Burnsville, MN

Pedestrian and Bicycle Design

DESIGN GUIDELINES







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Section I Introduction

Overview

This toolbox presents guidance for local planners, engineers, and advocates to improve the walkability of Burnsville and create more comfortable streets for pedestrians and bicyclists of all ages and abilities. Planners and project designers should refer to these guidelines in developing the infrastructure projects recommended by this plan, but they are not a substitute for thorough project-by-project evaluation by a landscape architect or engineer upon implementation.

Context

This Design Toolbox has been developed to assist the City of Burnsville in the selection and design of facilities. The designs featured in this Toolbox work to promote pedestrian and bicycle comfort, particularly among children. The chapter presents current planning, engineering, and design resources and approaches to implement bicycle and pedestrian enhancements.

What, Why, Where, When and How?

Future roadway planning, engineering, design and construction will continue to strive for a balanced transportation system that includes a seamless, accessible bicycle and pedestrian network and encourages bicycle and pedestrian travel wherever possible.

There are many reasons to integrate bicycle and pedestrian facilities into typical roadway development policy. The goal of a transportation system is to better meet the needs of people - whether in vehicles, bicyclists or pedestrians - and to provide access to goods, services, and activities.

Supporting active modes gives users important transportation choices, whether it is to make trips entirely by walking or cycling, or to access public transit. Often in urban or suburban areas, walking and cycling are the fastest and most efficient ways to perform short trips.

Convenient non-motorized travel provides many benefits, including reduced traffic congestion, user savings, road and parking facility savings, economic development, and a healthier environment.

Compatible design does more than help those who already walk or bicycle. It encourages greater use of non-motorized transportation and makes the street safer for everyone.

The design recommendations in this document are for use on Burnsville roadways. Projects must not only be planned for their physical aspects as facilities serving specific transportation objectives; they must also consider effects on the aesthetic, social, economic and environmental values, needs, constraints and opportunities in a larger community setting. This is commonly known as Context Sensitive Design, and should be employed when determining which standard is applicable in each scenario.

Pedestrian and bikeway design guidelines in this document meet or exceed the minimums set by the Americans with Disabilities Act.

Traffic control devices, signs, pavement markings used and identified in this document must conform to the latest edition of the Minnesota's Manual on Uniform Traffic Control Devices (MN MUTCD).

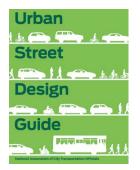
Whenever possible and appropriate, the National Association of City Transportation Officials (NACTO)'s guidance is recommended where applicable.

BURNSVILLE DESIGN GUIDELINES

Guidance Basis

The sections that follow serve as an inventory of pedestrian and bicycle design treatments and provide guidelines for their development. These treatments and design guidelines are important because they represent the tools for creating a pedestrian- and bicycle-friendly, accessible community. The guidelines are not, however, a substitute for a more thorough evaluation by a professional engineer prior to implementation of facility improvements. The following guidelines are incorporated in this Design Guide.

National Guidance



The National Association of City Transportation Officials' (NACTO) Urban Bikeway Design Guide (2012) and Urban Street Design Guide (2013) are collections of nationally recognized street design standards, and offers guidance on the current state of the practice designs.

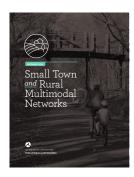


The National Association of City Transportation Officials' (NACTO)

Urban Bikeway Design Guide (2012)
provides cities with state-of-the-practice solutions that can help create complete streets that are safe and enjoyable for bicyclists. The designs were developed by cities for cities, since unique urban streets require innovative solutions. In August 2013, the Federal Highway Administration issued a memorandum officially supporting use of the document.



Separated Bike Lane Planning and Design Guide (2015) is the latest national guidance on the planning and design of separated bike lane facilities released by the Federal Highway Administration (FHWA). The resource documents best practices as demonstrated around the U.S., and offers ideas on future areas of research, evaluation and design flexibility.



The Federal Highway Administration's Small Town and Rural Multimodal Networks Report (2016) offers resources and ideas to help small towns and rural communities support safe, accessible, comfortable, and active travel for people of all ages and abilities. It connects existing guidance to rural practice and includes examples of peer communities.

Minnesota Guidance



Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD) defines the standards used by road managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways, and private roads open to public traffic.



The Minnesota Department of Transportations's Bicycle Facility Design Manual (2020) establishes uniform design criteria for Minnesota roadways. The manual should be used in conjunction with the current versions of the MnDOT Road Design Manual and the Minnesota Manual on Uniform Traffic Control Devices.



The Minnesota Department of Transportations's
Minnesota's Best
Practices for Pedestrian and Bicycle Safety
(2021) identifies proven strategies and treatments. The manual should be used in conjunction with the current versions of the MnDOT Road Design Manual and the Minnesota Manual on Uniform Traffic Control Devices.

Design Needs of Pedestrians

The MN MUTCD recommends a normal walking speed of 3.5 feet per second when calculating the pedestrian clearance interval at traffic signals. The walking speed can drop to 3 feet per second for areas with older populations and persons with mobility impairments. While the type and degree of mobility impairment varies greatly across the population, the transportation system should

Types of Pedestrians

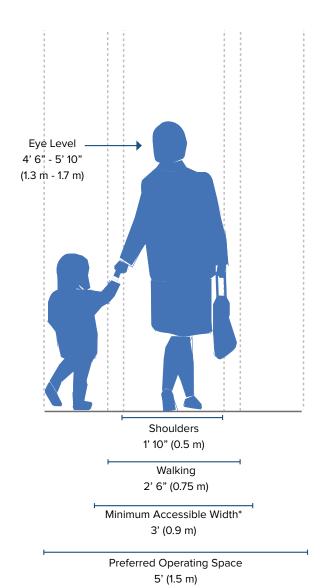
Pedestrians have a variety of characteristics and the transportation network should accommodate a variety of needs, abilities, and possible impairments. Age is one major factor that affects pedestrians' physical characteristics, walking speed, and environmental perception. Children have lower eye height and may walk slower than adults. They also perceive the environment differently at various stages of their cognitive development. Older adults walk more slowly and may require assistive devices for walking stability, sight, and hearing.

Disabled Pedestrian Design Considerations

The table below summarizes common physical and cognitive impairments, how they affect personal mobility, and recommendations for improved pedestrian-friendly design.

Disabled Pedestrian Design Considerations

Impairment	Effect on Mobility	Design Solution
-	•	
Physical Impairment Necessitating	Difficulty propelling over uneven or soft surfaces.	Firm, stable surfaces and structures, including ramps or beveled edges.
Wheelchair and Scooter Use	Cross-slopes cause wheelchairs to veer downhill or tip sideways.	Cross-slopes of less than two percent.
	Require wider path of travel.	Sufficient width and maneuvering space.
Physical Impairment Necessitating Walking Aid Use	Difficulty negotiating steep grades and cross slopes; decreased stability and tripping hazard.	Cross-slopes of less than two percent. Smooth, non-slippery travel surface.
	Slower walking speed and reduced endurance; reduced ability to react.	Longer pedestrian signal cycles, shorter crossing distances, median refuges, and street furniture.
Hearing Impairment	Less able to detect oncoming hazards at locations with limited sight lines (e.g. driveways, angled intersections, channelized right turn lanes) and complex intersections.	Longer pedestrian signal cycles, clear sight distances, highly visible pedestrian signals and markings.
Vision Impairment	Limited perception of path ahead and obstacles; reliance on memory; reliance on non-visual indicators (e.g. sound and texture).	Accessible text (larger print and raised text), accessible pedestrian signals (APS), guide strips and detectable warning surfaces, safety barriers, and lighting.
Cognitive Impairment	Varies greatly. Can affect ability to perceive, recognize, understand, interpret, and respond to information.	Signs with pictures, universal symbols, and colors, rather than text.



*At point of contact

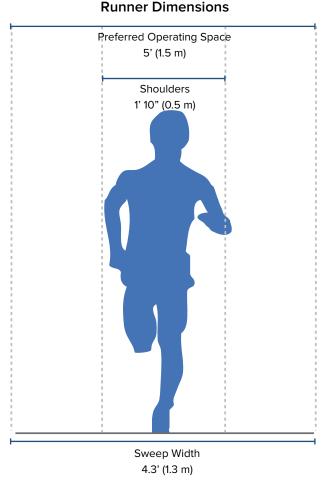
Pedestrian Characteristics by Age

Age	Characteristics
0-4	Learning to walk
	Requires constant adult supervision
	Developing peripheral vision and depth perception
5-8	Increasing independence, but still requires supervision
	Poor depth perception
9-13	Susceptible to "darting out" in roadways
	Insufficient judgment
	Sense of invulnerability
14-18	Improved awareness of traffic environment
	Insufficient judgment
19-40	Active, aware of traffic environment
41-65	Slowing of reflexes
65+	Difficulty crossing street
	Vision loss
	Difficulty hearing vehicles approaching from behind

Source: AASHTO. Guide for the Planning, Design, and Operation of Pedestrian Facilities, Exhibit 2-1. 2004.

Design Needs of Runners

Running is an important recreation and fitness activity commonly performed on shared use paths. Many runners prefer softer surfaces (such as rubber, bare earth or crushed rock) to reduce impact. Runners can change their speed and direction frequently. If high volumes are expected, controlled interaction or separation of different types of users should be considered.



Sweep Width 3' 6" (1.5 m)

Design Needs of Strollers

Strollers are wheeled devices pushed by pedestrians to transport babies or small children. Stroller models vary greatly in their design and capacity. Some strollers are designed to accommodate a single child, others can carry 3 or more. Design needs of strollers depend on the wheel size, geometry and ability of the adult who is pushing the stroller.

Strollers commonly have small pivoting front wheels for easy maneuverability, but these wheels may limit their use on unpaved surfaces or rough pavement. Curb ramps are valuable to these users. Lateral overturning is one main safety concern for stroller users.

Stroller Dimensions



Physical Length 5' (1.5 m)

Design Needs of Wheelchair Users

As the American population ages, the age demographics in Burnsville may also shift, and the number of people using mobility assistive devices (such as manual wheelchairs, powered wheelchairs) will increase.

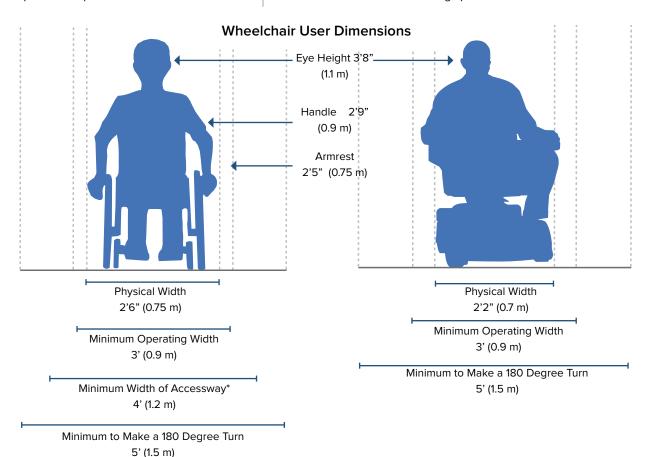
Manual wheelchairs are self-propelled devices. Users propel themselves using push rims attached to the rear wheels. Braking is done through resisting wheel movement with the hands or arm. Alternatively, a second individual can control the wheelchair using handles attached to the back of the chair.

