NACTO Urban Bikeway Design Guide

State of the Practice Solutions

January 2012

TRB 91st Annual Meeting

Building Modern Bikeways

The National Association of City Transportation Officials' Guide and National Experience

Morning Schedule

- **9:00-12:00** **An Overview of the Urban Bikeway Design Guide**

• 9:00-9:30	Bike Lanes and Cycle Tracks	*Ryan Russo, NYCDOT*
• 9:30-10:00	Intersections	*Jim Sebastian, DDOT*
• 10:00-10:30	Signals	*Peter Koonce, City of Portland*
• 10:30-11:00	Signing & Marking	*Seleta Reynolds, SFMTA*
• 11:00-11:30	Q & A	
• 11:30-12:00	Module II Preview	*David Vega-Barachowitz, NACTO*

Building Modern Bikeways

The National Association of City Transportation Officials' Guide and National Experience

Afternoon Schedule

- **1:00-2:30** **Implementation and Case Studies**
  Ryan Russo, NYCDOT
  Peter Koonce, City of Portland
  Seleta Reynolds, SFMTA
  Jim Sebastian, DDOT
  Cara Seiderman, City of Cambridge

- 2:30-2:45 Break

- **2:45-4:00** **The Politics of Implementation**
  The Honorable Ralph Becker, Mayor, Salt Lake City
  Stephen Buckley, City of Philadelphia
  Vineet Gupta, Boston Transportation Department

BIKE LANES

Bike Lanes

Conventional Bike Lanes

Buffered Bike Lanes

Contra-Flow Bike Lane

Left-Side Bike Lane

CONVENTIONAL BIKE LANES

Required Features

The desirable bike lane width adjacent to a curbface is 6 feet. The desirable ridable surface adjacent to a street edge or longitudinal joint is 4 feet, with a minimum width of 3 feet. In cities where illegal parking in bike lanes is an concern, 5 foot wide bike lanes may be preferred.[3]

When placed adjacent to a parking lane, the desirable reach from the curb face to the edge of the bike lane (including the parking lane, bike lane, and optional buffer between them) is 14.5 feet; the absolute minimum reach is 12 feet. A bike lane next to a parking lane shall be at least 5 feet wide, unless there is a marked buffer between them. In cities where illegal parking in bike lanes is an concern, 5 feet wide bike lanes are preferred.[3]

The desirable bike lane width adjacent to a guardrail or other physical barrier is 2 feet wider than otherwise in order to provide a minimum shy distance from the barrier.[4]

Bicycle lane word and/or symbol and arrow markings (MUTCD Figure 9C-3) shall be used to define the bike lane and designate that portion of the street for preferential use by bicyclists.[5]

Bike lane word, symbol, and/or arrow markings (MUTCD Figure 9C-3) shall be placed outside of the motor vehicle tread path at intersections, driveways, and merging areas in order to minimize wear from the motor vehicle path.

A solid white lane line marking shall be used to separate motor vehicle travel lanes from the bike lane. Most jurisdictions use a 6 to 8 inch line.[6]

A through bike lane shall not be positioned to the right of a right turn only lane or to the left of a left turn only lane (MUTCD 9C.04). A bike lane may be positioned to the right of a right turn only lane if split-phase signal timing is used. For additional information, see bicycle signal heads. For additional strategies for managing bikeways and right turn lanes, see through bike lanes in this guide.

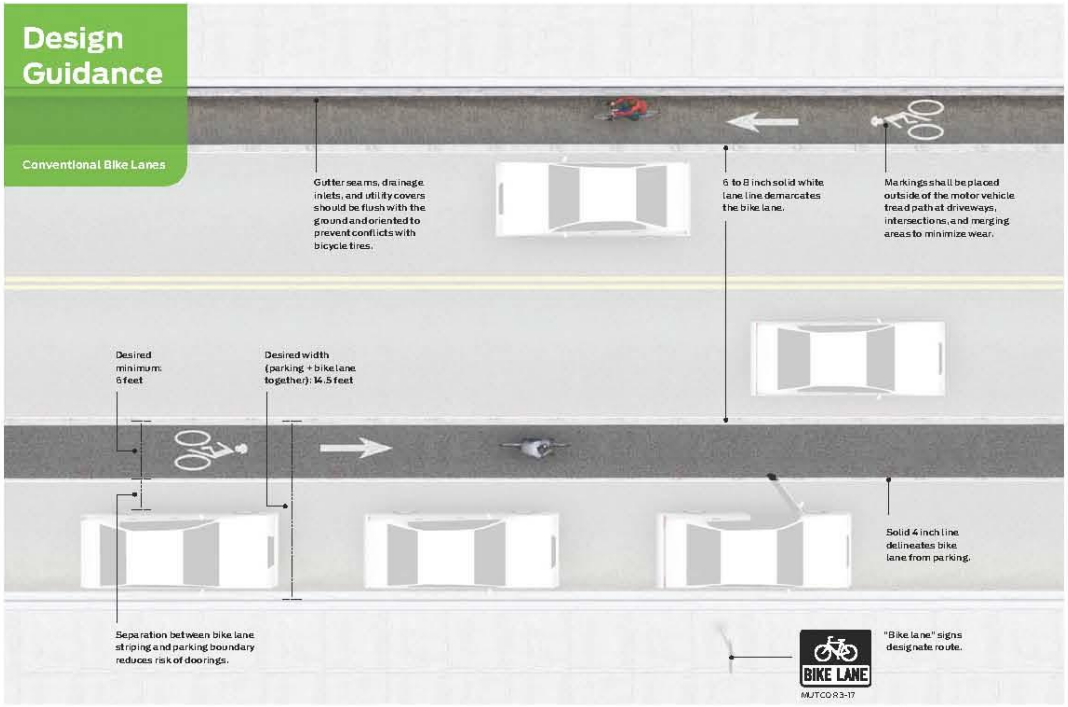
Recommended Features

Bike lanes should be made wider than minimum widths wherever possible to provide space for bicyclists to ride side-by-side and in comfort. Reduce bike lane width only after other street elements (e.g., travel lanes, medians, median offsets) have been reduced to their minimum dimensions. If sufficient space exists to exceed desirable widths, see buffered bike lanes. Very wide bike lanes may encourage illegal parking or motor vehicle use of the bike lane.

When placed adjacent to parking, a solid white line marking of 4 inch width should be used between the parking lane and the bike lane to minimize encroachment of parked cars into the bike lane.[7]

Design Guidance

Conventional Bike Lanes



Gutter seams, drainage inlets, and utility covers should be flush with the ground and oriented to prevent conflicts with bicycle tires.[8]

If sufficient space exists, separation should be provided between bike lane striping and parking boundary markings to reduce door zone conflicts. Providing a wide parking lane may offer similar benefits. Refer to buffered bike lanes for additional strategies.

If sufficient space exists and increased separation from motor vehicle travel is desired, a travel side buffer should be used. Refer to buffered bike lanes for additional details.

Lane striping should be dashed through high traffic merging areas. See through bike lanes for more information.

The desirable dimensions should be used unless other street elements (e.g., travel lanes, medians, median offsets) have been reduced to their minimum dimensions.

In cities where local vehicle codes require motor vehicles to merge into the bike lane in advance of a turn movement, lane striping should be dashed from 50 to 200 feet in advance of intersections to the intersection. Different states have varying requirements.

Optional Features

"Bike Lane" signs (MUTCD R3-17) may be located prior to the beginning of a marked bike lane to designate that portion of the street for preferential use by bicyclists. The 2009 MUTCD lists bike lane signs as optional; however, some states still require their use.

On bike lanes adjacent to a curb, "No Parking" signs (MUTCD R8-3) may be used to discourage parking within the bike lane.

If the word, symbol, and/or arrow pavement markings (shown at left) are used, Bike Lane signs (see Section 9B.04) may also be used, but to avoid overuse of the signs not necessarily adjacent to every set of pavement markings.

Federal Highway Administration. (2009). Manual on Uniform Traffic Control Devices.

Color may be used to enhance visibility of a bike lane.

