

City of Minneapolis

Department of Public Works
Traffic and Parking Services Division

Design Guidelines For Bicycle Boulevards

Prepared For:

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Minneapolis Bicycle Boulevard Design Guidelines

The Minneapolis Bicycle Boulevard Design Guidelines (MBBDG) has been prepared for the City of Minneapolis Public Works Department with federal funding provided by the Federal Highway Administration (FHWA) Non-Motorized Transportation Pilot (NTP) Program. The NTP projects are administered by a non-profit Transit for Livable Communities and implemented through Bike Walk Twin Cities.

1. Bicycle Boulevard Purpose

Bicycle boulevards are low-volume and low-speed streets that have been optimized for bicycle travel through treatments such as traffic calming and traffic reduction, roadway signing and pavement markings, and intersection crossing treatments. The purpose of a bicycle boulevard is to improve bicycle safety and circulation, by providing cyclists a designated travel route as an alternative to or as a companion route to using lanes on higher motor vehicle volume streets.

Bicycle boulevards take the shared roadway concept to a new level, creating an attractive, comfortable and convenient cycling environment that caters to all cyclist abilities. Although each bicycle boulevard may vary greatly in specific design features, they will all have the same purpose to maintain a low motor vehicle volume and a low motor vehicle speed street with consistent route signing and markings.

2. Goals and Objectives

The goal of the Minneapolis Bicycle Boulevard Design Guidelines (MBBDG) is to establish minimum design standards for bicycle boulevards within the City. The minimum design standards (or basic signing and pavement marking elements) will work to maintain consistency and to create an identity for these types of corridors. In addition, the MBBDG will provide a toolbox illustrating examples of types of design options available for use on bicycle boulevard projects. The primary characteristics and goals of a bicycle boulevard include:

- Maintain low motor vehicle volumes (discouragement of non-local motor vehicle traffic).
- Maintain low motor vehicle speeds.
- Provide logical, direct and continuous routes that are well marked and distinctively signed.
- Provide bicyclists convenient access to desired destinations.
- Provide bicycle parking at convenient locations.
- Maintain minimal bicyclist delay. (Prioritized travel for bicycles at intersections where possible).
- Improve bicyclist safety, crossing at higher motor vehicle volume streets.

3. Supporting Documents

The MBBDG are modeled after and are based upon previous research, study and work conducted for the Initiative for Bicycle and Pedestrian Innovation (IBPI) and the City of Berkeley, CA. The documents listed below provide the leading research and standards for the planning, design and construction of Bicycle Boulevard facilities and are incorporated into these guidelines by reference.

- Fundamentals of Bicycle Boulevard Planning and Design¹
- Bicycle Boulevard Design Tools and Guidelines²

Concepts presented in the above documents have been applied and refined to fit the characteristics of the City of Minneapolis street network and to be in compliance with Public Works design standards and policies.

4. Bicycle Boulevard Design Elements

The specific design elements needed to create a bicycle boulevard must be tailored to the unique conditions of each corridor. A variety of design option examples are illustrated in the toolbox to allow the flexibility to address the needs of the corridor. Design options selected will need to be compatible with bicycling and consistent with the City of Minneapolis Public Works neighborhood traffic management policies. The bicycle boulevard design elements are grouped into two primary categories – basic elements and corridor specific elements. Basic element components are required on all bicycle boulevard corridors.

In general, the key elements of any bicycle boulevard may include:

- Signing and Pavement Markings (Basic Element)
- Intersection Treatments (Corridor Specific)
- Motor Vehicle Traffic Calming (Corridor Specific)
- Motor Vehicle Traffic Reduction (Corridor Specific)
- Prioritize Bicycle Travel on Bicycle Boulevard (Corridor Specific)

All of these items or a select few may be employed on a single corridor based upon how favorable the existing conditions of the street are for bicycle travel. The combined impact of these elements is far greater than any single element alone.

¹ Fundamentals of Bicycle Boulevard Planning and Design, ibpi, alta Planning + Design, Portland State University, July 2009.

² Bicycle Boulevard Design Tools and Guidelines, City of Berkeley, Wilbur Smith Associates, 2M Associates, HPV Transportation Consulting, April 2000.

4.1 Basic Elements

The basic elements include the bicycle boulevard roadway signing and pavement markings. The basic elements required of all bicycle boulevards are described below and set the minimum required design standards.

1. Modified Street Name Signs

To provide a signifying element, specific to bicycle boulevards, the City will install modified street name signs. The modified street name signs are consistent with the City of Minneapolis Bicycle Route and Destination Signing Standards;³ however, are the inverse colors – green legend on white background. The green legend on white background signs (sign color with bicycle symbol) provides the facility type recognition and should be reserved specifically for bicycle boulevard corridors. All intersection street name signs along the route would be replaced.

- Two individual panels per location are required. The signs are mounted back-to-back.
- The maximum sign panel width shall be 42 inches.
- The bicycle symbol and street name suffix (i.e., Pkwy, Blvd, Av, St, etc.) may be reduced to 3 or 4 inch letter height if necessary. The spacing between words and letters may also be compressed.

A typical intersection street name sign is illustrated below.



