Town of West Hartford

Bicycle Plan and Facility Selection & Design Guide *2024*

11/20/24

FHI studio

Contents

1.0 INTRODUCTION

1.1 PURPOSE

This bicycle plan and guide complies with West Hartford's Complete Streets Policy, which requires that the Town plan, design, and implement facilities that accommodate all users including bicyclists. The Policy also requires the Town to update its bicycle plan on a regular basis.

The purpose of this guide is to assist the Town of West Hartford in planning and designing bicycle facilities that are safe, appropriate, and comfortable for a wide range of users within the Town. This guide provides a methodology for selecting appropriate bicycle facilities and intersection treatments, as well as design guidance on those facilities and treatments.

There are a range of bicycle facilities that are appropriate for different contexts and types of users. This guide identifies the context for which specific facilities are most appropriate and the types of users that those facilities are most likely to serve.

1.2 IMPLEMENTATION

In accordance with the Complete Streets Policy, this Plan will be implemented through the Town's Capital Improvement Program. The Town will plan, design, construct, operate and maintain the routes identified on the Bicycle Network Map by implementing single elements or facilities of a route into a project, completing a series of improvements over the course of time, or by developing major network level improvements. The Town will seek to expedite the development of bicycle facilities across West Hartford by continuing to apply for grant funding to assist in financing development of the bicycle network.

The Town will approach every planned Transportation improvement within the Bicycle Network as an opportunity to create safer and more accessible streets for all users. The Town recognizes that its infrastructure includes a transportation network that should provide convenient access and safe travel for all users within the Town and beyond the Town's borders. Because of its regional impact, implementation of this policy reinforces the need for collaboration among the many regional partners and stakeholders affected by this Plan.

It is important to note that implementation of this Plan will require substantial resources. Full town-wide implementation of the Bicycle Network will take many years of dedicated capital improvements and a continued commitment to supporting bicycling by the Town.

1.3 EMPHASIS ON SAFETY

In addition to complying with the Town's Complete Streets Policy, this guide and plan were developed and updated as recommended by West Hartford's 2024 Vision Zero Plan. The Vision Zero Plan establishes a commitment to eliminating all traffic (including bicyclist) fatalities and severe injuries. More specifically, the Vision Zero Plan recommends the following with respect to improving bicycle safety:

> *"The Plan should identify feasible and appropriate bicycle facilities for reasonably confident bicyclists on all streets where shared facilities are not appropriate. It should include a low-stress bicycle network appropriate for less confident bicyclists of all ages."*

1.4 USE OF GUIDE

This guide is not intended to be a detailed design manual to supersede the need for the application of sound principles by knowledgeable transportation professionals, nor is it intended to eliminate the flexibility needed to encourage independent designs tailored to specific conditions. Engineering judgment based upon knowledge of bicycle facility planning, operations, and design is needed to select appropriate bicycle accommodations.

This guide provides three levels of design guidance:

- Where design values are clearly and authoritatively established as requirements either through legislation such as the American with Disabilities Act (ADA) or through standards such as the MUTCD, design standards are provided using words such as “required”, “must”, and “shall”.
- Where there is a significant body of research to support design guidance on a particular issue or topic (such as from FHWA and AASHTO guidance documents), specific design values and recommendations are provided as guidance, using words like “should”.
- Where reliable research is not available to suggest definitive guidance, or where the guidance provided within this guide deviates from other guidance documents (such as NACTO), the term ”recommended” or ”acceptable” is used. This guidance is based upon the consensus and expert opinion of the consultants and reviewers who contributed to this guide.

There will be instances where it is appropriate for designs to vary from the guidance presented in this guide. In some cases, application of the guidance in this guide will be limited by constraints placed on the design by unique site conditions, fiscal constraints, or right-of-way constraints.

1.5 MAINTENANCE CONSIDERATIONS

The maintenance of bicycle facilities should be considered when planning and designing facilities. Facilities should be selected and designed with consideration of the ability of the Town to maintain those facilities which may include snow and ice removal, sweeping, pavement marking renewal, and other activities.

1.6 FOUNDATIONAL GUIDES, GUIDELINES & MANUALS

Multiple guides and manuals were referenced in the creation of this guide. While the Manual on Uniform Traffic Control Devices, PROWAG, and the ATBCB guidelines provide specific standards regarding requirements for signage and pavement markings and accessibility, the other resources identified below are only advisory; they reference best practices and preferable or desirable standards. The field of bicycle facility planning and design is emerging and evolving, which leaves room for the application of standards that are specific to local conditions and based upon professional planning, design, and engineering judgement. The guides and manuals referenced include:

Required Standards

FHWA Manual on Uniform Traffic Control Devices (MUTCD), *11th Edition*
The MUTCD provides specific standards on bicycle signage and pavement markings. This recently updated manual now provides expanded guidance for bicycle facilities.

US Access Board Public Right-of-Way Accessibility Guidelines (PROWAG)
The purpose of these guidelines is to ensure that pedestrian facilities located in the public right-of-way are readily accessible to and usable by pedestrians with disabilities. While oriented towards pedestrian facilities and wheelchair users, the design of bicycle facilities should ensure compliance with these accessibility standards.

Architectural and Transportation Barriers Compliance Board (ATBCB) Shared Use Path Accessibility Guidelines
These guidelines provide accessibility standards for shared use paths specific to facility width, grade, surface materials and other design factors.

Advisory Guidelines

AASHTO Guide for the Development of Bicycle Facilities*, 4th Edition, 2012*
The 2012 AASHTO guide provides information relevant to the design, operation, and maintenance of shared lanes, bicycle lanes, shared use paths and intersection treatments. The guide lacks reference to the selection of appropriate bicycle facilities. An update of the guide was in draft form at the time of this writing. References to the "AASHTO Guide" in this document are in reference to this guide.

FHWA Bikeway Selection Guide*, 2019*
The FHWA guide provides a recommended process for, and information on, the selection of appropriate bicycle facilities for roadway contexts. The guide provides recommendations for the selection of various bicycle facilities including shared lanes, bike lanes, buffered bike lanes, separated bike lanes, and sidepaths in urban, suburban, and rural contexts. The guide also recommends appropriate facilities based upon a range of conditions including traffic volume and speed.

FHWA Separated Bike Lane Planning & Design Guide*, 2015*
The guide provides specific planning and design information for separated bike lanes. It provides guidance for the integration and interface of separated bike lanes with elements such as transit stops, loading zones, utilities, drainage, on-street parking and landscaping.

NACTO Urban Bikeway Design Guide*, Second Edition, 2012*
The NACTO guide provides state of the practice information regarding the planning and design of bicycle facilities including bike lanes, buffered bike lanes, cycle tracks (separated bike lanes), intersection treatments, pavement markings, and signage. The guide is tailored to urban contexts and references practices and standards used and adopted by cities throughout the country. The NACTO guide is advisory only and presents many facility design concepts and treatments that are experimental.

1.7 UNDERSTANDING THE USER

Bicyclists vary in age, experience, skill, and preferences. As such, bicycle networks should accommodate a wide range of users. According to FHWA's Facility Selection Guide, approximately 30% of people surveyed do not cycle and have no interest in cycling. The greatest share (51-56%) of those surveyed are "interested but concerned"; this group is more likely to ride on a quiet street or on a sidewalk. A smaller share (5-9%) of those surveyed are characterized as "somewhat confident" and are comfortable riding in bike lanes but might prefer separated facilities. The smallest share (4-7%) of those surveyed are comfortable riding with traffic.

