Designing and Implementing Separated Bikeways

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Kyle Cook, P.E.

- Bicycle-related project experience at different scales (e.g. regional/city master plans vs. corridor-level construction documents)
- Urban and rural environments
- Specialist in transit station access (first mile last mile)

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Rick Plenge, P.E., PTOE

- Over 18 years of transportation engineering experience in both the public and private sectors
- National Complete Streets Instructor
- Designed and implemented innovative bicycle facilities across the country
- Designed and implemented several of Chicago's and Denver's first separated bikeways

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Discussion Topics

- The need for separated bikeways
- Design standards and guidance for separated bikeways
- Different types of separated bikeways
- Design elements of separated bikeways
- Determining where to apply these treatments
- Implementation considerations

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Learning Objectives

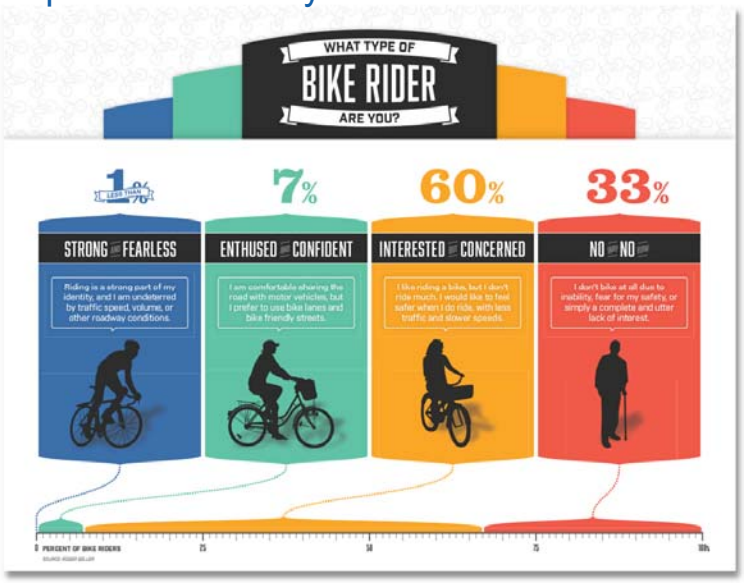
- Become familiar with the latest innovations in bikeway facility design
- Understand available design resources
- Know how to apply the referenced design resources
- Understand the federal approval status for the various bikeway elements
- Understand the design considerations when designing separated bikeways
- Assess the potential for implementation of separated bikeways

What is a Separated Bikeway?

- Also known as cycle tracks or protected bike lanes
- *"A cycle track is an exclusive bike facility that combines the user experience of a separated path with the on-street infrastructure of a conventional bike lane"* – NACTO Urban Bikeway Design Guide
- *"Separated bike lanes are differentiated from standard and buffered bike lanes by the vertical element"* – FHWA
- Shared use paths operate in separate rights-of-way

Source: FHWA Separated Bike Lane Planning and Design Guide

Why Separated Bikeways?



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Design Standards vs. Guidance

What's the difference?

- Manual on Uniform Traffic Control Devices (MUTCD)

- **Standards** *must* be followed and require documentation when they can't be ("design exceptions")
- **Guidance**
  - There are varying degrees of flexibility for following guidance
  - Guidance may not apply in all situations
  - Usually don't require documentation of design exceptions

Example (MUTCD Section 2B.05):

- **Standard:** "The STOP sign *shall* be an octagon with a white legend and border on a red background"
- **Guidance:** "Plaques with the appropriate alternatives messages TRAFFIC FROM LEFT (RIGHT) DOES NOT STOP or ONCOMING TRAFFIC DOES NOT STOP *should* be used at intersections where…"

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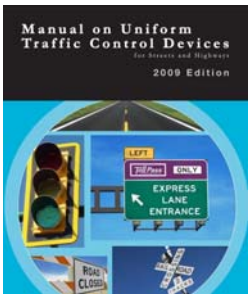
Standards

Two types

- Those with legal standing
  - Utah Traffic Code (Title 41, Chapter 6a) 41-6a-301 *"...the Department of Transportation shall make rules consistent with this chapter adopting standards and establishing specifications for a uniform system of traffic-control devices used on a highway."*
  - **California** Vehicle Code (CVC) 21400, **Colorado** Revised Statutes 42-4-105, Revised Code of **Washington** 47.36.020, **Washington D.C.** Municipal Regulations (DCMR) 18-2100.
  - *Manual on Uniform Traffic Control Devices (MUTCD)*



- Geometric standards adopted by a jurisdiction
  - UDOT 2012 Standards and Specifications
  - California Highway Design Manual
  - American Public Works Association (APWA) Manual of Standard Plans

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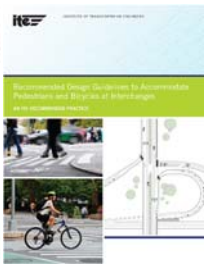
Guidance

Many types

- NACTO – Urban Bikeway Design Guide
- FHWA – Separated Bike Lane Planning and Design Guide
- CROW – Design Manual for Bicycle Traffic (Dutch Guide in English)
- ITE Recommended Design Guidelines to Accommodate Pedestrians and Bicycles at Interchanges
- Local guidance



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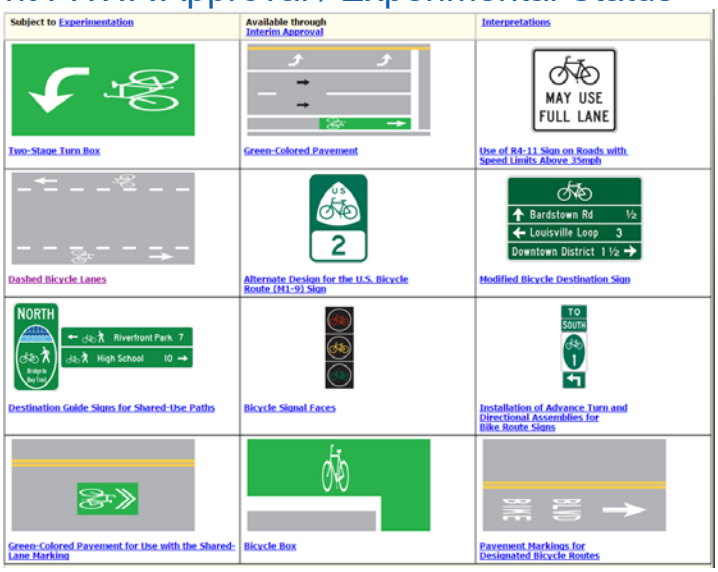
Current FHWA Approval / Experimental Status



https://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/mutcd/index.cfm

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Buffered Bike Lanes

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Buffered Bike Lane Design Considerations

