Innovative Design Treatments

In addition to standard statewide requirements of the MUTCD and national guidelines from AASHTO, best practices from many other communities throughout the country and world provide guidance for implementing high-quality bikeway facilities. While the Albuquerque Bikeways and Trails Master Plan Design Guidelines use standard documents as a baseline for minimum conditions, these guidelines are intended to find creative solutions to a wide range of challenges and roadway types. These treatments draw upon creative solutions in use in other states as well as European cities. These designs are conceptual at this stage and should undergo additional engineering review before being applied in Albuquerque. Strong design guidelines will allow the City of Albuquerque to improve the quality of the walkway and bicycle network by applying the highest standard of pedestrian and bicycle safety, comfort, and convenience.

Innovative facilities should be implemented in conjunction with a public involvement campaign to build support for the public investment and to increase compliance and understanding of the technique. The public should be involved in any planning process that considers use of innovative treatments and notification can be provided on the City's website or via brochures (see Figure 1).

The following treatments are not present in state or federal guidelines but are being used nationally and internationally to provide bikeways that appeal to a wide variety of users. In addition to the discrete treatments identified here, several techniques commonly used on bicycle boulevards are not standard, but were included in the main section for clarity. These include:

- Bicycle Boulevard Wayfinding Signs Option
- Bicycle Forward Stop Bar
- Bicycle Left Turn Pocket
- Choker Entrances
- Raised Median
- Remote Traffic Microwave Sensor Detection (RTMS)
- Bicycle Boulevard Directional Pavement Markings
- Bicycle Left-Turn Lane
- Chicanes
- Traffic Diverter
- Scramble Signal

Figure 1. The City of Portland, OR published a brochure to educate drivers and cyclists about the use of bike boxes.

Contents

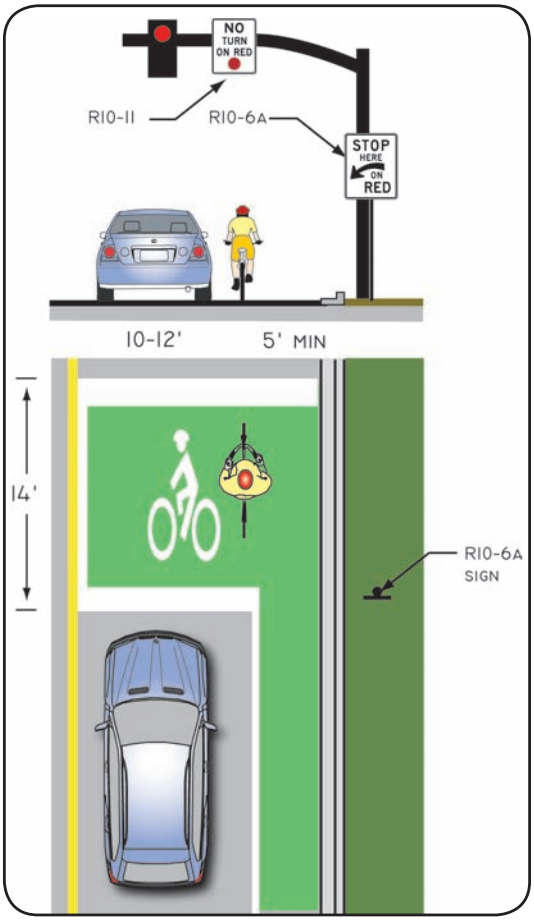
1. Innovative Bike Lane Treatments

1.1. Bike Box

Design Summary

Bike Box Dimensions:

- 14' deep to allow for bicycle positioning.
- Signage:
- Appropriate signage as recommended by the MUTCD applies. Signage should be present to prohibit 'right turn on red' and to indicate where the motorist must stop.



Recommended bike box design.

Discussion

A bike box is generally a right angle extension of a bike lane at the head of a signalized intersection. The bike box allows bicyclists to move to the front of the traffic queue on a red light and proceed first when that signal turns green. Motor vehicles must stop behind the white stop line at the rear of the bike box.

Bike boxes can be combined with dashed lines through the intersection for green light situations to remind right-turning motorists to be aware of bicyclists traveling straight, similar to the colored bike lane treatment described earlier. Bike boxes can be installed with striping only or with colored treatments to increase visibility. Use of coloration substantially increases costs of maintenance over uncolored (striping, bicycle symbol, and text only) treatments.

Bike boxes should be located at signalized intersections only, and right turns on red should be prohibited. Bike boxes should be used locations that have a large volume of cyclists, and are often utilized in central areas where traffic is usually moving slowly. Reducing right turns on red improves safety for cyclists and does not significantly impede motor vehicle travel.

On roadways with one travel lane in each direction, the bike box also facilitates left turning movements for cyclists.

Bike boxes have been installed at several intersections in Portland, OR where right-turning motorists conflict with through bicyclists.