1.0" Radius, 0.5" Border, Green on White;
 Symbol RG025; "S Bryant" D 40% spacing;
 "Av" D 80% spacing;

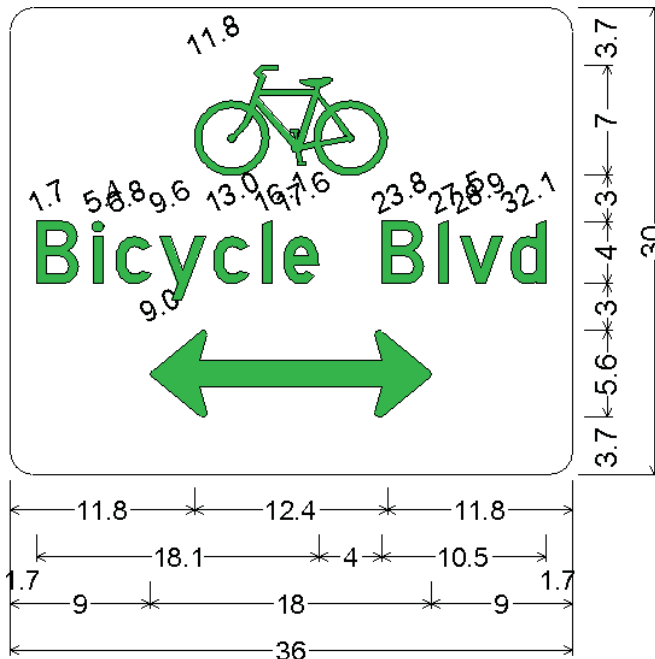
2. Advanced Bicycle Boulevard Guide Sign

At major intersections, an advanced bicycle boulevard guide sign should be provided and face the major street traffic approaches. The purpose of this sign is to bring directional guidance and significance to the bicycle boulevard corridor. The use of the guide sign should be in accordance with the following provisions:

³ Bicycle Route and Bicycle Destination Signing Standards, City of Minneapolis, January 2009.

- Locate sign in advance of the bicycle boulevard corridor, for each direction of traffic approach. The bicycle boulevard guide sign should face the major street traffic.
- Signs should only be installed if the major street has greater than 5,000 daily motor vehicles; or, the major street has bicycle lanes.
- The guide sign will be green lettering on a white background.
- The guide sign legend shall include a “bicycle symbol”, “Bicycle Blvd”, and a “directional arrow.”

A typical guide sign design is illustrated below. Design is specific for each corridor and directional arrow requirement.



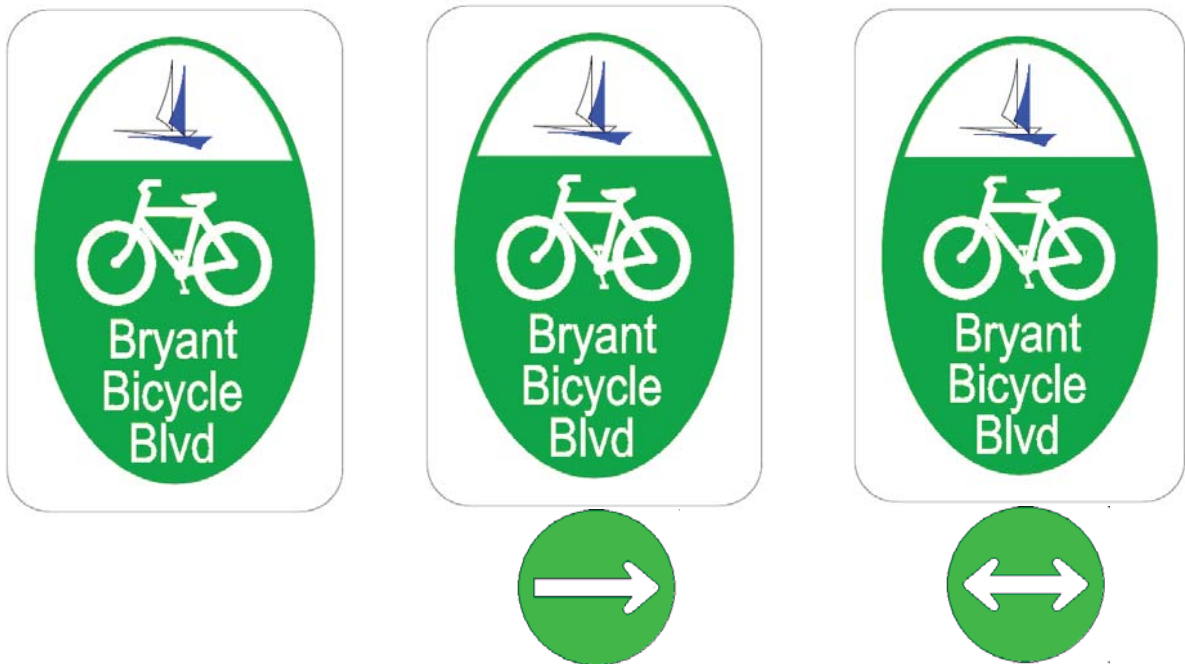
1.5" Radius, No border, White on White;
 Symbol RG025 Green;
 "Bicycle Blvd" Green D;
 Double Headed Arrow 1 - 18.0" 0° Green;

3. Route Marker and Trailblazing Signs

Route marker and trailblazing signs are critical to informing both motorists and bicyclists they are on a designated bicycle route. Route marker and trailblazing signs should conform to the following provisions:

- Minneapolis Standard M1-8a with Minneapolis Pictograph and be a green symbol on white background. The standards sign size should be 18” x 24.”
- The sign legend should label the specific corridor or bicycle boulevard name.
- Where trailblazing (arrow plaque) assemblies are required, the directional plaque should be in accordance with the MMUTCD 9B.21 and be a M7-1 to M7-7 and be mounted below the M1-8a sign. As an alternative, Minneapolis standard M18.A and M18.B white arrow on green circle (8.75” diameter) background may be used.
- Route marker signs M1-8a should be located at: key decision points; following major intersections; following cross-streets with bicycle lanes; and locations where the route changes direction. Where there is significant distance between key decision points, it may be appropriate to provide additional route marker signs.
- At route beginning and ending points, post a M1-8a route marker and use a “Begin” and “End” plaque.

The typical sign and trailblazing assemblies are illustrated below.