- Apply on streets with:
  - Higher travel speeds
  - Higher amounts of truck traffic
  - Extra lanes or lane width

Source: NACTO

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Buffered Bike Lane Design Criteria

- Width:
  - Bicycle travel area should meet width requirements for a traditional bike lane
  - Buffer width:
    - 18” minimum (impractical to mark a narrower zone) between bike lane and travel lane; wider is better
    - Door zone is ~4’ wide, NACTO recommends 5’ minimum buffer width between bike lane and parking lane
- Buffer can be provided on both sides of bike lane
- Chevron or diagonal lines for cross hatching when buffer is 3’ or greater
- Buffer should be dashed through conflict areas

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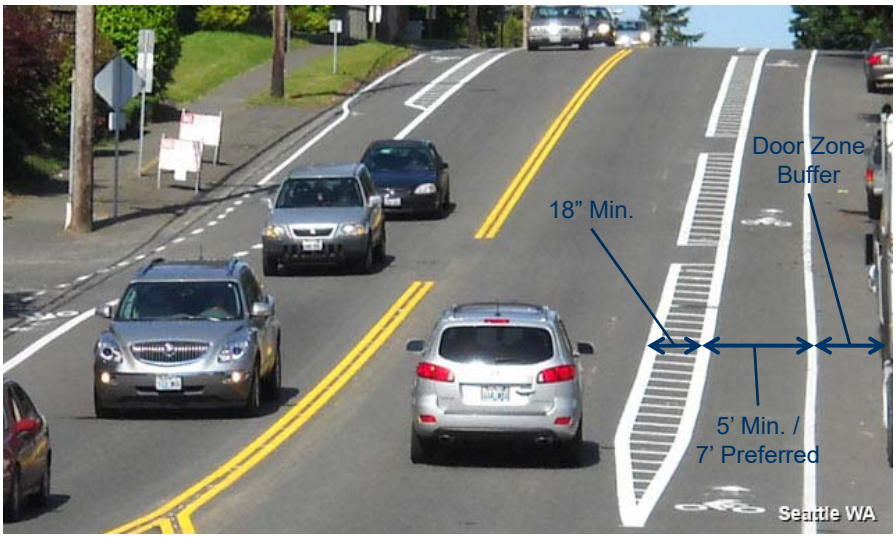
Buffered Bike Lanes



Source: NACTO

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Buffered Bike Lanes

Source: NACTO

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Buffered Bike Lanes

Source: NACTO

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Buffered Bike Lanes

Source: NACTO

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Separated Bike Lanes / Cycle Tracks

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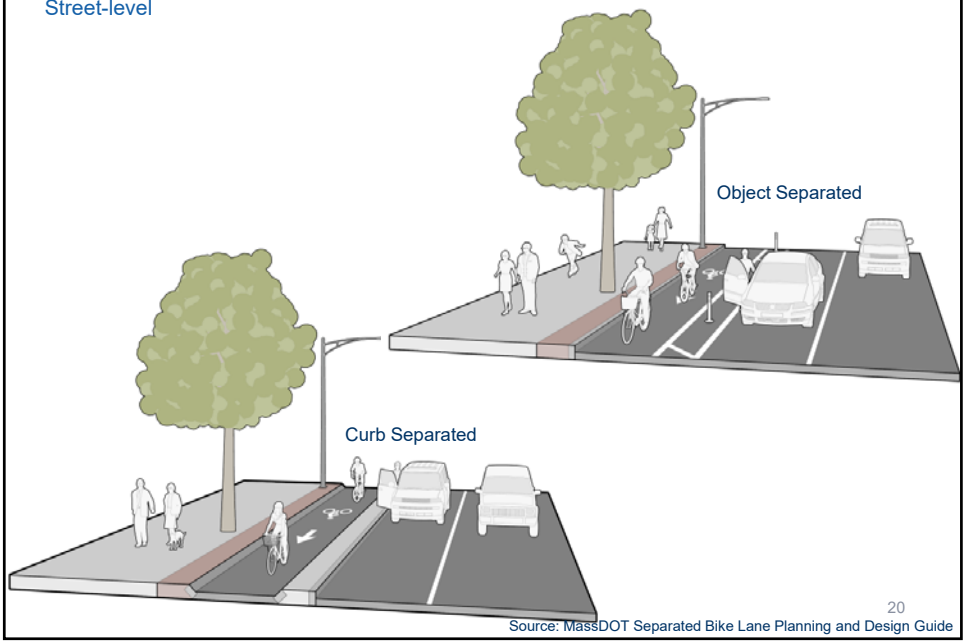
Separation Types