Guidance

Evaluation of Innovative Bike-Box Application in Eugene, Oregon, Author: Hunter, W.W., 2000

1.2. Shared Bicycle/Bus Lane

Design Summary

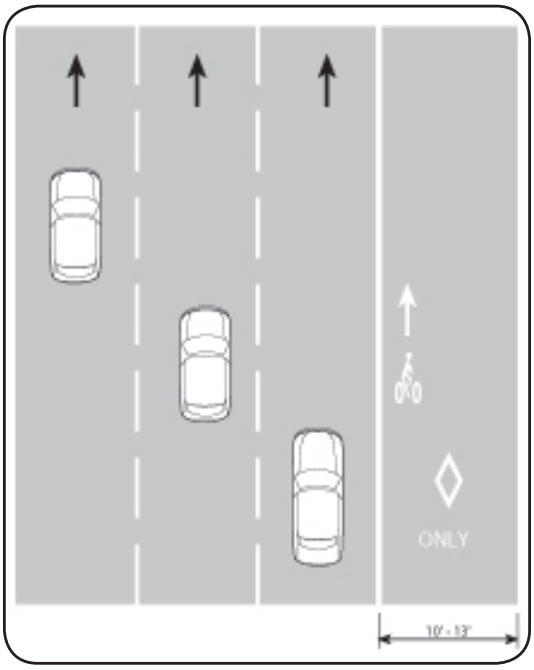
- Provide a standard width bike lane (minimum 4') where possible.
- Paint bicycle symbol or shared lane marking symbol to the left side of the bus lane, to allow bicyclist to pass a bus that has turned in at a stop.

Discussion

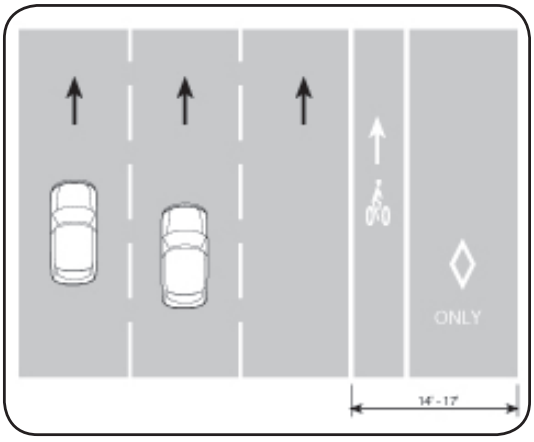
The shared bus/bicycle lane should be used where width is available for a bus lane, but not a bus and bike lane. The dedicated lane attempts to reduce conflicts between bicyclists, buses, and automobiles. Various cities have experimented with different designs and there is currently no evidence of one design being more effective than the others.

Shared bike/bus lanes can be appropriate in the following applications:

- On auto-congested streets, moderate or long bus headways.
- Moderate bus headways during peak hour.
- No reasonable alternative route.



Minimum design: shared bicycle/bus lane.



Preferred design: separated bike lane and bus lane.

1.3. Shared Bike/Right Turn Lane

Design Summary

Width:

- Shared turn lane – min. 12'width.
- Bike lane pocket – min. 4'-5' preferred.

Discussion

This treatment is recommended at intersections lacking sufficient space to accommodate a standard bike lane and right turn lane. The shared bicycle/right turn lane places a standard-width bike lane on the left side of a dedicated right turn lane. A dashed strip delineates the space for bicyclists and motorists within the shared lane. This treatment includes signage advising motorists and bicyclists of proper positing within the lane.

Case studies cited by the Pedestrian and Bicycle Information Center indicate that this treatment works best on streets with lower posted speeds (30 MPH or less) and with lower traffic volumes (10,000 ADT or less).

Advantages:

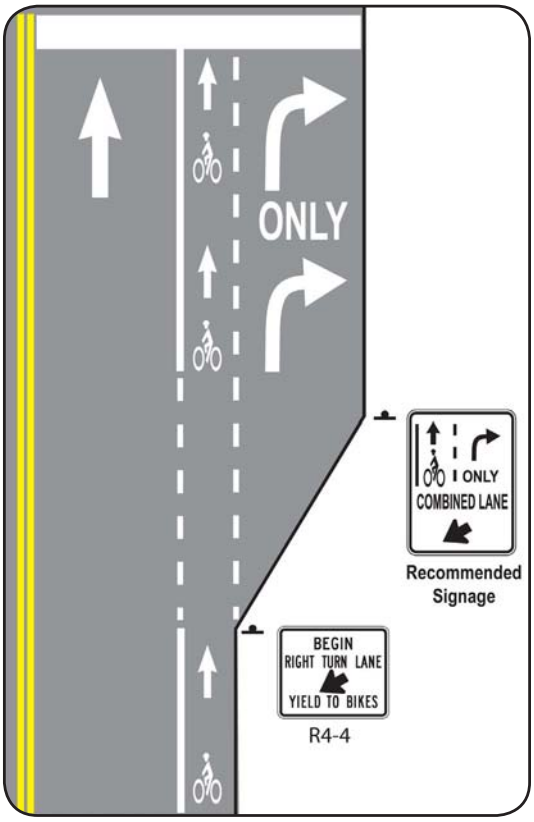
- Aids in correct positioning of cyclists at intersections with a dedicated right turn lane without adequate space for a dedicated bike lane.
- Encourages motorists to yield to bicyclists when using the right turn lane.
- Reduces motor vehicle speed within the right turn lane.

