BIKE BOULEVARD

DENVER

Design Guidelines

INTRODUCTION

What is a Bike Boulevard?

A bike boulevard is a street designed to give priority to non-motorized users and discourage through traffic by motorized vehicles (particularly non-local cut-through traffic). A separated space in the street is not necessary because the priority for non-motorized users is communicated through the roadway design, signage, and traffic calming measures. A bike boulevard is not a single treatment, but rather a combination of treatments used to convey the intended use of the street and provide a comfortable environment with minimal delays for bicyclists.

Key Features and Characteristics

Connectivity

Bike boulevards connect destinations such as residential neighborhoods, schools and universities, employment centers, commercial centers, recreation facilities, transit, and other bike facilities. Bike boulevards should be long enough to provide continuity over a typical urban bicycle trip (one to five miles), but they can also be used for shorter distances when needed to connect other bike facilities.

Traffic Volumes

Bike boulevards have low traffic volumes. Streets with volumes less than 1,500 vehicles per day are ideal, between 1,500 and 4,000 vehicles per day is acceptable, and streets with traffic volumes exceeding 4,000 vehicles per day will require modifications to decrease traffic volumes.

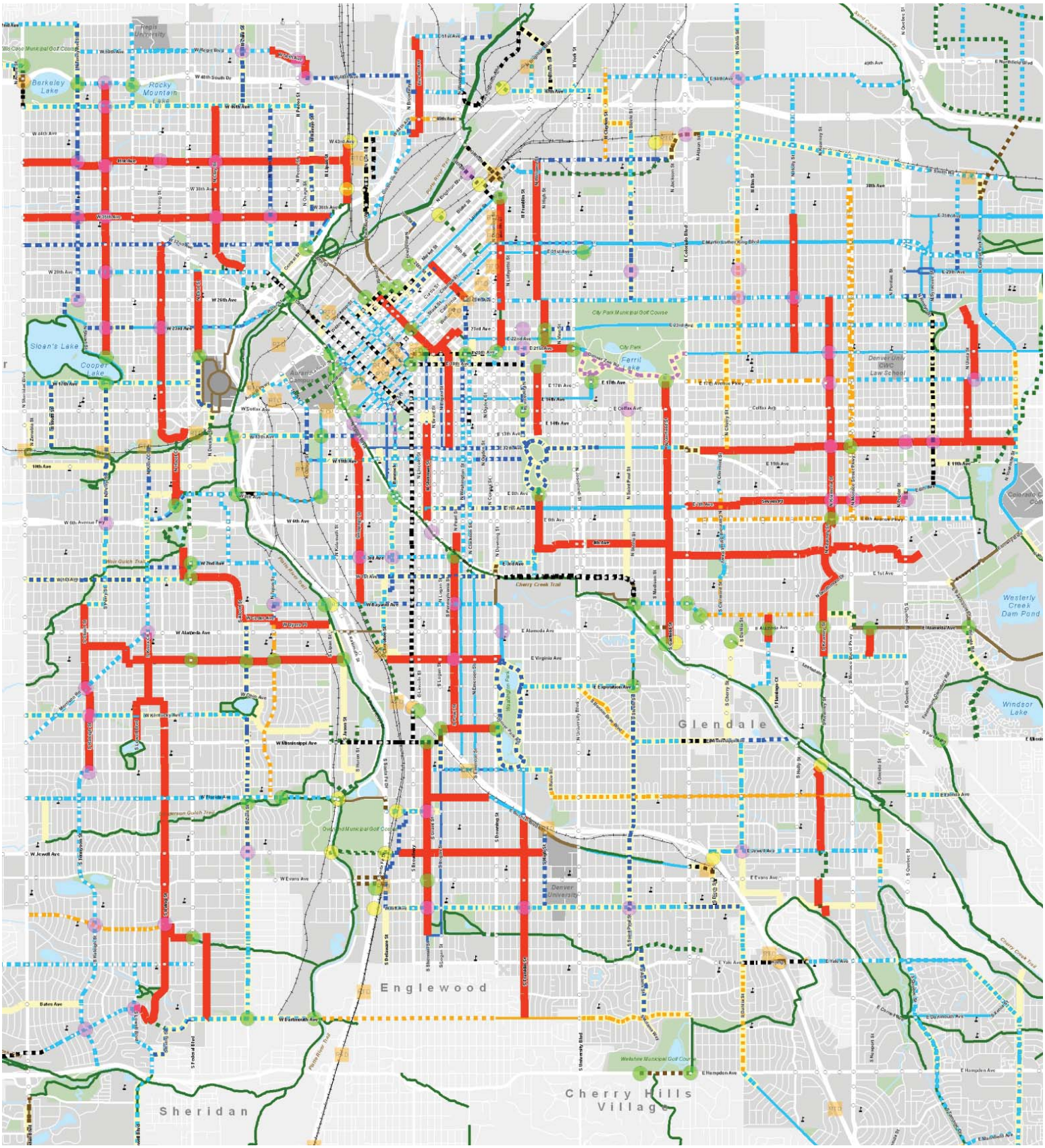
Travel Speed

Bike boulevards have low posted travel speeds to minimize the speed differential between motorists and cyclists. Streets with travel speeds of 25 miles per hour or less are preferable for bike boulevards. Roadways with higher travel speeds will likely need to be slowed to an acceptable level with traffic calming when designated as a bike boulevard.

Bike Boulevards in Denver Moves

Bike boulevards are typically best accomplished in neighborhoods with a gridded street network where one street is chosen as the bike boulevard, and alternate routes for motorized traffic are readily available. Bike boulevards should provide connectivity between neighborhoods and common destinations via low-volume streets. They can also be created by combining a series of road and trail segments to form one continuous route.