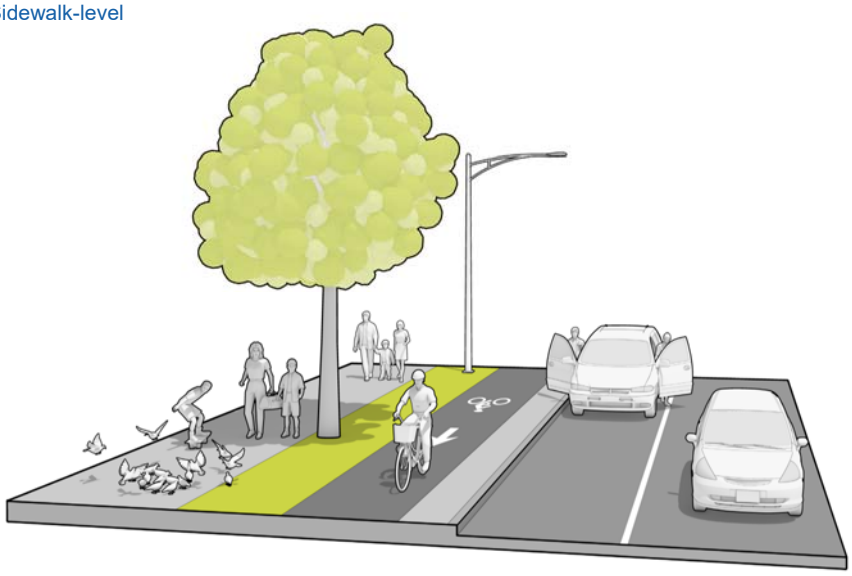
Street-level



Source: MassDOT Separated Bike Lane Planning and Design Guide

Separation Types

Sidewalk-level



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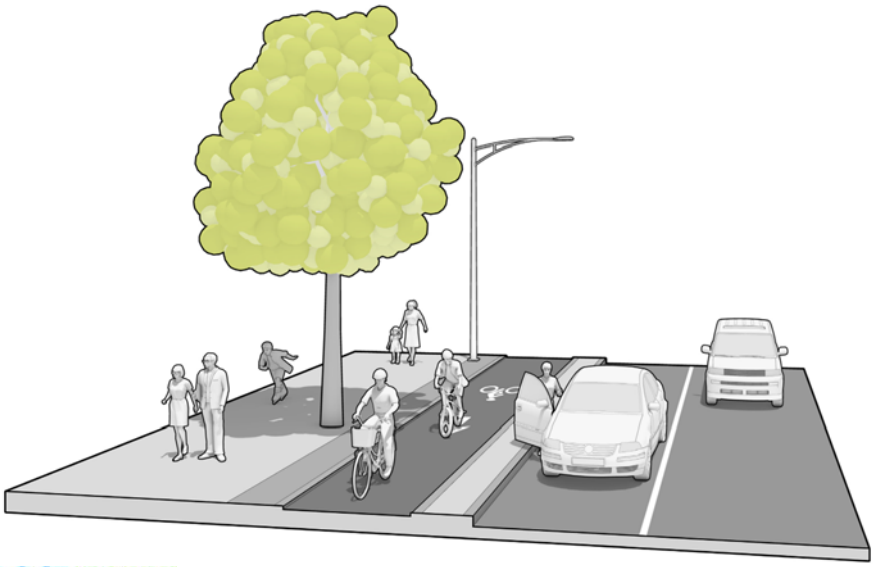
Source: MassDOT Separated Bike Lane Planning and Design Guide

Separation Types

Intermediate-level



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Source: MassDOT Separated Bike Lane Planning and Design Guide

Separation Device Examples

Source: Peopleforbikes.com

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Separation Device Examples

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Separation Device Examples

Source: Peopleforbikes.com

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Sidewalk-level Example

Source: NACTO

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One-Way Cycle Track Criteria

- Bicycle lane
  - 5’ minimum width, 7’ desired width (depending on bicycle volume, gutter width and pavement condition)
  - Driveway conflict areas should be marked and signed
- Buffer space
  - 3’ minimum width, 4’ preferred width (wheel chairs/baby strollers)
  - Define with solid outside lines/crosshatched center
  - Consider maintenance vehicle width (street sweeper/snow plow)
- Parking lane
  - 7’ minimum width, 8’ desired width (bicycle volume/gutter width)
  - Driveway conflict areas should be marked and signed
  - Parking should be restricted a minimum of 20’ on the approaches to all driveways and intersections

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One-Way Cycle Track

Source: Chicago DOT

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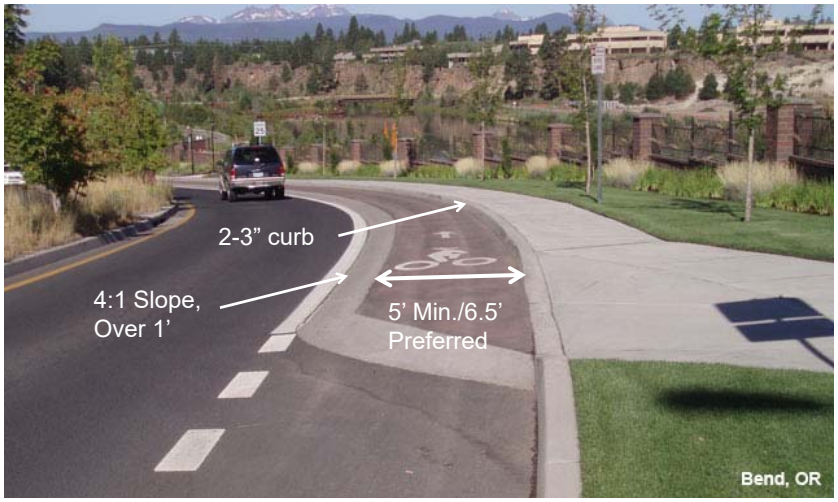
Sidewalk-level Cycle Track



Source: NACTO

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Two-Way Cycle Track

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Two-Way Cycle Track Design Criteria

- Bicycle lane
  - 12’ desired width/8’ minimum width in constrained locations
  - Dashed yellow centerline to separate bike traffic and define as two-way
  - Utilize enhanced treatments at conflict areas
- Buffer space
  - 3’ minimum width/4’ preferred width when adjacent to parked cars
  - Define with solid outside lines/crosshatched center
  - Consider maintenance vehicle width (street sweeper/snow plow)
- Parking lane
  - 7’ minimum width, 8’ desired width (bicycle volume/gutter width)
  - Should be restricted on approaches to driveways and intersections (20’ from minor street crossings, 20’ from driveway crossings)
  - Conflict areas should be marked and signed