Disadvantages/potential hazards:

- May not be appropriate for high-speed arterials or intersections with long right turn lanes.
- May not be appropriate for intersections with large percentages of right-turning heavy vehicles.

Guidance

This treatment has coverage in the draft 2009 AASHTO *Guide For the Development of Bicycle Facilities*. It has been previously implemented in the Cities of San Francisco, CA and Eugene, OR.



Recommended shared bike/right turn lane design.

Shared bike-right turn lanes require warning signage as well as pavement markings.

1.4. Colored Bike Lanes

Design Summary

- Bike lane pocket – min. 4'-5' preferred.
- Use colored pavement through entire merge area.
- Dashed lines can be used to indicate that automobiles are crossing the bike lane.
- Signage reminds drivers to yield to cyclists in the bike lane.

Discussion

Cyclists are especially vulnerable at locations where the volume of conflicting vehicle traffic is high, and where the vehicle/bicycle conflict area is long. Some cities are using colored bike lanes to guide cyclists through major vehicle/bicycle conflict points. These conflict areas are locations where motorists and cyclists must cross each other's path (e.g., at intersections or merge areas). Colored bike lanes typically extend through the entire bicycle/vehicle conflict zone (e.g., through the entire intersection, or through the transition zone where motorists cross a bike lane to enter a dedicated right turn lane.

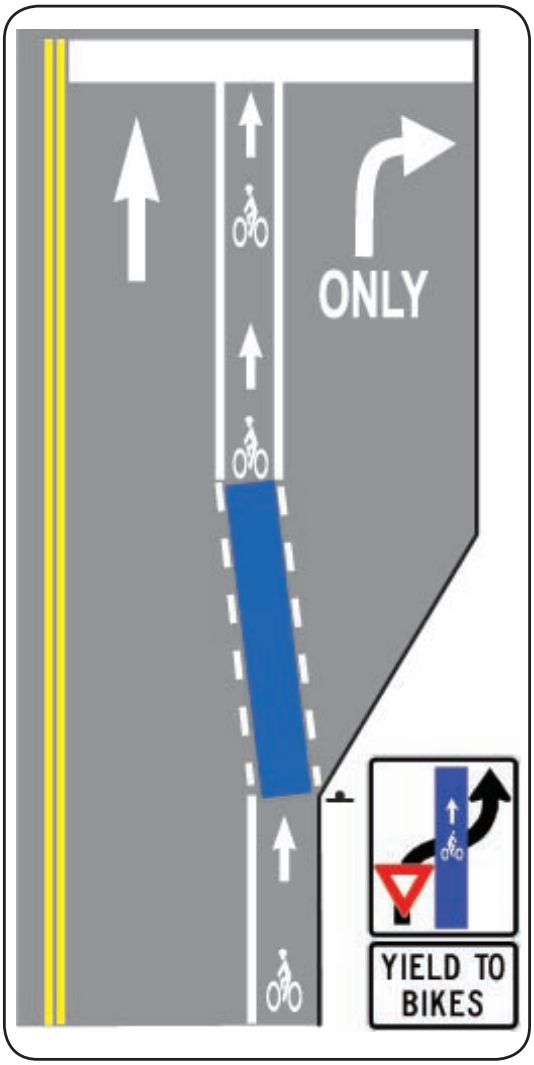
There are three colors commonly used in bike lanes: blue, green, and red. Several cities initially used blue; however, this color is associated with amenities for handicapped drivers or pedestrians. Green is the color recommended for use in Albuquerque.

Advantages of colored bike lanes at conflict points
- Draws attention to conflict areas
- Increases motorist yielding behavior
- Emphasizes expectation of bicyclists on the road

Guidance

Although colored bike lanes are not an official standard at this time, they continue to be successfully used in cities, including Portland, OR, Philadelphia, PA, Cambridge, MA, Toronto, Ontario, Vancouver, BC and Tempe, AZ. This treatment typically includes signage alerting motorists of vehicle/ bicycle conflict points. Portland's Blue Bike Lane report found that significantly more motorists yielded to bicyclists and slowed or stopped before entering the conflict area after the application of the colored pavement.