Denver Public Works' non-motorized plan, Denver Moves (May 2011), established a proposed facility network for bicycle travel. The Facility Map identifies locations where a variety of bicycle and multi-use facility types are recommended for implementation throughout the City. Denver Moves includes 62 miles of proposed bike boulevards, all of which are on local residential streets that generally align, or could be designed to align, with the key features and characteristics of a bike boulevard. Bike boulevards account for nearly a quarter of the proposed bicycle network miles recommended for implementation. The proposed bike boulevards were selected to complement Denver's overall bicycle network, taking advantage of low traffic volume, low-speed streets that provide direct connections to the network and key destinations. Many of the proposed bike boulevards in Denver have been identified as near-term projects (Phase I of Denver Moves).



Bike Boulevards in Denver Moves

Bicycle Boulevard

BIKE BOULEVARD DESIGN STUDY

A design study will be conducted prior to implementation of any bike boulevards along the corridors identified in Denver Moves or other corridors that may be considered for bike boulevards in the future. The purposes of the design study are to gather technical data, work directly with the adjacent property owners and surrounding community, assess the viability of the corridor as a bike boulevard, and identify appropriate bike boulevard treatments.

Data Collection

As the first step in a design study, the data collection effort will be tailored to fit the unique conditions of the subject corridor. It will consider the following items:

- Existing and future land uses, zoning, and demographics
- Street cross-section(s) including dimensions of travel lanes, parking, sidewalks, etc.
- Surrounding street grid
- Traffic control including traffic signals, stop signs (and orientation), posted speed limits, other signs
- Existing daily traffic volumes, peak period turning movement counts at major intersections
- Bicycle and pedestrian counts
- Signal timing
- Radar speed data
- Crash history (minimum three years)
- Future traffic forecasts if the corridor is in or near an Area of Change, as designated in Blueprint Denver

These data will be analyzed to provide an assessment of the technical feasibility and potential benefits or trade-offs of implementing a bike boulevard. They may also be used to understand the level to which traffic calming and/or traffic diversion would be needed to achieve the desired conditions of a bike boulevard, as described in the Key Features and Characteristics section.

Public Outreach Process

The transition of a street into a bike boulevard can change the appearance and function of the street. In conducting a bike boulevard design study, a public outreach process will be conducted that allows the property owners on the study corridor and adjacent corridors and the larger community to be involved in the decision making process. Customized to meet the needs of the specific study, outreach to the community should occur at a minimum twice during the study:

- At the onset of the study to understand the needs and concerns of the community as well as to educate the public on the concept and purpose of a bike boulevard;
- During the alternatives evaluation process, at which time the public can provide input on the alternative bike boulevard treatments being considered.

The outreach process will be tailored to best match the schedules and preferred communication methods of the corridor property owners and the larger community. The following are possible tools and approaches:

- Small group workshop(s) with the corridor property owners;
- Public open house(s);

- Use of established neighborhood groups, bicycle advocacy groups, or other non-profit organizations that promote non-motorized travel to engage the public, reach their constituents, and advertise public meetings;
- Presentations at established neighborhood meetings;
- Walking or biking tour of corridor with residents;
- Door-to-door surveys to solicit input from all property owners, including those who may not be inclined to partic ipate in community meetings;
- Direct mailings to residents and businesses along or near the corridor;
- Post current information on a project website, and include contact information and/or solicit input directly on the website;
- Use of social media to advertise community meetings and/or website updates
- Use of an interpreter for meeting flyers and at community meetings;
- Frame the discussion around overall benefits of a bike boulevard (walkability and livability) to help engage property owners who may not be interested in cycling.

Common Concerns

Property Access and Traffic Rerouting

A common feature of bike boulevards is the discouragement of through travel by motorized vehicles. Residents and property owners along the corridor may be concerned about the resulting impact on their access. Access to their property by motor vehicles will be maintained; however, depending on the design, the route to access properties by car may change for some residents, and may require some out-of-direction travel as well. Local traffic patterns adapt to motor vehicle movement restrictions over time, and the adjacent property owners often value the resulting reduction in through traffic. However, traffic calming or movement restrictions along a bike boulevard may induce traffic on adjacent parallel streets; these impacts shall be considered during the design study.

Road Maintenance and Snow Removal

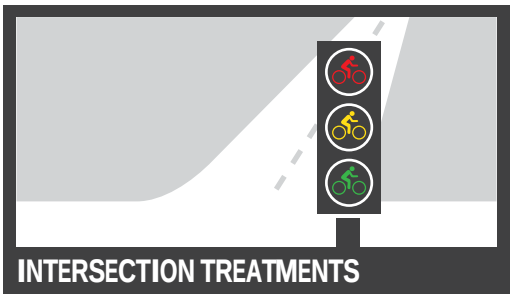
The design and implementation of bike boulevards will consider roadway maintenance, street sweeping, and snow removal operations. The corridors that have been identified as proposed bike boulevards in DenverMoves are local residential streets, most of which are not snow plow routes for Denver. Denver generally does not plow residential streets, except in the vicinity of schools. During the design study, it will be determined whether or not the corridor is a snow plow route; this determination may influence the design elements that are appropriate for the corridor.

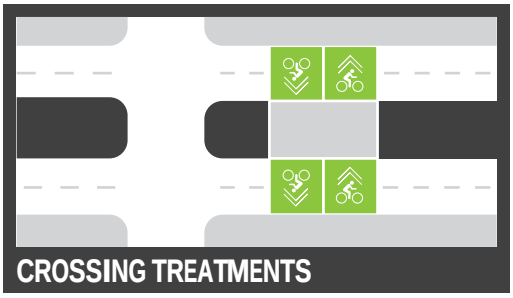
Emergency services

Traffic calming elements can affect fire and emergency services because of increased response times to properties along the bike boulevard or lack of sufficient width to accommodate emergency vehicles. Design will consider whether the corridor is a frequently used route for fire trucks (i.e., near a fire station), which may influence the desired treatments; and compliance with emergency service standards.