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Two-Way Cycle Tracks

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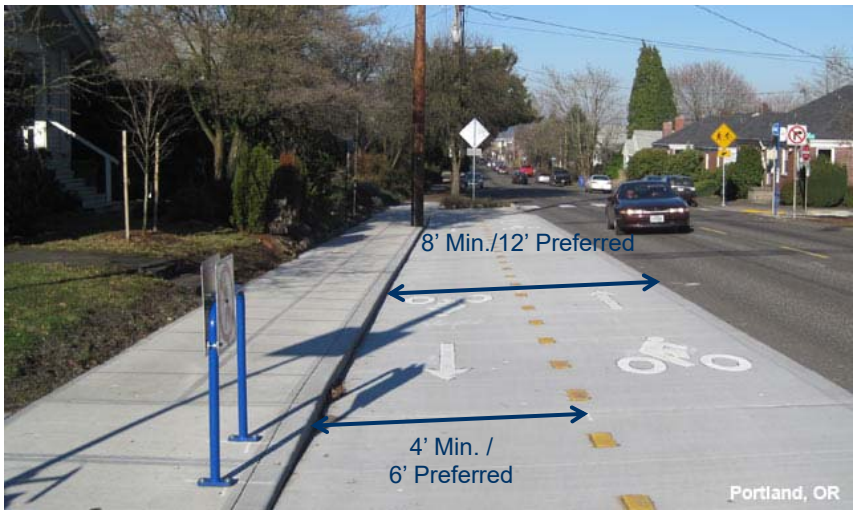
Raised Two-Way Cycle-Tracks



Source: NACTO

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Intersection Marking Treatments

FHWA Status: Allowable

Source: NACTO

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Intersection Marking Treatments

Source: Chicago DOT

Intersection Marking Treatments

Source: NACTO

Intersection Marking Treatments

Source: NACTO

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Bike Boxes

FHWA Status: Available through interim approval

Source: NACTO

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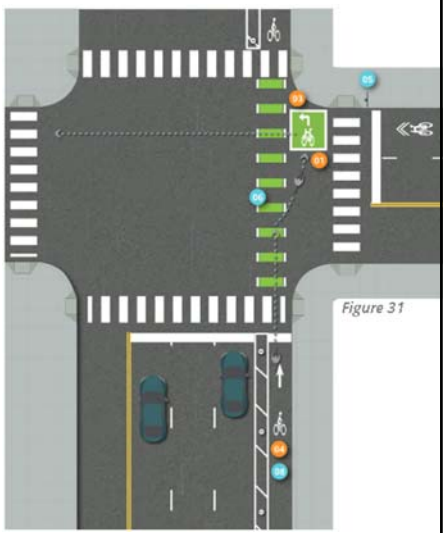
Bike Boxes

Source: NACTO

Two-Stage Turn Queue Boxes

FHWA Status: Experimental



Source: FHWA Separated Bike Lane Planning and Design Guide

Two-Stage Turn Queue Boxes

Source: NACTO

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Two-Stage Turn Queue Boxes

Source: Peter Koonce

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Bike Signals

FHWA Status: Available through interim approval

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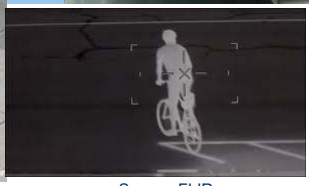
Bike Detection

Source: NACTO



Source: FLIR

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Cycle Tracks at Intersections

Source: NACTO

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Cycle Tracks at Intersections

Source: NACTO

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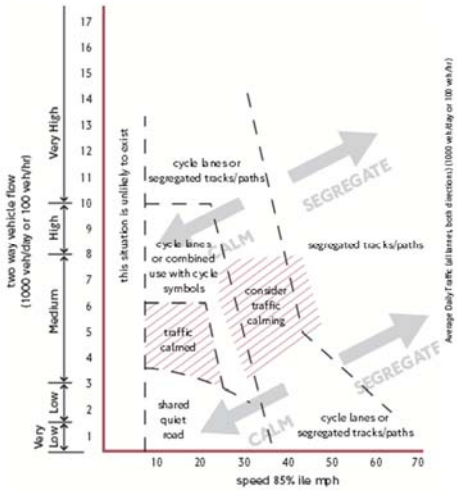
Cycle Tracks at Intersections - Mixing Zones