Additional information in Portland Office of Transportation (1999). Portland's Blue Bike Lanes: Improved Safety through Enhanced Visibility. Available: www.portlandonline.com/shared/cfm/image.cfm?id=58842



Recommended colored bike lane design.

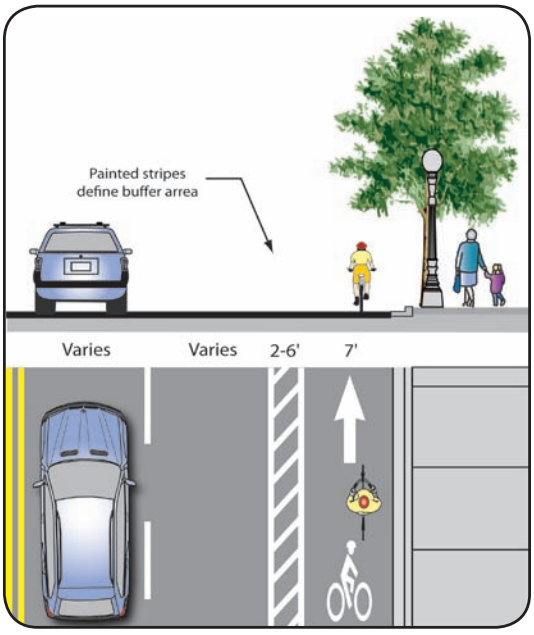
Portland, OR has implemented colored bike lanes.

1.5. Buffered Bike Lanes

Design Summary

Guidelines for buffer width varies:

- 2.6 feet/80 cm (London and Brussels)
- 1.6-2.5 feet/50-75 cm (CROW Guide)
- 6 feet (Portland, OR)



Recommended buffered bike lane design.

Discussion

Bike lanes on high-volume or high-speed roadways can be dangerous or uncomfortable for cyclists, as automobiles pass or are parked too close to bicyclists. Buffered bike lanes are designed to increase the space between the bike lanes and the travel lane or parked cars.

This treatment is appropriate on bike lanes with high automobile traffic volumes and speed, bike lanes adjacent to parked cars, and bike lanes with a high volume of truck or oversized vehicle traffic. Frequency of right turns by motor vehicles at major intersections should determine whether continuous or truncated buffer striping should be used approaching the intersection.

Advantages of buffered bike lanes:

- Provides cushion of space to mitigate friction with motor vehicles on streets with narrow bike lanes.
- Provides space for cyclists to pass one another without encroaching into the travel lane.
- Provides space for cyclists to avoid potential obstacles in the bike lanes, including drainage inlets, manholes, trash cans or debris.
- Parking side buffer provides cyclists with space to avoid the 'door zone' of parked cars.
- Provides motorists greater shy distances from cyclists in the bike lane.

Disadvantages / potential hazards

- Requires additional roadway space.
- Requires additional maintenance for the buffer striping.
- Frequency of parking turnover should be considered prior to installing buffered bike lanes.
- Increases the debris collection in the bike lane.

Buffered bike lanes protect cyclists from fast-moving traffic.

Guidance

This treatment is not currently present in any state or federal design standards.

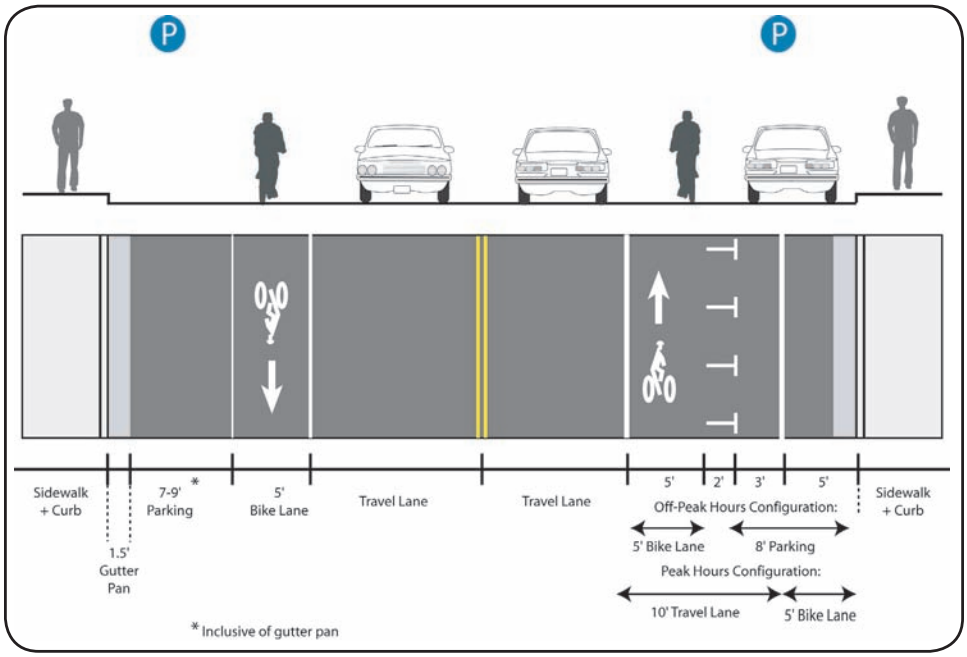
The City of Portland, OR included this treatment in the Bikeway Design Best Practices for the 2030 Bicycle Master Plan. Buffered bike lanes are currently also used in Brussels & Bruges, Belgium, Budapest, Hungary, London, UK, Seattle, WA, San Francisco, CA, and New York, NY.