BOSTON, MA

CONVENTIONAL BIKE LANES

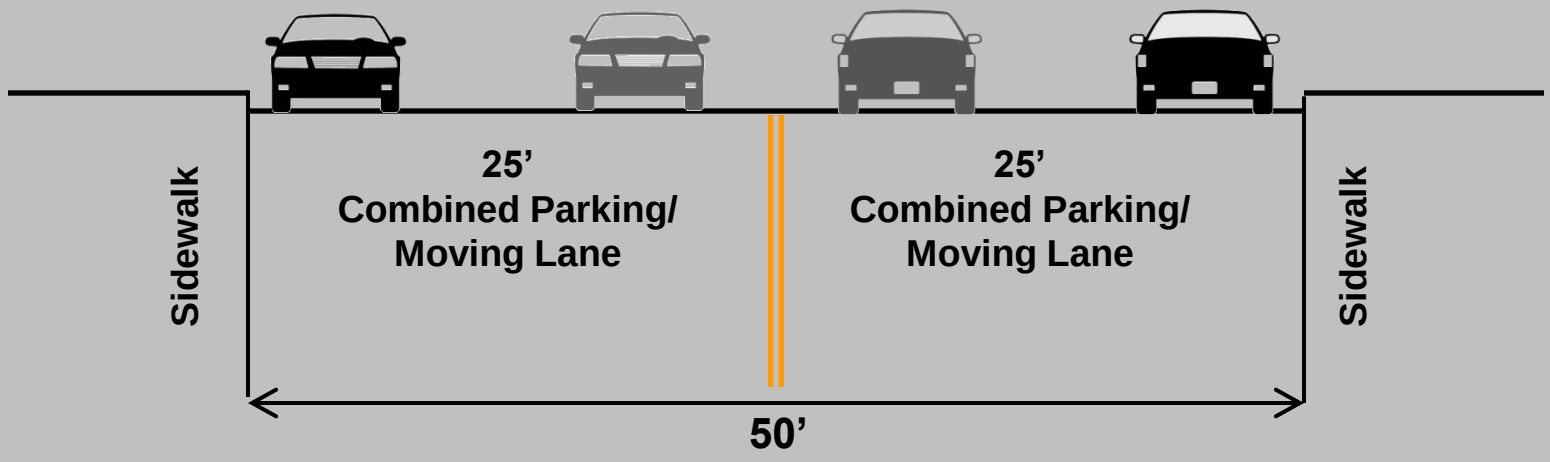
- Comfort on Busy Streets
- Separation from moving autos
- Can increase street capacity
- Visual reminder of cyclist right to street

Conventional Bike Lane
NEW YORK CITY

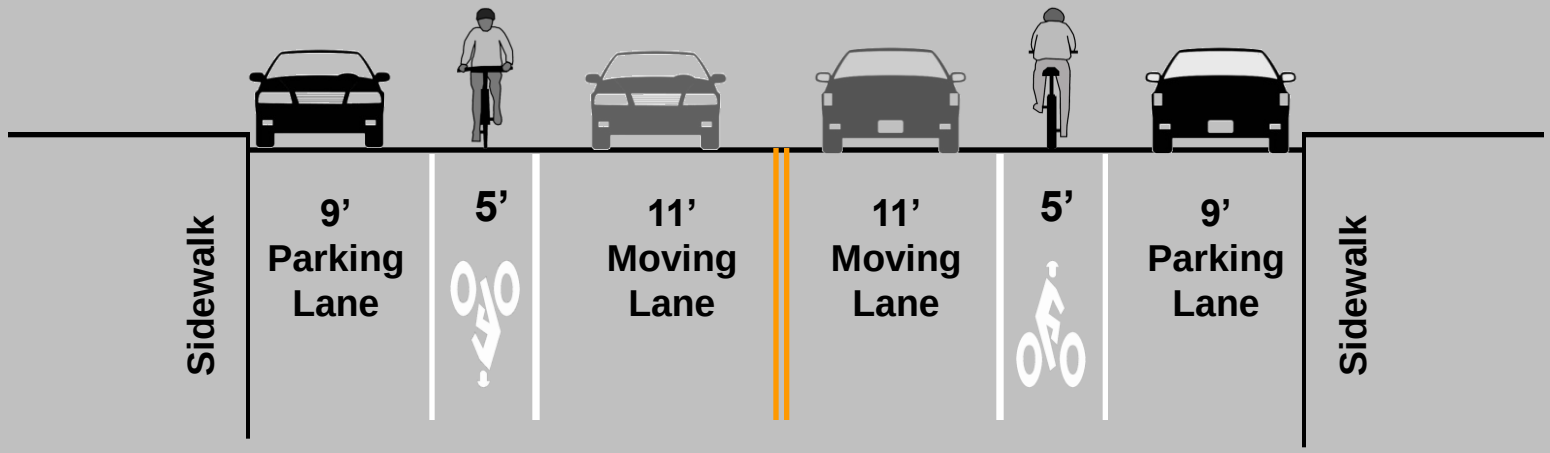
CLARENDON ROAD, BROOKLYN, NY

Conventional Bike Lane

EXISTING

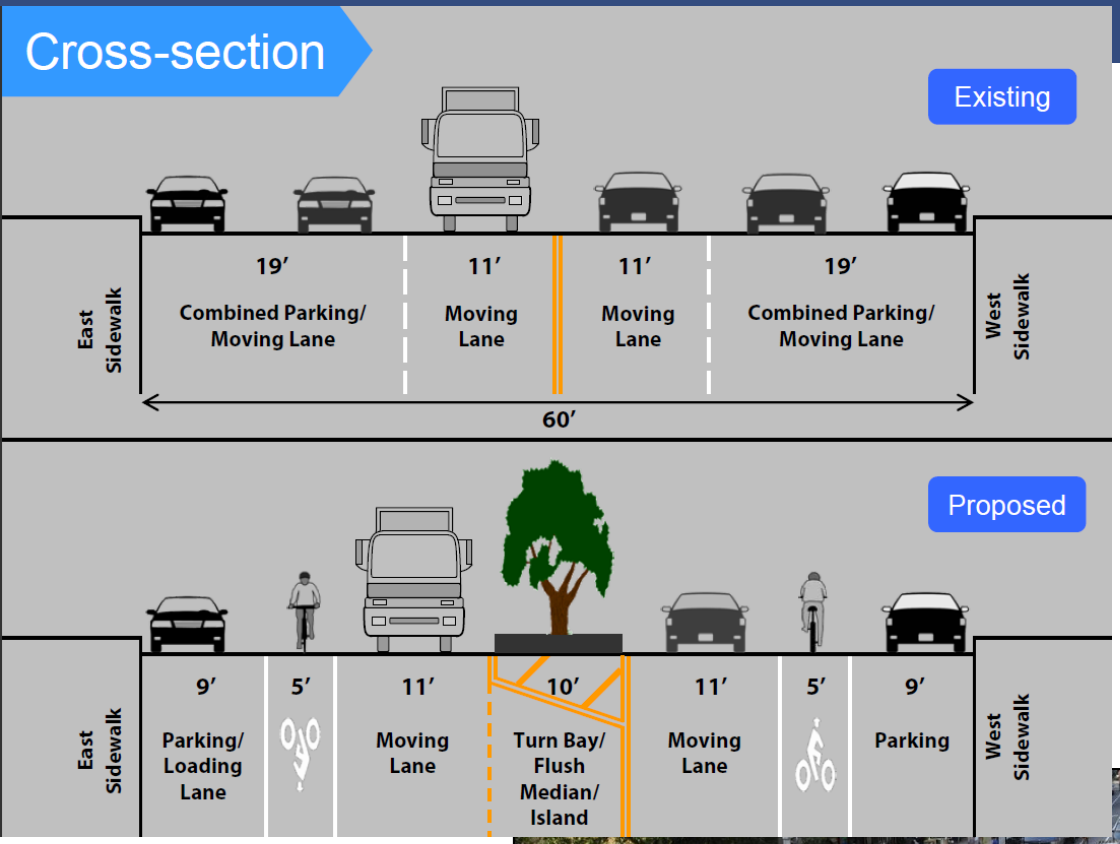


PROPOSED



Conventional Bike Lane
AUSTIN, TX

4-to-3 Road Diet with Bike Lanes



Vanderbilt Ave, Brooklyn

Conventional Bike Lane
NEW YORK CITY

BUFFERED BIKE LANES

Required Features

Bicycle lane word and/or symbol and arrow markings (MUTCD Figure 9C-3) shall be used to define the bike lane and designate that portion of the street for preferential use by bicyclists.[9]

The buffer shall be marked with 2 solid white lines with diagonal hatching if 3 feet in width or wider. Double white lines indicate lanes where crossing is discouraged, though not prohibited. For clarity, consider dashing the inside buffer boundary where cars are expected to cross.[10]

Recommended Features

The combined width of the buffer(s) and bike lane should be considered "bike lane width" with respect to guidance given in other documents that don't recognize the existence of buffers. Where buffers are used, bike lanes can be narrower because the shy distance function is assumed by the buffer. For example, a 3 foot buffer and 4 foot bike lane next to a curb can be considered a 7 foot bike lane. For travel side buffered lanes next to on street parking, a 5 foot minimum width is recommended to encourage bicyclists to ride outside of the door zone.