Source: NACTO

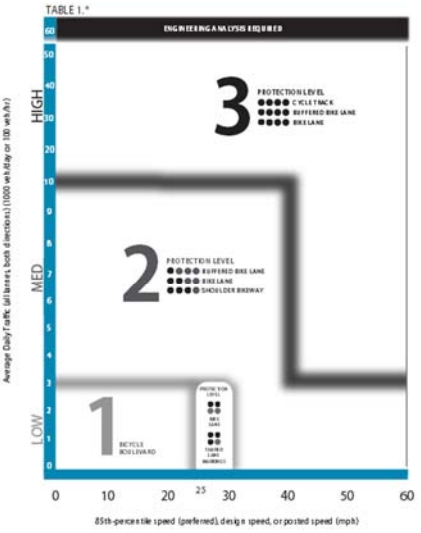
Protected Intersections

Source: NACTO

Bicycle Facility Selection Tools

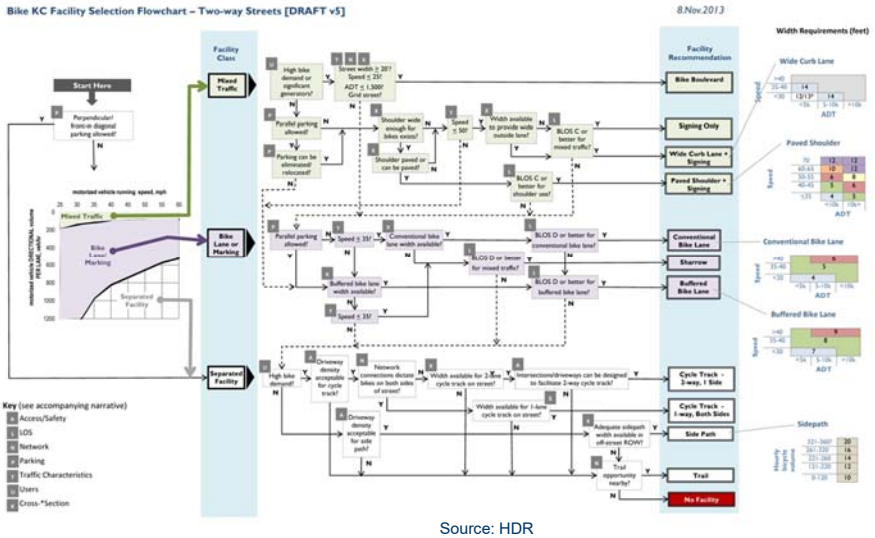


Source: Transport For London



Source: Washington County, OR

Bicycle Facility Selection Tools



Source: HDR

Buffered Bike Lane Side Selection

Source: Peopleforbikes.org/Images.frompo.com/Activetrans.org/LAStreetblog

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Cycle Track Position Location

Source:
www.voleospeed.co.uk/www.aviewfromthecyclepath.com/www.bikeexprt.com/wiki.coe.neu.edu

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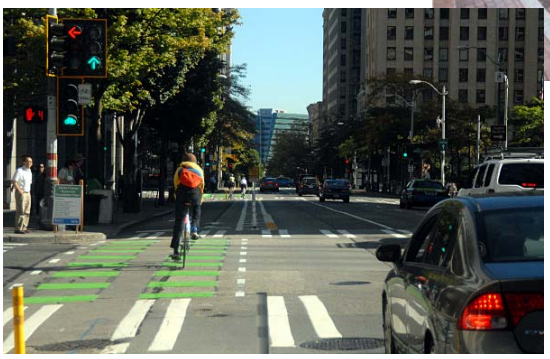
Intersection Conflict Resolution

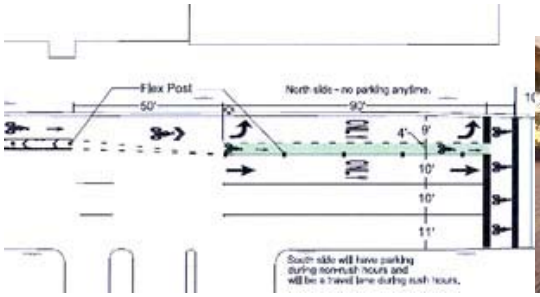
- Mixing Zones
  - < 60 turning veh/hr
- Bike Signals/Protected Phasing
  - 31% to 81% jump in compliance

Source: Streetsblog



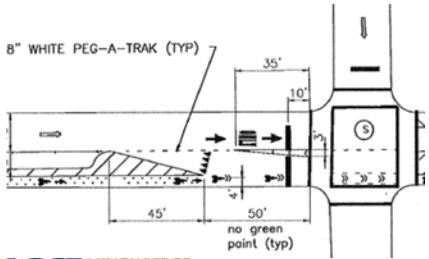
Source: People for Bikes

Mixing Zones



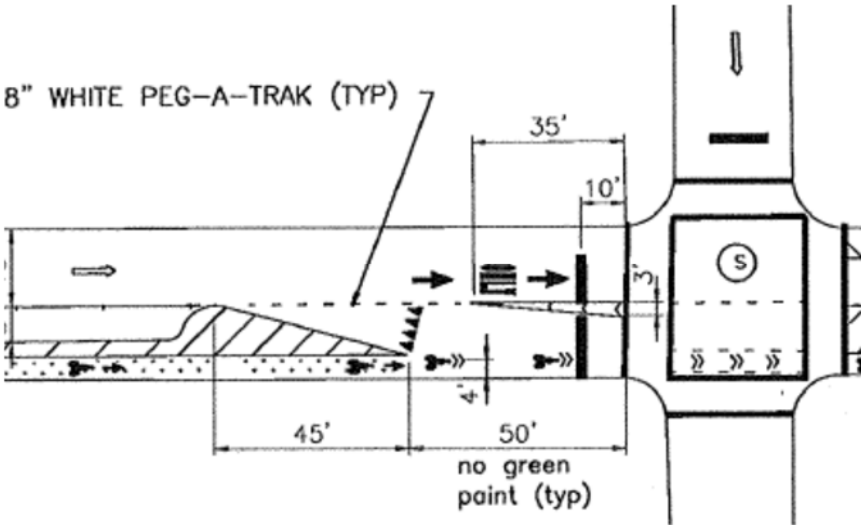
Source: Waba.org

Source: DDOT



Source: NYCDOT

Mixing Zones



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Source: NYCDOT

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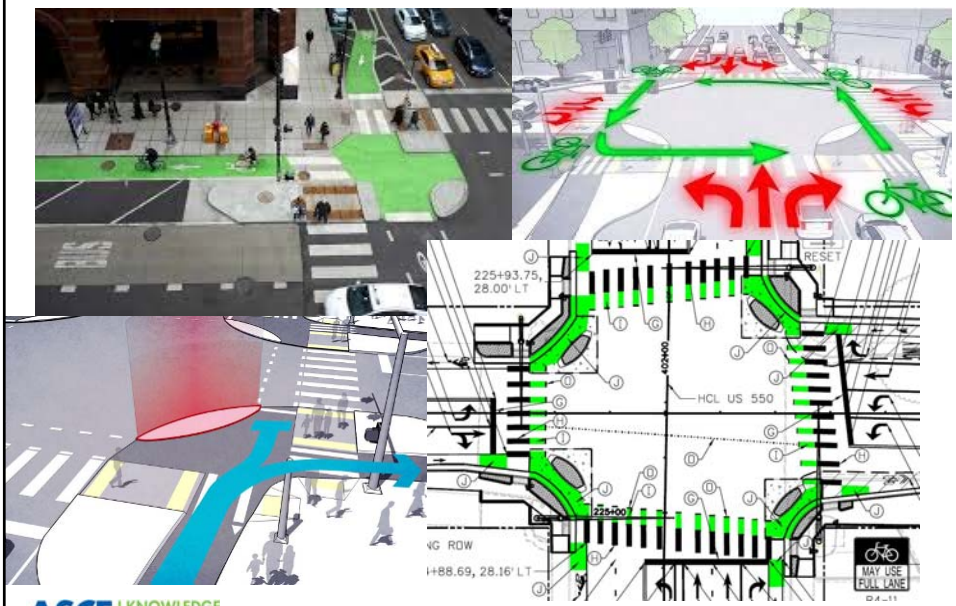
Protected Intersections