Power wheelchairs use battery power to move the wheelchair. The size and weight of power wheelchairs limit their ability to negotiate obstacles without a ramp. Various control units are available that enable users to control the wheelchair movement, based on their ability (e.g., joystick control, breath controlled, etc).

Maneuvering around a turn requires additional space for wheelchair devices. Providing adequate space for 180 degree turns at appropriate locations is an important element of accessible design.

Wheelchair User Design Considerations

Effect on Mobility	Design Solution
Difficulty propelling over uneven or soft surfaces.	Firm, stable surfaces and structures, including ramps or beveled edges.
Cross-slopes cause wheelchairs to veer downhill.	Cross-slopes of less than two percent.
Require wider path of travel.	Sufficient width and maneuvering space.



Design Needs of Bicyclists

The facility designer must have an understanding of how bicyclists operate and how their bicycle influences that operation. Bicyclists, by nature, are much more affected by poor facility design, construction and maintenance practices than motor vehicle drivers.

By understanding the unique characteristics and needs of bicyclists, a facility designer can provide quality facilities and minimize user risk.

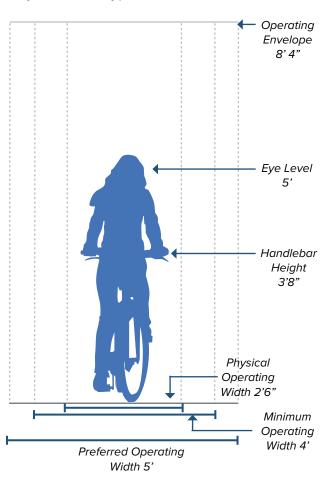
Bicycle as a Design Vehicle

Similar to motor vehicles, bicyclists and their bicycles exist in a variety of sizes and configurations. These variations occur in the types of vehicle (such as a conventional bicycle, a recumbent bicycle or a tricycle), and behavioral characteristics (such as the comfort level of the bicyclist). The design of a bikeway should consider reasonably expected bicycle types on the facility and utilize the appropriate dimensions.

The figure illustrates the operating space and physical dimensions of a typical adult bicyclist, which are the basis for typical facility design. Bicyclists require clear space to operate within a facility. This is why the minimum operating width is greater than the physical dimensions of the bicyclist. Bicyclists prefer five feet or more operating width, although four feet may be minimally acceptable if the pavement is continuous and there is no curbing present..

In addition to the design dimensions of a typical bicycle, there are many other commonly used pedal-driven cycles and accessories to consider when planning and designing bicycle facilities. The most common types include tandem bicycles, recumbent bicycles, and trailer accessories.

Bicycle Rider - Typical Dimensions



Bicycle as Design Vehicle - Design Speed Expectations

BICYCLE TYPE	FEATURE	TYPICAL SPEED
Upright Adult Bicyclist	Paved level surfacing	8-12 mph*
	Crossing Intersections	10 mph
	Downhill	30 mph
	Uphill	5 -12 mph
Recumbent Bicyclist	Paved level surfacing	18 mph

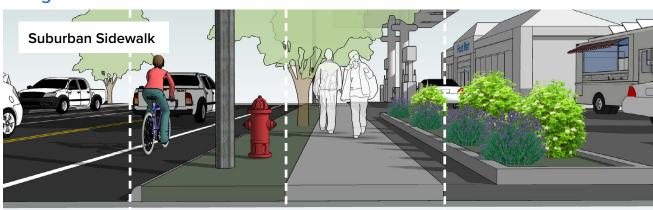
^{*} Typical speed for causal riders per MnDOT Bicycle Facility Design Manual.

Section 2 Pedestrian Toolbox

Sidewalk Zones & Widths

Sidewalks are the most fundamental element of the walking network, as they provide an area for pedestrian travel separated from vehicle traffic. Providing adequate and accessible facilities can lead to increased numbers of people walking, improved accessibility, and the creation of social space.

Design Features





Enhancement Zone

The curbside lane can act as a flexible space to further buffer the sidewalk from moving traffic., and may be used for a bike lane. Curb extensions and bike corrals may occupy this space where appropriate.

Buffer Zone

The buffer zone, also called the furnishing or landscaping zone, buffers pedestrians from the adjacent roadway, and is also the area where elements such as street trees, signal poles, signs, and other street furniture are properly located.

Pedestrian Through Zone

The through zone is the area intended for pedestrian travel. This zone should be entirely free of permanent and temporary objects.

Wide through zones are needed in areas or where pedestrian flows are high.

Frontage Zone

The frontage zone allows pedestrians a comfortable "shy" distance from the building fronts, fencing, walls and vertical landscaping. It provides opportunities for window shopping, to place signs, planters, or chairs.

Street Classification	Parking Lane/ Enhancement Zone	Buffer Zone	Pedestrian Through Zone	Frontage Zone*
Local Streets	Varies	4 - 6 ft	5 ft	1 - 2 ft
Pedestrian Priority Areas	Varies	4 - 6 ft	12 ft	2 - 10 ft
Arterials and Collectors	Varies	4 - 6 ft	6 - 8 ft	1 - 5 ft

^{*}Indicates ideal frontage zone space. Actual frontage zone is contingent upon the City's development code and required set backs

Typical Application

- » Wider sidewalks should be installed near schools, at transit stops, or anywhere high concentrations of pedestrians exist.
- » At transit stops, an 8 ft by 5 ft clear space is required for accessible passenger boarding/ alighting at the front door location per ADA requirements.
- » Sidewalks should be continuous on both sides of urban commercial streets, and should be required in areas of moderate residential density (1-4 dwelling units per acre).
- » When retrofitting gaps in the sidewalk network, locations near transit stops, schools, parks, public buildings, and other areas with high concentrations of pedestrians should be the highest priority.

Materials and Maintenance

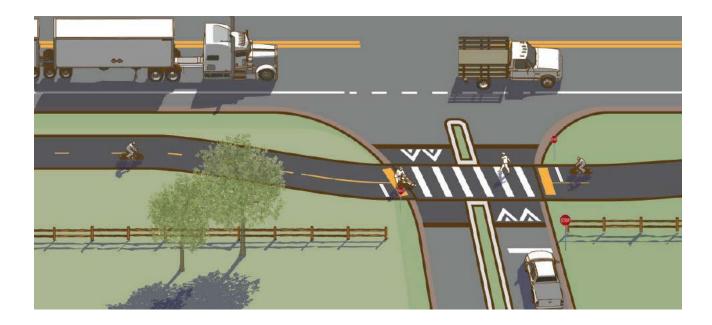
Sidewalks are typically constructed out of concrete and are separated from the roadway by a curb or gutter and sometimes a landscaped boulevard. Less expensive walkways constructed of asphalt, crushed stone, or other stabilized surfaces may be appropriate. Ensure accessibility and properly maintain all surfaces regularly. Surfaces must be firm, stable, and slip resistant. Colored, patterned, or stamped concrete can add distinctive visual appeal.

Approximate Cost

Cost of standard sidewalks range from about \$6-10 per square foot for concrete sidewalk. This cost can increase with additional right-of-way acquisition or addition of landscaping, lighting or other aesthetic features. As an interim measure, an asphalt concrete path can be placed until such time that a standard sidewalk can be built. The cost of asphalt path can be less than half the cost of a standard sidewalk.

Sidepaths

A sidepath is a bidirectional shared use path located immediately adjacent and parallel to a roadway. Sidepaths can offer a high-quality experience for users of all ages and abilities.



Typical Application

Sidepaths should be considered where one or more of the following conditions exist:

- » The adjacent roadway has relatively high volume and/or high-speed motor vehicle traffic that might discourage many people from riding on the roadway. Sidepaths do not preclude the installation or maintenance of existing bike lanes.
- » Along corridors with few intersections with minor streets and driveways.
- » To provide continuity between existing segments of shared use paths.
- » For use near schools, neighborhoods, and mixed use commercial areas, where increased separation from motor vehicles is desired, and there are few roadway and driveway crossings.

Design Features

Sidepaths should be designed to meet transportation standards as defined by American Association of State Highway and Transportation Officials (AASHTO), Public Right of Way Accessibility Guidelines (PROWAG), and MN MUTCD.

- Materials: Asphalt is the standard paving material for sidepaths.
- » Minimum Width: Minimum width of a sidepath is 10'. Where user volumes are high, additional width, as well as parallel facilities such as bike lanes and sidewalk can provide needed space.
- » Roadway Separation: The preferred minimum roadway separation width is 6.5 16.5' (Schepers, 2011). Absolute minimum separation width of 5' unless a barrier is provided. (MnDOT Bicycle Facility Design Manual).
- » Roadway Separation: Separation from roadway traffic is an essential design feature of sidepaths. Separation should increase as volumes and speed of adjacent roadway increase (MnDOT Bicycle Facility Design Manual).



A sidepath provides a continuous path of travel along roadway corridors with few driveways or intersections. Depending on the anticipated volumes and context, the sidepath can be constructed in lieu of sidewalk and/or bike lanes. Oftentimes, anticipated volumes, mix of skills, or other factors such as route continuity will also be considered in the decision to also include bike lanes and sidewalks.

- » Horizontal Clearance: A lateral clearance to landscaping, street furnishings and signs is required. MnDOT Bicycle Facility Design Manual identifies minimum clearance. Signs and other street furniture should be placed outside of the minimum path width.
- » Vertical Clearance: Standard clearance to overhead obstructions is 10'.
- » Cross Slope and Running Slope: As sidepaths are typically located within public rights of way, their designs are governed by ADA guidelines.

Further Considerations

- » Sight Lines: It is important to keep approaches to intersections and major driveways clear of obstructions due to parked vehicles, shrubs, and signs on public or private property.
- » Corner radii at driveways and minor streets should be minimized to facilitate vehicle turning speeds of 10-15 mph.

Materials and Maintenance

Like shared use paths, sidepaths must be regularly maintained so that they are free of potholes, cracks, root lift, and debris. Signage and lighting should also be regularly maintained to ensure sidepath users feel comfortable, especially in areas where visibility is limited.

Adjacent landscaping should be regularly pruned, to allow adequate sightlines along the path and at minor street crossings and driveways, allow for daylight, and pedestrian-scale lighting, and so as not to obstruct the path of travel of trail users.

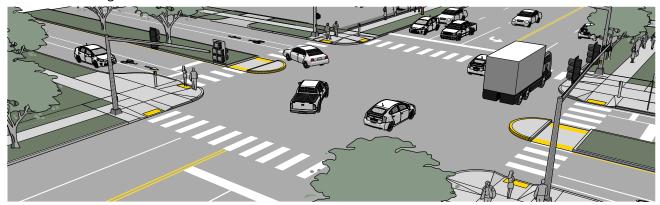
Approximate Cost

The cost of a sidepath can vary, but typical costs are similar to shared use paths between \$90,000 per mile to \$4 million per mile. These costs vary with materials, such as asphalt, concrete, boardwalk, grading, and ROW acquisition.