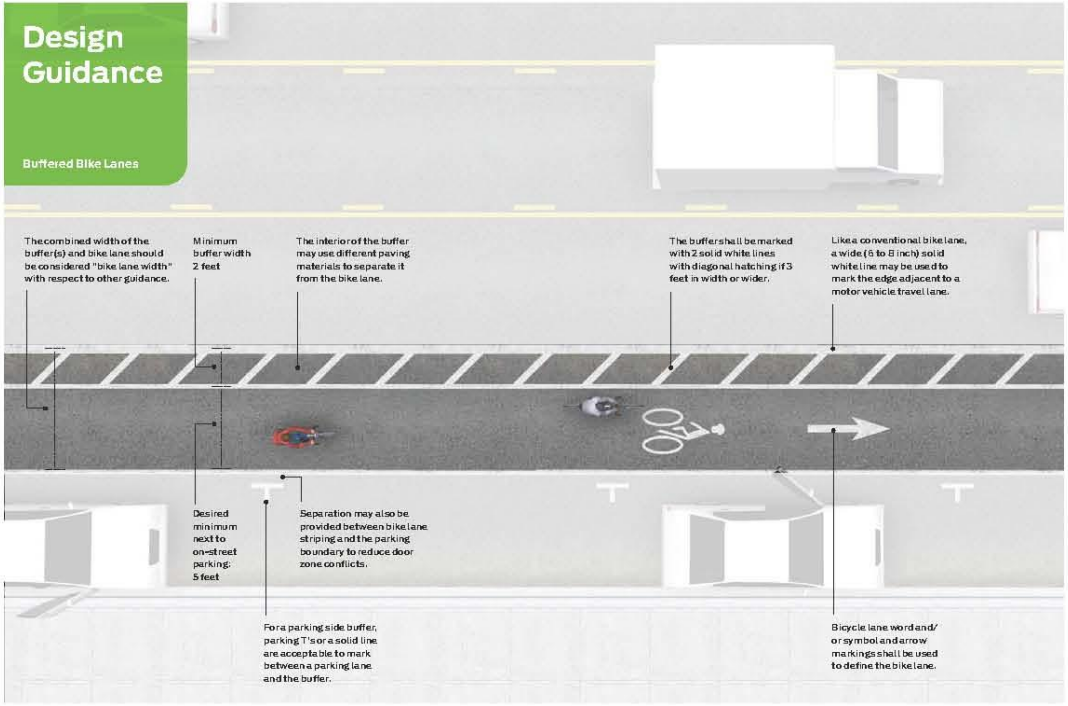
The combined width of the buffer(s) and bike lane should be considered "bike lane width" with respect to guidance given in other documents that don't recognize the existence of buffers. Where buffers are used, bike lanes can be narrower because the shy distance function is assumed by the buffer.

MUTCD 3B-24

MUTCD 3B-24

Design Guidance

Buffered Bike Lanes



Where bicyclist volumes are high or where bicyclist speed differentials are significant, the desired bicycle travel area width is 7 feet.

Buffers should be at least 2 feet wide because it is impractical to mark a zone narrower than that.

On intersection approaches with right turn only lanes, the bike lane should be transitioned to a through bike lane to the left of the right turn only lane, or a combined bike lane/turn lane should be used if available road space does not permit a dedicated bike lane.

On intersection approaches with no dedicated right turn only lane the buffer markings should transition to a conventional dashed line. Consider the use of a bike box at these locations.

Optional Features

Like a conventional bike lane, a wide (6 to 8 inch) solid white line may be used to mark the edge adjacent to a motor vehicle travel lane. For a parking side buffer, parking T's or a solid line are acceptable to mark between a parking lane and the buffer.

For travel lane buffer configurations, separation may also be provided between bike lane striping and the parking boundary to reduce door zone conflicts. This creates a type of parking-side buffer.

On wide one-way streets with buffered bike lanes, consider adding a buffer to the opposite side parking lane if the roadway appears too wide. This will further narrow the motor vehicle lanes and encourage drivers to maintain lower speeds.

The interior of the buffer area may use different paving materials to separate it from the bike lane. Textured surface materials may cause difficulties for bicyclists as surfaces may be rough. Increased maintenance requirements are likely.

TUSCON, AZ

Color may be used at the beginning of each block to discourage motorists from entering the buffered lane. For other uses of color in buffered bike lanes see colored bike facilities.

PORTLAND, OR

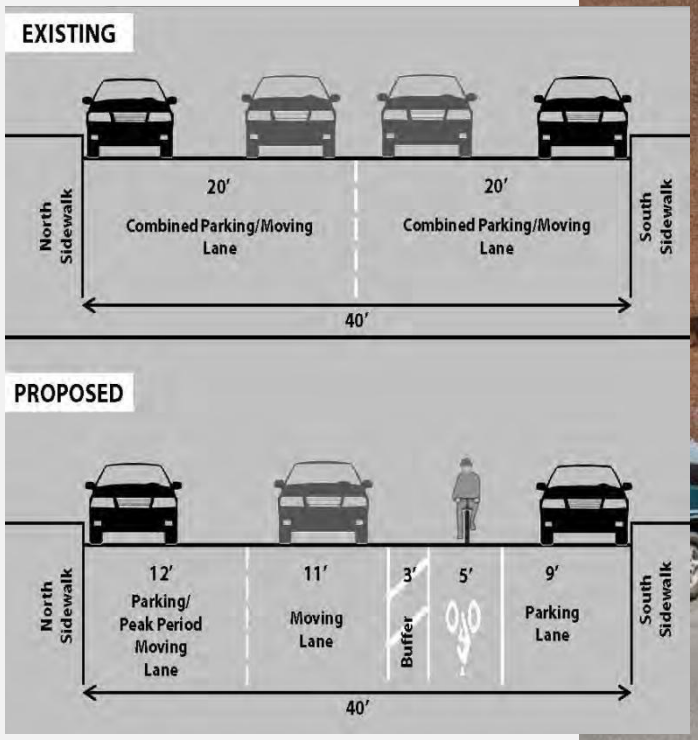
BUFFERED BIKE LANES

- Greater shy distance
- Cyclist passing room
- Added comfort appeals to wider cross-section
- Higher perception of safety

SEATTLE

DEKALB AVENUE, BROOKLYN, NY

Buffered Bike Lane



Buffered Bike Lane
Warren Street, Manhattan

Buffered Bike Lane
Flushing Avenue, Brooklyn

CONTRA-FLOW BIKE LANES

Required Features

Bicycle lane word, symbol, and arrow markings (MUTCD Figure 9C-3) shall be used to define the bike lane direction and designate that portion of the street for preferential use by bicyclists.

A "One Way" sign (MTCD R6-1, R6-2) with "Except Bikes" plaque shall be posted along the facility and at intersecting streets, alleys, and driveways informing motorists to expect two-way traffic.

Intersection traffic controls along the street (e.g., stop signs and traffic signals) shall also be installed and oriented toward bicyclists in the contra-flow lane.

PORTLAND, OR

CHICAGO, IL

Recommended Features

A "Do Not Enter" sign (MUTCD R5-1) with "Except Bikes" plaque should be posted along the facility to only permit use by bicycles.