Most bicyclists prefer low stress facilities. The stress level of a facility is based upon several factors, the primary factor being the degree of separation between bicyclists and traffic. In addition to degree of separation from traffic, traffic speed and volume affect user comfort; higher speeds and volumes are associated with higher levels of bicyclist stress. Less experienced bicyclists exhibit a strong preference for low stress facilities, this is also true of youth and elderly bicyclists.

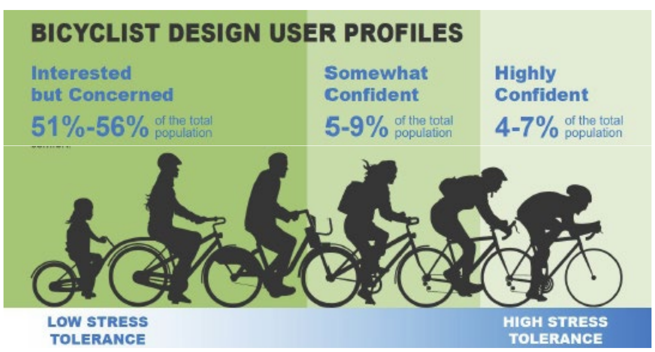


Figure 1-1: Bicyclist Design User Profiles. Credit: FHWA Facility Selection Guide

1.8 FACILITY CHARACTERISTICS

Bicycle facility types vary in the type of user they attract, amount of space they occupy, amount of traffic separation they provide, stress or comfort level of use, and cost of implementation.

Low stress facilities are those that less experienced riders find comfortable. These facilities require a high degree of separation between bicyclists and motor vehicle traffic. Providing this separation typically requires additional space within the right-of-way, which may compete with the operational needs of other modes of travel within the corridor.

The preference of users for low stress facilities needs to be balanced with the feasibility of providing those facilities. The lack of provision of bicycle facilities should not be considered preferable to the provision of higher stress facilities that are suitable for roadway conditions. Bicycle facilities should be selected to maximize safety and this preference should be weighed above providing facilities that are perceived as lower stress. Ideally, the preferred facility type is one that is both low stress and low risk (see Figure 1-2 below).

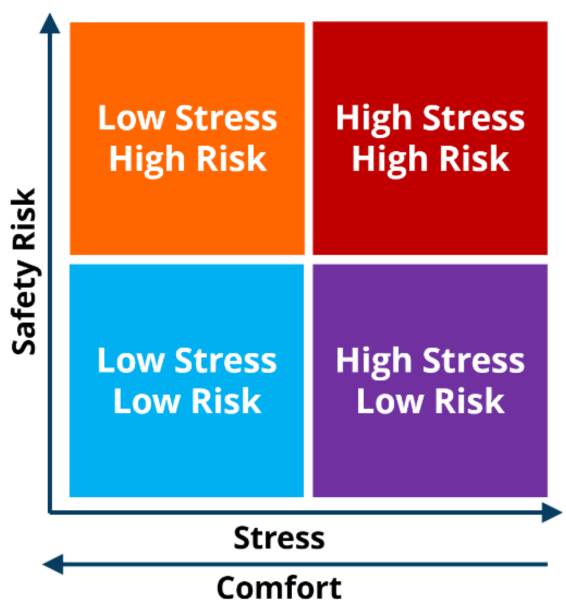


Figure 1-2 Safety Risk and Stress

1.9 BICYCLE SAFETY & CRASH RISK

Paramount to supporting and encouraging bicycling through the provision of bicycle facilities is the need for those facilities to reduce crash risks, whether injury or fatal, over the risk presented to users if no bicycle facility were provided. A fundamental understanding of the characteristics of crashes, particularly fatal crashes, is beneficial to the planner and designer in understanding the risks associated with bicycling and the use of bicycle facilities.

1.9.1 State and National Bicycle Crash Statistics

According to data from the Connecticut Crash Data Repository, fatal injuries comprised less than one percent of bicycle related crashes in Connecticut between 2021 and February of 2024. Serious injury crashes over that timeframe comprised 8.4% of crashes and minor or possible injury crashes comprised 74.6% of crashes. Additionally, nearly one quarter of crashes (23.5%) occurred between 4:00 pm and 6:00 pm.

National Highway Traffic Safety Administration (NHTSA) 2021 Traffic Safety Facts

- 85% of bicyclist fatalities occurred in urban areas.
- 29% of fatalities occurred at intersections.
- The fatality rate (fatalities per total population in age cohort) was highest for those age 60-64.
- The injury rate (injuries per total population in age cohort) was highest for those age 15-20.
- 96% of bicyclist fatalities involved crashes with a single vehicle.
- Bicyclists were struck by the front of the vehicle in 83% of fatal crashes.
- 46% of fatal crashes involved a collision with a light truck; 87% of those crashes involved the front of the truck.
- Buses and large trucks had the highest percentages of right-side impacts, accounting for 33.3% and 21.5% of bicyclist fatalities respectively, versus 4.5% for passenger vehicles.

1.9.2 Risk Factors for Bicycle/Motor Vehicle Crashes

One of the definitive bicycle crash studies (Risk Factors for Bicycle-Motor Vehicle Collisions at Intersections) was published in the ITE (Institute of Transportation Engineers) Journal in 1994. That study found that:

Risk Factors for Bicycle-Motor Vehicle Collisions at Intersections

- Bicyclists traveling against the direction of traffic, whether on the roadway or on the sidewalk incur much greater risk than those traveling with traffic (on average 3.6 times as great), at an overwhelmingly high level of significance.
- Bicyclists on a sidewalk or bicycle path incur greater risk than those on the roadway (on average 1.8 times as great), most likely because of blind conflicts at intersections. Wrong-way sidewalk bicyclists are at even greater risk, and sidewalk bicycling appears to increase the incidence of wrong-way travel.
- Bicycling on the roadway in the same direction as adjacent traffic, whether or not bicycle lanes are designated, is not associated with increased accident risk for any group.
- Urban roadway design—not only bikeway design—must take into account that intersections, construed broadly, are the major point of conflict between bicycles and motor vehicles.
- Separation of bicycles and motor vehicles leads to blind conflicts at intersections. It also encourages wrong-way travel, both on sidewalks or paths and on the roadway at either end, further increasing conflicts.
- Shared use of the roadway in the same direction of travel leads to fewer conflicts and fewer accidents.
- Where sidewalk (or sidepath) bicycling is permitted, it is desirable to maintain clear sight lines at intersections of sidewalks (or sidepaths) with streets and driveways.

1.9.3 Bicycle Crash Typology

The University of North Carolina Highway Safety Research Center provides one of the most in-depth and comprehensive reports (*Bicycle Crash Types 2015-2019*) on bicycle crash types of any state in the country. North Carolina's composition of rural, suburban, and urban areas is similar to Connecticut's, providing a useful analog for conditions in Connecticut.