Marked Crosswalks at Intersections

Marked crosswalks signal to motorists that they must stop for pedestrians and encourages pedestrians to cross at designated locations. Installing crosswalks alone will not necessarily make crossings safer, particularly on multi-lane roadways.

Marked crosswalks across the uncontrolled leg of unsignalized intersections should follow the design guidance of marked crosswalks at mid-block locations. See Marked Crosswalks at Mid-Block for more guidance.



Typical Application

At signalized intersections, all crosswalks should be marked. At unsignalized intersections, crosswalks may be marked under the following conditions:

- » At an intersection within a school zone or on a walking route, trail crossings, and at parks, libraries, or community centers.
- » At a complex intersection, to orient pedestrians in finding their way across.
- » At an offset intersection, to show pedestrians the preferred route across traffic with the least exposure to vehicular traffic and traffic conflicts.
- » At an intersection with visibility constraints, to position pedestrians where they can best be seen by oncoming traffic.

Design Features

- The crosswalk should be located to align as closely as possible with the through pedestrian zone of the sidewalk corridor.
- » Transverse markings are the most basic crosswalk marking type, but may wear faster as every vehicle drives over the markings.
- » Continental markings provide improved visibility and can be located outside of vehicle wheel paths.
- » Local climate can present unique challenges for pavement markings due to extreme heat/ cold, snow plows, and de-icing techniques.

Further Considerations

Continental crosswalk markings should be used at crossings with high pedestrian use, particularly where the crossing is not controlled by signals or stop signs, such as a local street crossing of a multilane arterial. These type of markings should also be used where vulnerable pedestrians are expected, including crossings near schools. Continental crosswalk marking also requires less on-going maintenance and lasts longer than other marking techniques.

Materials and Maintenance

The effectiveness of marked crossings depends entirely on their visibility; maintaining marked crossings should be a high priority. Thermoplastic markings offer increased durability when compared to conventional paint.¹

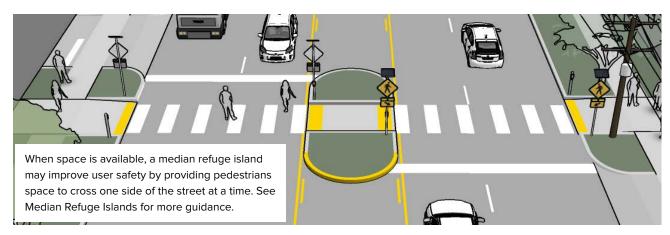
Approximate Cost

- Traditional paint \$9/linear foot
- » Thermoplastic paint \$15/linear foot
- » Total cost varies by crosswalk length and design e.g. solid, standard, continental, dashed, zebra, or ladder

¹ The appropriate marking material(s) should be determined on a project basis.

Marked Crosswalks at Mid-Block

An effective pedestrian crossing at an uncontrolled location consists of a marked crosswalk, appropriate pavement markings, warning signage, and other treatments to slow or stop traffic such as curb extensions, median refuges, beacons, hybrid beacons, and signals. Designing crossings at mid-block locations depends on an evaluation of motor vehicle traffic volumes, sight distance, pedestrian traffic volumes, land use patterns, vehicle speed, and road type and width.



Typical Application

- » Locations where mid-block crossings should be considered include:
 - » Long blocks (longer than 600 ft.) with destinations on both sides of the street
 - » Locations with heavy pedestrian traffic, such as schools, shopping centers, and shared use path crossings
 - » At transit stops, where transit riders must cross the street on one leg of their journey

Design Features

- » Detectable warning strips are required to help visually impaired pedestrians identify the edge of the street and are required through ADA
- » Advance stop lines should be placed 20-50 feet in advance of multi-lane uncontrolled mid-block crossings
- » Crosswalk markings legally establish mid-block pedestrian crossing
- » Pedestrian and stop warning signage (W11-2 and R1-5C) should be installed at the crossing to alert drivers of the potential presence of pedestrians in the roadway

Further Considerations

Uncontrolled crossings of multi-lane roadways with over 15,000 ADT may be possible with features such as sufficient crossing gaps in vehicular traffic (more than 60 per hour), median refuges, or beacons, and good sight distance.

On roadways with low to moderate traffic volumes and posted speeds at or below 30 mph, a raised crosswalk may be the most appropriate crossing design to improve pedestrian visibility and safety.

Approximate Cost

- \$55,000 Minimal installation (2 beacons, 2 poles)
- » \$60,000 Multi-lane side mounted (4 beacons, 2 poles)
- » \$280,000 Multi-lane overhead

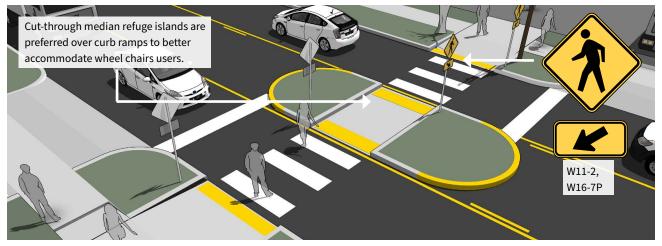
Crosswalk Examples Transverse Markings Continental Markings

Median Refuge Islands

Median refuge islands are located at the mid-point of a marked crossing and help improve safety by increasing visibility and allowing pedestrians to cross one direction of traffic at a time.

Refuge islands minimize pedestrian exposure at mid-block crossings by shortening the crossing distance and increasing the number of available gaps for crossing.

Median refuge islands can also be configured as an off-set crossing. This requires pedestrians to change their direction of travel while in the median - to face on-coming vehicles - before crossing. Here, pedestrians are more likely to see, and establish eye contact with on-coming motorists before stepping into the roadway.



Typical Application

- Refuge islands can be applied on any roadway with a left turn center lane or median that is at least 6' wide.
- » Islands are appropriate at signalized or unsignalized crosswalks.
- » The refuge island must be accessible, preferably with an at-grade passage through the island rather than ramps and landings.
- » The island should be at least 6' wide between travel lanes and at least 20' long (40' minimum preferred).
- Provide double centerline marking, reflectors, and "KEEP RIGHT" signage in the island on streets with posted speeds above 30 mph.

Design Features

- » Cut-through median refuge islands are preferred over curb ramps to better accommodate wheel chairs users.
- » Pedestrian warning signage should be placed at the crossing. Advanced warning signage should also be considered where site obstructions may be present on the approach.

Further Considerations

» This treatment may be combined with Rectangular Rapid Flashing Beacons (RRFBs). See treatment description for more information.

Materials and Maintenance

Refuge islands may require frequent maintenance of road debris. Trees and plantings in a landscaped median must be maintained so as not to impair visibility, and should be no higher than 30 inches.

Approximate Cost

\$10,000 - \$20,000 depending on presence of existing median and length of new median.

BURNSVILLE DESIGN GUIDELINES

Pedestrian Signalization Improvements

Typical Application

Pedestrian signal heads indicate to pedestrians when to cross at a signalized crosswalk. Pedestrian signal indications are recommended at all traffic signals except where pedestrian crossing is prohibited by signage.

Countdown signals should be used at all new and rehabbed signalized intersections.

Design Features

Adequate pedestrian crossing time is a critical element of the walking environment at signalized intersections. The length of a signal phase with parallel pedestrian movements should provide sufficient time for a pedestrian to safely cross the adjacent street. The MN MUTCD recommends a walking speed of 3.5 ft per second.

At crossings where older pedestrians or pedestrians with disabilities are expected, crossing speeds as low as 3 ft per second should be assumed. Special pedestrian phases can be used to provide greater visibility or more crossing time for pedestrians at certain intersections (See *Pedestrian Traffic Signal Enhancements*).

Large pedestrian crossing distances can be broken up with medians and islands into multiple stages. If the crossing is multi-stage, pedestrian push buttons must be provided. This ensures that pedestrians are not stranded on the median, and is especially applicable on large, multi-lane roadways with high vehicle volumes, where providing sufficient pedestrian crossing time for a single stage crossing may be an issue.

- » Consider the use of a Leading Pedestrian Interval (LPI) to provide additional trafficprotected crossing time to pedestrians. See Pedestrian Traffic Signal Enhancements for additional detail.
- » Accessible Pedestrian Signals (APS) provide crossing assistance to pedestrians with various types of disabilities at signalized intersections



Further Considerations

Pushbuttons should be located so that someone in a wheelchair can reach the button from a level area of the sidewalk without deviating significantly from the natural line of travel into the crosswalk. Pushbuttons should be marked (for example, with arrows) so that it is clear which signal is affected.

In areas with very heavy pedestrian traffic, consider an all-pedestrian signal phase to give pedestrians free passage in the intersection when all motor vehicle traffic movements are stopped. This may provide operational benefits as vehicle turning movements are then unimpeded.

Materials and Maintenance

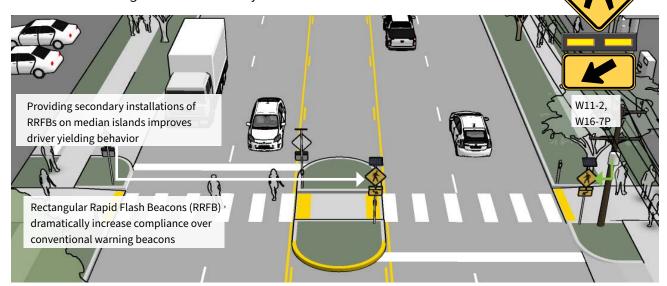
It is important to perform ongoing maintenance of traffic control equipment. Consider semi-annual inspections of controller and signal equipment, intersection hardware, and detectors.

Approximate Cost

Adjusting signal timing is relatively inexpensive, as it requires only a few hours of staff time to accomplish. New signal equipment ranges from \$20,000 to \$140,000.

Rectangular Rapid Flash Beacons (RRFB)

Rectangular Rapid Flash Beacons (RRFB) are a type of active warning beacon used at unsignalized crossings. They are designed to increase driver compliance on multi-lane or high-volume roadways.



Typical Application

- » Guidance for marked/unsignalized crossings applies.
- » RRFBs should not be used at crosswalks controlled by YIELD signs, STOP signs, Pedestrian Hybrid Beacons (HAWKs), or traffic control signals.
- » RRFBs should initiate operation based on user actuation and should cease operation at a predetermined time after the user actuation or, with passive detection, after the user clears the crosswalk.
- » Rectangular Rapid Flash Beacons (RRFB) dramatically increase compliance over conventional warning beacons.

Design Features

- » RRFBs are typically activated by pedestrians manually with a push button, or can be actuated automatically with passive detection systems. See Enhanced Crossing Treatment Selection page for more details on appropriate applications.
- » Providing secondary installations of RRFBs on median islands improves conspicuity and driver stopping behavior.
- » Must be used in conjunction with W11-2, S1-1, or W11-15, (and W16-7P if post-mounted). See FHWA Interim Approval 21 for more information.