PRIORITIZE BICYCLE TRAVEL

SIGNAGE


INTERSECTION TREATMENTS


CROSSING TREATMENTS


TRAFFIC CALMING

Key Design Considerations

Bike boulevards are designed to provide increased convenience for non-motorized users by minimizing stops and cross-traffic. Traffic calming devices help maintain low motor-vehicle speeds while allowing a consistent pat of travel for non-motorized users. The types of traffic calming devices used in each bike boulevard vary depending on adjacent land use context and community desires.

Careful consideration is given to bike boulevard crossings of arterials. If inadequate gaps are available, additional engineering treatments could be required to facilitate safe crossings of the arterial, otherwise the arterial may function as a barrier, limiting the local street's usefulness for non-motorized travel.

A variety of tools are available to achieve the desired characteristics of a bike boulevard. The tools in this guidebook have been organized into five general categories, as follows:

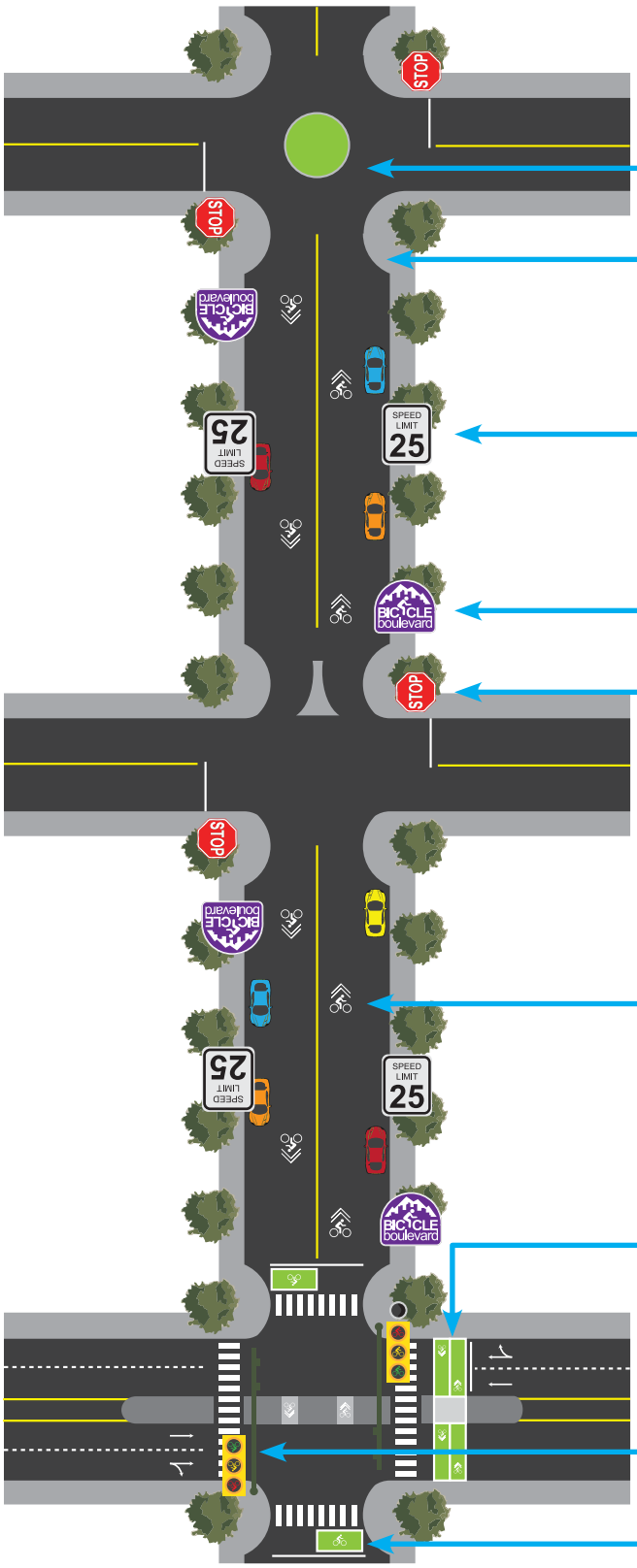
- Prioritize Bicycle Travel
- Signage
- Intersection Treatments
- Crossing Treatments
- Traffic Calming

Specific treatments in each of these five categories are described in the following sections. The selection of appropriate treatments for use on a particular bike boulevard should consider the context of the street, adjacent land uses, and community desires. Each bike boulevard in Denver may be a unique combination of design elements aimed at:

- Reducing or maintaining low traffic volumes
- Reducing or maintaining low motor vehicle speeds
- Creating a logical, direct, and continuous bike route with access to desired destinations
- Creating comfortable and safe intersection crossings for bicyclists
- Reducing cyclist delays

Design of a bike boulevard in Denver will be done in coordination with the corridor property owners, Traffic Engineering Services, the Street Maintenance, Emergency Services, the Police Department, and the general public.