North Carolina Bicycle Crash Types 2015-2019

- 74.4% of crashes occurred in urban areas.
- 53.8% of crashes were located at or related to an intersection (excluding non-signalized commercial and private driveways).
- 21.1% of all bicycle crashes involved a motorist overtaking a bicyclist.
- 8.9% of crashes involved a motorist driving out of a sign-controlled intersection, after having obeyed the traffic sign.
- 8.7% of crashes involved a motorist left turn in the opposite direction of bicycle travel.
- 10.3% of crashes involved a bicyclist ride-through (without obeying the traffic control device) of a signalized or sign-controlled intersection.
- 8.7% of crashes involved a motorist driving out of a driveway or alley and failing to yield to the bicyclist (81% of bicyclists in these crashes were riding against traffic).
- 5.4% of crashes involved a motorist right turn in the same direction as bicycle travel.
- 4.6% of crashes were not in the roadway.
- 3.3% of crashes involved a bicyclist left turn with a motorist travelling in the same direction.
- 61.2% of crashes in urban areas were at intersections or were intersection related.
- 66% of all "motorist overtaking bicyclist" crashes occurred on roadways with a speed limit of 40 mph or higher.
- 64.6% of crashes on a sidewalk, crosswalk, or across a driveway involved a bicyclist riding against traffic.
- Less than 1% of crashes were parking related.

1.9.4 Crash Research Implications for Bicycle Facility Selection and Design

Based upon national bicycle fatality statistics and bike crash research, the following should be taken into consideration when planning and designing bicycle facilities in West Hartford:

1. A significant share of bicycle crashes in urban areas occur at or are related to intersections. **The provision of appropriate intersection treatments can improve bicycling safety.**

2. Most overtaking crashes (crashes involving a side swipe of a bicyclist or bicyclist collision with the side of a vehicle) occur on higher speed roadways. **The provision of appropriate bicycle facilities or the separation of bicyclists from traffic can reduce crash rates and risk on higher speed roads.**

3. Bicyclists on sidewalks or sidepaths incur a greater risk of experiencing a crash at intersections than those on the roadway due in part to blind conflicts at intersections. Contra-flow bicyclists are at even greater risk. **The protection of sightlines and provision of appropriate intersection treatments, signals, and signage are needed to reduce conflicts for bicyclists operating adjacent to the roadway.**

4. Bicyclists travelling against traffic (contra-flow) are at a much greater risk of experiencing a crash than bicyclists travelling with traffic. **Contra-flow bicycle facilities should be carefully selected and designed to minimize exposure to motor vehicle traffic.**

5. Because of the risk presented by sidewalk/sidepath riding and contra-flow riding, **the application of contra-flow facilities, particularly those located adjacent the roadway, is discouraged in areas with frequent side street or driveway intersections.**

1.10 DATA COLLECTION AND APPLICATION

The selection of appropriate bicycle facilities is incumbent upon the collection and application of data relevant to the corridor. This includes the following:

- **Functional Classification:** Roadways are classified by the Connecticut Department of Transportation as arterial, collector, or local roadways, with arterial and collector roadways intended and designed to accommodate a higher number of vehicles and more freight traffic than local roadways. While functional classification is a consideration in the selection of bicycle facilities, the implementation of bicycle facilities is not limited by functional classification type nor is functional classification used to select a bicycle facility type.
- **Traffic Volume:** Average Daily Traffic (ADT) or Annual Average Daily Traffic (AADT) data should be collected or referenced prior to the selection of bicycle facilities for a corridor. Historical data can be used for planning purposes, but the collection of current data is recommended. Traffic volume data should be collected at multiple locations for corridors which have segments that vary significantly in traffic patterns or roadway geometry. Future traffic volume conditions should be considered.
- **Traffic Speed:** 85^{th} percentile traffic speeds should be used in the selection of appropriate bicycle facilities. Posted speed limits may be used as a proxy if speed data is unavailable, but the collection of data is recommended. Traffic speed data should be collected at multiple locations for corridors that have segments that vary significantly in traffic characteristics or roadway geometry.
- **Roadway Conditions:** Information regarding roadway conditions is necessary to inform facility selection. Necessary information includes right-of-way, roadway width, pavement markings, traffic and queuing behavior, parking lane location, driveway locations, utility structures, and topography.
- **Land Use:** Adjacent land use data should be collected and used to inform bicycle facility selection. Planned developments with potential access along the corridor should be considered in facility selection.
- **Bicycle and Pedestrian Volume:** While this data may not be readily available when planning facilities, the collection of this data can be informative to the facility selection and design process. The value of this data may be limited by the fact that existing bicycle and pedestrian volume may be representative of the potential demand for these facilities, particularly if there are no existing accommodations in the data collection area.
- **Bicycle Network:** The existing bicycle network approaching, connecting to, or intersecting the corridor should be considered in bicycle facility selection. Planned bicycle facilities and local bicycle plans should be referenced and considered.

1.11 TRAFFIC SPEED AS A DESIGN FACTOR

Speed plays a large factor in the selection of appropriate bicycle facilities. The desirable bicycle separation from vehicles is primarily a function of traffic speed; other factors include traffic volume and traffic type (share of trucks and large vehicles). While bicyclist comfort generally declines with higher traffic volumes and heavy vehicles, bicyclist safety is most impacted by traffic speed. As traffic speed increases, the severity of collision increases.

Bicyclist safety on higher speed roads can be improved using traffic calming techniques that reduce traffic speed and/or adequate separation should be provided between bicyclists and vehicles in response to the traffic speed conditions. Additional separation has the added benefit of providing a more comfortable experience for bicyclists.

Connecticut General Statute Section 14-232 requires that motor vehicles provide three feet of separation when passing bicyclists. This separation should be considered the minimum separation required and is adequate at speeds at or below 30 mph. Additional separation or other measures should be considered where speed conditions exceed 30 mph.

1.12 FACILITY PLANNING PROCESS

This guide is intended for use in the selection, planning, and design of bicycle facilities. This process begins with the collection of supporting data such as traffic volume, traffic speed, geometric data, and land use. Based upon this available data, an appropriate facility type is identified with a preference for facilities that are within the "recommended" or "exceeds recommendations" ranges for ***both*** traffic volume ***and*** speed conditions. If these conditions cannot be met, alternatives include selecting an "acceptable" facility or providing improvements that modify the existing conditions to fall within "recommended" or "acceptable" ranges.

Once an appropriate facility has been identified, an analysis of geometric and land use conditions should be conducted to assess the spatial feasibility of providing the facility on the existing roadway or within the existing right-of-way. If the facility cannot be accommodated on the roadway or within the right-of-way, the feasibility of modifying the roadway via a road diet, narrowing of traffic lanes, removal of parking lanes, or widening should be explored. Expansion of the right-of-way may also be necessary to accommodate the bicycle facility.

If roadway modifications or right-of-way widening is not feasible, other solutions should be considered or an alternative corridor should be identified. Town officials should meet and coordinate with the Pedestrian and Bicycle Commission (PBC) in the selection of alternatives including the selection of facility in the "acceptable" range or the selection of an alternative corridor.

The planning process should proceed to the design process once an appropriate bicycle facility has been identified as feasible for the corridor. This process may be iterative; the design process may reveal additional information or identify constraints that require a reconsideration of the appropriate facility type for a corridor. The design process may also result in a determination that the provision of bicycle facilities on a corridor is not feasible due to right-of-way constraints, construction costs, or physical constraints that would result in adverse impacts that are not outweighed by the benefit expected to be provided through provision of the bicycle facility.

Figure 1-3 at right provides an overview of the facility planning process. The process may differ.