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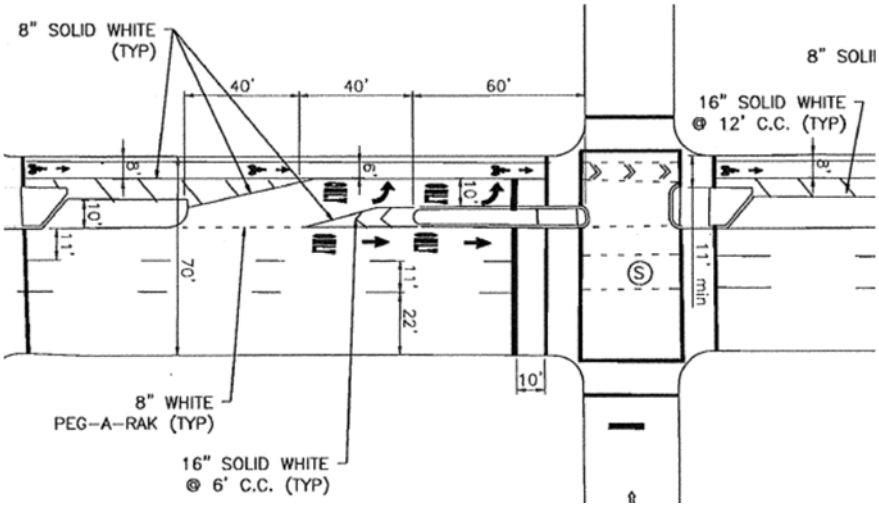
Bicycle Signals/Protected Turn Phasing

Source: NACTO

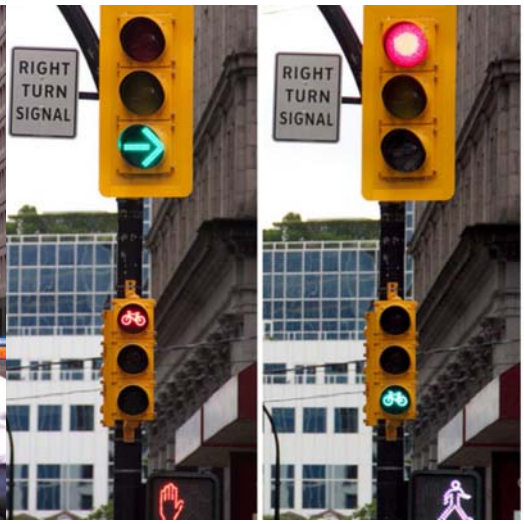
Bicycle Signals/Protected Turn Phasing



Source: NACTO

Bicycle Signals/Protected Turn Phasing

Source: Peter Koonce



Source: Streetsblog

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Cycle Track Separation Devices

Cycle Track Barrier Selection Matrix

DRAFT

	Striped Buffer	Delineator Posts	Turtle Bumps	Large Bumps	Oblong Low Bumps	Parking Stops	Linear Barrier	6" Cast in Place Barrier Curb	Parked Cars	Jersey Barriers	Planters	Rigid Bollards	Cast in Place Barrier Curb	Precast Barrier Curb	Raised Cycle Track (Full Fence)
Cost/Benefit															
Cost	★★★★	★★★	★★★	★★★	★★★	★★★	★★★	★★★	★★	★★	★★	★★	★★	★	★
Cyclist Perceived Safety	★	★★★	★★★	★★★★	★★	★★★	★★★	★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★	★★★★
Other Considerations															
Durability / Maintenance	★★	★	★★★	★★★	★★★	★★★	★★★	★★★	★★★★	★★★★	★	★★★	★★★★	★★★	★★★★
Sweeping	★★★★	Depends on Width	Depends on Width	Depends on Width	Depends on Width	Depends on Width	Depends on Width	Depends on Width	★★★	Depends on Width	Depends on Width	Depends on Width	Depends on Width	Depends on Width	Depends on Width
Trash Collection	★★★★	★	★★★★	★	★★★★	★★★★	★★★★	★★★★	Depends on Time of Day	★	★	★	★★★★	★★★★	★★★★
Storm Water	★★★★	★★★	★★★	★★★	★★★	★★	★★★	★★★	★★★★	★★	★★	★★★	★★	★★	★
Traffic Compatibility (Motor vehicle / barrier interactions)	★★★★	★★★★	★★	★★	★★★	★★★	★★★	★★★★	★★★	★★★★	★★★	★★	★★★★	★★★	★★★★
Aesthetics (Accounts for Full Life Cycle)	★★	★	★★★	★★★★	★★	★★	★★	★★	★★★	★	★★★★	★★★	★★★	★★★	★★★
Construction Impacts	★★★★	★★★	★★★	★★★	★★★	★★★	★★★	★★	★★★★	★★★	★★★	★★	★★	★★★	★
Width Required	1.5'	1.5'	1.5'	1.5'	1.5'	6.5'	6.5'	6.5'	11' for parking and buffer	2'	3'	2'	1'	1.5	3'

Source: Peopleforbikes
http://www.peopleforbikes.org/blog/entry/wonktastic-chart-rates-15-different-ways-to-protect-bike-lanes

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Cycle Track Separation Devices – Flex Posts

Source: Peopleforbikes.com

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Cycle Track Separation Devices – Floating Parking