Bike Boulevards - At a Glance



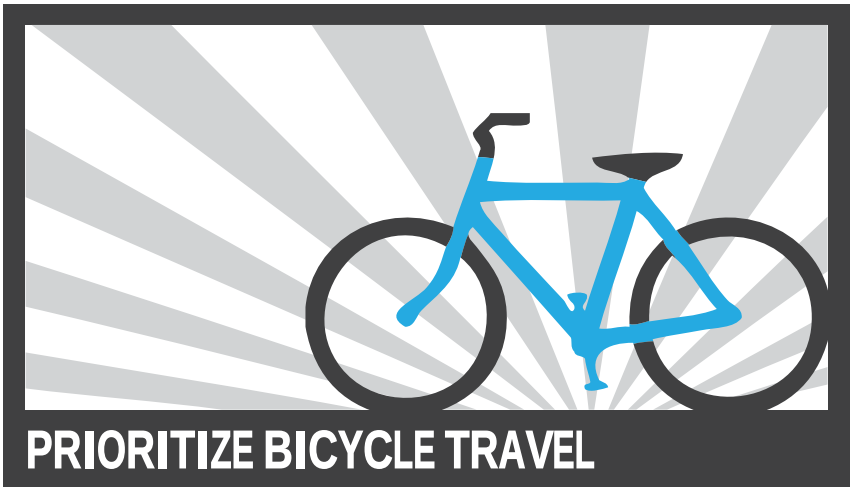
Traffic Calming

Signage

Prioritize Bicycle Travel

Crossing Treatments

Intersection Treatments



Design elements that prioritize bicycle travel help to remind roadway users that the street is intended as a bicycle throughway and create conditions that minimize delays for cyclists.

Pavement Markings

Description and Purpose

(Figure 1) Pavement markings can be used to supplement wayfinding and identification signage. They serve as a reminder to cyclists and motorist that streets heavily used by bicycle travel and have frequent markings act as trailblazing/wayfinding for cyclists.

Design Considerations

- Must comply with Manual on Uniform Traffic Control Devices (MUTCD).
- Develop specific pavement markings for bike boulevard.

Pavement Markings - Bike Blvd. Marking in Minneapolis

Contraflow Bike Lanes

Description and Purpose

(Figure 2) A designated bicycle facility that allows cyclists to travel against the flow of traffic on a one-way street. They can provide direct access and improve cyclist connectivity, reducing cyclist travel time by eliminating out-of-direction detours and unauthorized wrong-way riding. Use of contra-flow lanes is context sensitive and often limited to a short segment of the overall bike boulevard corridor.

Design Considerations

- May need a separate signal control at intersections to provide safe crossing at intersections where bicyclists are not expected on the left side of the street.
- May require elimination of parking on one side of the street.

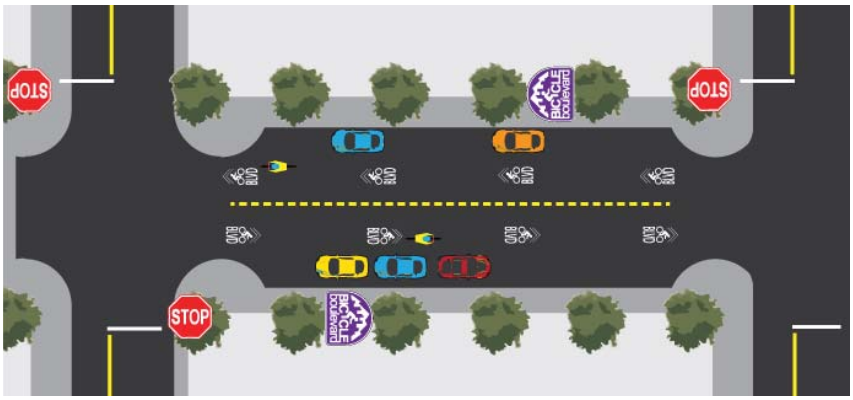


Figure 1 - Pavement Markings - Sharrows

Stop Control

Description and Purpose

Stop controls increase cycling time and energy expenditure due to frequent starting and stopping, leading to non-compliance by cyclists and motorists alike, and/or use of other routes. Bicyclists should be able to travel continuously for the entire length of the bike boulevard with a minimum of stops. Modification of stop sign control could be re-orientated from the bike boulevard to the side street, or conversion from 4-way to 2-way stop control.

Design Considerations

- Re-orientation of stop signs or conversion from 4-way to 2-way stop condition should be coupled with traffic calming to prevent speeding along a bike boulevard.
- Consider Denver policy and procedure for re-orientation of two-way stop control at intersection.
- To convert multi-way stop control to 2-way stop condition in the context of a bike boulevard, the existing policy and procedure in multi-way stop control will need to be modified or new policy and procedure will need to be developed.

Contraflow Bike Lane - Baltimore

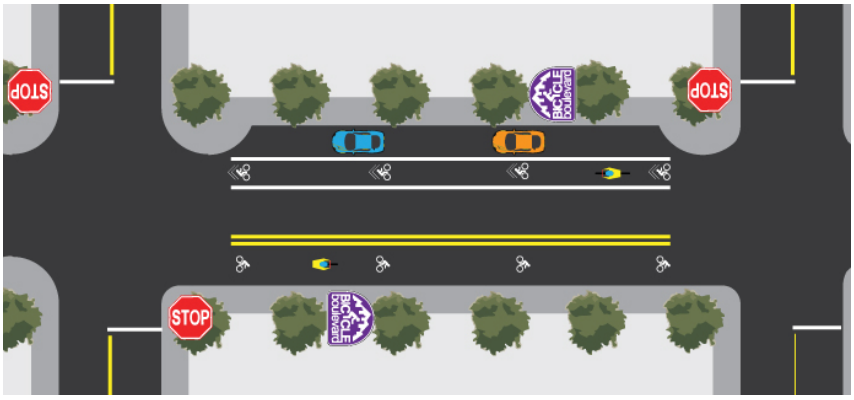


Figure 2 - ContraFlow Bike Lane

Stop Control - Marion Pkwy. and Dakota Ave. - Denver

SIGNAGE

Residential Speed Limit - Denver: 25 mph

Identification Sign - Bike Boulevard

Wayfinding Sign - South Bend, Indiana

Distinctive signage can be used to inform all roadway users that the street is a bicycle boulevard, to create a unique identity for the bike boulevard, and to convey to users how the street is expected to be used.