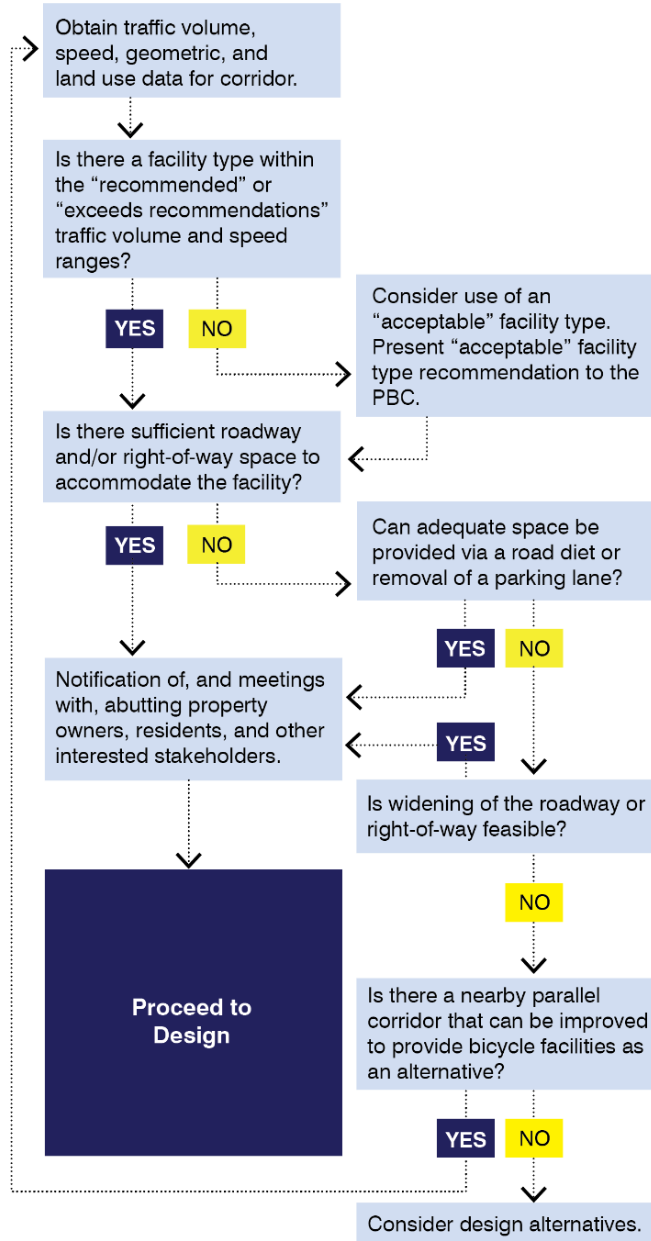


Figure 1-3: Facility Planning Process

1.13 BIKE FACILITY SELECTION

Several factors should be considered when selecting the appropriate bicycle facility for a roadway corridor. The primary factors are motor vehicle traffic speed and volume, but other factors such as right-of-way width, adjacent land uses, utility infrastructure, traffic operations, and construction costs should be considered.

The facility selected for a corridor should be selected based upon suitability for both traffic volume and speed conditions with the intent of providing facilities that are safe and comfortable for the widest range of users. **Where there is a difference between the facility recommended based upon the speed conditions versus traffic volume conditions, the facility that provides greater separation should be selected for use.** Such facility types typically include "recommended" facilities or facilities that "exceeds recommendation" for the conditions. Should those facility types not be feasible to implement, a facility type within the acceptable range may be considered for use. The use of facilities that fall into the acceptable range for both speed and traffic volume conditions is discouraged, but not prohibited. Such facilities should be carefully considered for use to ensure that they are appropriate for the conditions.

For the purposes of this plan, facilities are classified as following:

- **Facilities Exceeding Recommendations:** These facilities should be considered for use based upon local conditions such a high number of expected riders or proximity to a school but may exceed the measures necessary based upon traffic volume and speed conditions. The application of these facilities is typically associated with higher cost of implementation, higher maintenance cost, and additional space requirements than would otherwise be required by a recommended facility type.
- **Recommended Facilities:** These facilities are the recommended facility type given conditions specific to that corridor. While this is the facility type that should be targeted for implementation, facilities that provide a higher measure of separation should also be considered.
- **Acceptable Facilities:** These facilities are acceptable for application where physical conditions such as utility poles, traffic control equipment, on-street parking demand, retaining walls, trees, landscaping, or other similar factors place significant spatial or cost of construction constraints on the provision of recommended facility types. Acceptable facilities are generally reserved for use where the cost of construction due to physical conditions, and/or property constraints make the installation of recommended facilities infeasible.

Table 1 on the following page is based on CTDOT's Appendix A Bicycle Facility Selection Matrix, which was adopted by CTDOT as part of the Complete Streets Controlling Design Criteria and Justification Process implemented in 2023. These standards have been adopted by CTDOT for use on State and local roadways. While local municipalities may approve more stringent standards, they are discouraged from adopting standards that would allow facilities on higher volume or higher speed roadways than are recommended through this matrix.

The facility types identified in the matrix and recommended in this plan include shared roadways, bike lanes, buffered bike lanes, separated bike lanes, and sidepaths. Shared use paths are also recommended for use as part of the Town's bicycle network, but those facilities are not subject to traffic speed and volume consideration in their planning and are therefore not identified in the selection matrix. For more information on the facility types, see Section 1.14 and Sections 2 through 7.

Those facilities are described in Section 1.14 and are identified in Table 1 on the next page. Low-cost facilities, particularly those provided within the limits of an existing roadway, are typically more feasible to implement but may be less attractive to users and perceived as high stress depending on the roadway conditions. Typically, there is an inverse correlation between the stress level and the cost of a facility with low stress facilities being more expensive to build and high stress facilities costing less to construct. See Figure 1-4 on the following page for a comparison of facilities.

Facilities should be selected based upon those that will provide bicyclists with a suitable accommodation and are feasible to implement given considerations such as, but not limited to, available right-of-way, geometric constraints, construction cost, and maintenance factors. Flexibility should be allowed in the selection of facilities and selections should be made on a case-by-case basis. Refer to the FHWA Bikeway Selection Guide for additional guidance.

Table 1: Bike Facility Selection Summary Matrix

<table>
<tr><th>Traffic Volume (ADT)</th><th>0-5,000</th><th>5,000-10,000</th><th>10,000-15,000</th><th>15,000-20,000</th><th>20,000-25,000</th></tr>
<tr><td>Shared Roadway</td><td>Recommended</td><td>Acceptable</td><td></td><td></td><td></td></tr>
<tr><td>Bike Lane</td><td colspan="2">Recommended</td><td>Acceptable</td><td></td><td></td></tr>
<tr><td>Buffered Bike Lane</td><td>Exceeds Recom.</td><td colspan="2">Recommended</td><td colspan="2">Acceptable</td></tr>
<tr><td>Separated Bike Lane</td><td colspan="2">Exceeds Recommendation</td><td colspan="3">Recommended</td></tr>
<tr><td>Sidepath</td><td colspan="2">Exceeds Recommendation</td><td colspan="3">Recommended</td></tr>
</table>

<table>
<tr><th>85th Percentile Traffic Speed (mph)</th><th>30 or less</th><th>31-35</th><th>36-40</th><th>41-45</th><th>46+</th></tr>
<tr><td>Shared Roadway</td><td>Recommended</td><td>Acceptable</td><td></td><td></td><td></td></tr>
<tr><td>Bike Lane</td><td colspan="2">Recommended</td><td>Acceptable</td><td></td><td></td></tr>
<tr><td>Buffered Bike Lane</td><td>Exceeds Recommendation</td><td colspan="2">Recommended</td><td>Acceptable</td><td></td></tr>
<tr><td>Separated Bike Lane</td><td>Exceeds Recommendation</td><td colspan="4">Recommended</td></tr>
<tr><td>Sidepath</td><td>Exceeds Recommendation</td><td colspan="4">Recommended</td></tr>
</table>

Low Stress Facilities include: Separated Bike Lanes and Sidepaths in all applications, and Buffered Bike Lanes when ADT <5,000 and 85th percentile speed <30 mph.