1.6. Floating Bike Lanes

Design Summary

It is important to provide adequate space to minimize the risk of "doorings" when parking is permitted. The bicycle symbol may be used curbside or sharrow markings in lieu of bike lane striping.

In San Francisco, parking is permitted during off-peak times: 9am-3pm and 7pm to 7am.



Recommended floating bike lane design.

Discussion

This treatment maintains the bicycle facility when an extra travel lane (for automobiles) is added during peak hours. A single lane can function as a parking lane or an exclusive bike lane. During peak hours, parking is not allowed and cyclists use a curbside bike lane. During off-peak hours, cyclists travel in the space between the motorized traffic lane and parked cars.

This treatment can be used on primary bicycle routes during peak hours or on streets warranting bike lanes with high parking demand where there is insufficient space to provide both standard bike lane and parking.

Floating bike lane when parking is allowed on The Embaradero, San Francisco. Source: sfmta.org

Advantages of buffered bike lanes:

- Can accommodate bicycles at all times, even when parking is permitted.
- Provides bicycle facilities on streets with constrained rights-of-way.

Disadvantages / potential hazards

- Unorthodox design can be confusing to both cyclists and motorists.
- Enforcement is required.

Guidance

This treatment is not currently present in any state or federal design standards.

The City of Portland, OR included this treatment in the Bikeway Design Best Practices for the 2030 Bicycle Master Plan. Floating bike lanes are currently used in San Francisco, CA.

1.7. Contraflow Bike Lane

Design Summary

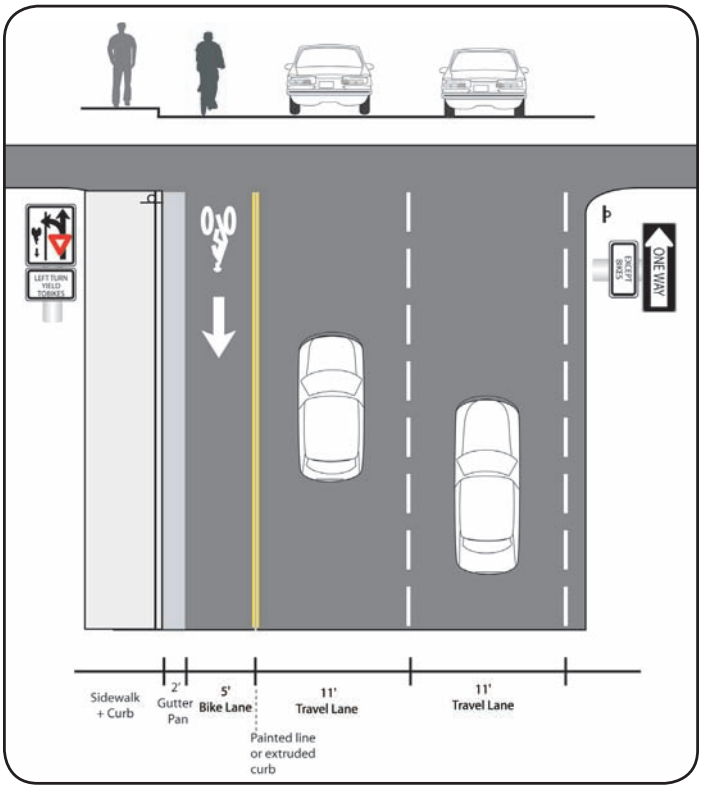
- The contraflow lane should be 5.0 feet to 6.5 feet and marked with a solid double yellow line and appropriate signage.
- Bike lane markings should be clearly visible to ensure that contraflow lane is exclusively for bicycles.
- Coloration should be considered on the bike lane.

Discussion

Contraflow bike lanes provide bi-directional bicycle access along a roadway that is one-way for automobile traffic. This treatment can provide direct access and connectivity for bicyclists, avoiding detours and reducing travel distances for cyclists.

Advantages of contraflow bike lanes:

- Provides direct access and connectivity for bicycles traveling in both directions.
- Influences motorist choice of routes without limiting bicycle traffic.
- Cyclists do not have to make detours as a result of one-way traffic.



Recommended contraflow bike lane design.