Residential Speed Limit

Description and Purpose

(Figure 3) Discourage motorists from traveling through residential neighborhoods by posting the residential speed limit of 25 mph. Speed limit signs are generally posted following a traffic control device such as a signal or stop sign, or where conditions change (e.g., in a school zone).

Design Considerations

- Signs must comply with MUTCD.
- Speed limits must comply with Denver's ordinance for residential local streets that requires residential local streets to have a minimum 25 mph speed limit (except in school zones).
- Changes in posted speed limit may be based on an engineering design or speed study.

Identification Signs

Description and Purpose

(Figure 3) Identification signs can be used to passively market the bike boulevard network. They may be an enhancement to help brand the corridor.

Design Considerations

- Ensure visibility of signs for both bicyclists and motorists.
- Colors reserved by the MUTCD for regulatory and warning signs are not applicable.
- Denver street signs must include the address. Bike boulevard signs could be supplemental, possibly between the two street name signs.
- Materials, colors and configuration for bike boulevard signs will be established by Denver.

Wayfinding Signs

Description and Purpose

Wayfinding signs provide cyclists with direction and distance to destinations including commercial districts, transit stations, schools and universities, and other bikeways.

Design Considerations

- Colors reserved by the MUTCD for regulatory and warning signs are not applicable.
- Wayfinding signs along bike boulevards shall tie into Denver's overall wayfinding system.