Using the Bicycle Facility Selection Matrix: Boulevard as an example (South Main Street to Mountain Road)

As described on page 9, the matrix above is used to identify facility types that should be considered for a corridor given two factors: traffic volume and speed. The facility selected should fall into (or exceed) the recommended range for both factors. Below is an example of how a facility would be selected for Boulevard using Table 1 above. See Appendix A for a sample bicycle facility selection worksheet for Boulevard.

Boulevard's Average Daily Traffic Volume: 4,706

This places Boulevard in the first column (0-5,000 ADT) of the Traffic Volume criteria, which means that a shared roadway or bike lane is recommended. Buffered bike lanes, separated bike lanes, or sidepaths may be used, but those facilities exceed the recommendation given the traffic volume on Boulevard.

Boulevard's 85th Percentile Speed: 37 mph

This places Boulevard in the fourth column of the Traffic Speed criteria (36-40 mph), which means that buffered bike lanes, separated bike lanes, or sidepaths are recommended. Bike lanes are an acceptable facility type, which means that the Town would first need to explore the feasibility of providing buffered bike lanes, separated bike lanes, or sidepaths before considering the use of bike lanes.

Results

A buffered bike lane, separated bike lane, or sidepath would first be considered for installation on Boulevard because those facility types meet or exceed the recommendations for the conditions. If, or where, those facility types cannot be provided, bike lanes may be considered for use along segments or the entire length of Boulevard. A shared roadway would not be considered for installation because that facility type falls outside of the recommended and acceptable ranges for traffic speed.

1.14 LOW-STRESS NETWORK

The West Hartford Vision Zero Plan recommends the identification and development of a low-stress bicycle network appropriate for less confident bicyclists of all ages. Low-stress facilities include separated bike lanes, sidepaths, shared use paths, and buffered bike lanes in certain contexts. These higher comfort facilities attract less confident users. Because these facilities are more costly to construct and maintain, and generally require more right-of-way space than other facility types, they should be strategically located to serve as much of the town as possible. A potential low-stress network could include three corridors in each the east-west and north-south directions. Potential corridors could include:

Potential East-West Low-Stress Facilities

- *North Corridor:* Albany Avenue
- *Central Corridor:* Fern Street, Farmington Avenue, Boulevard, *or* Park / Sedgwick Road
- *South Corridor:* New Britain Avenue

Potential North-South Low-Stress Facilities:

- *West Corridor:* Canal Road (MDC)
- *Central Corridor:* Trout Brook Trail
- *East Corridor:* New Park Avenue, and Oakwood *or* Prospect Avenue

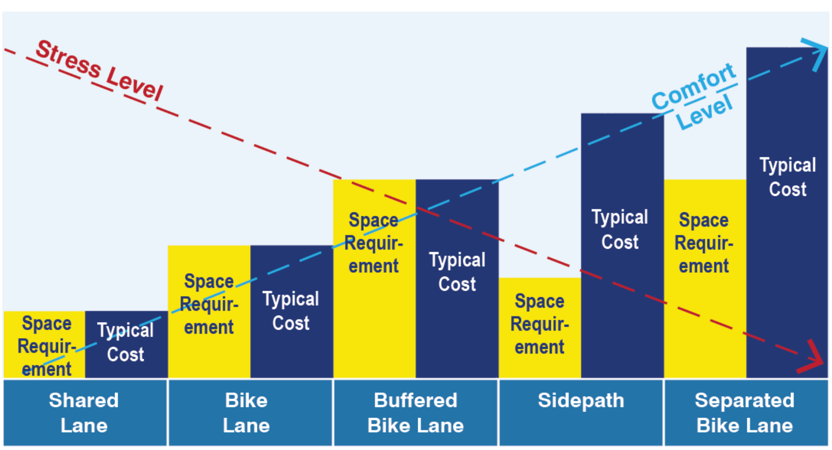


Figure 1-4: Typical Facility Characteristics (actual conditions may vary)

Comfort and Stress as a Consideration

In addition to considering factors such as traffic volume and speed in selecting a facility, both of which have direct associations with safety, comfort and stress should also be considered. Comfort using a facility has an inverse association with the stress experienced while using the facility. Stress is a deterrent to less experienced bicyclists who prefer higher comfort facilities.

1.15 FACILITY TYPES

Sections 2 through 8 of this guide provide detailed guidance for facility types that are most appropriate for use in West Hartford.

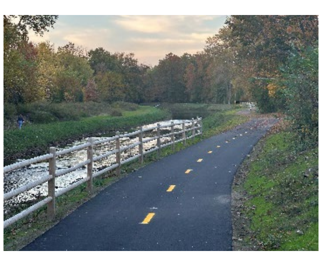
Shared Roadway: Shared roadways allow bicyclists and motor vehicles to use the same roadway space without any separate lane designations. Shared roadways are typically delineated by "sharrow" pavement markings and accompanying signage.

Bike Lane: Bike lanes designate an exclusive space on the roadway for bicycle travel, which is signified by pavement markings and signage. Bike lanes are typically located between a motor vehicle travel lane and the curb, road edge, or parking lane.

Buffered Bike Lane: Buffered bicycle lanes are conventional striped bike lanes with a painted or textured pavement buffer space that is used to separate the bike lane from the adjacent motor vehicle lane and/or parking lane.

Separated Bike Lane: Separated Bike Lanes (also known as cycle tracks or protected bike lanes) are bicycle lanes that are physically separated from motor vehicle traffic. Separated bike lanes can be designed for one-way or two-way travel and can be at street level, at sidewalk level, or at an intermediate level between the two.

Sidepath: Sidepaths provide a separated facility for the shared use of bicyclists and pedestrians. Like sidewalks, these facilities are physically separated from motor vehicles by a curb, open space, or barrier. These facilities are adjacent to the roadway and are typically located within the right-of-way.



Shared Use Path: A shared use path is a facility that is shared by bicyclists and pedestrians. These facilities are recreational in nature and often travel through open space areas and along natural features such as riverfronts. While similar in design and function to a sidepath, shared use paths, are not typically located adjacent to a roadway.

Image Credits: FHI Studio, Town of West Hartford, Planetizen

2.0 SHARED ROADWAY

2.1 DESCRIPTION

Shared roadways allow bicyclists and motor vehicles to use the same roadway space without separate lane designations. While every roadway (except for limited access highways) is shared by multiple users including bicyclists, the reference to "shared roadway" in this guide is to facilities that provide pavement markings and signage supporting bicycle use.

Motorists have a greater awareness of bicyclists on shared roadways when compared to roadways that lack bicycle pavement marking or signage. Shared roadways should be used where the provision of dedicated bike lanes or other dedicated bicycle facilities is not feasible due to geometric or right-of-way constraints or are not required due to the traffic conditions.

One of the limitations of shared roadways is that they are susceptible to bicycle and vehicular conflicts because of the lack of designated space and/or separation between bicyclists and motorists. As such, the application of shared roadways should be sensitive to conditions such as lane and roadway width, on-street parking, and traffic volume and speed.