Disadvantages / potential hazards

- Parking should not be provided on the far side of the contraflow bike lane.
- Space requirements may require reallocation of roadway space from parking or travel lanes.
- The lane could be illegally used by motorists for loading or parking.
- Conversion from a two-way street requires elimination of one direction of automobile traffic
- Public outreach should be conducted prior to implementation of this treatment.

This contraflow bike lane in Portland, OR (left) provides a key connection along a narrow one-way street.

Guidance

This treatment is a federally-recognized design standard, and present in some state DOT manuals, such as the Wisconsin Bicycle Facility Design Handbook.

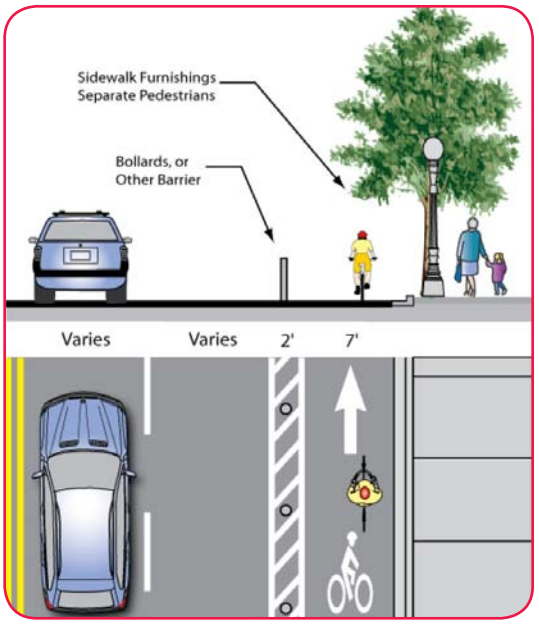
The City of Portland, OR included this treatment in the Bikeway Design Best Practices for the 2030 Bicycle Master Plan. Contraflow bike lanes are currently used in Olympia and Seattle, WAm as well as Madison, WI, Cambridge, MA, San Francisco, CA, and Portland, OR.

2. Cycle Tracks

Design Summary

A cycle track is an exclusive bicycle facility that combines the user experience of a separated path with the on-street infrastructure of a conventional bike lane. Recommended cycle track width:

- 7 foot minimum to allow passing.



Recommended cycle track design without parking, using striping and flexible bollard separation.

Discussion

Cycle tracks provide space that is intended to be exclusively or primarily for bicycles, and are separated from vehicle travel lanes, parking lanes and sidewalks. Cycle tracks can be either one-way or two-way, on one or both sides of a street, and are separated from vehicles and pedestrians by pavement markings or coloring, bollards, curbs/medians or a combination of these elements.

Cycle tracks provide:

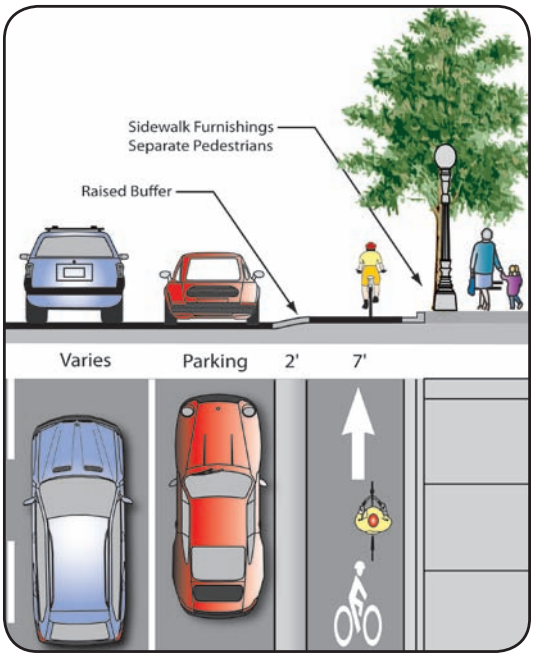
- Increased comfort for bicyclists.
- Greater clarity about expected behaviour.
- Fewer conflicts between bicycles and parked cars as cyclists ride inside the parking lane.
- Space to reduce the danger of 'car dooring.'

Danish research has shown that cycle tracks can increase bicycle ridership 18-20%, compared with the 5-7% increase associated with bike lanes.

However, disadvantages of cycle tracks include:

- Increased vulnerability at intersections.
- Regular street sweeping trucks cannot maintain the cycle track; requires smaller sweepers.
- Conflicts with pedestrians and bus passengers can occur, particularly on cycle tracks that are un-differentiated from the sidewalk or that are between the sidewalk and a transit stop.

Cycle tracks should be placed along slower speed urban/suburban streets with long blocks and few driveways or mid-block access points for vehicles. Cycle tracks located on one-way streets will have fewer potential conflicts than those on two-way streets. A two-way cycle track is desirable when there are more destinations on one side of a street or if the cycle track will connect to a shared-use path or bicycle facility on one side of the street.