M1-8a
(18” x 24”)
Route Marker

M1-8a
(18” x 24”)
M18.B
(8.75” DI)
e.g. Trailblazing Assembly

M1-8a
(18” x 24”)
M18.A
(8.75” DI)
e.g. Trailblazing Assembly

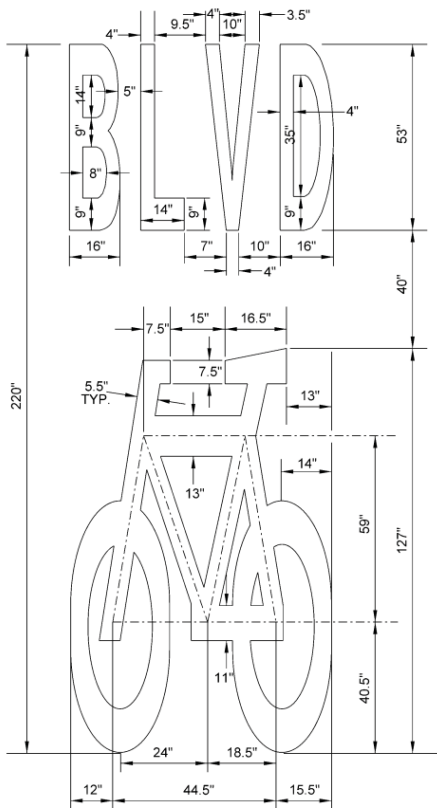
4. Bicycle Boulevard Pavement Legend

The pavement legend will be unique to bicycle boulevard corridors and will follow the design implemented in Berkeley, CA. The pavement legend will

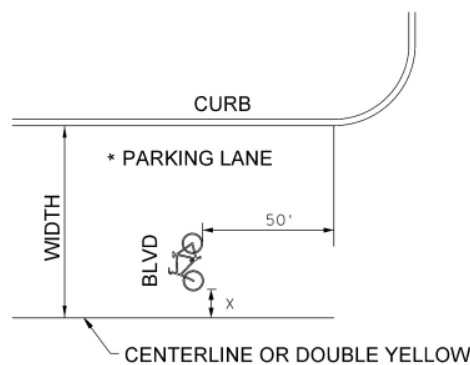
include a “bicycle symbol” and the text “BLVD.” A directional arrow will not be used. The following provisions should apply:

- The minimum pavement marking installation material will be standard paint. However, more durable materials (epoxy or poly perform) should be considered as project budgets allow.
- The spacing of markings should be one per direction every other block on roadway segments containing short blocks (400 feet or less) and one per long block (blocks exceeding 400 feet in length) per direction.
- The marking should be located approximately 50 feet from the end of the curb radius at the beginning of the block.
- Additional pavement messages may be considered at: following major intersections; following cross-streets with bicycle lanes; and locations where the route changes direction. Where there is significant distance between crossing streets, it may be appropriate to provide an additional pavement message.
- The stencil template is shown below.

The following illustrations show the typical installation and pavement marking template.



Bicycle Blvd Standard Stencil



WIDTH	X
14 - 15'	1'
>15 - 17'	2'
>17 - 19'	3'
>19 - 21'	4'

* If there is no parking, then place symbol in the center of lane for direction of travel

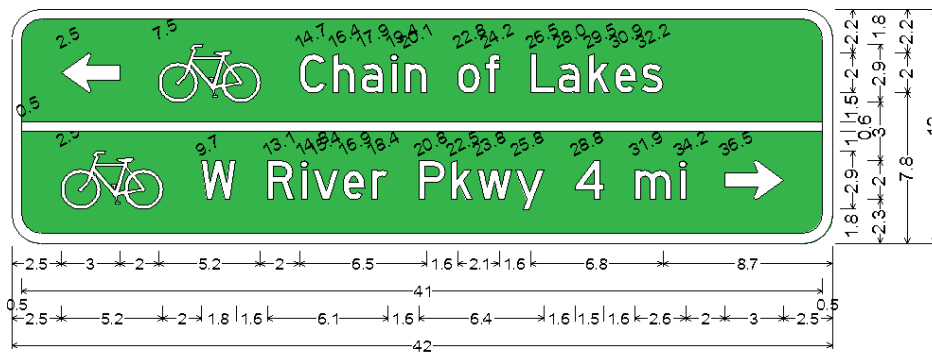
Bicycle Blvd Standard Placement

5. Bicycle Destination Signs

Install bicycle destination signs in accordance with the City of Minneapolis Bicycle Route Signing Standards. Location of signs and legends will be determined during project process and will be specific to each corridor. Specific design requirements include:

- Distance should only be denoted on the sign panel if the destination is greater than 1 mile.
- Distance legend should be fraction and denoted in ½ mile increments.
- Multiple destinations can be used on a single sign panel. Each destination should be separated by a solid white line, consistent in width with the border.
- The maximum sign panel width shall be 42 inches.
- If two legend lines are required to meet the 42 inch maximum sign panel width, the directional arrow and bicycle symbol shall be placed on the top line (left justified for “Up” and “Left” arrows and right justified for a “Right” arrow) and the text legend placed on the second line.
- The street name suffix (i.e., Pkwy, Bkwy, Gnwy, Blvd, Av, St, etc.) may be reduced to 2 inch letter height if necessary.
- Signs shall be mounted a minimum of 7 feet above grade (to bottom of sign) and 18 inches behind the back of curb. Wayfinding and destination signs shall not be mounted on the same post as Stop signs.

A sample bicycle destination sign is illustrated below.