Warning Signs

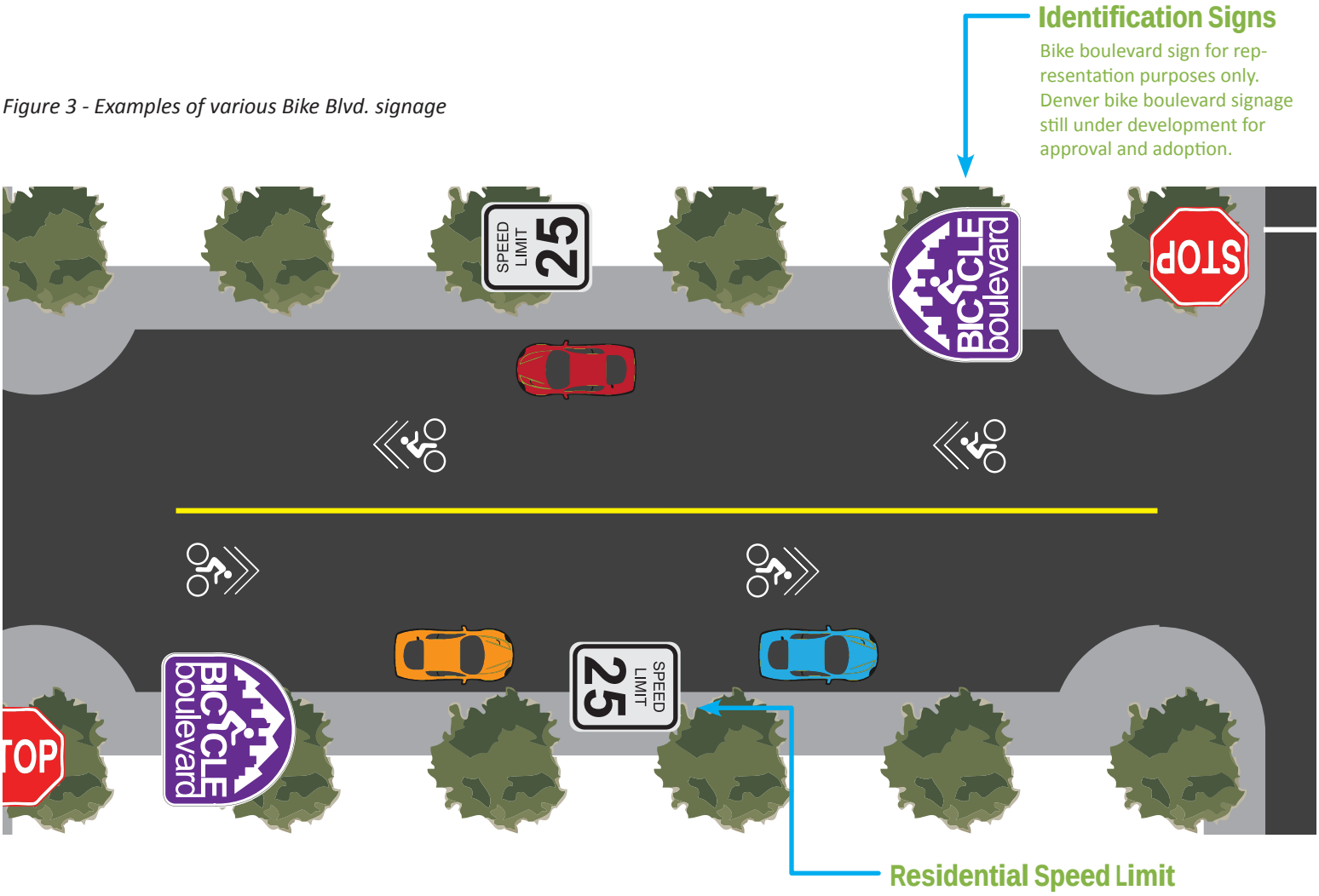
Description and Purpose

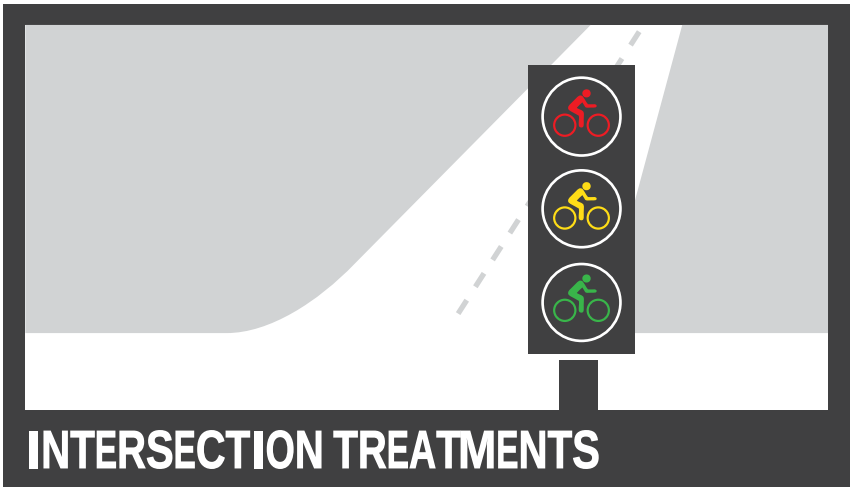
Alert motorists and cyclists of road condition changes including end of bike boulevard, upcoming traffic calming features, and traffic control devices.

Design Considerations

Must comply with MUTCD.

Figure 3 - Examples of various Bike Blvd. signage





Activated Signals - Bicycle Detection

Activated Signals - Leading Intervals - Bannock St.

Figure 4 - Activated Signals - Bicycle Detection

Improvements along bike boulevards can include intersection treatments at crossings with major roadways to enhance cyclist safety by raising awareness of potential areas of conflict between motorists and cyclists, and to reduce delay for cyclists.

Activated Signals – Bicycle Detection

Description and Purpose

(Figure 4) Allows a cyclist to trigger a green signal phase through the use of loop detection or push-button. Bicycle detection may reduce cyclist delay and discourage red-light running by cyclists.

Design Considerations

- Bicycle detection is appropriate on designated bikeways (e.g., bike lanes, bike boulevards, etc.) where the bikeway is a secondary roadway.
- Denver is testing detection devices at many intersections to choose successful technology.

Activated Signals – Leading Intervals

Description and Purpose

A leading interval stops all vehicle movement and allows cyclists and pedestrians to cross. A leading interval can be an exclusive phase for bicyclists and pedestrians or it can be an advance phase that provides bicyclists and pedestrians a head start in their path of travel across the intersection.

Design Considerations

- Could be used in combination with bike boxes and/or bicycle detection.
- Most appropriate at arterial street crossings.

Bike Boxes/Advanced Stop Bar

Description and Purpose

(Figure 5) This treatment helps to reduce "right-hook" conflicts. It gives cyclists priority at the intersection by allowing cyclists to position themselves for through movements or left turns.

Design Considerations

- Could be used in conjunction with bike leading interval.
- Most appropriate at arterial street crossings with a relatively low volume of right turning traffic.
- Right turns on red must be prohibited; may not be appropriate at intersections with high volumes of right turning vehicles.

Activated Signals – TOUCAN

Description and Purpose

(Figure 6) A TOUCAN (TwO GroUps CAN cross) signal facilitates pedestrian and cyclists at marked crosswalks. They restrict motor vehicle through movements on the minor street approaches, allowing only right turns to and from the major street by motor vehicles. Motorists on the major street receive a green signal until the signal is activated for a bicycle/pedestrian crossing interval.

Design Considerations

The TOUCAN is in the experimental phase with FHWA to be included in a future edition of the MUTCD.