» Beacons may be installed as side mounted or in overhead installations.

Further Considerations

Rectangular rapid flash beacons elicit the highest increase in compliance of all the amber warning beacon enhancement options.

A Florida study of the effectiveness of going from a no-beacon arrangement to a two-beacon RRFB installation increased yielding from 18 percent to 81 percent. A four-beacon arrangement raised compliance to 88%. Additional studies of long term installations show little to no decrease in yielding behavior over time.

See FHWA Interim Approval 21 (IA-21) for more information on RRFBs.

Materials and Maintenance

RRFBs should be regularly maintained to ensure that all lights and detection hardware are functional.

Approximate Cost

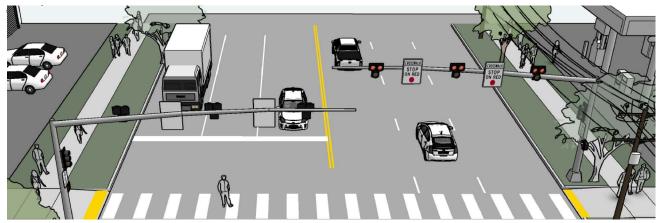
- » \$20,000-\$25,000 for Solar RRFB System
- » \$40,000-\$60,000 for Hardwire System

Note: this cost does not include any of the typical associated site work (curb, median, signage, etc).

Pedestrian Hybrid Beacon (PHB)

Pedestrian Hybrid Beacons (PHB) or High-Intensity Activated Crosswalks (HAWK) are used to improve non-motorized crossings of major streets. A hybrid beacon consists of a signal head with two red lenses over a single yellow lens on the major street, and a pedestrian signal head for the crosswalk.

Hybrid beacons are only used at marked mid-block crossings or unsignalized intersections. They are activated with a pedestrian pushbutton at each end. If a median refuge island is used at the crossing, another pedestrian pushbutton can be located on the island to create a two-stage



Typical Application

- » Suitable for arterial streets where speeds are above 30-45 mph and there are three or more lanes of traffic (or two lanes with a median refuge).
- » Where off-street bicycle facilities intersect major streets without signalized intersections.
- » At intersections or midblock crossings where there are high pedestrian volumes.

Design Features

- » Hybrid beacons may be installed without meeting traffic signal control warrants based on engineering judgement if roadway speed and volumes are excessive for comfortable pedestrian crossings.
- » If installed within a signal system, signal engineers should evaluate the need for the hybrid beacon to be coordinated with other signals.
- » Parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the marked crosswalk to provide adequate sight distance.
- » Crossings with a median refuge and no more than two lanes in each direction may utilize side mounted beacons for reduced cost and complexity.

Further Considerations

- » Hybrid beacon are normally activated by push buttons, but may also be triggered by infrared, microwave, or video detectors. If not on-demand, the maximum delay for activation of the signal should be two minutes, with minimum crossing times determined by the width of the street, but a much shorter delay is strongly preferred.
- » Each crossing, regardless of traffic speed or volume, requires review to identify sight lines, potential impacts on traffic progression, timing with adjacent signals, capacity, and safety.
- » The installation of hybrid beacons should also include public education and enforcement campaigns to ensure proper use and compliance.

Materials and Maintenance

PHBs are subject to the same maintenance needs and requirements as standard traffic signals.

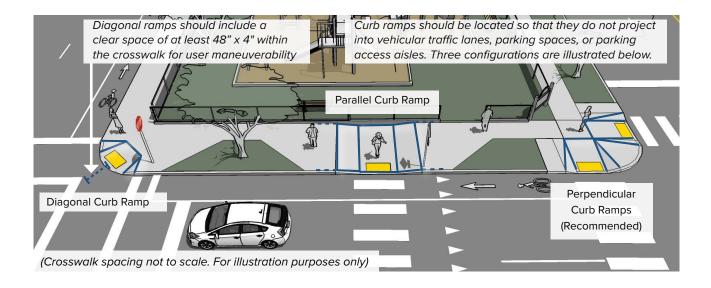
Signing and striping need to be maintained to help users understand any unfamiliar traffic control.

Approximate Cost

» \$125,000 - \$150,000 depending on complexity and overhead vs side mounted configuration.

Curb Ramps

Curb ramps are the design elements that allow all users to make the transition from the street to the sidewalk. A sidewalk without a curb ramp can be useless to someone in a wheelchair, forcing them back to a driveway and out into the street for access. There are a number of factors to be considered in the design and placement of curb ramps.



Typical Application

Curb ramps must be installed at all intersections and midblock locations where pedestrian crossings exist, as mandated by federal legislation (1973 Rehabilitation Act and ADA 1990). All newly constructed and altered roadway projects must include compliant curb ramps. In addition, existing facilities must be upgraded to current standards when appropriate.

The edge of an ADA compliant curb ramp should be marked with a detectable warning surface (also known as truncated domes) to alert people with visual impairments to changes in the pedestrian environment. Visual contrast between the raised tactile device and the surrounding infrastructure is important so that the change is readily evident to partially sighted pedestrians.

Design Features

- The level landing at the top of a ramp should be at least 4 feet long and at least the same width as the ramp itself. The slope of the ramp should be compliant to current standards.
- If the top landing is within the sidewalk or corner area where someone in a wheelchair may have to change direction, the landing must be a minimum of 4'-0" long (in the direction of the ramp run) and at least as wide as the ramp, although a width of 5'-0" is preferred.



Not recommended: Diagonal curb ramp configuration.

curb ramps for crossing in both directions.

Further Considerations

Where feasible, separate directional curb ramps for each crosswalk at an intersection should be provided rather than having a single ramp at a corner for both crosswalks. Although diagonal curb ramps might save money, they orient pedestrians directly into the center of the intersection, which can be challenging for wheelchair users and pedestrians with visual impairments. Diagonal curb ramp configurations are not recommended.

Curb radii need to be considered when designing directional ramps. While curb ramps are needed for use on all types of streets, the highest priority locations are on streets near transit stops, schools, parks, medical facilities, shopping areas.

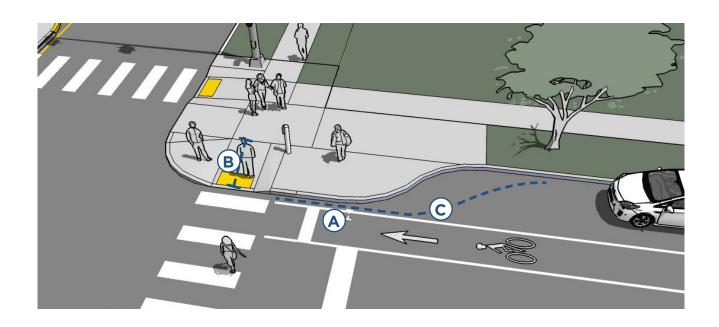


Materials and Maintenance

It is critical that the interface between a curb ramp and the street be maintained adequately. Asphalt street sections can develop vertical differentials where concrete meets asphalt at the foot of the ramp, which can catch the front wheels of a wheelchair.

Approximate Cost

The cost is approximately \$5,000-\$10,000 per curb ramp depending on drainage and right-of-way.



Curb Extensions

Curb extensions, also called curb bulbouts and neckdowns, minimize pedestrian exposure during crossing by shortening the crossing distance and giving pedestrians a better chance to see and be seen before beginning to cross. Curb extensions are appropriate for any crosswalk where it is desirable to shorten the crossing distance and there is a parking lane adjacent to the curb.

Typical Application

- » For purposes of efficient street sweeping, the minimum radius for the reverse curves of the transition is 10 ft and the two radii should be balanced to be nearly equal.
- » The curb extension width should terminate one foot short of the parking lane to maximize bicyclist safety when bicycle lanes are not present. This buffer is also preferred when bicycle lanes are present.

Design Features

- Where a bike lane runs adjacent to the curb extension, design with a 1' buffer from edge of parking lane (preferred).
- Crossing distance is shortened by approximately 6-8 feet with a parallel parking lane or 15 feet or more with an angled parking lane.
- Curb extension length can be adjusted to accommodate bus stops or street furniture.

Further Considerations

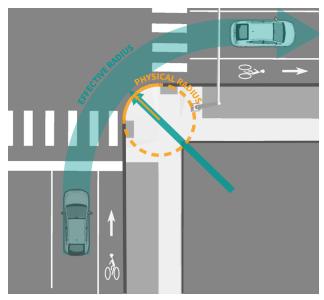
If there is no parking lane, adding curb extensions across a roadway shoulder may be a problem for bicycle travel and truck or bus turning movements.

Materials and Maintenance

Planted curb extensions may be designed as a bioswale, a vegetated system for stormwater management. To maintain proper stormwater drainage, curb extensions can be constructed as refuge islands offset by a drainage channel or feature a covered trench drain.

Approximate Cost

\$6,000-\$20,000 depending on size (per corner)



Recommended: Bidirectional curb ramps for crossing in both directions.

Corner Radii

The size of a curb's radius can have a significant impact on pedestrian comfort and safety. A smaller curb radius provides more pedestrian area at the corner, allows more flexibility in the placement of curb ramps, results in a shorter crossing distance and requires vehicles to slow more on the intersection approach. During the design phase, the chosen radius should be the smallest possible for the circumstances and consider the effective radius in any design vehicle turning calculations.

Typical Application

The curb radius may be as small as 3 ft where there are no turning movements, or 5 ft where there are turning movements and adequate street width.

On-street parking and bike lanes create a larger effective turning radius and can therefore allow a smaller curb radius.

Design Features

Corners have two critical dimensions which must be considered together.

- » The physical radius controls the pedestrian experience.
- » The effective radius is the widest turning arc that a vehicle can take through the corner and is larger than the physical radius.

Further Considerations

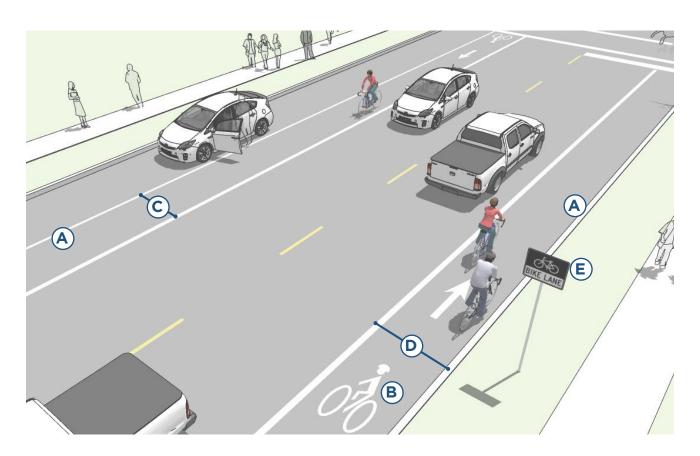
Several factors govern the choice of curb radius in any given location. These include the desired pedestrian area of the corner, traffic turning movements, street classifications, design vehicle turning radius, intersection geometry, and whether there is on-street parking or a bike lane (or both) between the travel lane and the curb.