Source: Peopleforbikes.com

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Cycle Track Separation Devices - Landscaping

Source: Peopleforbikes.com

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Cycle Track Separation Devices – Landscaping/Curb

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Source: Peopleforbikes.com

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Cycle Track Separation Devices – Bike Racks/Street Furniture

Source: Peopleforbikes.com

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Cycle Track Separation Devices - Armadillos

Source: GreatergreaterWashington.org

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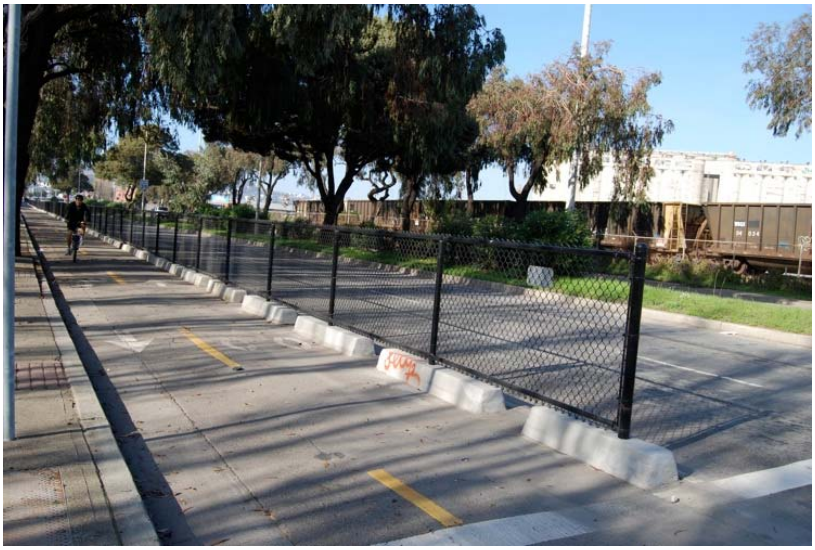
Cycle Track Separation Devices – Curb Stops/Fencing



Source: Peopleforbikes.com

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Cycle Track Separation Devices – Modular Curb

Source: wamu.org

Source: streetsblog.net

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Cycle Track Separation Devices – Raised Facility

Source: Peopleforbikes.com

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Pilot Projects

Source: MMM Group

Source: People for Bikes

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Pilot Projects

Source: NACTO

Cycle Track Design Considerations

- Maintenance vehicles
- ADA accessibility
- Transit stops
- Pedestrian conflicts
- Driveways/Land-use
- Parking enforcement
- Driver/cyclist sight lines
- Snow storage
- Special events
- Trash service
- Capital/maintenance costs
- Emergency/delivery vehicles
- Visibility of regulatory devices
- Termini
- City ordinances

Source: Eric Léonard, GENIVAR, Inc.

Maintenance Considerations

Source: Steven Vance

Source: phillymotu.worpress.com

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Pavement Condition/Maintenance

Source: beezeodogsplace.com

Source: city of chicago

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Pavement Marking Maintenance Issues

Source: /blogdowntown.com/StreetsblogChicago.org/ennisflint.com

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Flex Post Maintenance Issues

Source: Streets Blog Chicago

Source: bikeportland.org

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ADA Accommodations

Source: Bike Portland

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Bus Stop ADA Accommodations

Source: Fehr & Peers

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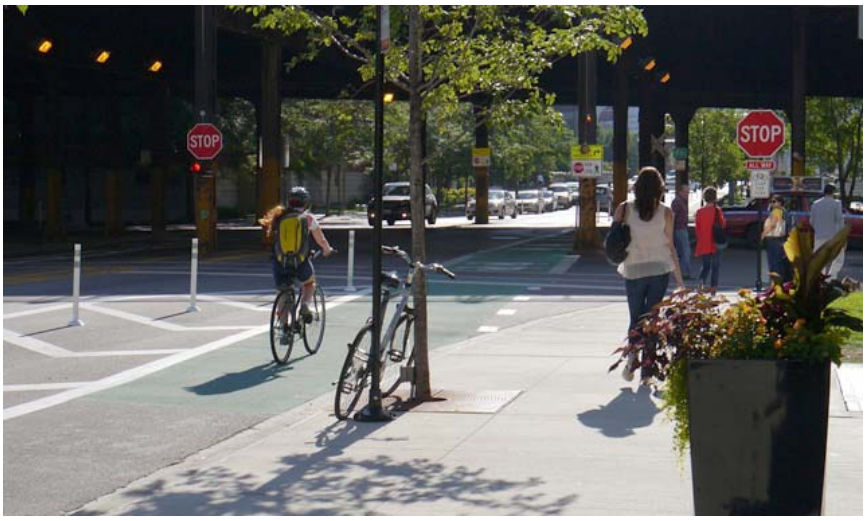
Trash Service

Source: Bike Portland

Traffic Control Placement



Pedestrian Conflicts

Source: Truewheelers.org

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Parking Conflicts

Source: Who's Blocking the L Street Bike Lane Today?

Source: Denver Public Works

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Emergency Responder Conflicts

Source: www.bates.edu

Source: www.fairfaxcounty.gov

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Delivery Vehicle Accommodations