Bike Box - Cleveland Pl. - Denver

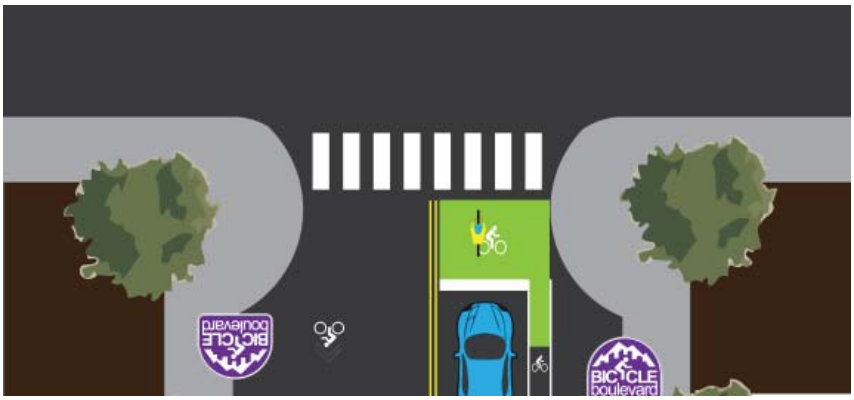


Figure 5 - Bike Box

TOUCAN Signal - Tucson, AZ

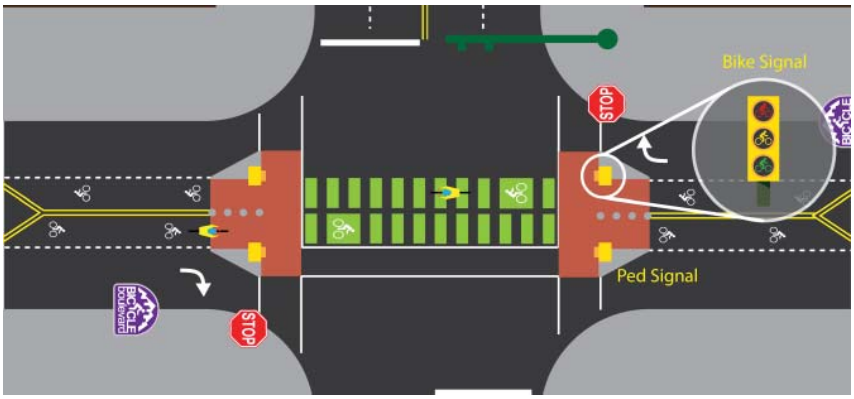
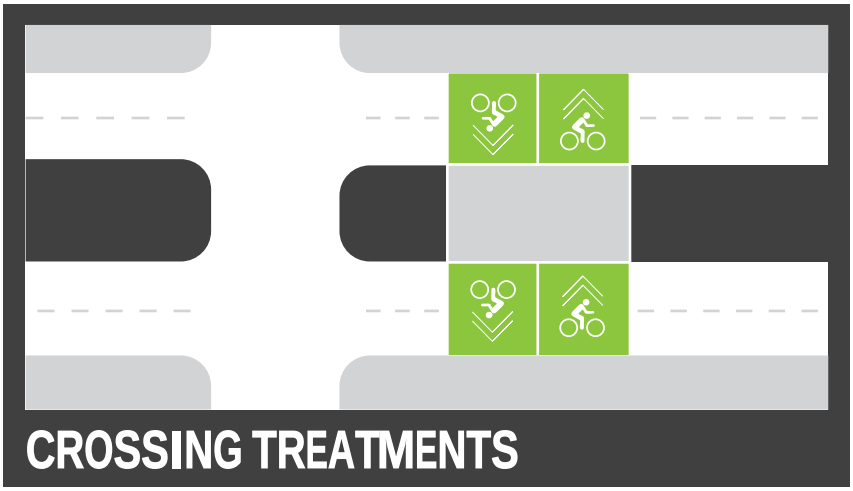


Figure 6 - TOUCAN Signal



Enhanced crossing treatments can be used to improve motorists' awareness of potential for bicyclists and pedestrians. They can also improve safety by provide a refuge for cyclists and/or by increasing motorists and cyclists' awareness of potential conflicts.

Crossing Islands

Description and Purpose

(Figure 6) Crossing islands provide space in the center of a roadway for bicyclists and pedestrians to wait for gaps in traffic.

Design Considerations

- Mountable curb may be required to accommodate emergency and fire vehicles.
- Crossing island design should consider integrating progressive storm water management features and low maintenance vegetation to improve the visual quality.
- Denver Fire Department requires a minimum clear width of 16 feet from flow-line to flow-line on residential; minimum of 25 feet including parking commercial mixed-use environment.

Crossing Island

Off-Set Intersection Crossing

Off-Set Intersection Crossing

Description and Purpose

(Figure 7) Off-set intersections are created when the "legs" of an intersection do not line up. Several striping configurations are available to enhance bicycle crossing at these intersections including a two-way center left turn and a median left turn pocket.

Design Considerations

- Most appropriate for directing bicyclists to follow a particular route (e.g., encourage them to make a left turn).
- Pavement marking treatment may be a concern when snow is on the ground; drivers would not expect a bike located to the left of the travel lane.

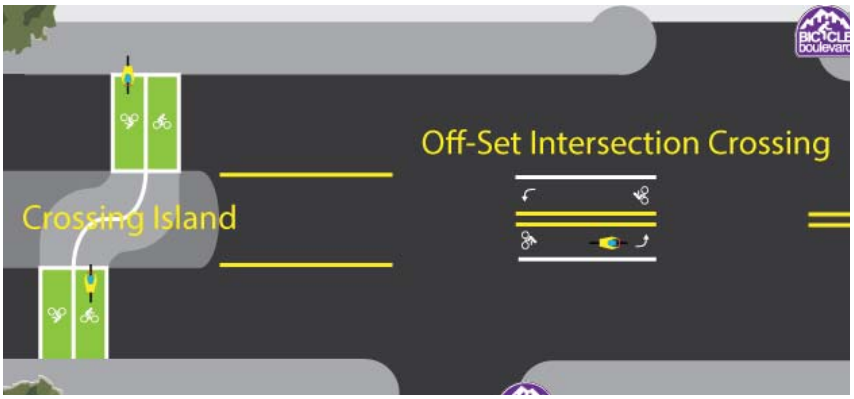


Figure 7 - Crossing Island & Off-Set Intersection Crossing

Traffic calming is intended to reduce the speeds of motor vehicle traffic to be closer to cyclists' travel speeds. Traffic calming may include design elements that restrict certain movements for motorized travel to discourage the use of the corridor for through travel by automobiles. Although traffic calming is not used everywhere in Denver, utilization on Bike Boulevards is possible.

Crosswalk/Crossbike

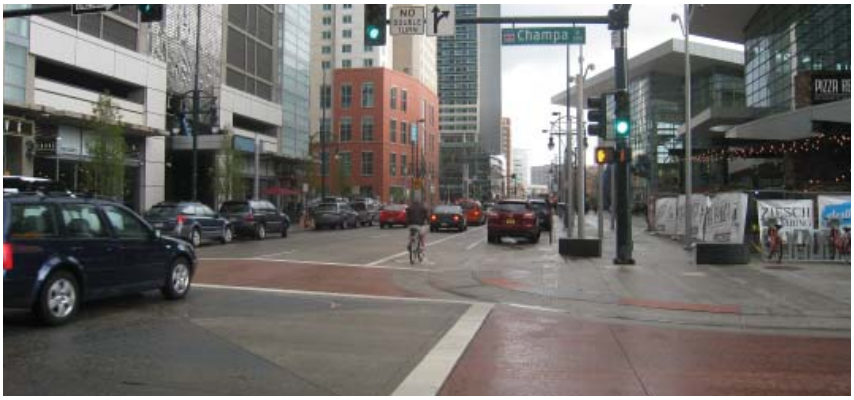
Description and Purpose

(Figure 7) Reduces motor vehicle speeds and create a visibly prominent crossing location for bicyclists and pedestrians.

Design Considerations

- Differentiate the crosswalk with enhanced pavement materials or markings, as raised crosswalks are a major concern for snow removal, street sweeping and overlays/maintenance activities.
- Brick pavers must meet HS-20 load requirements for emergency and fire vehicles and may become loose over time as a result of weather and traffic loads; stamped concrete may be a preferable treatment.