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Section 3 Bicycle Toolbox

Standard Bicycle Lanes

On-street bike lanes designate an exclusive space for bicyclists through the use of pavement markings and signs. The bike lane is located directly adjacent to motor vehicle travel lanes and is used in the same direction as motor vehicle traffic. Bike lanes are typically on the right side of the street, between the adjacent travel lane and curb, road edge or parking lane.



Typical Application

- » Bike lanes may be used on any street with adequate space, but are most effective on streets with moderate traffic volumes ≤ 6,000 ADT (≤ 3,000 preferred).
- » Bike lanes are most appropriate on streets with lower to moderate speeds ≤ 30 mph.
- » Appropriate for skilled adult riders on most streets.
- » May be appropriate for children when configured as 6+ ft wide lanes on lower-speed, lower-volume streets with one lane in each direction.

Design Features

- Mark inside line with 6" stripe. (MN MUTCD 9C.04) Mark 4" parking lane line or "Ts".
- B Include a bicycle lane marking (MN MUTCD Figure 9C-3) at the beginning of blocks and at regular intervals along the route. (MN MUTCD 9C.04)
- 6 foot width preferred adjacent to on-street parking, (5 foot min.)
- 5–6 foot preferred adjacent to curb and gutter
- or 4 feet more than the gutter pan width.
- The R3-17 "Bike Lane" sign is optional, but recommended in most contexts.

Further Considerations

- » On high speed streets (≥ 40 mph) the minimum bike lane should be 6 feet.
- » It may be desirable to reduce the width of general purpose travel lanes in order to add or widen bicycle lanes.
- » On multi-lane streets, the most appropriate bicycle facility to provide for user comfort may be buffered bicycle lanes or physically separated bicycle lanes.

Manhole Covers and Grates:

- » Manhole surfaces should be manufactured with a shallow surface texture in the form of a tight, nonlinear pattern.
- » If manholes or other utility access boxes are to be located in bike lanes within 50 ft. of intersections or within 20 ft. of driveways or other bicycle access points, special manufactured permanent nonstick surfaces ensure a controlled travel surface for bicyclists breaking or turning.
- » Manholes, drainage grates, or other obstacles should be set flush with the paved roadway. Roadway surface inconsistencies pose a threat to safe riding conditions for bicyclists. Construction of manholes, access panels or other drainage elements should be constructed with no variation in the surface. The maximum allowable tolerance in vertical roadway surface will be 1/4 of an inch.

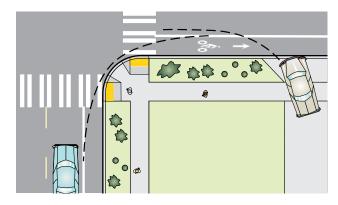
Materials and Maintenance

Bike lane striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained segments of roadway.

Bike lanes should also be maintained so that there are no pot holes, cracks, uneven surfaces or debris.



Bike lanes provided dedicated spaces for bicyclists to ride on the street.



Place Bike Lane Symbols to Reduce Wear

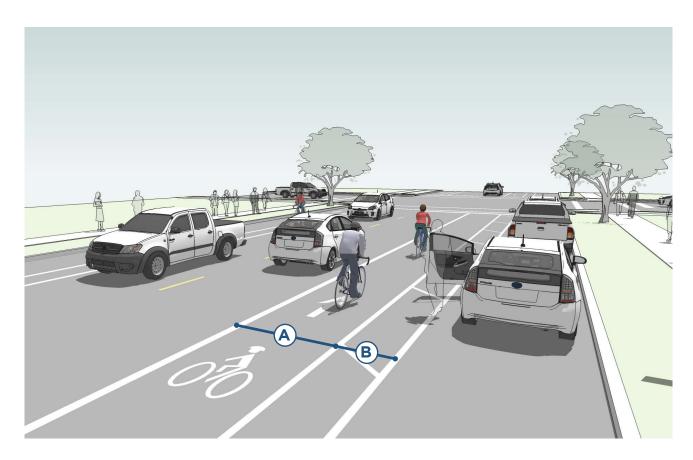
Bike lane word, symbol, and/or arrow markings (MN MUTCD Figure 9C-3) should be placed outside of the motor vehicle tread path in order to minimize wear from the motor vehicle path. (NACTO 2012)

Approximate Cost

The cost for installing bicycle lanes varies and will depend on the implementation approach. Typical costs are \$16,000 per mile for restriping using paint. More durable thermoplastic materials and the cost of repaving, or removing/replacing existing vehicle lane striping is not accounted for in this estimate.

Buffered Bicycle Lanes

Buffered bike lanes are conventional bicycle lanes paired with a designated buffer space, separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane.



Typical Application

- Anywhere a conventional bike lane is being considered.
- » While conventional bike lanes are most appropriate on streets with lower to moderate speeds (≤ 30 mph), buffered bike lanes provide additional value on streets with higher speeds (+30 mph) and high volumes or high truck volumes (up to 6,000 ADT).
- » On streets with extra lanes or lane width.
- » Appropriate for skilled adult riders on most streets.

Design Features

- The minimum bicycle travel area (not including buffer) is 5 feet wide.
- B Buffers should be at least 2 feet wide. If buffer area is 4 feet or wider, white chevron or diagonal markings should be used.
- » For clarity at driveways or minor street crossings, consider a dotted line.
- There is no standard for whether the buffer is configured on the parking side, the travel side, or a combination of both.



Buffered bike lanes should consider both vehicular traffic and parked cars.



The use of additional pavement markings delineates space between vehicles and bicyclists.

Further Considerations

- » Color may be used within the lane to discourage motorists from entering the buffered lane.
- » On multi-lane streets with high vehicles speeds, the most appropriate bicycle facility to provide for user comfort may be physically separated bike lanes.
- » NCHRP Report #766 recommends, when space is limited, installing a buffer space between the parking lane and bicycle lane where on-street parking is permitted rather than between the bicycle lane and vehicle travel lane.¹This buffer is particularly useful in commercial areas where parking turnover is higher.

Materials and Maintenance

Bike lane striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained segments of roadway.

Bike lanes should be maintained so that there are no pot holes, cracks, uneven surfaces or debris.

Approximate Cost

The cost for installing buffered bicycle lanes will depend on the implementation approach. Typical costs are \$16,000 per mile for paint based restriping. More durable thermoplastic materials and the cost of repaving, or removing/replacing existing vehicle lane striping is not accounted for in this estimate.

Bike Boulevards

A Bike Boulevard is a low-speed, low-volume roadway that is designed to enhance comfort and convenience for people bicycling. It provides better conditions for bicycling while improving the neighborhood character and maintaining emergency vehicle access. Bike Boulevards are intended to serve as a low-stress bikeway network, providing direct, and convenient routes across Burnsville. Key elements of Bike Boulevards are unique signage and pavement markings, traffic calming and diversion features to maintain low vehicle volumes, and convenient major street crossings.



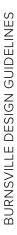
Treatments depicted may vary per roadway segment or location.

Typical Use

- Parallel with and in close proximity to major thoroughfares (1/4 mile or less) on low-volume, low-speed streets.
- » Follow a desire line for bicycle travel that is ideally long and relatively continuous (2-5 miles).
- » Avoid alignments with excessive zigzag or circuitous routing. The bikeway should have less than 10% out of direction travel compared to shortest path of primary corridor.
- » Local streets with traffic volumes of fewer than 3,000 vehicles per day and with average operating speeds below 30 mph. Utilize traffic calming to maintain or establish low volumes and discourage vehicle cut through / speeding.

Design Features

- » Signs and pavement markings are the minimum treatments necessary to designate a street as a bike boulevard.
- » Implement volume control treatments based on the context of the bike boulevard, using engineering judgment. While motor vehicle volumes should not exceed 3,000 vehicles per day, ideal conditions are 1,500 vehicles per day or less.
- » Intersection crossings should be designed to enhance comfort and minimize delay for bicyclists of diverse skills and abilities.





A painted intersection, planters, and curb extensions to reinforce that the street is intended for local, slow-speed use instead of cut-through vehicle traffic.



An example of an large pavement marking to reinforce that the street is a Bike Boulevard.

Further Considerations

- » Bike Boulevards are established on streets that improve connectivity to key destinations and provide a direct, low-stress route for bicyclists, with low motorized traffic volumes and speeds, designated and designed to give bicycle travel priority over other modes.
- » Bike Boulevard retrofits to local streets are typically located on streets without existing signalized accommodation at crossings of collector and arterial roadways. Without treatments for bicyclists, these intersections can become major barriers along the Bike Boulevard.
- » Traffic calming can deter motorists from driving on a street. Anticipate and monitor vehicle volumes on adjacent streets to determine whether traffic calming results in inappropriate volumes. Traffic calming can be implemented on a trial basis.

Materials and Maintenance

Bike Boulevards require few additional maintenance requirements to local roadways. Signage, signals, and other traffic calming elements should be inspected and maintained according to local standards.

Approximate Cost

Costs vary depending on the type of treatments proposed for the corridor. Simple treatments such as wayfinding signage and markings are most costeffective, but more intensive treatments will have greater impact at lowering speeds and volumes, at higher cost. Costs can range from \$5,000/mile on the simple end to \$50,000/mile for significant horizontal deflection and diversion.

Traffic Calming

Traffic calming devices can help mitigate speeding and cut-through traffic by changing driver behavior through a variety of visual or physical changes to the road environment. Such measures may reduce the design speed of a street and can be used in conjunction with reduced speed limits to reinforce the expectation of lowered speeds.

In conjunction with the MM Plan and CS Policy, the City is adopting a Traffic Calming Policy (Policy No.5.045) for local and minor collector streets, which will help effectively manage speed and volume concerns while enhancing the livability and safety on the City streets. This policy should be consulted for criteria requirements, procedure information, and the Traffic Calming Toolbox.



Typical Application

- » Traffic calming measures should be limited to local or minor collector streets, typically with a maximum posted speed of 35 mph.
- » Traffic calming measures should be implemented when the safety of all roadway users, especially pedestrians and bicyclists, is at risk due to high vehicular speeds. The risk can be determined by an engineering study.
- » Traffic calming measures can be more applicable in areas with high potential for conflict between pedestrian/bicyclist and motor vehicles.
- » Traffic calming measures may be most appropriate in areas with predominantly residential or mixed-use land use.
- » If applicable, traffic calming measures should not infringe on bicycle space. Where possible, provide a bicycle route outside of the element so bicyclists can avoid having to merge into traffic at a narrow pinch point.
- » Traffic calming measures should always consider emergency vehicle response times and turning abilities.

Design Features

- There are a variety of treatments and combinations of treatments that can be used for traffic calming. Reference Traffic Calming Policy (Policy No. 5.045) for a list of Category 1 and Category 2 traffic calming treatment options for the City of Burnsville. The Policy includes a Traffic Calming Toolbox "quick reference guide" in addition to a link to the FHWA ePrimer, which includes up-to-date design guidance for each measure.
- » Category 1 traffic calming measures include strategies and devices that are primarily educational or visual. These are traditionally low-cost and low-impact, including speed trailers, turn restrictions, and signing updates.
- » Category 2 traffic calming measures are physical design features that are more robust and typically higher in cost. These can include horizontal and/or vertical elements, including traffic circles, speed humps, raised crosswalks, and corner extensions.

