-side lanes on two-way streets.

New York City

Left-side bike lanes are used extensively in New York, primarily in Manhattan where most of the streets are one-way. The criteria the city used to determine whether to install left-side bicycle lanes were:

- **Frequency of bus service:** Streets with higher frequencies of bus service are more suitable, since the potential benefit in terms of avoiding bike/bus conflicts is most acute.
- **Parking turnover:** If parking turnover is high (commercial areas, metered parking), the risk of dooring increases, and the benefits of moving bike lanes to the left increase.

- **Continuity of the one-way street:** Left-side bicycle lanes were recommended on streets that were continuously one-way in order to avoid potential confusion for drivers and bicyclists.

Figure 10 depicts 9th Avenue in Manhattan, a street that has recently been resurfaced with bicycle lanes on the left side of the road, as well as protective barriers.

Figure 10: Left-side bicycle lane on 9th Avenue in New York City

Source: www.nycbikemaps.com 2009

No examination has been done reviewing the impact of the left-side bicycle lanes, but they are well-established as a standard practice in New York under the above circumstances.

Seattle, Washington

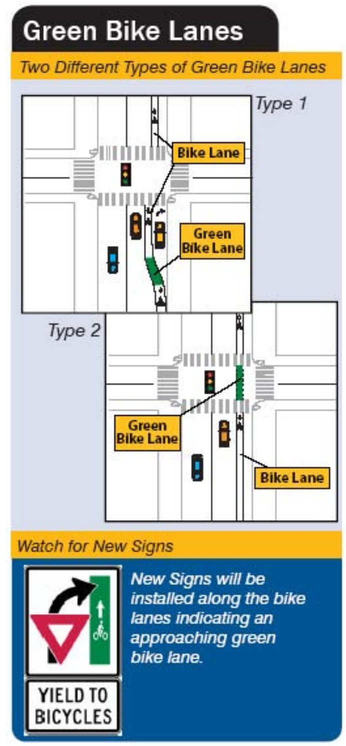
Seattle has two one-way streets with left-side bike lanes. In both cases, the curb space on the right side is completely taken up by buses during rush hours. Consequently, bicyclists were unable to use the curb lane, and the next lane was also often filled with buses which were passing stopped buses.

In Seattle, putting the bike lane on the left side was always a second choice (to the traditional right-side lane) and has received mixed results from the bicycling community. However, given a choice, the city decided that a left-side bike lane is better than no bike lane at all. To enhance the bike lane, the city installed green bike lanes across intersections to make sure turning motorists are aware of bicyclists going straight through (see

Figure 11, which depicts examples of treatments for right-side lanes in Seattle).

Potential left-side lane issues

Figure 11: Seattle Green Lane Brochure



Source: Seattle DOT 2007

While some cities have adopted left-side bicycle lanes as a standard practice on one-way streets, moving bicycle lanes to the left side introduces several potential conflicts. The first potential issue arises due to the unfamiliarity that drivers may have with the left-side lanes. The City of Seattle painted the lanes through intersections, increasing the visibility of cyclists, and also printed brochures that were attached to door handles throughout the city. Figure 11 (right) displays the brochure. While the lanes depicted are on the right side, the rules are applicable to the left-side bicycle lanes as well. The painted lanes were accompanied by signage explaining the proper stance motorists should take in dealing with the bicycle lanes.

Another potential issue occurs when lanes shift from the right to left side of the road or vice versa. It may be necessary to provide accomodations for bicyclists to make this transition. Bicycle boxes, which are traditionally used to protect bicyclists from right-turning vehicles by expanding the bicycle zone into the crosswalk, can be adapted to allow bicycles to cross in front of traffic in order to switch from one side to another. Figure 12 (below) shows two different bike box treatments.