When configured without parking, a solid double yellow lane line marking should be used to separate opposing motor vehicle travel lanes from the contraflow bicycle lane.[11]

Consider a No Turn on Red restriction by installing a "No Turn on Red" sign (MUTCD R10-11) on cross streets to minimize potential conflicts with turning vehicles. Cross street traffic may not look for or anticipate contraflow bicycle travel.

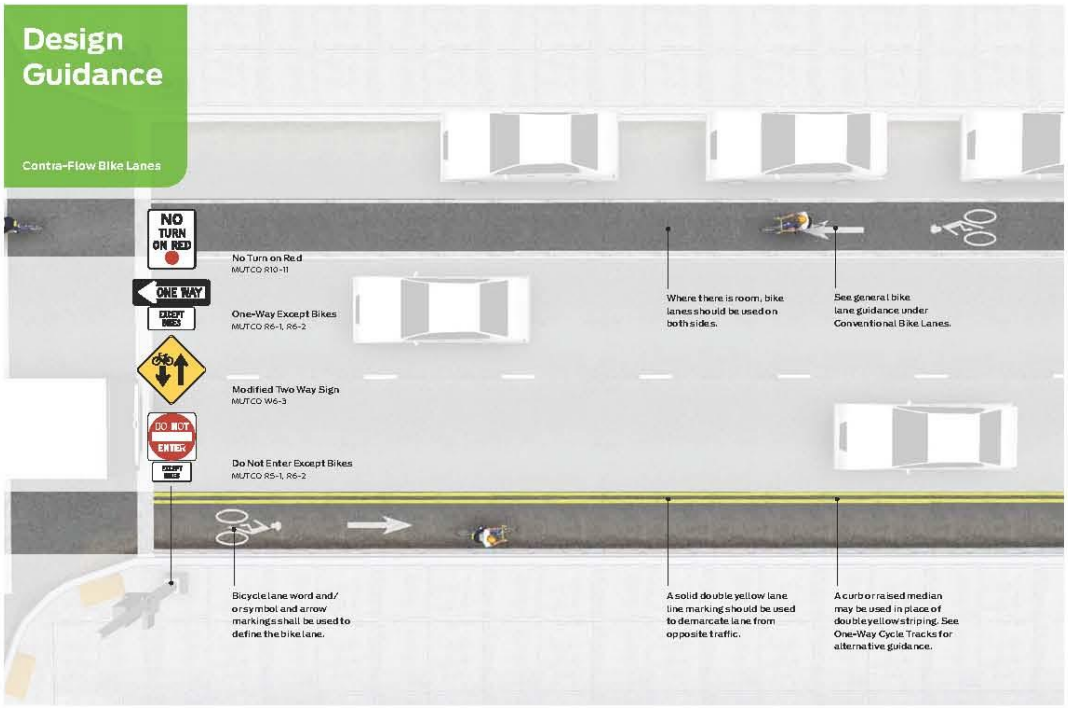
Where there is room, bike lanes should be used on both sides. When there is no room for a with-flow lane, shared lane markings should be used to guide with-flow bicyclists to keep to the right side of the road.[12]

If sufficient space exists, a buffered bike lane design should be used.

Contra-flow bike lane markings should be extended across the intersection, especially for contra-flow lanes against the curb, as a way of alerting cross street traffic to look for contra-flow bicyclists.

Design Guidance

Contra-Flow Bike Lanes



NEW YORK, NY

Optional Features

Warning signage, such as a modified "Two Way" sign (MUTCD W6-3) may be posted along the facility to inform motorists to expect two-way traffic.

Colored pavement may be used along the facility to draw attention to the unique function of the lane, or in areas with cross traffic, such as at driveway exits, for increased visibility of bicyclists.

Small versions of "Stop" signs (18 x 18 inches) and other regulatory signage may be used along the contra-flow lane to emphasize that only bike traffic is permitted to travel in the contra-flow direction.

Contra-flow lanes may be installed where there is parking on the contra-flow side. Most existing installations use a double yellow line to separate the contra-flow bicycle lane, however local ordinance may prohibit parking in the opposite direction of the contra-flow travel lane. A dashed yellow line, or dashed white line may also used to separate the contra-flow bicycle lane. Local urban practitioners should use best engineering judgment to determine which strategy to implement.

A curb or a raised median may be used in place of double yellow striping to separate the contra-flow lane from opposing vehicle traffic. Such a facility becomes a contra-flow protected cycle track.

CONTRAFLOW BIKE LANES

- Connectivity & access
- Reduces wrong-way & sidewalk riding
- Decreases trip distance
- Allows use of less trafficked streets

OCEAN PARKWAY, BROOKLYN, NY

Contraflow Bike Lane

Contra Flow Bike Lane
OLYMPIA, WA

LEFT SIDE BIKE LANES

PORTLAND, OR (PHOTO: WWW.PEDBIKEIMAGES.ORG, LAURA SANDT)

Required Features

Design guidance for conventional bike lanes applies to this treatment.

Recommended Features

Signage should accompany left-side bicycle lanes to clarify proper use by bicyclists and may be effective in reducing wrong-way riding. Modified MUTCD R3 series sign shown.

Bicycle through lanes should be provided to the right of vehicle left turn pockets to reduce conflicts at intersections. This is important for through bicyclists as well as left turning bicyclists as left turning vehicles will cross paths with a left turning bicyclist. Additional guidance can be found in through bicycle lanes in this guide.

Where bicyclist demand is high and street space permits, a buffered bike lane configuration or wider than minimum dimensions should be used to allow bicyclists to pass one another without encroaching upon the adjacent travel lane.

Intersection treatments such as bike boxes and bike signals, should be considered to assist in the transition from left-side bike lanes to right-side bike lanes.

A "Yield to Bikes" sign should be post-mounted in advance of and in conjunction with a left turn lane to reinforce that bicyclists have the right-of-way going through the intersection.[6]

Design Guidance

Left-Side Bike Lanes

Optional Features

Colored pavement may be used along the facility to draw attention to the unique function of the lane, or within conflict areas for increased visibility of bicyclists.

BOSTON, MA

SAN FRANCISCO, CA

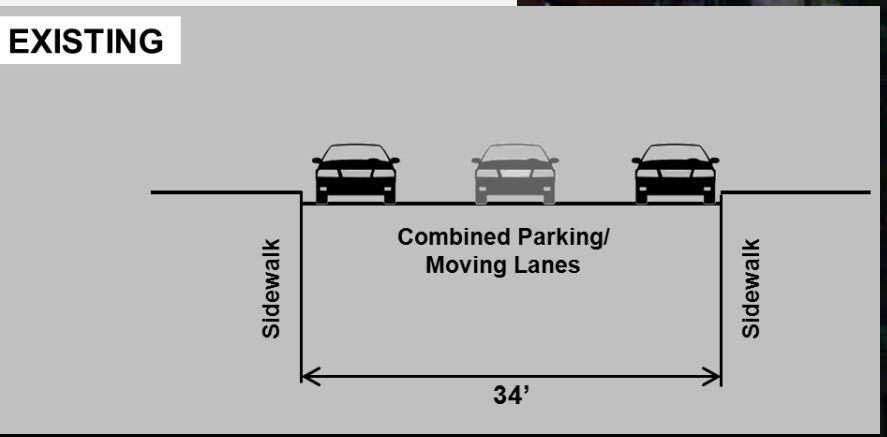
LEFT SIDE BIKE LANES

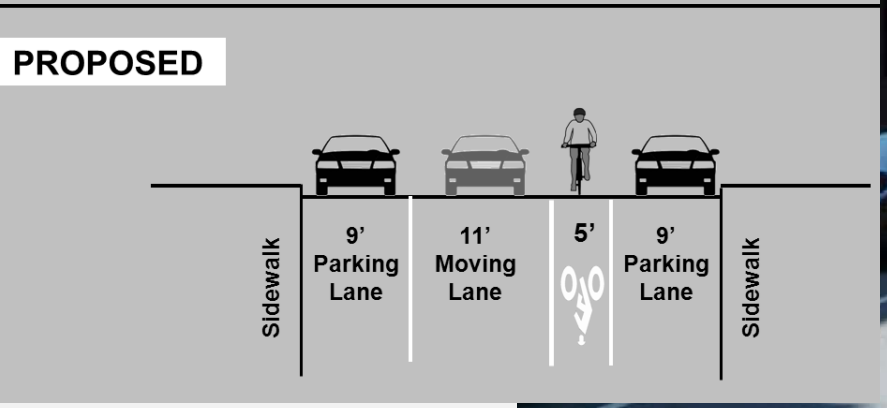
- Avoids bus conflicts
- Minimizes door conflicts
- Improved overtaking by motorists