Further Consideration

Benefits of speed management include:

- » Improves conditions for bicyclists, pedestrians, and residents on local and minor collector streets.
- » Reduced travel speeds decreases the exposure risks between bicyclists/pedestrians and motor vehicles.
- Reduced travel speeds result in reduced injury severity in the event of a collision.
- » Helps achieve a safer and more livable neighborhood while balancing the transportation needs of the roadway.

Wayfinding

Sign types

Decision

Sign

The ability to navigate across an urbanized area is informed by landmarks, natural features, and other visual cues. Signs throughout the city should indicate the direction of travel, the locations and travel time distances to those destinations. A pedestrian wayfinding system is similar to a transit, vehicular, or bike facility wayfinding system, in that it consists of comprehensive signing and/or pavement markings to guide pedestrians to their destination along routes that are safe, comfortable and attractive.



Turn

Sign





Typical Application

» Wayfinding signs will increase users' comfort and accessibility to the pedestrian system in denser urbanized areas and connections to other destinations across the larger region.

Confirmation

Sign

- » Signage can serve both wayfinding and safety purposes including:
 - » Helping to familiarize users with the pedestrian network
 - » Helping users identify the best routes to destinations within walking distance or connections to other modes.
 - » Helping to address misperceptions about time and distance.
 - » Helping overcome a "barrier to entry" for people who are not frequent walkers.

Design Features

- » Confirmation signs indicate to pedestrians that they are on the right path to their destinations. They include destinations and distance/time, but not arrows
- » Turn signs indicate where a route turns from one street onto another street.
- » Decision signs indicate the junction of two or more pedestrian routes to access key destinations. These include destinations, arrows and distances. Travel times are optional but recommended.

» A regional wayfinding sign plan would identify sign locations, sign type, destinations, and approximate distance and travel time to destinations, and highlight connections between urban and non-urbanized areas.

Further Considerations

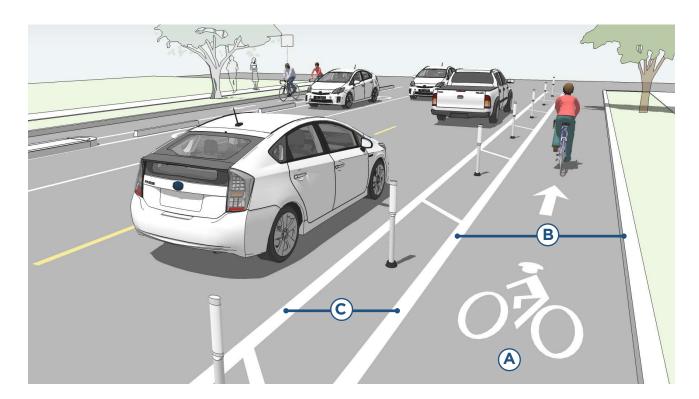
- » Bicycle wayfinding signs also visually cue motorists that they are driving along a bicycle route and should use caution. Signs are typically placed at key locations leading to and along bicycle routes, including the intersection of multiple routes.
- » Too many road signs tend to clutter the right-ofway, and it is recommended that these signs be posted at a level most visible to bicyclists rather than per vehicle signage standards.
- » Green is the color used for directional guidance and is the most common color of bicycle wayfinding signage in the US, including those in the MNMUTCD.
- » Check wayfinding signage along bikeways for signs of vandalism, graffiti, or normal wear and replace signage along the bikeway network as-needed.

Approximate Cost

- » Individual signs: \$500 \$1,000
- » Kiosk: \$1,500 \$7,000 dependent on design complexity

One-Way Separated Bikeway

One-way separated bikeways, also known as protected bikeways or cycle tracks, are on-street bikeway facilities that are separated from vehicle traffic. Physical separation is provided by a barrier between the bikeway and the vehicular travel lane. These barriers can include flexible posts, bollards, parking, planter strips, extruded curbs, or on-street parking. Separated bikeways using these barrier elements typically share the same elevation as adjacent travel lanes, but the bikeway could also be raised above street level, either below or equivalent to sidewalk level.



Typical Use

- » Along streets on which conventional bicycle lanes would cause many bicyclists to feel stress because of factors such as multiple lanes, high bicycle volumes, high motor traffic volumes (9,000-30,000 ADT), higher traffic speeds (35+ mph), high incidence of double parking, higher truck traffic (10% of total ADT) and high parking turnover.
- » Along streets for which conflicts at intersections can be effectively mitigated using parking lane setbacks, bicycle markings through the intersection, and other signalized intersection treatments.

Design Features

- Pavement markings, symbols and/or arrow markings must be placed at the beginning of the separated bikeway and at intervals along the facility based on engineering judgment to define the bike direction. (MN MUTCD 9C.04)
- **B** 10 foot width preferred in areas with high bicycle volumes or uphill sections to facilitate safe passing behavior (8 ft minimum).
- When placed adjacent to parking, the parking buffer should be 3 ft wide to allow for passenger loading and to prevent door collisions.
- When placed adjacent to a travel lane, one-way raised cycle tracks may be configured with a mountable curb to allow entry and exit from the bicycle lane for passing other bicyclists or to access vehicular turn lanes.



Parked cars serve as a barrier between bicyclists and the vehicle lane. Barriers could also include flexible posts, bollards, planters, or other design elements. Source: Bike East Bay

- » If the buffer area is 4 feet or wider, white chevron or diagonal markings should be used.
- » Curbs may be used as a channeling device. Grade-separation provides an enhanced level of separation in addition to buffers and other barrier types.
- » Where possible, physical barriers such as removable curbs should be oriented towards the inside edge of the buffer to provide as much extra width as possible for bicycle use.
- » A retrofit separated bikeway has a relatively low implementation cost compared to road reconstruction by making use of existing pavement and drainage and using a parking lane as a barrier.
- » Gutters, drainage outlets and utility covers should be designed and configured as not to impact bicycle travel.
- » For clarity at major or minor street crossings, consider a dotted line for the buffer boundary where cars are expected to cross.
- » Special consideration should be given at transit stops to manage bicycle and pedestrian interactions.

Materials and Maintenance

Bikeway striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained segments of roadway. Green conflict striping (if used) will also generally require higher maintenance due to vehicle wear.

Bikeways should be maintained so that there are no pot holes, cracks, uneven surfaces or debris.

Access points along the facility should be provided for street sweeper vehicles to enter/exit the separated bikeway.

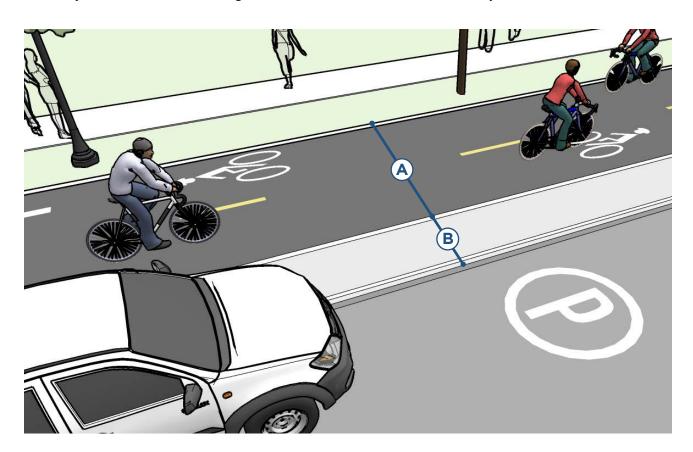
Install composite and reboundable delineator systems, which offer more durablity and better withstand winter conditions. Otherwise, delineators should be removed during winter for plowing operations.

Approximate Cost

Separated bikeway construction costs can vary drastically depending on the type of separation used, the amount of new curb and gutter, stormwater mitigation, and crossing treatments. On the lower end of the scale, construction of a striped parking protected bikeway without delineators or other vertical elements can cost as little as \$16,000 per mile.

Two-Way Separated Bikeway

Two-Way Separated Bikeways are bicycle facilities that allow bicycle movement in both directions on one side of the road. Two-way separated bikeways share some of the same design characteristics as one-way separated bikeways, but often require additional considerations at driveway and side-street crossings, and intersections with other bikeways.



Typical Application

Works best on the left side of one-way streets.

- » Streets with high motor vehicle volumes and/or speeds
- » Streets with high bicycle volumes.
- » Streets with a high incidence of wrong-way bicycle riding.
- » Streets with few conflicts such as driveways or cross-streets on one side of the street.
- » Streets that connect to shared use paths.

Design Features



12 foot operating width preferred (10 ft minimum) width for two-way facility.

» In constrained locations an 8 foot minimum operating width may be considered.



Adjacent to on-street parking a 3 foot minimum width channelized buffer or island should be provided to accommodate opening doors. (NACTO, 2012).

Additional signalization and signs may be necessary to manage conflicts.



A two-way facility can accommodate bicyclists in two directions of travel.

- » A two-way separated bikeway on one way street should be located on the left side.
- » A two-way separated bikeway may be configured at street level or as a raised separated bikeway with vertical separation from the adjacent travel lane.
- » Two-way separated bikeways should ideally be placed along streets with long blocks and few driveways or mid-block access points for motor vehicles.
- » Two-way separated bikeways may have implications for signalized and unsignalized intersections that put contra-flow bicyclists in increased levels of risk. This should be strongly considered with any project.

Materials and Maintenance

Bikeway striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained segments of roadway. Green conflict striping (if used) will also generally require higher maintenance due to vehicle wear.

Bikeways should be maintained so that there are no pot holes, cracks, uneven surfaces or debris.

Access points along the facility should be provided for street sweeper vehicles to enter/exit the separated bikeway.

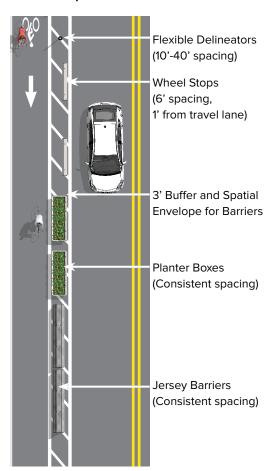
Approximate Cost

Separated bikeway construction costs can vary drastically depending on the type of separation used, the amount of new curb and gutter, stormwater mitigation, and crossing treatments. On the lower end of the scale, construction of a striped parking protected bikeway with delineators or other vertical elements can cost as little as \$15,000-\$30,000 per mile.

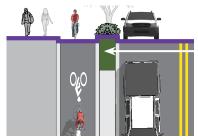
Separated Bikeway Barriers

Separated bikeways may use a variety of vertical elements to physically separate the bikeway from adjacent travel lanes. Barriers may be robust constructed elements such as curbs, or may be more interim in nature, such as flexible delineator posts.