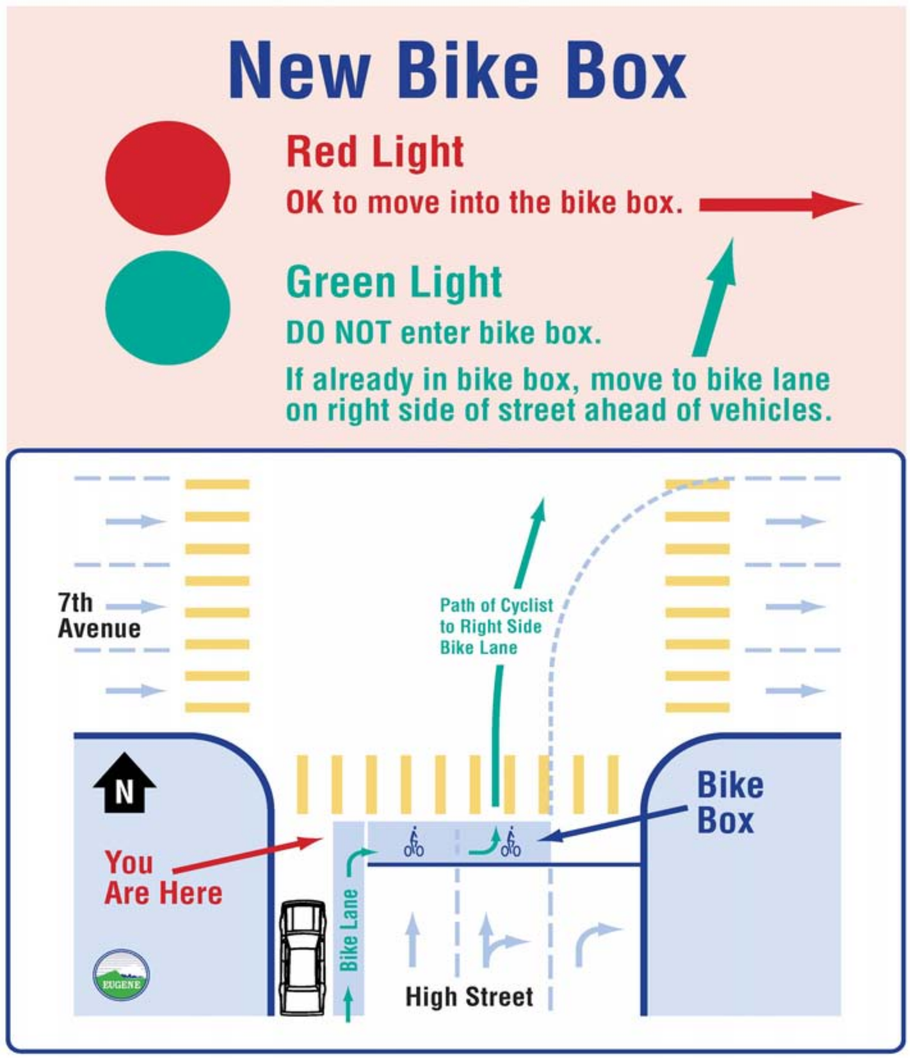
Figure 12: Examples of bike boxes

Source: www.bikeportland.org 2009

Source: www.streetsblog.org 2009

The two images that comprise Figure 12 represent two different uses of the bike box. The image on the left, from Portland, Oregon depicts the traditional bike box, meant to protect cyclists from right-turning cars by allowing them to stop in front of the cars at lights. The image on the right, from New York City, depicts a bike box as it can be used to assist cyclists in transferring from a bicycle lane on one side of the street to another. Figure 13 (below) depicts a diagram of a bike box in Eugene, Oregon that is used to transition from a left side to a right side lane. It depicts the movements that bicyclists are to make at intersections with the bike box.

Figure 13: Bike box as a left-side/right-side transition zone



Source: City of Eugene, Oregon 2009

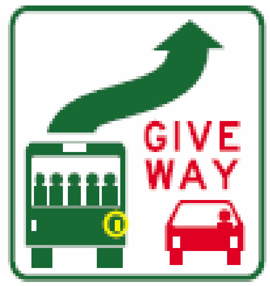
Strategy 5: Unique pavement markings and/or signage

While there are no apparent examples of signage or pavement markings to address the specific conflict at issue in this report, there are several examples of related signage that may be instructive as we weigh alternative strategies for Philadelphia.

On-bus markings

One potential method of highlighting this conflict is to put signs on buses that indicate the correct movement for bicycles to make when encountering a curbed or stopped bus. Figure 14 depicts a similar sign, used in Australia, that while geared towards automobiles could be adapted for cyclists.