D1-9a; 1.5" Radius, 0.5" Border, White on Green;
Arrow Custom - 3.0" 180°; Symbol RG025; "Chain of Lakes" D 80% spacing; Symbol RG025;
"W River Pkwy 4 mi" D 80% spacing; Arrow Custom - 3.0" 0°;

4.2 Corridor Specific Elements

Corridor specific elements are to be used where appropriate to achieve the goals of the bicycle boulevard, to address specific corridor issues or as determined through the neighborhood design process. A toolbox of potential intersection and corridor treatments has been assembled to assist in the design process. These items are an accumulation of strategies identified in the previously sourced City of Berkley

Bicycle Boulevard Guidelines, the Fundamentals of Bicycle Boulevard Planning, City of Minneapolis Traffic Calming Guidelines and other common design treatments used in the Transportation Industry. It should also be noted that these tools are not meant to be used individually. The concept is to combine several tools so that the cumulative effect will meet the goals of the bicycle boulevard. The selection of the appropriate tools should be determined in collaboration with local residents, stakeholders and public agencies and may vary significantly from one corridor to the next. Key elements of corridor specific tools include prioritize travel and improve safety on the bicycle boulevard, intersection treatments, traffic calming and traffic reduction measures. Table 1 documents the corridor element toolbox. Each item denoted in the corridor element toolbox is illustrated and discussed in greater detail in Appendix A.

The intent of the toolbox is to present a variety of design treatments in concept, highlight a few considerations and provide an estimated cost range. It should be understood the toolbox is not all in exclusive and should not be viewed as a limit to the designer. Other options, designs or alternatives not identified in Table 1 or Appendix A may be appropriate to address specific corridor issues and should be considered. Specific design features, considerations and costs may vary widely and should be determined specific to each corridor or location. For additional resource and design ideas, the City of Minneapolis Bicycle Manual⁴ could also be consulted. The web link can be found at (<http://www.ci.minneapolis.mn.us/bicycles/bicycle-plans.asp>)

Table 1. Bicycle Boulevard Corridor Element Toolbox

Category	Design Goal	Design Feature
Basic Element	Bicycle Boulevard Identity	See Section 4.1. Basic Elements - Modified Street Name Sign - Advanced Bicycle Boulevard Guide Sign - Route Marker and Trailblazing - Bicycle Boulevard Pavement Legend - Bicycle Destination Signs
Corridor Element	Prioritize Bicycle Travel on Bicycle Boulevard	1. Stop / Yield Signs 2. Bicycle Detection 3. Bike Use Full Lane Sign 4. Bicycle Parking
	Intersection Treatment	5. Traffic Signal - Actuated 6. Pedestrian Hybrid Signal (HAWK) 7. Overhead Flasher System 8. High Visibility Crosswalk (Raised or Not Raised) 9. Median Refuge Island 10. Bicycle Left Turn Lanes
	Traffic Calming	11. Traffic Circle 12. Speed Hump or Table 13. Chicane 14. Curb Extensions 15. Chokers 16. Landscaping and Street Trees 17. Residential Paint the Street Art 18. Temporary Street Furniture / Painting in Unnecessary Paved Areas
	Traffic Reduction	19. Half Closure with Bicycle Pass-Through 20. Diverter with Bicycle Accessibility (Permanent or Temporary) 21. Contraflow Lane (Painted & Signed or Signed Only)

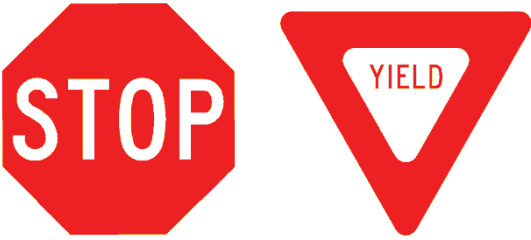
⁴ City of Minneapolis Bicycle Facility Manual, City of Minneapolis, November 2009.


5. Implementation Approach


The total desired funding of a bicycle boulevard project may not exist. If this is the case, the implementation of the bicycle boulevard should occur in phases and be prioritized as follows:


1. Basic elements (signing, pavement markings and bicycle destination signs)
2. Install devices to help cross major street intersections. Prioritize major crossing intersections in accordance with ADT, available crossing gaps or as selected through the neighborhood engagement process.
3. Prioritize travel along the bicycle boulevard by removing stop signs and replacing with traffic calming devices. Install other traffic calming devices or traffic reduction measures as necessary to address corridor issues.
4. Incorporate school area safety improvements.
5. Install planter strips and street landscaping.

Appendix A: Corridor Element Toolbox

1. Stop and Yield Signs		Prioritize Travel
	<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. Minimize the number of stop signs in the bicycle boulevard travel direction. 2. Use stop or yield signs to control cross-street traffic movements. 3. May consider replacing a stop sign on the bicycle boulevard travel direction with a yield sign. 4. Corner clearance zones may be required to improve intersection sight distance. 5. Minimize or avoid the use of all-way stop or all-way yield control. 6. The removal of an existing all-way stop or re-orientation of a two-way stop control may be challenging due to neighborhoods belief stop signs reduce vehicle speeds. See number 7 below. 7. Providing prioritized travel to the bicycle boulevard may require the implementation of traffic calming devices (refer to Items 11 to 18). 	
<p>Description: A primary goal of bicycle boulevards is to provide prioritized travel for cyclists. This reduces delay, improves attractiveness of the corridor and maximizes the cyclist's momentum. A bicycle boulevard design should minimize stops.</p>		
<p>Cost Range: Approximately \$200 per sign.</p>		

2. Bicycle Detection		Prioritize Travel
	<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. Standard loop detection or video detection may likely be used, but will need to be calibrated to detect bicycles. 2. In-pavement detection loops should be marked with a bicycle detector symbol (MUTCD, Figure 9C-7) to indicate optimum cyclist position. 3. Push button activation may be used; however, the push button should be located just off the roadway to prevent bicyclists from having to dismount. Typical minimum roadway clearance zone is 18" from back of curb. 4. Depending on the intersection or characteristics, an advanced loop could be considered. 5. Depending on the type of signal cabinet and controller at the intersection, the provision of detection may not be feasible or may require complete replacement of the cabinet and controller (approximately \$35,000) 	
<p>Description: A common problem at signalized intersections is cyclists are not typically detected and pedestrian push buttons are located on the sidewalk, off the roadway, increasing cyclist delay or violations. At signalized intersection, the provision of convenient or automatic bicycle detection system should be made a high priority. Several methods may be used including video detection, in pavement loop detector or push button activation.</p>		
<p>Cost Range: Approximately \$2,000 to \$6,000 depending upon the intersection layout and detection system chosen.</p>		