On a shared roadway, bicyclists can position themselves where they feel safest and most comfortable. While bicyclists often prefer the right edge of the shared lane, they may also opt to ride in the middle of the shared lane to discourage passing vehicles from attempting to pass within the lane.

Shared roadways can be a valuable tool in developing a bicycle network and providing strategic connections between corridors with dedicated bicycle facilities. Shared roadway pavement markings and accompanying signage provide cyclists with wayfinding assistance and promote awareness of the presence of bicyclists in the roadway environment.

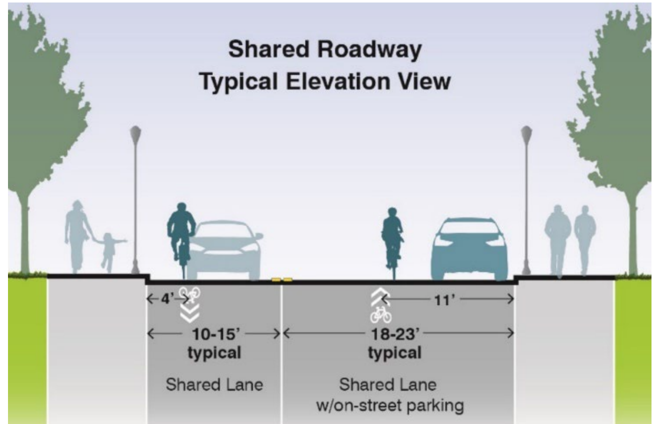


Figure 2-1: Typical Shared Roadway Elevation View

Figure 2-2: Shared Roadway, West Hartford, CT.
Image Source: FHI Studio

2.2 APPLICATION GUIDANCE

Shared roadways are suitable for corridors with low to moderate traffic volume and speeds. Table 2 below provides the recommended and acceptable traffic volume and speed ranges for the application of shared roadways. *Note: The MUTCD states that the shared lane marking (sharrow) should not be placed on roadways that have a speed limit above 35 mph.*

Table 2: Shared Roadway Application Guidance

Traffic Volume	Recommended	5,000 ADT or less
	Acceptable	5,000 – 10,000 ADT
85th Percentile Speeds	Recommended	30 mph or less
	Acceptable	31 – 35 mph

2.3 DESIGN GUIDANCE

2.3.1 Lane Width

- Shared lanes are generally suitable for roadways 20 feet or more in width that lack a yellow centerline pavement marking.
- Where a yellow centerline pavement marking is present, wide (13-15 foot) shared lanes are preferred over narrower lanes as they afford greater separation between motorists and bicyclists and require less encroachment of motor vehicles into adjacent traffic lanes when passing bicyclists. *Bike lanes are recommended instead of shared lanes where traffic lanes are continuously wider than 15 feet.*
- Where a yellow centerline pavement marking is present, narrow (less than 13 feet) shared lanes should only be used in lower traffic volume and speed conditions. Lower volume roadways afford greater gaps in traffic to allow for encroachment of motor vehicles into adjacent traffic lanes when passing bicyclists. Lower speed conditions are preferred for narrow shared lanes.

Table 3 below provides recommended shared lane width as a function of traffic speed and volume for roadways with no on-street parking.

Table 3: Recommended Shared Roadway Width (no on-street parking)

Recommended Shared Lane Width (inclusive of shoulder)	**Maximum 85th Percentile Speed**	**Maximum ADT**
10-12 feet	30 mph	5,000
13-15 feet	35 mph	10,000
No centerline: 20+ feet (edge of pavement to edge of pavement, bi-directional traffic)	35 mph	6,000

Table 4 below provides recommended shared lane width as a function of traffic speed and volume for roadways with on-street parking.

Table 4: Recommended Shared Roadway Width (on-street parking)

Recommended Shared Lane Width (inclusive of on-street parking lane)	**Maximum 85th Percentile Speed**	**Maximum ADT**
18-20 feet (edge of pavement to centerline)	30 mph	5,000
21-23 feet (edge of pavement to centerline)	35 mph	10,000
No centerline, parking one side: **24+ feet** (edge of pavement to edge of pavement, bi-directional traffic)	35 mph	6,000
No centerline, parking both sides: **28+ feet** (edge of pavement to edge of pavement, bi-directional traffic)	35 mph	6,000

2.3.2 Pavement Markings

- Shared lane markings (sharrows) shall be provided.
- Sharrows shall be 3′-4″ wide by 9′-4″ long.
- The centerline of the sharrow shall be placed at least 12 feet from the face of the curb or edge of pavement where on-street parking is present, and 4 feet from the face of the curb or edge of pavement where no on-street parking is present.
- Sharrows should be located and spaced in accordance with the following:
  - Low traffic/stress streets: At entry point only from intersecting arterial or collector roadways.
  - Medium traffic/stress streets: At entry points from intersecting arterial or collector roadways and spaced a maximum of 500′ apart.
  - High traffic/street streets: At entry points from intersecting arterial or collector roadways and spaced a maximum of 250′ apart.
- The first sharrow downstream from an intersection should be placed no more than 50 feet from the intersection.
- Edge (shoulder) lines are not recommended for use on shared roadways. In situations where edge lines are present or required, the sharrow marking shall be placed on the traffic side of the edge line. The edge of the sharrow marking shall be spaced a minimum of six inches away from the edge line.
- It is preferable that yellow centerline markings are not applied to, or are removed from, local shared roadways with less than 6,000 ADT unless required due to roadway curvature, the presence of three or more traffic lanes, or other unique condition. The absence of a centerline pavement marking provides additional separation between motorists and bicyclists due to the tendency of vehicles to operate closer to the center of the roadway in the absence of a center line pavement marking.

Figure 2-3: Shared Lane "Sharrow" Marking

2.3.3 Signage

- The MUTCD W11-1 Bicycle Warning sign should be placed at the beginning of a shared roadway and as conditions require. An "IN LANE" subplate may be used. "SHARE THE ROAD" subplates shall not be used.
- The MUTCD R5-1b "WRONG WAY" and R9-3cP "RIDE WITH TRAFFIC" plaque should be considered for use in areas prone to wrong-way riding.
- The MUTCD R9-20 "Bicycles Allowed Use of Full Lane" sign may be used. If used, the sharrow marking should be placed in the center of the travel lane. The sign may be used on roadways where no bicycle lanes or adjacent shoulders usable by bicycles are present and where travel lanes are too narrow for bicycles and motor vehicles to operate side-by-side.

Figure 2-4: MUTCD R9-20

Figure 2-5: Bicycle Warning Sign, MUTCD W11-1

2.4 LIMITATIONS

Shared roadways are low-cost facilities that have minimal impact on roadway operations. Shared roadways do not provide exclusive operating space for bicyclists and may not be as attractive to bicyclists as facilities that provide exclusive operating space.

3.0 BIKE LANE

3.1 DESCRIPTION

Bike lanes provide a dedicated space on the roadway for bicycle travel, which is signified by pavement markings and signage. Bike lanes are typically located between a motor vehicle travel lane and the curb, road edge, or parking lane. Bike lanes are used for one-way travel in the same direction as the adjacent traffic lane. Bike lanes are generally reserved for use by bicyclists with the exception of emergency use by public safety vehicles or disabled vehicles, temporary use by service/delivery vehicles, and maintenance activities.

Connecticut General Statutes Section 14-251 regulates the use of public highways and prohibits parking on public highways that would constitute a traffic hazard or obstruct the free movement of traffic.