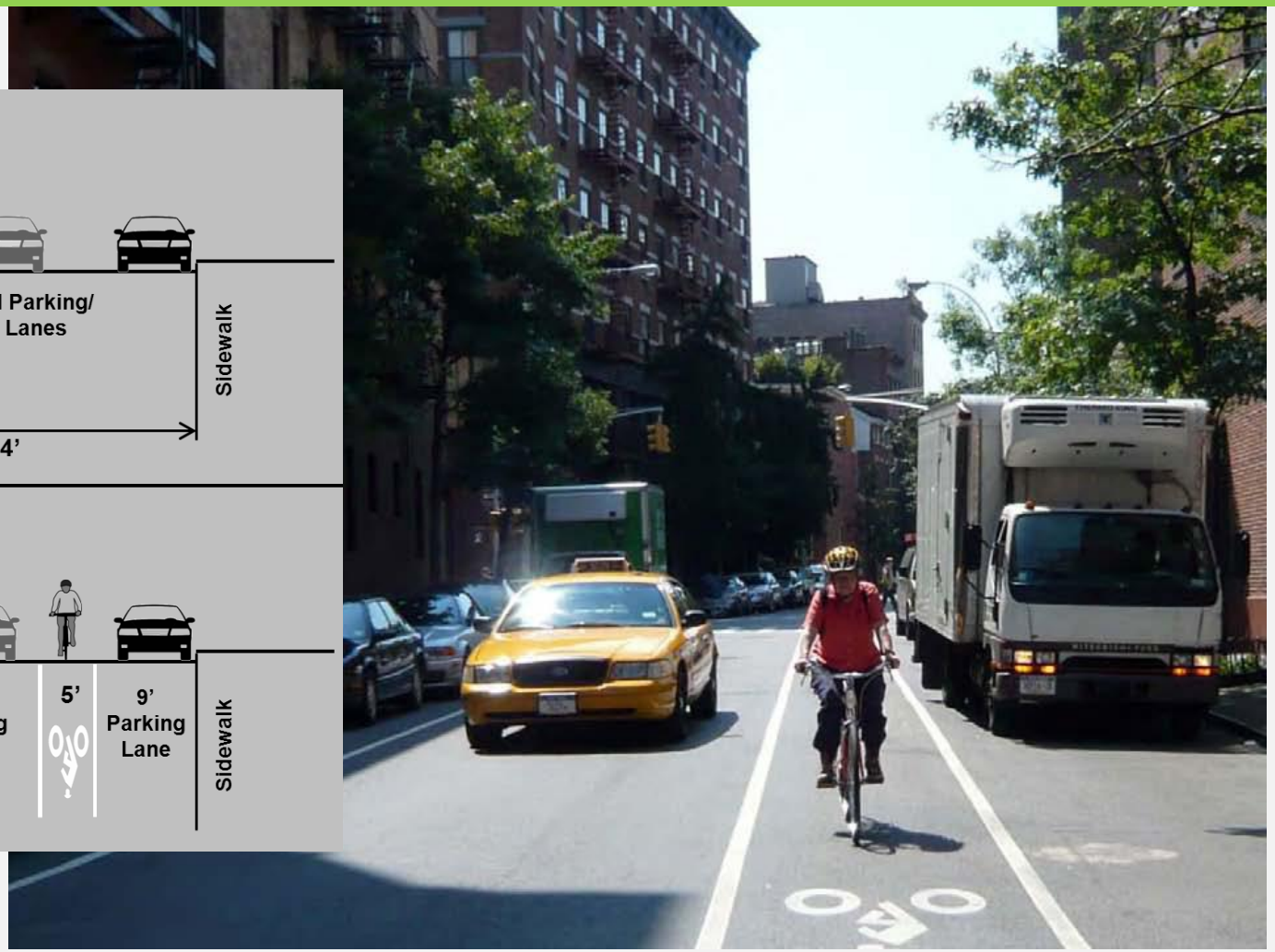
West 10th S
New York C

Greenwich Street

Left Side Bike Lane







Left Side
Bike Lane

BOSTON, MA

CYCLE TRACKS

Cycle Tracks

One-Way Protected Cycle Tracks

Raised Cycle Tracks

Two-way Cycle Tracks

ONE WAY PROTECTED CYCLE TRACK

Required Features

A cycle track, like a bike lane, is a type of preferential lane as defined by the MUTCD.[16]

Bicycle lane word, symbol, and/or arrow markings (MUTCD Figure 9C-3) shall be placed at the beginning of a cycle track and at periodic intervals along the facility based on engineering judgment.

If pavement markings are used to separate motor vehicle parking lanes from the preferential bicycle lane, solid white lane line markings shall be used. Diagonal crosshatch markings may be placed in the neutral area for special emphasis. See MUTCD Section 3B.24. Raised medians or other barriers can also provide physical separation to the cycle track.

Recommended Features

The desired width for a cycle track should be 5 feet. In areas with high bicyclist volumes or uphill sections, the desired width should be 7 feet to allow for bicyclists passing each other.[17]

Three feet is the desired width for a parking buffer to allow for passenger loading and to prevent door collisions.[18]

When using a pavement marking buffer, desired parking lane and buffer combined width is 11 feet to discourage motor vehicle encroachment into the cycle zone.

Driveways and minor street crossings are a unique challenge to cycle track design. A review of existing facilities and design practice has shown that the following guidance may improve safety at crossings of driveways and minor intersections:

- If the cycle track is parking protected, parking should be prohibited near the intersection to improve visibility. The desirable no-parking area is 30 feet from each side of the crossing.[19]
- For motor vehicles attempting to cross the cycle track from the side street or driveway, street and sidewalk furnishings and/or other features should accommodate a sight triangle of 20 feet to the cycle track from minor street crossings, and 10 feet from driveway crossing.
- Color, yield lines, and "Yield to Bikes" signage should be used to identify the conflict area and make it clear that the cycle track has priority over entering and exiting traffic.[20]
- Motor vehicle traffic crossing the cycle track should be constrained or channelized to make turns at sharp angles to reduce travel speed prior to the crossing.

Gutter seams, drainage inlets, and utility covers should be configured so as not to impede bicycle travel and to facilitate run-off.

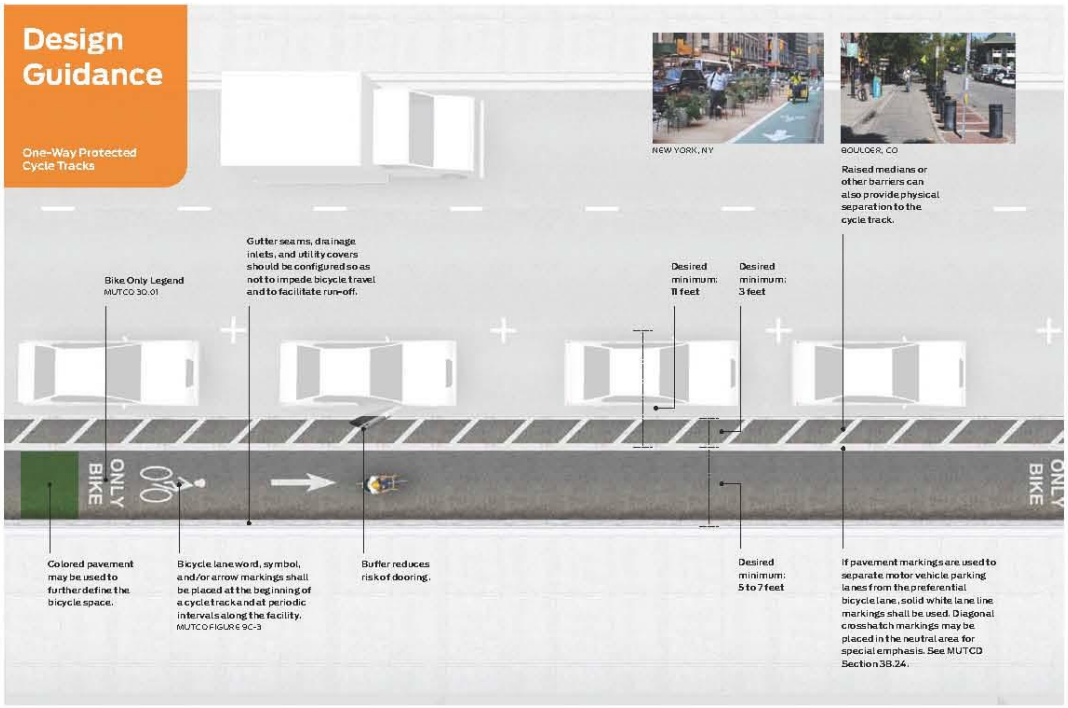
Sidewalk curbs and furnishings should be used to prevent pedestrian use of the cycle zone.