Barrier Separation



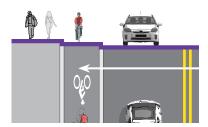
Media Separation



Raised Curb (2' min. width, 4' if plantings present)

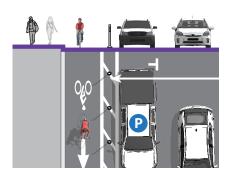
Optional Planting

Elevation Separation



Raised Bike Facility

Parking Separation



Buffered Door Zone (2' min. and optional Flexible Delineators)

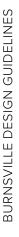
Typical Application

Appropriate barriers for retrofit projects:

- » Parked cars
- » Flexible delineators
- » Bollards
- » Planters
- » Parking stops (for use in areas where winter maintenance is not an issue)

Appropriate barriers for reconstruction projects:

- » Curb separation
- » Medians
- » Landscaped medians
- » Raised protected bike lane with vertical or mountable curb
- » Pedestrian Refuge Islands







Raised separated bikeways are bicycle facilities that are vertically separated from motor vehicle traffic.

Design Features

- » Maximize effective operating space by placing curbs or delineator posts as far from the through bikeway space as practicable.
- » Allow for adequate shy distance of 1 to 5 feet from vertical elements to maximize useful space.
- When next to parking allow for 3 feet of space in the buffer space to allow for opening doors and passenger unloading.
- » The presences of landscaping in medians, planters and safety islands increases comfort for users and enhances the streetscape environment.

Further Considerations

- » With new roadway construction, a raised separated bikeway can be less expensive to construct than a wide or buffered bicycle lane because of shouldower trenching and sub base requirements.
- » Parking should be prohibited within 30 feet of the intersection to improve visibility.

Materials and Maintenance

Separated bikeways protected by concrete islands or other permanent physical separation, can be swept and plowed by smaller street sweeper vehicles.

Access points along the facility should be provided for street sweeper vehicles to enter/exit the separated bikeway.

Approximate Cost

Separated bikeway barrier material costs can vary greatly, depending on the type of material, the scale, and whether it is part of a broader construction project.

Bike Detection and Actuation

Bicycle detection and actuation is used to alert the signal controller of bicycle crossing demand on a particular approach. Proper bicycle detection should meet two primary criteria: accurately detects bicyclists and provides clear guidance to bicyclists on how to actuate detection (e.g., what button to push, where to stand).

Typical Application

- » At signalized intersections within bicycle lanes or general purpose travel lanes.
- » At signalized intersections within left turn lanes used by bicyclists.
- » At signalized intersections within separated bike lanes.
- » In conjunction with active warning beacons and pedestrian hybrid beacons.

Design Features

Push Button Actuation

- » User-activated button mounted on a pole facing the street.
- The location of the device should not require bicyclists to dismount or be rerouted out of the way or onto the sidewalk to activate the phase. Signage should supplement the signal to alert bicyclists of the required activation to prompt the green phase.

Loop Detectors

- » Loop detectors are bicycle-activated and installed within the roadway to allow the presence of a bicycle to be detected by the signal. This allows the bicyclist to stay within the lane of travel without having to maneuver to the side of the road to a pedestrian push button.
- » Loops should be sensitive enough to detect bicycles should be supplemented with pavement markings to instruct bicyclists how to trip them.
- The MN MUTCD provides guidance on stencil markings and signage related to signal detection.

Video Detection

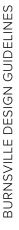
» Video detection systems use digital image processing to detect a change in the image at a location. These systems can be calibrated to detect bicycle, although there may be detection issues during poor lighting and weather conditions.

Thermal Detection

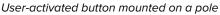
» Infrared detection systems typically consist of one or more thermal cameras, a microprocessor to process the thermal imagery, and software to interpret the traffic flow data and communicate with the traffic signal controller. These systems are typically able to extract a significant amount of data from the thermal imagery.

Microwave Detection

- Remote Traffic Microwave Sensor Detection (RTMS)
- » RTMS is a system which uses frequency modulated continuous wave radio signals to detect objects in the roadway. This method marks the detected object with a time code to determine its distance from the sensor.
- The RTMS system is unaffected by temperature and lighting, which can affect standard video detection.









Bicycle loop detection

- » Bicycle loops and other detection mechanisms can also provide bicyclists with an extended green time before the light turns yellow so that bicyclists of all abilities can reach the far side of the intersection.
- We user comprehension of the bicycle detector Pavement markings is low, although some treatments show promise in increasing proper usage. Researchers at Portland State University found that 23.5% of bicyclists correctly positioned themselves over the stand-alone marking, use increased to 34.8% when the marking was paired with a R10-22 sign, and increased further to 48.4% when installed over a green background.

Materials and Maintenance

It is important to perform ongoing maintenance of traffic control equipment. Consider semi-annual inspections of controller and signal equipment, intersection hardware, and detectors.

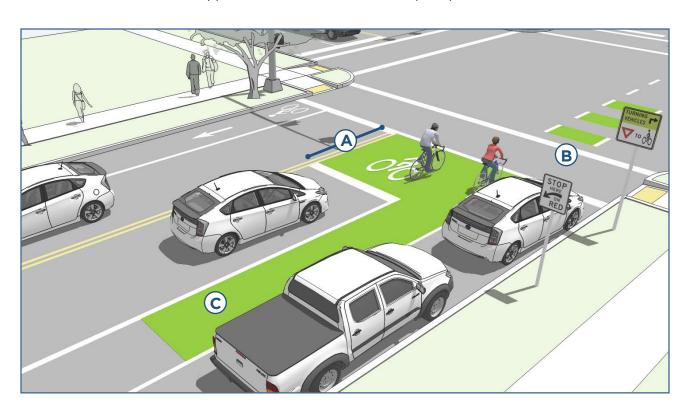
Approximate Cost

Costs vary depending on the type of technology used, but bicycle loop detectors embedded in the pavement are \$2,000 on average, and can range from \$1,500 to \$3,000

Video detection camera system costs range from \$20,000 to \$25,000 per intersection.

Bicycle Box

A bicycle box is designed to provide bicyclists with a safe and visible space to get in front of queuing traffic during the red signal phase. Motor vehicles must queue behind the white stop line at the rear of the bike box. On a green signal, all bicyclists can quickly clear the intersection. This treatment received Interim Approval from the FHWA in 2016 (IA-18).



Typical Use

- » At potential areas of conflict between bicyclists and turning vehicles, such as a right or left turn locations.
- » At signalized intersections with high bicycle volumes.
- At signalized intersections with high vehicle volumes.
- » Not to be used on downhill approaches to minimize the right hook threat potential during the extended green signal phase.

Design Features

- 14 foot minimum depth from back of crosswalk to motor vehicle stop bar. (NACTO, 2012)
- B A "No Turn on Red" (MN MUTCD R10-11) sign should be installed overhead to prevent vehicles from entering the Bike Box. A "Stop Here on Red" (MN MUTCD R10-6) sign should be post mounted at the stop line to reinforce observance of the stop line.
- A 50 foot ingress lane should be used to provide access to the box.
 - » Use of green colored pavement is recommended.



A bike box allows for bicyclists to wait in front of queuing traffic, providing high visibility and a head start over motor vehicle traffic.

- » This treatment positions bicycles together and on a green signal, all bicyclists can quickly clear the intersection, minimizing conflict and delay to transit or other traffic.
- » Pedestrian also benefit from bike boxes, as they experience reduced vehicle encroachment into the crosswalk.
- » Bike boxes require permission from the FHWA to implement, and jurisdictions must receive approval prior to implementation. A State may request Interim Approval for all jurisdictions in that State.¹
- » Bike boxes should not be used to accommodate bicyclist turns at intersections that have substantial parallel green time as bicyclists cannot safely occupy the box when arriving on green.

Materials and Maintenance

Bike boxes are subject to high vehicle wear, especially turning passenger vehicles, buses, and heavy trucks. As a result, bike boxes with green coloring will require more frequent replacement over time. The life of the green coloring will depend on vehicle volumes and turning movements, but thermoplastic is generally a more durable material than paint.

Approximate Cost

Costs will vary due to the type of paint or thermoplastic used and the size of the bike box, as well as whether the treatment is added at the same time as other road treatments.

Typical costs range from \$1.20/sq. ft. installed for paint to \$14/sq. ft. installed for thermoplastic.

Approximately \$1,000 per bike box (MnDOT Bike/Ped Safety Guide).

Two-Stage Turn Boxes

Two-stage turn boxes offer bicyclists a safe way to make turns at multi-lane signalized intersections from a physically separated or conventional bike lane. On separated bike lanes, bicyclists are often unable to merge into traffic to turn due to physical separation, making the two-stage turning critical. This treatment received Interim Approval from FHWA in 2017 (IA-20).

Typical Application

- » Streets with high vehicle speeds and/or traffic volumes.
- » At intersections of multi-lane roads with signalized intersections.
- » At signalized intersections with a high number of bicyclists making a left turn from a right side facility.
- » Preferred treatment to assist turning maneuvers on bike lanes, instead of requiring bicyclists to merge to make a vehicular left turn.
- » Required for protected bikeways to assist left turns from a right side facility, or right turns from a left side facility.

Design Features

- » The two-stage turn box should be placed in a protected area. Typically this is within the shadow of an on-street parking lane or protected bike lane buffer area and should be placed in front of the crosswalk to avoid conflict with pedestrians.
- » 10 foot x 6.5 foot preferred dimensions of bicycle storage area (6 foot x 3 foot minimum).
- » Bicycle stencil and turn arrow pavement markings should be used to indicate proper bicycle direction and positioning. (NACTO, 2012)

Further Considerations

- » Consider providing a "No Turn on Red" (MN MUTCD R10-11) on the cross street to prevent motor vehicles from entering the turn box.
- » This design formalizes a maneuver called a "box turn" or "pedestrian style turn."
- » Design guidance for two-stage turns apply to both bike lanes and separated bike lanes.
- » Two-stage turn boxes reduce conflicts in multiple ways; from keeping bicyclists from queuing in a bike lane or crosswalk and by separating turning bicyclists from through bicyclists.
- » Bicyclist capacity of a two-stage turn box is influenced by physical dimension (how many bicyclists it can contain) and signal phasing (how frequently the box clears.)



Materials and Maintenance

Turn boxes may subject to high vehicle wear, especially turning passenger vehicles, buses, and heavy trucks. As a result, bike boxes with green coloring will require more frequent replacement over time. The life of the green coloring will depend on vehicle volumes and turning movements, but Thermoplastic or MMA are generally more durable material than paint.

Approximate Cost

Costs will vary due to the type of paint used and the size of the two-stage turn box, as well as whether the treatment is added at the same time as other road treatments.

Typical costs range from \$1.20/sq. ft. installed for paint to \$14/sq. ft. installed for Thermoplastic.

Colored Pavement Treatment

Colored pavement within a bicycle lane may be used to increase the visibility of the bicycle facility, raise awareness of the potential to encounter bicyclists, and reinforce priority of bicyclists in conflict areas. In 2021, MnDOT received statewide Interim Approval from FHWA for the use of green-colored pavement for bike lanes (IA-14). MnDOT must maintains a list of locations using the green colored pavement.



Typical Application

Within a weaving or conflict area to identify the potential for bicyclist and motorist interactions and assert bicyclist priority.