Bike lanes provide separation between bicyclists and traffic and require minimal roadway space, which allows for their inclusion via traffic lane width reductions, removal of traffic lanes, and/or removal of on-street parking lanes.

Bike lanes may be provided in isolated segments as climbing lanes. Climbing lanes are placed on the uphill direction of a steep roadway grade to provide bicyclists space to ride without slowing down vehicular traffic.

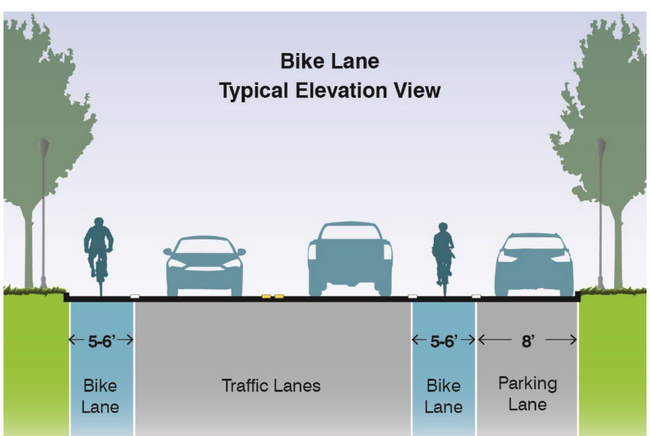


Figure 3-1: Typical Bike Lane Elevation View

Figure 3-2: Bike Lane, West Hartford, CT.
Image Credit: Town of West Hartford

3.2 APPLICATION GUIDANCE

Table 5 below provides guidance on the application of bike lanes based upon traffic speed and volume conditions.

Table 5: Bike Lane Application Guidance		
Traffic Volume	Recommended	10,000 ADT or less
	Acceptable	10,000 – 15,000 ADT
85th Percentile Speeds	Recommended	35 mph or less
	Acceptable	36 – 40 mph

3.3 DESIGN GUIDANCE

3.3.1 Bike Lane Width

- Bike lanes should be between 4 and 6 feet wide. Selection of a bike lane width is based upon edge of roadway conditions, traffic volume, and traffic speed. While AASHTO recommends a minimum of 4- to 5-foot-wide bike lanes, a 6-foot-wide bike lane is preferred for use in higher traffic volume and speed conditions where space allows.
- The maximum bike lane width is 6 feet to discourage its use as a parking lane. Buffered bike lanes should be used where the bicycle operating space is greater than 6 feet.
- A consideration in selecting an appropriate bike lane width is the presence and location of roadway features such as catch basins, utility covers, and longitudinal pavement joints. Bicyclists should be provided with sufficient operating space within the bike lane to avoid potentially hazardous surface features.
- When placed between a parking lane and traffic lane, the combined width of the parking lane and bike lane should be no less than 13 feet so as to minimize door zone conflicts. In areas of high parking turnover such as areas with metered or time-limited spaces, the parking lane width should be increased to 9 feet or a 2-foot-wide door zone buffer should be used with a 7-foot-wide parking lane to provide additional separation between bicyclists and open car doors.

Table 6 below provides guidance on determining appropriate bike lane width in response to adjacent traffic lane width, traffic speed, and traffic volume.

Table 6: Bike Lane Width Selection

Bike Lane Width	Adjacent Traffic Lane Width	Maximum 85th Percentile Speed	Maximum ADT
4 feet*	10 feet	30 mph	7,500
	11 feet	30 mph	10,000
5 feet	10 feet	30 mph	10,000
	11+ feet	35 mph	12,500
6 feet	10 feet	35 mph	12,500
	11+ feet	40 mph	15,000
Notes	*Only for use at edge of roadway where no curb is present, no drainage structures are located in bike lane, and area adjacent to the roadway is flush with edge of pavement.		

3.3.2 Pavement Markings

- A solid white lane marking (4 or 6 inches wide) shall be used to separate the bike lane from the motor vehicle travel lane.
- Bike lane lines should be dotted at turning lanes, bus stops, and at approaches to intersections. A 6-inch-wide dotted bike lane line (2-foot line, 6-foot gap) should be used. Bike lanes may also be dotted at bus stops or bus pullouts and across unsignalized intersecting streets and major driveways. Bike lane lines should remain solid (not dotted) at unsignalized driveways and alleys.
- Bike lane symbols shall be used to define the bike lane. Symbol pavement markings should be placed immediately after an intersection and spaced at intervals no greater than 1,000 feet.
- Green pavement color may be used to enhance the visibility of a bike lane in locations with high traffic volumes, large numbers of turning movements, or where bike lanes cross traffic lanes.

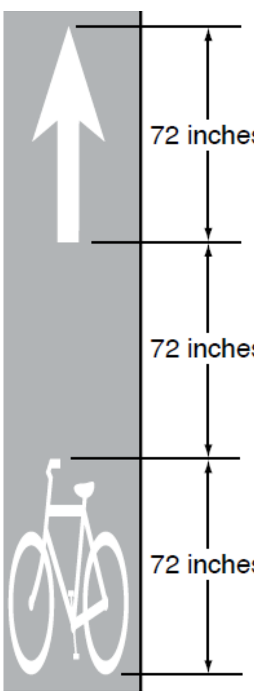


Figure 3-3: Bike Lane Symbol Pavement Marking

3.3.3 Signage

- Bike lane signage (MUTCD R3-17) is not required but may be used at the beginning of a bike lane or immediately following a signalized intersection.
- The "RIDE WITH TRAFFIC" plaque (MUTCD R9-3cP) should be considered for use in areas prone to wrong-way riding.
- The use of "Bike Lane Ahead" and "Bike Lane Ends" signage is not necessary.
- A "No Parking Bike Lane" (MUTCD R7-9 or R7-9a) sign may be used in areas with frequent and consistent parking in the bike lane.

Figure 3-4: Bike Lane Sign (MUTCD R3-17)

Figure 3-5: Ride With Traffic Plaque (MUTCD R9-3cP)

3.4 LIMITATIONS

While bike lanes provide separation between traffic and bicyclists, they do not physically protect bicyclists who remain exposed to traffic and opened car doors where on-street parking is present.

Proper intersection treatments are required to avoid conflicts with right-turning vehicles and to assist bicyclist with left-turn movements.

4.0 BUFFERED BIKE LANE

4.1 DESCRIPTION

Buffered bike lanes are located on the roadway and include a flush painted, colored, or textured buffer space that is used to separate the bike lane from the adjacent traffic or parking lane. Buffered bike lanes provide an improved level of comfort for the bicyclist above that provided by a standard bike lane by providing more space between bicyclists and motorists and more space for bicyclists to pass one another without encroaching into a traffic lane. Buffered bike lanes should be used where traffic volume and/or speed require additional separation between bicyclists and motor vehicles to improve bicyclist safety and comfort. Buffered bike lanes are typically paired one-way facilities that operate in the same direction of traffic.

One of the challenges of incorporating buffered bike lanes is the additional roadway space needed to accommodate the buffer space. Buffered bike lanes, while providing additional separation between bicyclists and motor vehicles, do not provide the same extent of physical separation as separated bike lanes. Buffered bike lanes may require additional maintenance when compared to standard bike lanes because of the need to maintain the buffer striping or surface treatment.