Design Guidance

One-Way Protected Cycle Tracks

NEW YORK, NY

BOULDER, CO



CHICAGO, IL (PHOTO: STEVEN VANCE)

Cycle track width should be larger in locations where the gutter seam extends more than 12 inches from the curb.[21]

Optional Features

Cycle tracks may be shifted more closely to the travel lanes on minor intersection approaches to put bicyclists clearly in the field of view of motorists.[22]

A "Bike Lane" sign (MUTCD R3-17) may be used to designate the portion of the street for preferential use by bicyclists. A supplemental "No Cars" selective exclusion sign may be added for further clarification.

"Bike Only" legend (MUTCD 3D.01) may be used to supplement the preferential lane word or symbol marking.[23]

Colored pavement may be used to further define the bicycle space.

Where the combined width of the cycle track and buffer is less than 8 feet, parking places next to the cycle track will not be accessible for disabled persons using vans or taxis (though they may be accessible to car users, for whom a 5 foot level landing area is needed). Consider local needs for van-accessible spaces and how best to meet those needs.

ONE WAY PROTECTED CYCLE TRACK

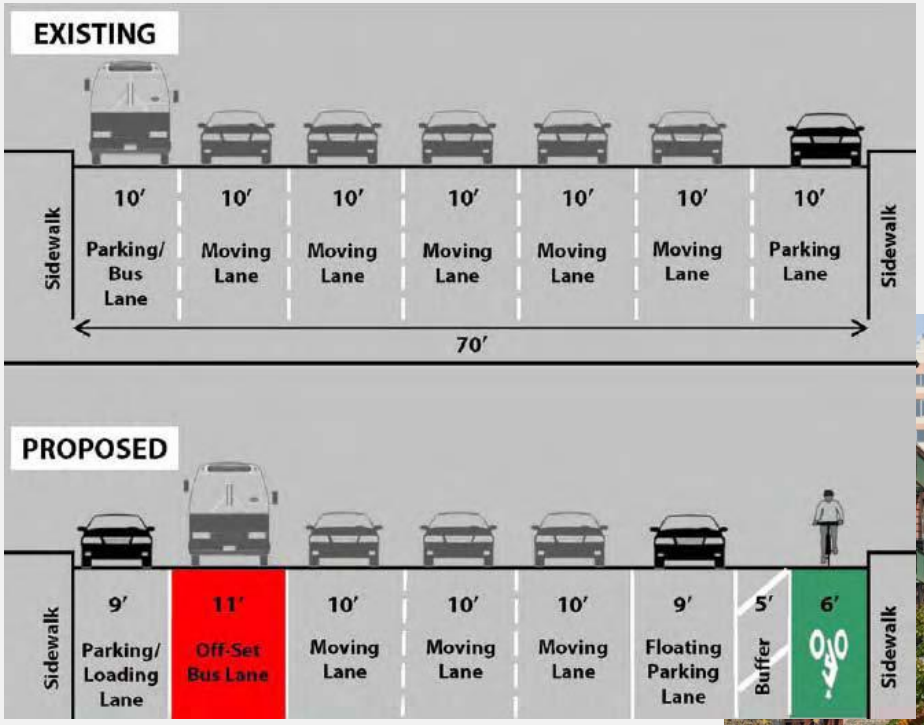
- Protected space for greater comfort
- Eliminated fear of over-taking crashes
- Double parking and parking maneuvers don’t occur in bike lane
- Attracts cyclists of all ages and levels

One way cycle track
Long Beach, CA

Credit: Bikeable Communities

FIRST AVENUE, NEW YORK, NY

Conventional Bike Lane



8th Avenue

W 23rd – W 34th St

Manhattan, 2010

Grand Street

Parking Protected Bicycle Path Pilot

Manhattan, 2008

One way cycle track
PORTLAND, OR

RAISED CYCLE TRACK

CAMBRIDGE, MA

Required Features

The cycle track shall be vertically separated from the street at an intermediate or sidewalk level.

Bicycle lane word, symbol, and/or arrow markings (MUTCD Figure 9C-3) shall be placed at the beginning of a cycle track and at periodic intervals along the facility based on engineering judgment.

A raised cycle track shall be protected from the adjacent motor vehicle travel lane. Protection strategies may include a raised or mountable curb, street furnishings, low vegetation or a parking lane.

If used, the mountable curb should have 4:1 slope edge without any seams or lips to interfere with bike tires to allow for safe entry and exit of the roadway. This curb should not be considered a ridable surface when determining cycle track width.[26]

Recommended Features

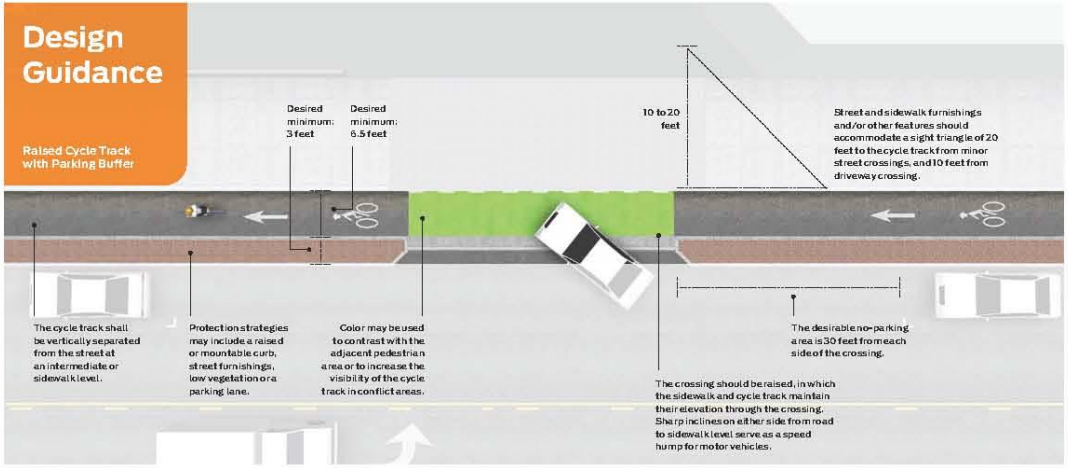
Desirable one-way raised cycle track travel surface width is 6.5 feet to allow side-by-side riding or passing. Desired minimum width is 5 feet at intersections and pinch points. Additional width may be needed for protection from traffic or parking and/or shy distance to sidewalks or furnishings.[27]

When configured next to a parking lane, 3 feet is the minimum desired width for a parking buffer to allow for passenger loading and to prevent dooring collisions. The buffer can be at street level or at the level of the cycle track.[28]