3. Bike Use Full Lane Signs		Prioritize Travel
	<p>Design Considerations: In accordance with the MUTCD, the Uniform Vehicle Code (UVC) defines a “substandard width lane” as a “lane that is too narrow for a bicycle and a vehicle travel safely side by side within the same lane.”</p> <ol style="list-style-type: none"> 1. The Bicycles May Use Full Lane (R4-11) sign may be used on roadways with no bicycle lanes or adjacent shoulders usable by bicyclists and where travel lanes are too narrow for bicyclists and motor vehicles to operate side by side. 2. The Bicycles May use Full Lane sign may be used in locations where it is important to inform road users that bicyclists may occupy the travel lane in order to prevent unsafe passing. 3. The sign must be black on white with 30”x30” dimensions and a 4”D Legend. 	
<p>Description: The purpose of this sign is to inform motorists bicyclists may occupy the full roadway width. The sign will often be located in locations where the roadway is too narrow for both the motorist and the bicyclist to travel side by side.</p>		
<p>Cost Range: Approximately \$200 per sign</p>		

4. Bicycle Parking		Prioritize Travel
	<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. There are several types of bicycle parking available, each offering different security levels. Choosing the appropriate level of bicycle parking is based on how much security is required at a location. 2. Bicycle lockers are the highest security type of bicycle parking and offer a fully enclosed area for bikes which protects against weather and potential thieves. 3. Bicycle racks are the most economical type of bicycle parking and are designed to provide short term parking. 4. Bicycle lockers should be considered for long term bicycle parking and bicycle racks should be considered for short term bicycle parking. 5. Bicycle parking demand and cost are two major factors that should be considered when choosing the number of bicycle parking spaces. 	
<p>Bicycle parking facilities are essential elements for bicycle transportation. Every bicycle trip begins and ends with the need for a safe and secure place to park one’s bike. A lack of adequate and secure parking will discourage people from biking. Bicycle parking facilities can be provided at both trip origin and destination points and offer a protection from theft and damage.</p>		
<p>Cost Range: \$250 (rack) to \$2,500 (locker) depending on type and style of bicycle parking system.</p>		



5. Actuated Traffic Signal		Intersection Treatment
 		<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. To be used where crossings are difficult for bicyclists and local residents support a traffic signal. 2. Should meet the warrants and standards outlined in the MUTCD. A bicycle may be considered a pedestrian or a vehicle for evaluating the justification warrants. 3. Minimize or avoid the use of traffic signals at intersections unless they are warranted. 4. The installation of a traffic signal should not serve to significantly impede traffic flow on the arterial or major-street (i.e., should operate in coordination). 5. The traffic signal should be actuated and rest in green on the mainline. 6. Bicycle detection and cross-street vehicle detection should be provided. Bicycle detection should follow Item 2 of these guidelines. 7. The traffic signal should be a compatible and be consistent in the traffic control type with the remainder of the major street.
<p>Description:</p> <p>A primary goal of bicycle boulevards is to provide prioritized travel for cyclists and improve the safety or delay at critical intersections. A traffic signal is one option for improving right of way compliance, minimizing delay, potentially improving safety and providing prioritized travel for cyclists where other geometric or design treatments might be unsuccessful. Exclusive bicycle phasing or bicycle signal indications may also be an appropriate strategy were determined warranted.</p>		
<p>Cost Range:</p> <p>\$120,000-\$150,000</p>		

Photo Source: Photo to Left - Bicycle Signal Indications Dialite LED Traffic Module Spec Sheet




6. Pedestrian Hybrid Signal (HAWK)		Intersection Treatment
 		<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. May be use at locations that do not meet other signal warrants to facilitate pedestrian and cyclist crossings. 2. An engineering study evaluating, width, speeds, gaps, major-minor street volumes and bicycle/pedestrian delays should be conducted to assess need. 3. Signal will require educational outreach to explain function. 4. Signal utilizes both red (two) and yellow (one) signal heads in accordance with the MUTCD Section 4F. 5. All other criteria of MUTCD Section 4F must be satisfied prior to installation. 6. Signal's unlit signal may confuse drivers, conveying a broken signal, and may also confuse motorists whether they have a statutory requirement to stop at a dark signal. 7. Consider design such that pedestrians use the marked crosswalk and bicyclists use an unmarked travel-way. 8. Provide countdown pedestrian timer indications and a bicycle signal indication. (red, yellow, green).
<p>Description:</p> <p>A common problem at high volume unsignalized intersections is lack of adequate gaps in traffic for safe pedestrian and cyclist crossings. The pedestrian hybrid signal utilizes both red and yellow signal heads to facilitate pedestrian and cyclist crossings at unsignalized locations at marked crosswalks. Studies have found the HAWK signal greatly improves compliance at crosswalk locations.</p>		
<p>Cost Range:</p> <p>Approximately \$50,000 to \$125,000 depending upon infrastructure required.</p>		

Photo Source: Photo to Right - FHWA (http://safety.fhwa.dot.gov/ped_bike/legis_guide/rpts_cnsgs/pedrpt_0808/chap_3.cfm) Pedestrian Safety Report to Congress

7. Overhead Flasher System		Intersection Treatment
	<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. An overhead pedestrian actuated flasher system may be provided if the following requirements are satisfied: <ul style="list-style-type: none"> • There is adequate stopping sight distance for vehicles • The roadway is classified as a Collector or Arterial • A peak hour gap study finds there to be less than 60 safe crossing gaps per 60 minute interval (on average over the peak hour)⁵. Note: Pedestrian crossing time = (street width / 3.5 feet per second) + 3.0. • An engineering study determines there is a need to provide additional right of way protection. 2. Place the push button in a convenient location to prevent bicyclists from having to dismount. 3. Consider the W11-15 Shared Pedestrian/Bicycle Warning Sign. 4. Minimize the double threat. Where locating an overhead flasher system look for an opportunity to reduce the travel lanes. 	
<p>Description: To help improve compliance of crosswalks or bicycle path crossings, an overhead flasher system may be an appropriate solution. The overhead flasher system rests in dark until activated. Once activated, yellow beacons are flashed in an alternating sequence for a programmed amount of time. Pedestrians and bicyclists are required to enter roadway only when safe to cross.</p>		
<p>Cost Range: Approximately \$35,000 to 50,000 depending on infrastructure required.</p>		