Recommended cycle track design with on-street parking.

Guidance

While only recently implemented in U.S. and Canadian cities, cycle tracks have been used in European countries for several decades. The cycle track design guidance was developed using best practices from European experience, as well as New York City, Montreal, and Portland, OR. Additional guidance: Cycle Tracks: Lessons Learned, Alta Planning + Design (2009). www.altaplanning.com/App_Content/files/pres_stud_docs/Cycle%20Track%20lessons%20learned.pdf

2.1. Cycle Track Separation

Design Summary

Cycle tracks can be separated from vehicle traffic by a barrier or through grade-separation. Physical barriers can include bollards, parking, a planter strip, an extruded curb, or parking. Cycle tracks using barrier separation typically share the same elevation as adjacent travel lanes. Pavement markings or other minimal separation should designate pedestrian space and discourage pedestrians from walking in the cycle track.

Openings in the barrier or curb are needed at driveways or other access points. Grade-separated cycle tracks should incorporate a rolled curb, which allows cyclists to enter or leave the cycle track at will, and enables motorists to cross the cycle track at intersections and crossings.

Cycle track with a parking buffer, Copenhagen.

Discussion

Parking Placement

Where on-street parking exists, the cycle track should be placed between the parking and the sidewalk. The cycle track should be placed with a 2' buffer between parking and the sidewalk to minimize the hazard of 'dooring' cyclists. Drainage inlets should be provided adjacent to the sidewalk curb to facilitate run-off. This technique is common in Copenhagen, as pictured left.

Cycle track with curb separation, Amsterdam.

Channelization

Cycle tracks can be at street-level, provided that there is a physical separation. The curb creates the separated space, as well as preventing passengers from opening doors into the cycle track and discouraging pedestrians from walking on the facility.

Mountable Curb

Cycle tracks can be grade-separated from the roadway. The cycle track should be two or three inches above street-level, and the sidewalk should be an additional two to three inches above that. Where cyclists may enter or leave the cycle track, or where motorists cross at a driveway, the curb should be mountable with a small ramp, allowing cyclist turning movements.

Mountable curb, Copenhagen.

Bollards and Pavement Markings

In addition to grade separation or channelization, the cycle track should have signage, pavement markings and/or different coloration or texture, to indicate that the facility is provided for bicycle use. Signage, in addition to flexible bollards, can add to the physical separation of the facility, shown in this example from Melbourne, Australia.

Cycle track with bollard separation, New York City.

Guidance

A buffer is not required of a cycle track wider than seven feet, but is recommended where possible. The CROW Design Manual for Bicycle Traffic recommends that the buffer area inside built-up areas should be a minimum of 1.1 feet. If the buffer is a fence or other taller obstacle, a minimum of two feet shy distance is recommended on either side.

2.2. Cycle Track Intersection Treatments

Cycle tracks separate cyclists and motor vehicles to a greater degree than bike lanes. This leads to added comfort for cyclists on the cycle track, but it creates additional considerations at intersections that must be addressed. A right-turning motorist conflicting with cycle track users represents the most common conflict. Both roadway users have to expand their visual scanning to see potential conflicts.

2.2.1. Cycle Track Treatments at Driveways and Minor Street Crossings

Design Summary

Recommendations for increasing bicyclist visibility at driveways and minor street crossings:

- Maintain height level of cycle track, requiring automobiles to cross over.
- Remove parking 16 feet prior to the intersection.
- Use colored pavement markings through the conflict area.
- Place warning signage to identify the crossing (see page 5).

Discussion

At driveways and crossings of minor streets, the majority of traffic will continue through intersections, while a small number of automobiles will cross the cycle track. At these locations, cyclist visibility is important, as a buffer of parked cars or vegetation can hide a cyclist traveling in the cycle track. Cyclists should not be expected to stop at these minor intersections if the major street does not stop, and markings and signage should be used to indicate that drivers should watch for cyclists.

Access management should be used to reduce the number of crossings of driveways on a cycle track.

Guidance

See the CROW Design Manual for Bicycle Traffic or Cycle Tracks: Lessons Learned, Alta Planning + Design (2009) for additional guidance.

www.altaplanning.com/App_Content/files/pres_stud_docs/Cycle%20Track%20lessons%20learned.pdf

Cycle tracks should be continued through driveway crossings, improving visibility.

Colored pavement informs bicyclists and drivers of a potential conflict area.

Bicycle markings at a driveway crossing.

2.2.2. Cycle Track Treatments at Major Street Crossings

Design Summary

Recommendations for increasing bicyclist visibility at major street crossings:

- Stripe stop line 16 feet back from the intersection.
- Remove parking 16 feet prior to the intersection.
- Drop cycle track to bike lane 16 feet back from intersection.
- Use bike box treatments to move cyclists in front of traffic (see page 2).
- Use colored pavement markings through the conflict area.