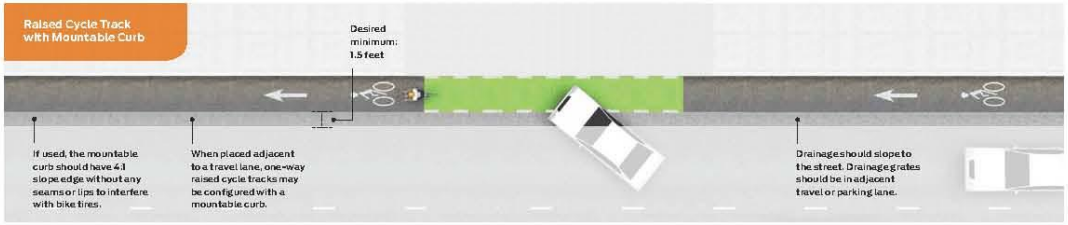
When configured next to a motor vehicle travel lane, 1.5 feet is the desired minimum width for a buffer to provide safety and comfort for bicyclists in the cycle track. The buffer areas should exist as either a raised or mountable curb or be suitable for street furniture, low vegetation, and/or trees.[29]

Design Guidance

Raised Cycle Track with Parking Buffer



Raised Cycle Track with Mountable Curb



Driveways and minor street crossings are a unique challenge to cycle track design. A review of existing facilities and design practice has shown that the following guidance may improve safety at crossings of driveways and minor intersections:

- If the cycle track is parking protected, parking should be prohibited near the intersection to improve visibility. The desirable no-parking area is 30 feet from each side of the crossing.[30]
- For motor vehicles attempting to cross the cycle track from the side street or driveway, street and sidewalk furnishings and/or other features should accommodate a sight triangle of 20 feet to the cycle track from minor street crossings, and 10 feet from driveway crossings.
- Color, yield lines, and "Yield to Bikes" signage should be used to identify the conflict area and make it clear that the cycle track has priority over entering and exiting traffic.[31]
- Motor vehicle traffic crossing the cycle track should be constrained or channelized to make turns at sharp angles to reduce travel speed prior to the crossing.
- The crossing should be raised, in which the sidewalk and cycle track maintain their elevation through the crossing. Sharp inclines on either side from road to sidewalk level serve as a speed hump for motor vehicles.[32]
- If configured at a height flush with the sidewalk, color, pavement markings, textured surfaces, landscaping, or other furnishings should be used to discourage pedestrian use of the cycle zone.

Drainage should slope to the street. Drainage grates should be in adjacent travel or parking lane.

Two-stage turn boxes should be provided to assist in making turns from the cycle track facility.

Optional Features

Cycle tracks may be shifted more closely to the travel lanes on minor intersection approaches to put bicyclists clearly in the field of view of motorists.[33]

When placed adjacent to a travel lane, one-way raised cycle tracks may be configured with a mountable curb to allow entry and exit from the bicycle lane for passing other bicyclists or to access vehicular turn lanes. This configuration has also been known as a "raised bike lane."

PORTLAND, OR

Color may be used to contrast with the adjacent pedestrian area or to increase the visibility of the cycle track in conflict areas.


RAISED
CYCLE TRACK
CAMBRIDGE, MA

SANDS STREET, BROOKLYN, NY

Raised Cycle Track (Centerline)

SANDS STREET, BROOKLYN, NY

Raised Cycle Track (Centerline)

Raised Cycle Track
VANCOUVER, BC

Raised (Contraflow) Cycle Track
DENVER, CO

TWO-WAY CYCLE TRACK

Required Features

Bicycle lane word, symbol, and/or arrow markings (MUTCD Figure 9C-3) shall be placed at the beginning of a cycle track and at periodic intervals along the facility to define the bike lane direction and designate that portion of the street for preferential use by bicyclists.

If configured on a one-way street, a "ONE WAY" sign (MUTCD R6-1, R6-2) with "Except Bikes" plaque shall be posted along the facility and at intersecting streets, alleys, and driveways informing motorists to expect two-way traffic.

MUTCD R6-1, R6-2

A "DO NOT ENTER" sign (MUTCD R5-1) with "EXCEPT BIKES" plaque shall be posted along the facility to only permit use by bicycles.

MUTCD R5-1

Intersection traffic controls along the street (e.g., stop signs and traffic signals) shall also be installed and oriented toward bicyclists traveling in the contra-flow direction.

Recommended Features

The desirable two-way cycle track width is 12 feet. Minimum width in constrained locations is 8 feet.[36]

When protected by a parking lane, 3 feet is the desired width for a parking buffer to allow for passenger loading and to prevent dooring collisions.[37]

A dashed yellow line should be used to separate two-way bicycle traffic and to help distinguish the cycle track from any adjacent pedestrian area.

Driveways and minor street crossings are a unique challenge to cycle track design. A review of existing facilities and design practice has shown that the following guidance may improve safety at crossings of driveways and minor intersections:

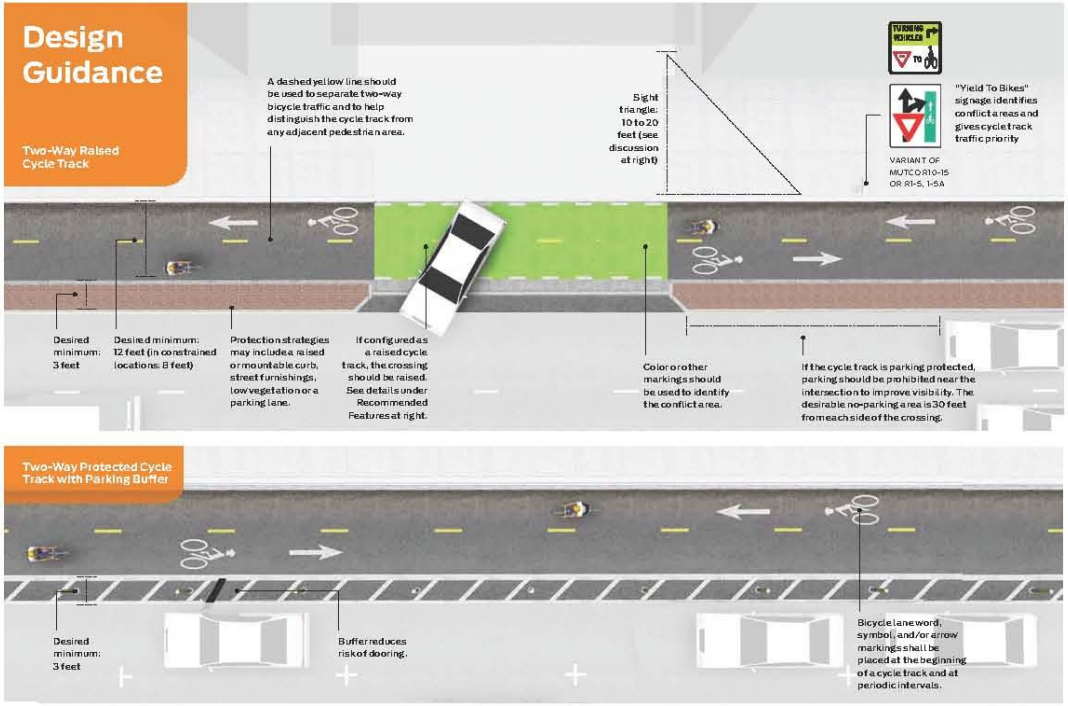
- If the cycle track is parking protected, parking should be prohibited near the intersection to improve visibility. The desirable no-parking area is 30 feet from each side of the crossing.[38]
- For motor vehicles attempting to cross the cycle track from the side street or driveway, street and sidewalk furnishings and/or other features should accommodate a sight triangle of 20 feet to the cycle track from minor street crossings, and 10 feet from driveway crossing.
- Color, yield lines, and "Yield to Bikes" signage should be used to identify the conflict area and make it clear that the cycle track has priority over entering and exiting traffic.[39]
- Motor vehicle traffic crossing the cycle track should be constrained or channelized to make turns at sharp angles to reduce travel speed prior to the crossing.
- If configured as a raised cycle track, the crossing should be raised, in which the sidewalk and cycle track maintain their elevation through the crossing. Sharp inclines on either side from road to sidewalk level serve as a speed hump for motor vehicles.[40]

Two-stage turn queue boxes should be provided to assist in making turns from the cycle track facility.

Optional Features

Cycle tracks may be shifted more closely to the travel lanes on minor intersection approaches to put bicyclists clearly in the field of view of motorists.[41]

May be configured as a raised cycle track.