Figure 14: Rear-of-bus signage (Australia)



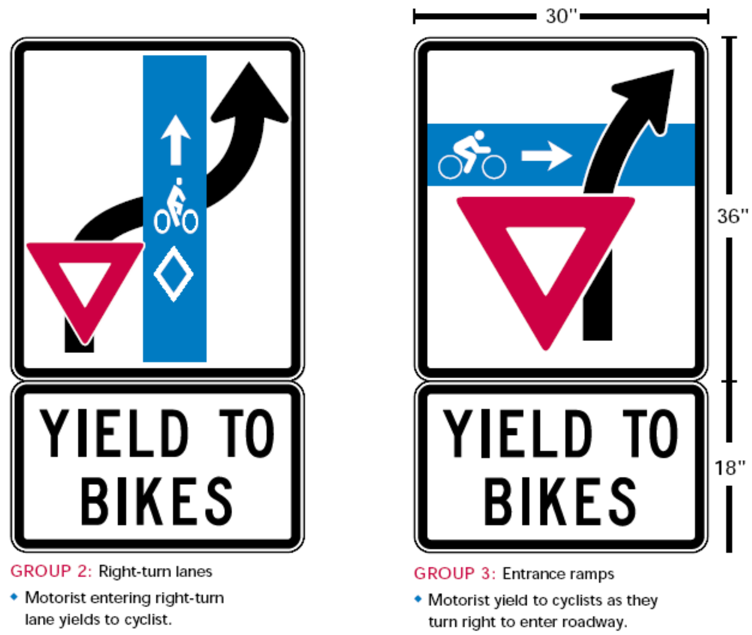
Source: Austroads 2005

The sign shown in Figure 14 is used to tell drivers to yield to buses that are reentering a traffic lane. A similar sign could be used for bicyclists who are in a bicycle lane, approaching a stopped bus that is about to reenter traffic.

Signage accompanying conflict zones

Strategy 1 described using colored bicycle lanes to denote locations of particular conflicts and pointed to several instances throughout the world where this method is used. The City of Portland, Oregon paired these colored lanes with signage specifically designed to remind drivers that they were crossing bicycle lanes and should yield to cyclists. Figure 15 depicts two of the signs the city used.

Figure 15: Accompanying signage for blue bicycle lanes, Portland



Source: Portland Office of Transportation 1999

Figure 15 depicts two of the yield signs used to accompany the painted bicycle lanes. In testing the effectiveness of these lanes, the city found that the signs were 'crucial' in clarifying right-of-way and yield rules. In the case of the present project, the yield rule is more nuanced, however. Further, these signs were designed for motorists – it is unclear whether roadside post signage would be as effective in attracting the attention of bicyclists.

Summary of Strategy Types

- **Strategy 1:** Colored bike lanes in conflict hotspots, including transit stop areas
- **Strategy 2:** Discontinue bike lanes at transit stops
- **Strategy 3:** Physical re-routing of bike lane around stop location
- **Strategy 4:** Left-side bicycle lanes
- **Strategy 5:** Unique pavement markings and/or signage

Conclusions & Recommended Strategies

After considering crash data and the results of our videologs, as well as reviewing treatments employed elsewhere in the United States and around the world, several initial conclusions can be drawn:

- There are complex conflicts and responsibilities among and between bicyclists, buses, bus passengers, and general traffic. To the extent possible, yielding responsibilities should be clarified.
- There are a variety of physical/design modifications that might be pursued to address this series of conflicts, but few seem likely to offer significant improvement.
- The most acute conflict appears to be that between boarding/alighting transit passengers (pedestrians) and bicyclists passing to the right of stopped transit vehicles. This is apparent from both the videologs analyzed for this project and the treatments found for other locations on the specific bike/bus conflict (which universally aim to protect passengers/pedestrians).

With these conclusions in mind, and after consideration by DVRPC planning and engineering staff, two broad recommendations can be made: one policy recommendation, and one design recommendation.

Street design change: left-side bicycle lanes on one-way streets where significant transit conflicts exist

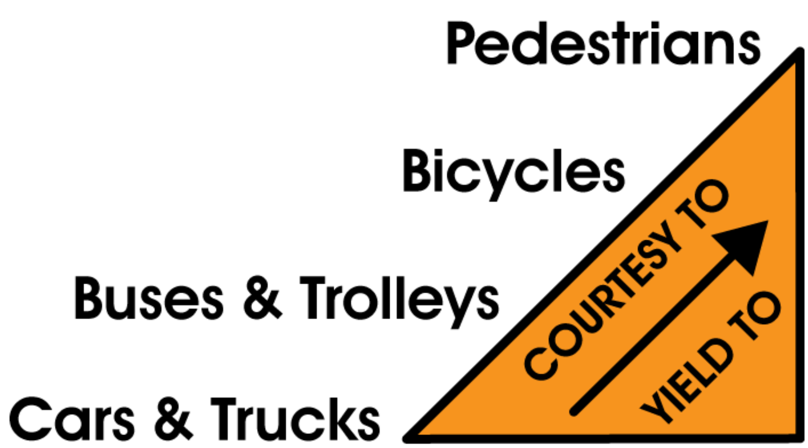
As described in Chapter 3, a variety of design strategies exist which could be used to attempt to address the conflict at issue. These include colored bike lane treatments (either in-line, or with a redirection of the bike lane to the left as occurs with right-turning lanes), as well as experimental pavement markings. Of the strategies reviewed, however, only left-side bike lanes have been applied elsewhere to address the specific conflict between bicyclists and transit vehicles/passengers. Colored lane treatments or experimental pavement markings applied to existing in-line bicycle lanes would highlight an area of conflict, but not necessarily change behavior. Colored lane treatments that would redirect bike lanes to the left would introduce new conflicts with general traffic, particularly on narrow streets. Directing the bike lane back to the right through an intersection could be particularly problematic.