8. High Visibility Crosswalk (Raised or Not Raised)		Intersection Treatment
	<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. Use retro-reflective pavement markings and signage. 2. Raised crossings should not be considered on MSA or major streets. 3. Consider installing “X-ING Ahead” pavement markings in addition to the crosswalk signage. 4. Optional enhancements include curb extensions to shorten crossing distance (may eliminate some on-street parking), a refuge island to assist crossing roadways with higher traffic volumes and/or multiple lanes. 5. The design may be modified to facilitate unimpeded crossings by wide-chassis vehicles such as fire trucks. 6. Consider installing high-contrast and pedestrian dome ramps at the edge of the crosswalk to aid the visually impaired. 	
<p>Description: High visibility crosswalks in combination with signage and pavement markings may be used at mid-block or intersections to improve visibility and safety.</p>		
<p>Cost Range: Approximately \$2,000 to \$15,000 depending on extent of treatment, size of the road, and drainage issues.</p>		

Photo Source: Photo to Right – Berkley, California. Fundamentals of Bicycle Boulevard Planning and Design, ibpi, alta Planning + Design, Portland State University, July 2009.

⁵ Minnesota Manual on Uniform Traffic Control Devices, Part 4 Highway Traffic Signals, Warrant 3 Pedestrian Volume Warrant, May 2005.

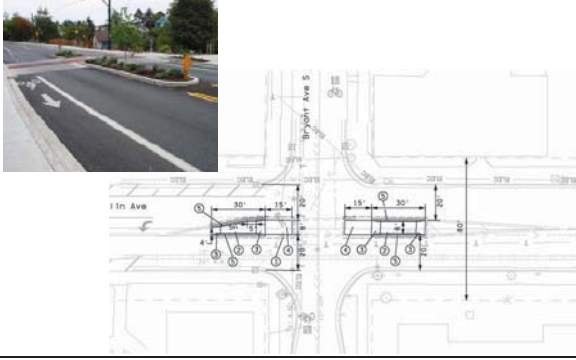

9. Median Refuge Island		Intersection Treatment
	<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. Medians can be constructed entirely out of concrete or can allow space for landscaping. 2. Maintenance, right of way, street width, cost and time should be considered when deciding what type of median to construct. 3. Roadway width should be considered when deciding to install a median. Some locations may not have enough space to accommodate a median. The median should be a minimum of 6 feet in width, but ideally 10 feet for bicyclists. 4. If landscaped, native or low-maintenance plants are recommended to reduce maintenance. 5. Installing reflectors at the refuge area should be considered to provide safe crossings at night. 6. Provide separated pedestrian and bicycle crossings. Depressed area for bicyclists and ADA compliant pedestrian ramps or cut-through for pedestrians. 	
<p>Description: Crossings at unsignalized multi-lane intersections can be difficult for pedestrians and bicyclists to safely make the crossing. Median refuge islands assist pedestrians and bicyclists when crossing by providing a space to wait for gaps in vehicle traffic.</p>		
<p>Cost Range: \$15,000 to \$30,000 per 100 feet. For perspective, the median shown above (design plan illustration) was bid at \$23,000.</p>		

Photo Source: Photo to Left. Fundamentals of Bicycle Boulevard Planning and Design, ibpi, alta Planning + Design, Portland State University, July 2009. Photo to Right – Franklin Avenue/Bryant Avenue planned median construction.

10. Bicycle Left Turn Lanes		Intersection Treatment
	<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. Use retro-reflective materials on both raised and painted left turn lanes to increase visibility at night. 2. Raised medians should be at least 6 feet in width and 8 feet in length to provide acceptable separation between bicycle and motorist. 3. This treatment may only be appropriate when the volumes of bicyclists are very high and there are sufficient gaps in traffic. 	
<p>Description: Providing a dedicated space for a bicyclist to make a left turn movement may be appropriate. Left Pocket Zones have been used at locations where two major bicycle routes intersect or when a roadway/bike route jogs. The advantage of a Left Pocket Zone is added visibility and greater separation between cars and bikes. This treatment may only be appropriate when the volumes of bicyclists are very high and there are sufficient gaps in traffic.</p>		
<p>Cost Range: Range from \$500 to \$15,000+ depending upon design.</p>		

Photos: Portland, Oregon.



11. Traffic Circles		Traffic Calming
	<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. Less effective than speed bumps at reducing mid-block motor vehicle speeds, but more effective at reducing speeds through intersections. 2. Multiple traffic circles at several intersections along the bicycle boulevard may be more effective at reducing motor vehicle speeds. 3. Should be landscaped, native or low-maintenance plants are recommended to reduce maintenance. Tree in center encouraged for center of road obstruction visibility during winter months. 4. Used to eliminate stop signs for the bicycle boulevard direction which may potentially reduce cyclists delay. 5. Two-way stop signs or yield signs (on cross-street) should be used. Four-way stop not recommended. 6. The fish hook sign accompanied by solid yellow pavement markings should be considered to appropriate direct motor vehicle traffic. 7. Diameter is sized to accommodate fire-truck and school-bus through and right turn movements. Left turns occur in front of circle. Circle also sized to account for snow creep. 8. Cooperative maintenance agreements with residents may be created for watering and maintaining landscaping. 	
<p>Description: A primary goal of bicycle boulevards is to provide a safe and comfortable route for cyclists. A common problem cyclist's face on roadways is traveling on roadways with higher speed motor vehicles. Traffic calming, such as traffic circles, reduces the speed and volume of motor vehicles traffic on roadways.</p>		
<p>Cost Range: \$5,000 to \$10,000 for mini traffic circles depending on landscaping and road material. \$45,000+ for landscaped roundabout at neighborhood intersections.</p>		