Cycle track dropping to bike lane before an intersection.

Discussion

Protected phases at signals or 'scramble signals' separate automobile turning movements from conflicting thru-bicycle movements. Bicycle signal heads ensure that all users know which signals to follow. Demand-only bicycle signals can require user actuation and reduce vehicle delay by preventing an empty signal phase from regularly occurring (see page Error! Bookmark not defined.).

Advanced signal phases can be set to provide cycle track users an advance green phase. This places cyclists in front of traffic and allows them to make their turning movements without merging into traffic.

An advanced warning allows bicyclists to prepare to move forward through the intersection. This warning can be accomplished through a pre-green interval, a yellow warning display two seconds before the green, or a bicycle countdown signal.

Crossings should separate space for bicyclists and pedestrians.

Guidance

The CROW guide states that, if the speed of the main street is 45 mph or less, the cycle track should turn inwards prior to crossing a side street. This is to improve visibility of cyclists to motorists in the main road turning right. If the speed is greater, the cycle track should bend away from the main road at intersections, so that vehicles leaving the main road can stack up on the cross street, between the cycle track and the main road. Signage should also warn motorists of the crossing.

At this unsignallized right turn, the cycle track has dropped to a bike lane with blue coloration and pavement markings through the conflict area.

Bike-specific signals are small and placed on the near-side of traffic.

2.2.3. Left Turn Movements

Design Summary

Left turn opportunities for cyclists can be provided in the following ways:

- Copenhagen lefts are a two-stage crossing, which include a turning and waiting area at the far side of the first intersection.
- Box lefts are pockets where bicyclists can move to the right hand side of the cycle track and wait for a crossing signal. This treatment can result in the cyclist being on the wrong side of the street, in a standard four-way intersection.
- Scramble signals (see page Error! Bookmark not defined.).

Discussion

Bicyclists are often not allowed to make left-turn movements from the cycle track can be physically barred from moving into the roadway by the cycle track barrier.

The "Copenhagen Left" (also known as the "Melbourne Left," the "jug-handle turn," and the "two-stage left") is a way of enabling a safe left-turn movement by bicyclists in a cycle track. Bicyclists approaching an intersection can make a right into the intersecting street from the cycle track, to position themselves in front of cars. Bicyclists can go straight across the road they were on during next signal phase. All movements in this process are guided by separate traffic signals – motorists are not allowed to make right turns on red signals. In addition, motorists have an exclusive left-turn phase, in order to make their movements distinct from the bicyclists'

Guidance

See the CROW Design Manual for Bicycle Traffic or Cycle Tracks: Lessons Learned, Alta Planning + Design (2009) for additional guidance.

www.altaplanning.com/App_Content/files/pres_stud_docs/Cycle%20Track%20lessons%20learned.pdf

Left-turn from a cycle track on the right via bicycle-signal phase in Stockholm, Sweden.

"Copenhagen Left" application.

"Box left" turn in Troisdorf, Germany.

2.3. Two-Way Cycle Tracks

Design Summary

- 12 foot minimum to allow passing, 14 foot recommended (New York City).
- Striped center line to separate traffic.
- Pavement markings should indicate direction.

Discussion

A two-way cycle track is desirable when more destinations are on one side of a street (therefore preventing additional crossings), if the facility connects to a path or other bicycle facility on one side of the street, or if there is not enough room for a cycle track on both sides of the road.

Bidirectional cycle tracks are acceptable in the following situations:

- On a street with few intersections or without access on one side (e.g., along a waterway or rail line).
- On a one-way street with fewer than one intersection every 100 feet.
- On two-way streets where left-hand turns are prohibited, and with a limited number of intersections and driveway entrances.

Parking should be banned along the street with the bike path to ensure adequate stopping sight distances for motorists crossing the path.

Two-way cycle tracks have many similar design characteristics as one-way tracks; they are physically divided from cars and pedestrians, and require similar amenities at driveway and side-street crossings.

Two-way cycle tracks require a higher level of control at intersections, to allow for a variety of turning movements. These movements should be guided by a separated signal for bicycles and for motor vehicles. Transitions onto bidirectional cycle tracks should be simple and easy to use, to deter bicyclists from continuing to ride against the flow of traffic.
In addition, bicyclists riding against roadway traffic in two-way cycle tracks may surprise pedestrians and drivers at intersections.

Guidance

Vélo Québec Technical Handbook of Bikeway Design. (2003), CROW Design Manual for Bicycle Traffic and Alta Planning + Design Cycle Tracks: Lessons Learned, (2009).

Two-way cycle track with dividing line.

Directional markings on cycle track.

Pavement markings indicate travel direction at a minor roadway crossing on this cycle track in Paris, France.