VANCOUVER, BC

NEW YORK, NY

NEW YORK, NY

PORTLAND, OR

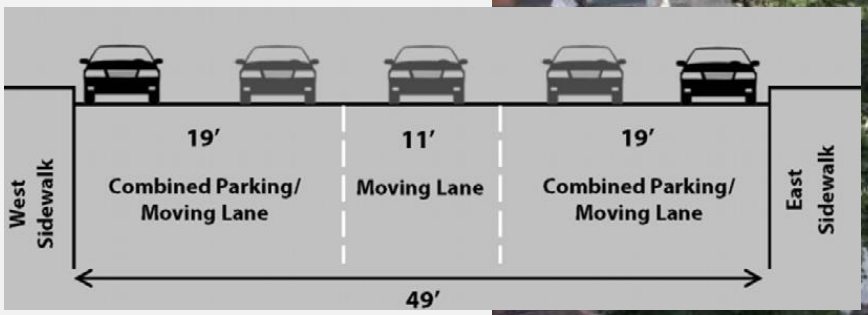
TWO-WAY CYCLE TRACK

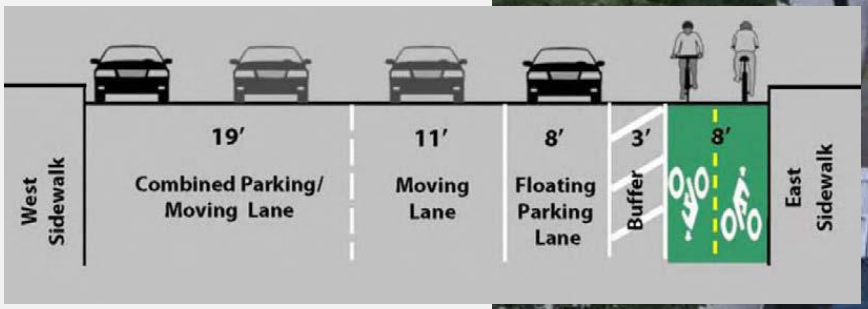
- Edges
- Where intersections are at a minimum

Kent Avenue
Brooklyn

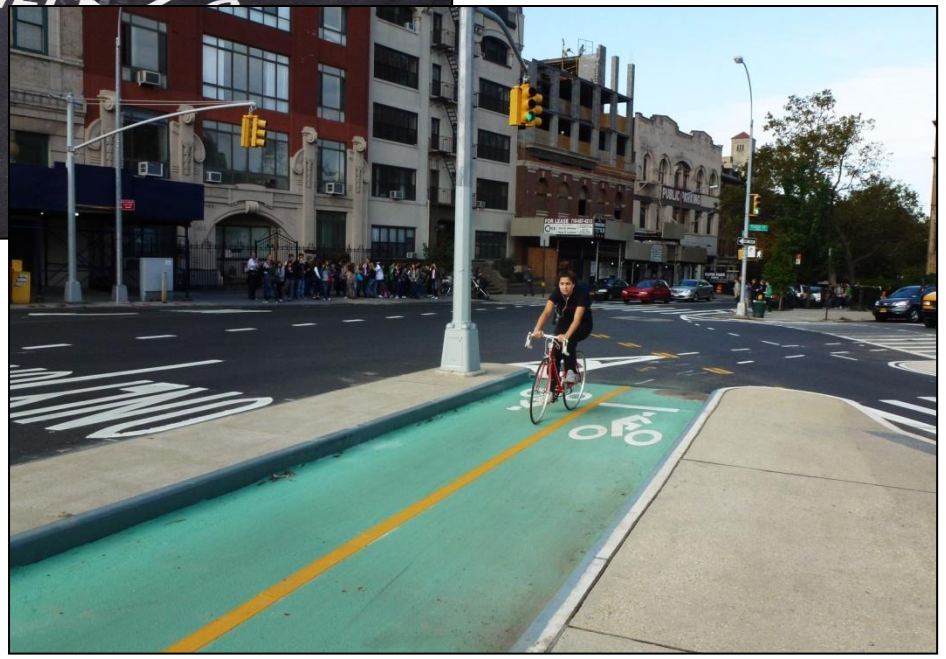
PROSPECT PARK WEST, BROOKLYN, NY

Two-way Cycle Track





Grand Army Plaza
Brooklyn

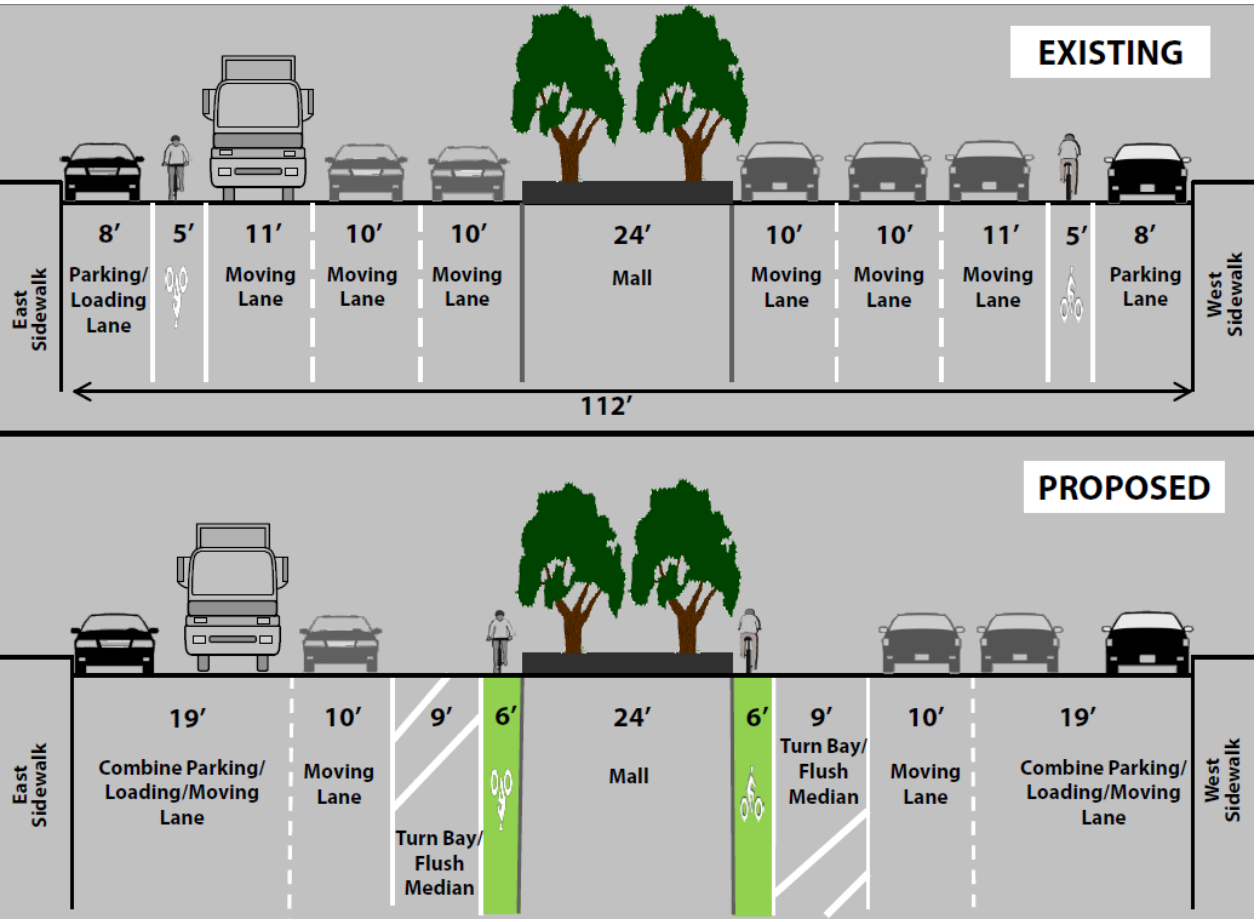


Two-way Cycle Track

KENT AVENUE, BROOKLYN, NY

Two-way Cycle Track

Two-way Cycle Track
WASHINGTON DC



Allen Street, Manhattan

Allen & Pike Streets

Pedestrian & Bicycle Improvements

Manhattan, 2009