Photo Source: Portland Bureau of Transportation. <http://www.sustainableportland.org/TRANSPORTATION/index>

12. Speed Humps		Traffic Calming
	<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. Additional treatments may be necessary to prevent motorists from driving around the speed hump of constructed on streets without curbs. 2. Speed tables are typically installed in a series; spaced 300-500 feet apart. Speed humps are typically installed in pairs spaced at 135 foot intervals. 3. Drivers may speed up between humps or tables. 4. Roadway grade may present drainage issues. 5. May increase volumes on adjacent streets. 6. Gradual and longer speed tables or humps are more comfortable for bicyclists to ride over without reducing their speeds. 7. May often be combined with mid-block crossings, traffic circle, and other traffic calming design elements. 8. Speed humps or tables may be shortened to allow cyclist to pass to the right of it. 	
<p>Description: A primary goal of bicycle boulevards is to provide a safe and comfortable route for cyclists. A common problem cyclist's face on roadways is traveling on roadways with higher speed motor vehicles. Traffic calming, such as speed humps or tables, reduces the speed of motor vehicles traffic on roadways.</p>		
<p>Cost Range: Approximately \$5,000 per pair.</p>		


13. Chicanes		Traffic Calming
	<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. May be designed separated from the curb face to create a bicycle bypass and/or to allow water to continue draining along a gutter pan, but this may require maintenance to remove leaf matter and other debris build up. 2. If the chicane is landscaped, it is recommended that low growing shrubs and/or trees with high canopies be planted to preserve sight distance. 3. Installation may reduce on-street parking. 4. May present maintenance challenges, especially for snow plow drivers and street sweepers. Emergency vehicles may also have difficulties if the chicane curve radius is too small. 	
<p>Description: Chicanes are raised curbs that create serpentine, horizontal shifting of the travel lanes along a roadway. The shifting lanes reduce vehicles speeds by eliminating long stretches of straight roadway.</p>		
<p>Cost Range: Landscaped chicanes: \$10,000+ depending upon drainage structure and infrastructure impacts and needs.</p>		

Photo Source: Photo to Left. Fundamentals of Bicycle Boulevard Planning and Design, ibpi, alta Planning + Design, Portland State University, July 2009.


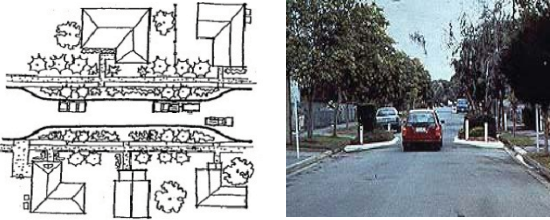

14. Curb Extensions		Traffic Calming
	<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. Recommended that 12-14 feet of outside lane width at the curb extension be provided if bike lanes are present. 2. The turning radius of larger vehicles, such as delivery vehicles and fire trucks, should be considered when designing curb extensions. 3. If the curb extension is landscaped, it is recommended that low growing shrubs and/or trees with high canopies be planted to preserve sight distance. 4. Catch basins must be placed to optimize rainwater collection but may present design challenges. 5. Curb extensions may be installed at intersections or at mid-block locations to constrict traffic and to provide shorter pedestrian crossings. 	
<p>Description: At multi lane intersections it can be difficult for pedestrians and bicyclists to safely make the crossing. Curb extensions extend the sidewalk or curb face into the parking lane at an intersection. This reduces the width of the crosswalk, shortening bicyclist and pedestrian crossing distance and calms traffic by reducing vehicle speeds.</p>		
<p>Cost Range: \$20,000+ per corner dependent upon existence of drainage structures.</p>		

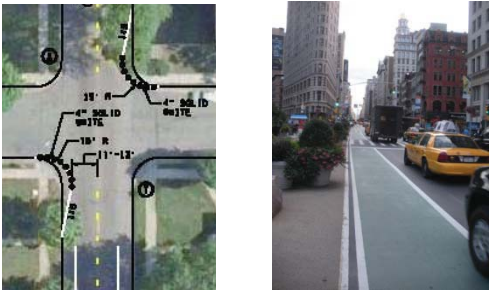
Photo Source: Photo to Left. http://cstreetne.blogspot.com/2009_12_01_archive.html


15. Chokers		Traffic Calming
		<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. Not recommended where parking needs are extensive. 2. Driveways, alleys and snowplow operations should be considered when deciding when to use chokers. 3. A more economical way of achieving the same effect of chokers would be to provide on-street parking. 4. Chokers should not be installed without the approval of the adjacent residents/property owners. 5. Drainage impacts should be considered when designing chokers. 6. If landscaped, native or low-maintenance plants are recommended to reduce maintenance.
<p>Description: Chokers are a physical narrowing of the roadway mid-block. The narrow roadway, reduces vehicle speeds by eliminating long stretches of straight roadway.</p>		
<p>Cost Range: \$15,000+ depending on length/width of choker and drainage structure impacts.</p>		