Left-side bike lanes could be implemented quickly (and without an FHWA experiment application) where bike lanes do not currently exist, or where the entire multi-block length of a right-side bike lane is replaced. This should be the most typical circumstance, since instances where a left-side lane becomes a right-side lane (or vice versa) should preferably be avoided. However, when circumstances dictate that a left-side lane must connect with a right-side lane, a bike box at the intersection to permit a safe transition for bicyclists (see Figure 13) should be installed, which would require an FHWA experiment application. Policy discussions and draft materials for the city's new Bicycle/Pedestrian Master Plan suggest that bike boxes will be pursued where one bike lane connects with another as a left turn. If this becomes a widespread policy, a combined experiment application could be made, including provision for bike boxes adjoining left-side bike lanes.

Policy change: pursue a citywide "yield pyramid" to clarify roles and responsibilities

The complex multimodal conflicts around transit stops are one acute example of a broader citywide challenge: as city streets are increasingly used for more than vehicular throughput, "border skirmishes" increasingly occur between the territories assigned (or left to) the various modes. With this in mind – along with an increasing policy emphasis on sustainability – the city should seek to clarify a simple set of "deference ground rules" or "rules of the road" (and of the sidewalk). In the simplest terms, one suggested set of rules is illustrated in Figure 16.

Figure 16: Suggested "yield/courtesy pyramid" concept



Source: DVRPC 2009

If such a policy were implemented, the conflicts at issue in this study would be clarified: buses would yield to bicyclists, and bicyclists would yield to boarding/alighting passengers. With this suggested policy course in mind, one related outgrowth strategy presents itself.

Discourage bicyclists from passing stopped transit vehicles on the right

As this is the most acute conflict observed, absent left-side bike lanes, it could be addressed through a targeted signage and education campaign. Videolog reviews from Walnut Street indicated that in most cases where bikes and buses met at bus stops, they did so when bicyclists reached already-stopped buses. One possibility for conveying a message to these bicyclists is the installation of signage on the right-rear of buses, trackless trolleys, and trolleys (i.e., “bikes should not pass on the right” or “watch for transit passengers on the right”; see Figure 14). A more aggressive alternative along these lines could include a light-up indicator on the rear of buses to alert bicyclists when the bus doors are open (indicating passenger activity rather than a simple stop at the traffic light). A still more aggressive alternative could include a yield sign or stop bar in the bicycle lane, as occurs in several European examples in Chapter 3.

Next Steps

- The Philadelphia City Planning Commission is currently completing a bicycle and pedestrian master plan for portions of the city (including Center City and Northwest, North, and South Philadelphia), which will include a prioritization of strategies and facilities for specific corridors and street classifications. The master plan presents a good opportunity to further explore this report’s recommendations in the context of specific locations. After consulting with city staff, Walnut and Chestnut streets in Center City have been suggested for initial consideration.
- This study originated through DVRPC’s participation in the joint city-SEPTA Transit Improvement Committee. This committee has recently gained new emphasis as the Transit First Committee, and will consider various recommendations from this report for implementation in the coming months as part of its ongoing agenda.

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Abstract

Increasing bicycle use and bus ridership are both desirable policy goals from a sustainability standpoint, but on city streets these two modes of transport are often in conflict. While occupying opposite ends of the size and weight spectrum, they typically operate in the same space and at roughly the same speeds over significant stretches of road. This report includes a review of crash data and an analysis of videologs along Walnut Street in University City, with an aim of documenting and highlighting the precise nature of this conflict in Philadelphia. After reviewing how other places have dealt with these conflicts, staff proposes two specific strategies to address the problems that were observed: the increased use of left-side bike lanes on one-way streets where transit conflicts exist, and the pursuit of a citywide “yield/courtesy pyramid” to clarify roles and responsibilities (with one example being a new “do not pass stopped transit vehicles on the right” rule for bicyclists).

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