Crosswalk/Crossbike - Tucson, AZ



Curb Extension along 14 St. - Denver

Curb Extensions

Description and Purpose

(Figure 8) Curb extensions (also referred to as "bulb outs") extend the sidewalk or curb face into the parking lane at an intersection. This visually narrows the roadway and reduces the width of the crosswalk, shortening bicyclist and pedestrian crossing distance. Additionally, curb extensions can be used for reducing stormwater pollution and runoff.

Design Considerations

- The radius of the curb extension shall be designed to allow snow plows and street sweepers to effectively maneuver adjacent to the curb.
- A storm sewer inlet may be needed at the midpoint of the radius.

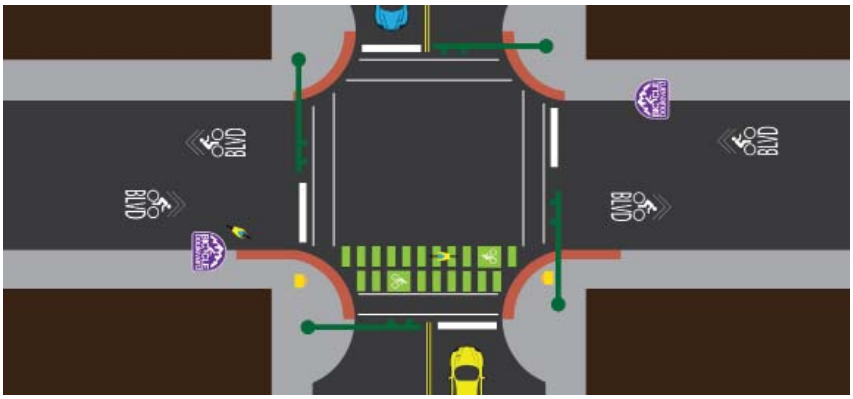


Figure 8 - Crossbike/Crosswalk and Curb Extensions

Chicane - Berkeley, CA

Traffic Circle - Long Beach, CA

Figure 9 - Traffic Circle and Chicane

- Denver Fire Department requires a minimum clear width of 16 feet from flow-line to flow-line on residential; minimum of 25 feet including parking commercial mixed-use environment.

Chicanes

Description and Purpose

Raised curbs that create serpentine, horizontal shifting of the travel lanes along a roadway. The shifting lanes reduce speeds by limiting long stretches of straight roadway where motorists can pick up speed.

Design Considerations

- May require elimination of some parking spaces
- Chicane design should consider integrating progressive storm water management features and low maintenance vegetation to improve the visual quality.
- Landscaping of chicanes would require maintenance; consider district-based maintenance.
- Denver Fire Department requires a minimum clear width of 16 feet from flow-line to flow-line on residential; minimum of 25 feet including parking commercial mixed-use environment.

Traffic Circles

Description and Purpose

Traffic circles are raised circular islands located in the center of intersection. They can result in a slight reduction in traffic speeds by requiring vehicles to maneuver around the center island circulating in a counter-clockwise direction. By eliminating the need for stop signs, they can reduce bicycle delays.

Design Considerations

- Width of approaching streets may affect feasibility of traffic circle.
- Design radius or Mountable curb may be required to accommodate emergency and fire vehicles, as well as snow plows and street sweepers.

• Landscaping of traffic circles would require maintenance; consider district-based maintenance.
• Traffic circle design should consider integrating progressive storm water management features and low maintenance vegetation to improve the visual quality.

Non-Motorized Crossings

Description and Purpose

(Figure 10) Non-motorized crossings allow for pedestrian and bicycle connectivity otherwise limited or not accessible by motor vehicles. This reduces out-of-direction travel for pedestrians/bicycles and reduces automobile volumes. Partial non-motorized crossings eliminate some motor vehicle movements at intersections, forcing motorists to turn off of and/or restricting turns onto the minor road. Fully non-motorized only crossings can be achieved by short off-street path connections or use of raised/vertical barriers.

Design Considerations

• Consider only where a bike boulevard intersects a higher functional classification street such as an arterial or dead-end streets.
• Potential impacts to neighboring streets need to be considered.
• Consider impacts to emergency vehicles; can be designed to accommodate emergency access.

Non-Motorized Crossing - San Luis Obispo, CA

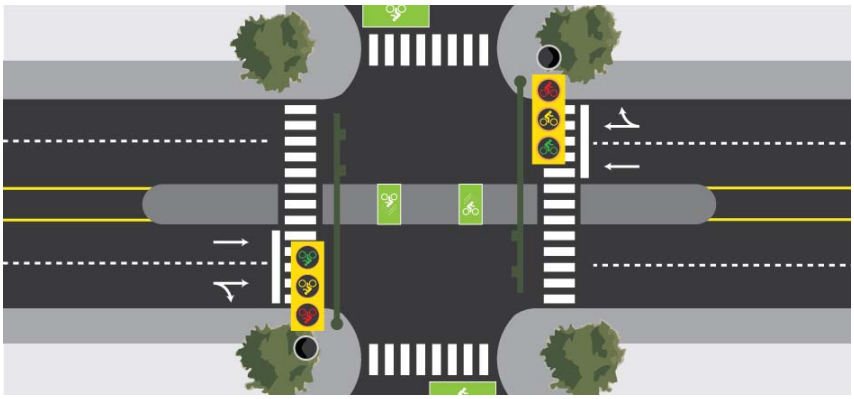


Figure 10 - Non-Motorized crossing

DESIGN RESOURCES

- MUTCD
- NACTO Urban Bikeway Design Guide
- AASHTO Guide for the Development of Bicycle Facilities
- Fundamentals of Bicycle Boulevard Planning & Design

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