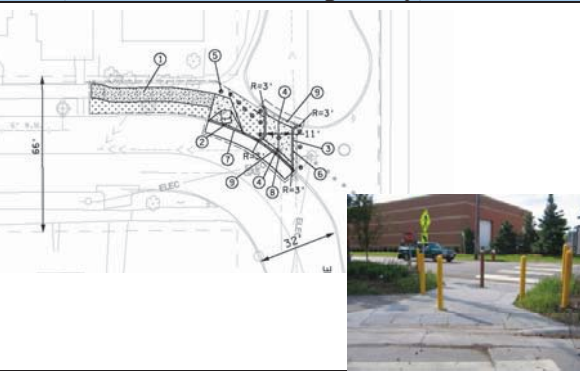
16. Landscaping and Street Trees		Traffic Calming
		<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. Funding for landscaping can come through partnerships with parks and recreation and environmental services departments, as well as private funding sources. 2. Consider using native or low-maintenance plants for landscaping. 3. Cooperative agreements may be formed with nearby residents and business owners to provide for minor maintenance activities such as watering or pruning.
<p>Description: Landscaping and street trees improves the attractiveness of a bicycle boulevard. Corridors landscaped with street trees and planted medians beautify the streetscape and provide traffic calming benefits.</p>		
<p>Cost Range: \$150+ per tree depending upon trunk size and species selected.</p>		

Photo Source: Photo to Left. <http://www.completestreets.org/resources/streetscape-improvements-help-make-streets-complete/>. Grandview Drive, WA, Dan Burden.

17. Residential Paint the Street Art		Traffic Calming
	<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. Holding public competitions for artistic bicycle parking or intersection mural designs can be considered. 2. Art work that is functional, such as decorative bicycle parking or bicycle pavement markings is suggested. 3. Maintenance and or replacement of artwork should be considered depending on wear and tear. 4. Artwork should be tasteful and appeal to the general public. 5. Should meet the requirements and specifications of the City of Minneapolis Paint the Pavement Program. 	
<p>Description: Public art defines the space along a bicycle boulevard, and is may serve to increase public involvement.</p>		
<p>Cost Range: --</p>		

18. Temporary Street Furniture/Painting in Unnecessary Paved Areas		Traffic Calming
	<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. Cooperative agreements should be formed with nearby residents and business owners to provide for minor maintenance activities such as watering or pruning. 2. The use of delineators or pavement markings will require routine maintenance. 3. Strategies may be considered for April to October months to not interfere with snow plowing and additional maintenance efforts. 	
<p>Description: Providing large landscape pots or tube delineators or pavement markings may be an inexpensive temporary solution (as opposed to curb or geometric changes) to narrowing intersections or roadways.</p>		
<p>Cost Range: Varies widely dependent upon features selected.</p>		

19. Half Closure with Bicycle Pass-Through		Traffic Reduction
	<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. Assess potential motor vehicle traffic diversion onto nearby streets and consider additional traffic calming to mitigate impacts. 2. Consider impacts to emergency vehicles and nearby businesses (delivery and patron circulation). 3. Post signs and other appropriate signing to permit bicycle traffic. 4. Consider using native or low-maintenance plants for landscaping. 5. Restrictions through signing only may present enforcement issues. 6. Consider temporary half-closures through the use of barrier or landscaped pots to test effectiveness and measure impacts. 	
<p>Description: A half closure is intended to reduce motor vehicle traffic along the roadway by prohibiting the through movement in at least one direction. This often accomplished through a landscaped curb extension or barrier and roadway regulatory signing.</p>		
<p>Cost Range: Approximately \$20,000+ but may vary widely depending on existing conditions, drainage and design of connection.</p>		

20. Divorter with Bicycle Accessibility (Permanent or Temporary)		Traffic Reduction
	<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. Assess potential motor vehicle traffic diversion onto nearby streets and consider additional traffic calming to mitigate impacts. 2. Consider impacts to emergency vehicles. 3. Post signs and other appropriate signing to permit bicycle traffic. 4. Bollards should be used to physically prevent motor vehicles from cutting through the diverter in addition to "No Motor Vehicles" signage combined with enforcement. 5. Temporary or permanent barricades may be used. 6. Low profile bollards, etc may be use to allow emergency vehicles access to roadway. 7. May require a series of diverters through a neighborhood to maintain reasonable traffic circulation patterns. 	
<p>Description: Traffic diverters are designed to prevent a continuous through motor vehicle movement along a street. Diverters are very effective in reducing traffic along the local street grid, and removing regional trips from the local streets.</p>		
<p>Cost Range: \$50,000+ but may vary widely depending on existing conditions, drainage and design of connection.</p>		

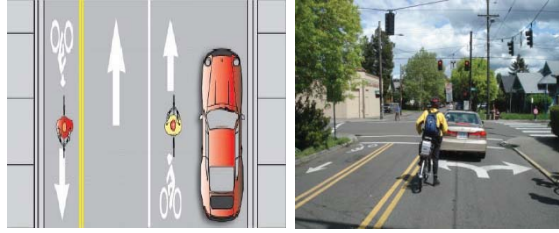
21. Contraflow Lane (Painted & Signed or Signed Only)		Traffic Reduction
		<p>Design Considerations:</p> <ol style="list-style-type: none"> 1. May require modification to existing traffic signals to allow bicyclists to activate signal from the “opposite” direction. 2. May create safety concerns due to bicyclists traveling in a direction where motorists do not expect them. 3. Depending on the roadway, the contraflow lane is generally separated from the motor vehicle lane with a double-yellow line. 4. Posting signs only to notify motor vehicles of contraflow bicycle travel can also be used. 5. Not recommended for use on streets with many driveways. 6. Posting of a “except bicycles” plaque below the “Do Not Enter” sign is recommended. 6. A signed only option (“except bicycles” plaque) with no other markings may be considered. However, this may violate driver expectation and pose a potential safety hazard, depending on the characteristics of the street. An evaluation of the corridor should be conducted before implementing.
<p>Description:</p> <p>On roadways with one-way vehicle traffic it can be difficult for bicyclists to travel safely in both directions. A contraflow lane provides direct access for bicyclists to safely travel against the flow of traffic on one-way streets.</p>		
<p>Cost Range:</p> <p>\$1.00 per foot (paint) \$250 per sign</p>		

Photo Source: Photo to Left. Fundamentals of Bicycle Boulevard Planning and Design, ibpi, alta Planning + Design, Portland State University, July 2009.