Source: NACTO

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Special Events

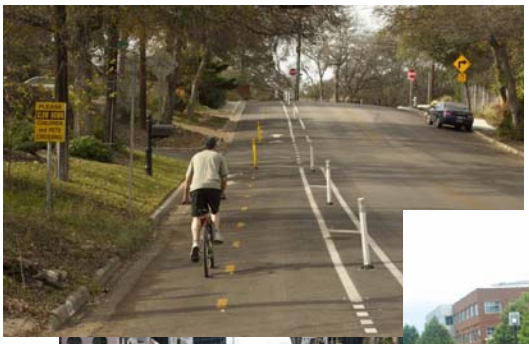
Source: Chicago Sun Times

Transitions/Termini

Source: StreetsblogSF

Source: NACTO

Land-Use/Access



Source: Columbusridesbikes.com

Source: Bicycletimesmag.com

Source: Streetsblog

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Education

Source: City of Chicago

Source: StreetsBlog Chicago

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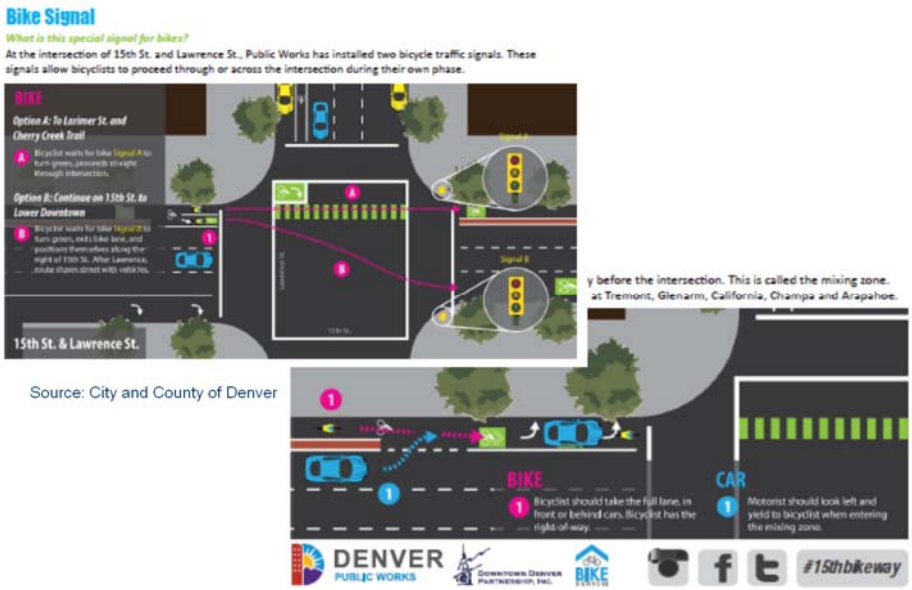
Education



Source: City and County of Denver

Enforcement

- Illegally Parked Vehicles
  - Design for Delivery Vehicles
  - Park dummy vehicle
- Know the Laws
  - Some communities allow 20 min parking in bike lane
- Report the Problem
  - Police Department
  - Social Media
- Encourage Active Enforcement Campaign for 1 Month

Source: NACTO/People for Bikes

Vehicle Code/City Ordinances

Millennium Edition of the Uniform Vehicle Code.

ARTICLE VI—TURNING AND STARTING
AND
SIGNALS ON STOPPING AND TURNING

§ 11-601—Required position and method of turning

The driver of a vehicle intending to turn shall do so as follows:
(a) *Right turns* — Both the approach for a right turn and a right turn shall be made as close as practicable to the right-hand curb or edge of the roadway.

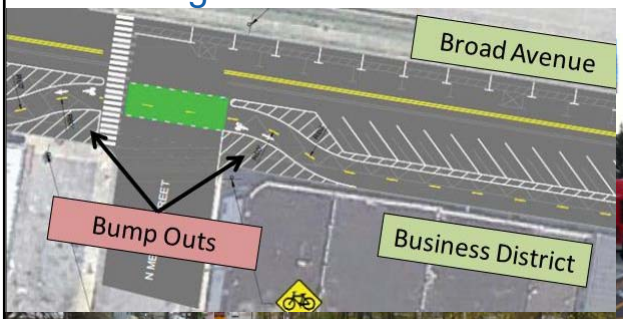
§ 11-1004—Additional parking regulations
(a) Except as otherwise provided in this section, every vehicle stopped or parked upon a two-way roadway shall be so stopped or parked with the right-hand wheels parallel to and within 12 inches of the right-hand curb or as close as practicable to the right edge of the right-hand shoulder.

Pavement Marking Applications

- Consistency versus Priority

Source: NACTO

Driver Sight Lines



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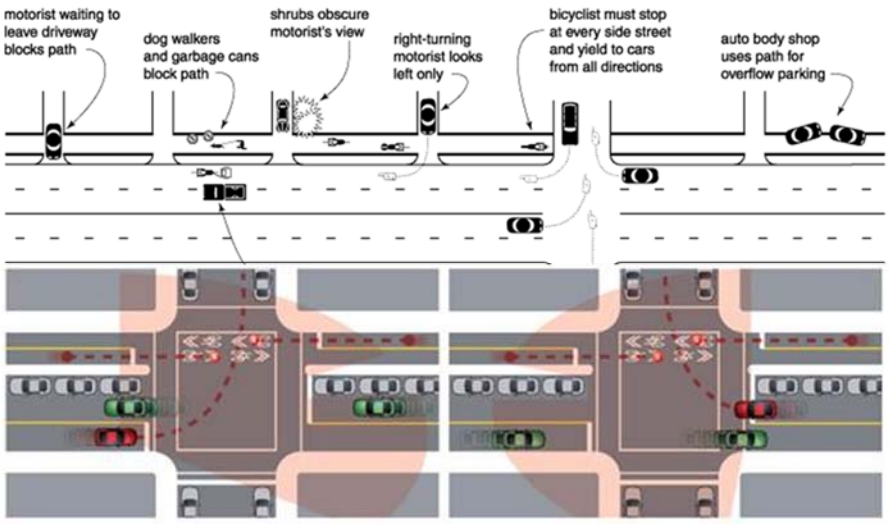
Driver Sight Lines



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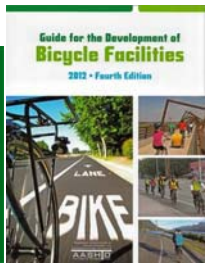
Innovative Design Guidance

- CROW – Design Manual for Bicycle Traffic (Dutch Guide in English)
- NACTO – Urban Bikeway Design Guide
- FHWA – Separated Bike Lane Planning and Design Guide
- AASHTO – Guide for the Development of Bicycle Facilities
- City/State Design Manuals



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Questions?

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