- » Across intersections, driveways and Stop or Yield-controlled cross-streets.
- » At bike boxes and two-stage turn boxes

Design Features

- A Typical white bike lane striping (solid or dotted 6" stripe) is used to outline the green colored pavement.
- B In weaving or turning conflict areas, preferred striping is dashed, to match the bicycle lane line extensions.
- » The colored surface should be skid resistant and retro-reflective (MnMUTCD Section 3G.01).
- » In exclusive use areas, such as bike boxes, color application should be solid green.





Green colored conflict striping indicates the path of travel of people on bicycles, and alerts people intending to turn across the bike lane to yield when bicyclists are present.

- » Green colored pavement should be used in compliance with FHWA Interim Approval (FHWA IA-14.10).¹
- » While other colors have been used (red, blue, yellow), green is the recommended color in the US.
- » The application of green colored pavement within bicycle lanes is an emerging practice. The guidance recommended here is based on best practices in cities around the county.

Materials and Maintenance

As intended, paint or thermoplastic are placed in locations that are trafficked by vehicles, and are subject to high vehicle wear. Colored pavement treatments will experience higher rates of wear at locations with higher turning vehicles, buses, and heavy trucks. At these locations, green coloring will require more frequent replacement over time.

The life of the green coloring will depend on vehicle volumes and turning movements, but thermoplastic is a more durable material than paint.

Approximate Cost

The cost for installing colored pavement markings will depend on the materials selected and implementation approach. Typical costs range from \$1.20/sq. ft installed for paint to \$14/sq. ft installed for thermoplastic. Colored pavement is more expensive than standard asphalt installation, costing 30-50 percent more than non-colored asphalt.

Short-Term Bicycle Parking

People need a safe, convenient place to secure their bicycle when they reach their destination. This may be short-term parking of 2 hours or less, or long-term parking for employees, students, residents, and commuters.

Information on short- and long-term bike parking has been informed by the Association of Pedestrian and Bicycle Professionals (APBP) Bicycle Parking Guide, which is updated frequently and is available online at www.apbp.org.

Application

Bike Racks

» Bike racks provide short-term bicycle parking and are meant to accommodate visitors, customers, and others expected to depart within two hours. It should be an approved standard rack, appropriate location and placement.

Bike Corrals

- » On-street bike corrals (also known as on-street bicycle parking) consist of bicycle racks grouped together in a common area within the street traditionally used for automobile parking.
- » Bicycle corrals are reserved exclusively for bicycle parking and provide a relatively inexpensive solution to providing highvolume bicycle parking. Bicycle corrals can be implemented by converting one or two on-street motor vehicle parking spaces into on-street bicycle parking.
- » Each motor vehicle parking space can be replaced with approximately 6-10 bicycle parking spaces.

Design Features

Bike Racks

- » When placed on sidewalks, 2 feet minimum from the curb face to avoid 'dooring.'
- 4 feet between racks to provide maneuvering room.
- » Locate close to destinations; 50 feet maximum distance from main building entrance.
- » Minimum clear distance of 6 feet should be provided between the bicycle rack and the property line.
- » While bike racks could be installed perpendicular or parallel to the curb, it is important to ensure there is sufficient room for pedestrian traffic, even when a bike is locked to the rack.

Bike Corrals

- Bicyclists should have an entrance width from the roadway of 5-6 feet.
- » Can be used with parallel or angled parking.
- » Parking stalls adjacent to curb extensions are good candidates for bicycle corrals since the concrete extension serves as delimitation on one side.

- Where the placement of racks on sidewalks is not possible (due to narrow sidewalk width, sidewalk obstructions, street trees, etc.), bicycle parking can be provided in the street where on-street vehicle parking is allowed in the form of on-street bicycle corrals.
- » Some types of bicycle racks may meet design criteria, but are discouraged except in limited situations. This includes undulating "wave" racks, schoolyard racks, and spiral racks. These discouraged racks are illustrated on the following page.
- » Bike racks should be made of thick stainless steel to reduce the chance of thieves cutting through the racks to take bicycles. Square tubing can provide further protection from cutting, as well.
- » If a bike rack is installed as surface mount, countersink bolts or expansion bolts should be used to keep the rack in place. Covering the bolts with putty or epoxy can provide additional protection.

Approximate Cost

Costs vary based on the design and materials used. Bicycle rack costs can range from approximately \$200 to \$3,600, depending on design and materials used. On average the cost is approximately \$660.



Inverted-U racks provide two points of contact.



Racks with square tubing, good spacing, and a concrete base likewise offer two points of contact.

Types of Bike Racks to Use

These racks provide two points of contact with the bicycle, accommodate varying styles of bike, allow for the frame of a bicycle and at least one wheel to be secured by most U-locks, and are intuitive to use.

Types of Bike Racks to Avoid

These racks do not provide support at two places on the bike, can damage the wheel, do not provide an opportunity for the user to lock the frame of their bicycle easily, and are not intuitive to use. Because of performance concerns, the APBP Essentials of Bike Parking Report recommends selecting other racks instead of these.



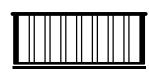






POST & RING

WHEELWELL SECURE



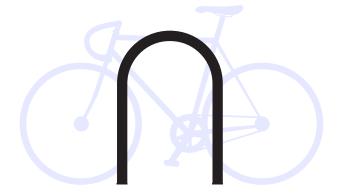
COMB



INVERTED-U







Communities may consider purchasing branded *U-racks for installation on sidewalks.*

CROSSWALK

Space Requirements

The following minimum spacing requirements apply to some common installations of fixtures like inverted U or post and ring racks that park one bicycle roughly centered on each side of the rack. Recommended clearances are given first, with minimums in parentheses where appropriate. In areas with tight clearances, consider wheelwellsecure racks, which can be placed closer to walls and constrain the bicycle footprint more reliably than inverted U and post and ring racks. The footprint of a typical bicycle is approximately 6' x2'. Cargo bikes and bikes with trailers can extend to 10' or longer.

48" (36" MIN)

48" (36" MIN)

Sidewalk racks

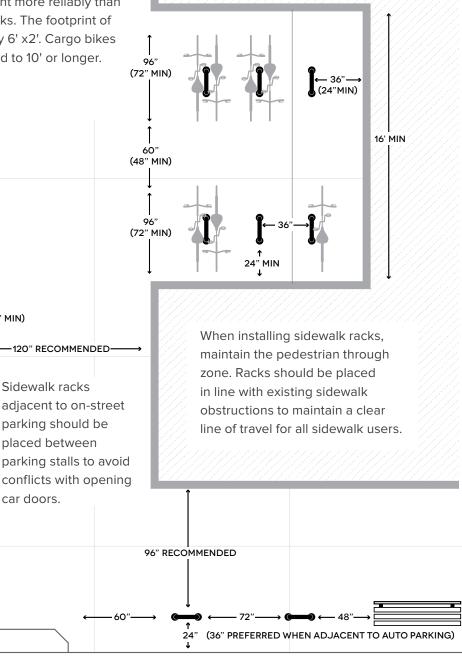
parking should be

placed between

car doors.

CROSSWALK

←36"**→ 😉** (24" MIN)



BURNSVILLE DESIGN GUIDELINES

Long-Term Bicycle Parking

Users of long-term parking generally place high value on security and weather protection. Long-term parking is designed to meet the needs of employees, residents, public transit users, and others with similar needs.

Information on short and long term bike parking has been obtained from the APBP Bicycle Parking Guide, which is updated frequently and is available online at www.apbp.org.

Application

- » At transit stops, bike lockers or a sheltered secure enclosure may be appropriate long term solutions.
- » On public or private property where secure, long-term bike parking is desired.
- » Near routine destinations, such as workplaces, universities, hospitals, etc.

Design Features

Bike Lockers

- » Minimum dimensions: width (opening) 2.5 feet; height 4 feet; depth 6 feet.
- 4 foot side clearance and 6 foot end clearance.7 foot minimum distance between facing lockers.

Secure Parking Area

- » Closed-circuit television monitoring or on-site staff with secure access for users.
- » Double high racks & cargo bike spaces.
- » Bike repair station with bench and bike tube and maintenance item vending machine.
- » Bike lock "hitching post" allows people to leave bike locks.

Further Considerations

- » As the APBP Bike Parking Guide notes, increasing density of bike racks in a long-term facility without careful attention to user needs can exclude users with less-common types of bicycles which may be essential due to age, ability, or bicycle type.
- » To accommodate trailers and long bikes, a portion of the racks should be on the ground and should have an additional 36" of in-line clearance.

Approximate Cost

Bicycle lockers costs range from \$1,280 to \$2,680, and secure parking areas are approximately \$250,000.

High Density Bike Racks

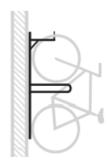
Racks may be used that increase bike parking density, like the ones below. While these types of racks provide more spaces, racks that require lifting should not be used exclusively. People with heavier bikes (i.e. cargo bikes) or people with disabilities or people who are simply small in stature may be unable to lift their bikes easily.

Bike Parking Rooms

Long term bike parking may be available in dedicated rooms in residential and commercial buildings. Bicycle parking can be accommodated in 15 square feet per space or less.



STAGGERED WHEELWELL-SECURE



VERTICAL





Bike lockers



Secured parking areas

Where should parking be located?

Well-located bike parking will be:

- » Visible to the public.
- » Near primary entrances/exits, as close to the entrance as the first motor vehicle parking spot not designated for people with disabilities when possible.
- » Easily accessed without dismounting a bike.
- » Clear of obstructions which might limit the circulation of users and their bikes.
- » In areas that are well-lit.
- » Installed on a hard, stable surface that is unaffected by weather.

How much parking should be provided?

APBP's Essentials of Bicycle Parking Recommendations

The Association of Pedestrian and Bicycle
Professionals' (APBP) has published
recommendations for bicycle parking locations and
quantities. These guidelines and recommendations
are based on industry best practices as
well as APBP's Essentials of Bicycle Parking
Recommendations, but can be adjusted to meet the
context and needs of each community.

Recommendations for Bicycle Parking Locations and Quantities

Land Use or Location	Physical Location	Quantity (Minimum)
Parks	Adjacent to restrooms, picnic areas, fields, and other attractions	8 bicycle parking spaces per acre
Schools	Near office and main entrance with good visibility	8 bicycle parking spaces per 40 students
Public Facilities (e.g., libraries, community centers)	Near main entrance with good visibility	8 bicycle parking spaces per location
Commercial, Retail, and Industrial Developments (over 10,000 square feet)	Near main entrance with good visibility	1 bicycle parking space per 15 employees or 8 bicycles per 10,000 square feet
Shopping Centers (over 10,000 square feet)	Near main entrance with good visibility	8 bicycle parking spaces per 10,000 square feet
Transit Stations	Near platform, security or ticket booth	1 bicycle parking space or locker per 30 automobile parking spaces
Multi-Family Residential	Near main entrance with good visibility	1 short-term bicycle parking space per 10 residential units and 1 long- term bicycle parking space per 2 residential units