Figure 4-1: Typical Buffered Bike Lane, West Hartford, CT. Image Credit: FHI Studio

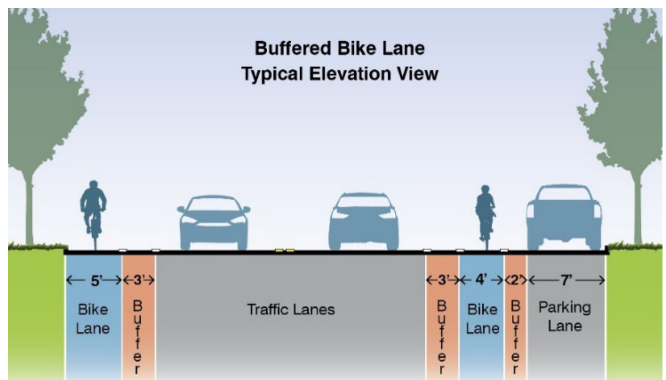


Figure 4-2: Typical Buffered Bike Lane Elevation View

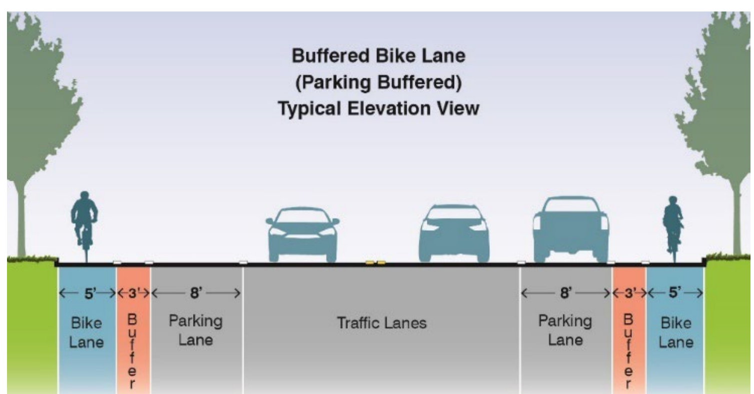


Figure 4-3: Typical Parking Buffered Bike Lane

4.2 APPLICATION GUIDANCE

Table 7 below provides guidance on the application of buffered bike lanes based upon traffic speed and volume conditions.

Table 7: Buffered Bike Lane Application Guidance		
Traffic Volume	Exceeds Recommendation	Less than 5,000 ADT
	Recommended	5,000 - 15,000 ADT
	Acceptable	15,000 - 25,000 ADT
85th Percentile Speeds	Exceeds Recommendation	30 mph or less
	Recommended	31 - 40 mph
	Acceptable	41 - 45 mph

4.3 DESIGN GUIDANCE

4.3.1 Bike Lane Width

- Bike lanes may be a minimum of 4 feet wide if buffered on both sides.
- Bike lanes shall be a minimum of 5 feet wide if buffered only on one side.

4.3.2 Buffer Width and Application

- Buffers, whether traffic side or parking side shall be no less than 2 feet in width. Appropriate traffic side buffer width should be determined based upon adjacent traffic lane width, traffic speed, and traffic volume as per Table 8 at right.
- Where a parking lane buffer is provided on the left (driver) side of a parking lane, the combined width of the parking lane and parking lane buffer shall be no less than 9 feet to minimize door zone conflicts.
- Where a buffered bicycle lane is located on the right (passenger) side of a parking lane, the minimum buffer width between the parking lane and bike lane shall be 3 feet to minimize door zone conflicts.
- Bike lanes located between traffic and parking lanes should include parking lane side buffers when located adjacent to parking lanes in areas of high parking turnover such as metered spaces, time-limited spaces, and retail areas.
- Rumble strips may be used within a traffic side buffer and should be placed at the traffic side edge of the buffer when used.

Table 8: Traffic Side Buffer Width Selection Guidance

Traffic Side Buffer Width Minimum	Adjacent Traffic Lane Width	Maximum 85th Percentile Speed	Maximum ADT
2 feet	10 feet	40 mph	15,000
	11 feet	42.5 mph	20,000
3 feet	10 feet	42.5 mph	20,000
	11+ feet	45 mph	25,000

4.3.3 Pavement Markings

- Bicycle symbols shall be provided in the bike lane as per Bike Lane design guidance.
- The buffer area should be marked with two solid longitudinal white lines with interior diagonal cross hatching.
- Diagonal markings should be provided in buffer spaces 3 feet wide or less and shall be provided in buffer spaces greater than 3 feet wide.
- The diagonal marking should be an 8-inch, 45-degree, white diagonal cross hatch spaced 30 feet apart.

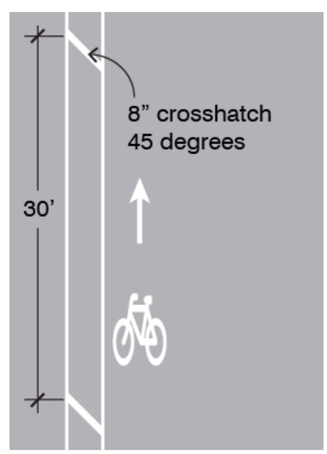


Figure 4-4: Bike Buffer Pavement Marking

4.3.4 Signage

Signage should be provided in accordance with design guidance for Bike Lanes (see Section 3.3).

4.4 LIMITATIONS

Buffered bike lanes may not provide physical protection from traffic. Proper intersection treatments are required to avoid conflicts with right-turning vehicles and to assist bicyclist with left-turn movements.

5.0 SEPARATED BIKE LANE

5.1 DESCRIPTION

Separated bike lanes are physically separated from motor vehicle traffic. Physical separation can be provided by grade separation or by permanent physical barriers such as delineator posts, curbs, bollards, guardrails, or other traffic barrier systems. Separated bike lanes can be designed for one-way or two-way travel and can be at roadway (Figure 5-2 and Figure 5-3) or sidewalk level (Figure 5-4 and Figure 5-5).

Separated bike lanes are preferred by less experienced bicyclists and bicyclists of all ages because of the physical separation from traffic. While separated bike lanes improve safety and comfort along a corridor, physical separation does not resolve conflicts with turning motor vehicles at intersections and driveways. Special treatment is therefore required at intersections to reduce conflicts. Separated bike lanes usually require bicycle specific traffic signals at signalized intersections or require bicyclists to use a pedestrian crossing signal phase to assist with intersection crossings.

Two-way separated bike lanes located on one side of the roadway may be a desirable facility where the opposite side of the roadway experiences significant turning movements such as at a highway interchange. Two-way separated bike lanes are most appropriately located along the side of a roadway that is not frequently interrupted by driveways or intersections.

Paired one-way separated bike lanes are generally preferable over two-way separated bike lanes as they present less conflict at intersections and driveways due to the lack of contraflow traffic. Paired one-way facilities may, however, require more space than a two-way separated bike lane.

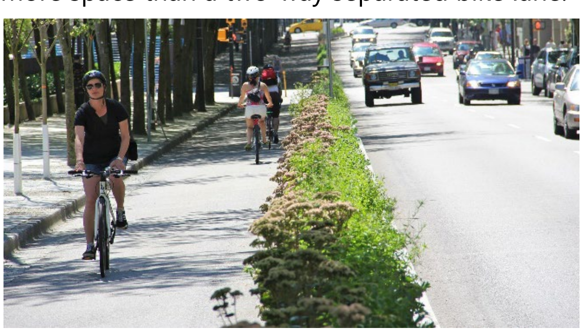


Figure 5-1: Two-Way Separated Bike Lane at Roadway Level

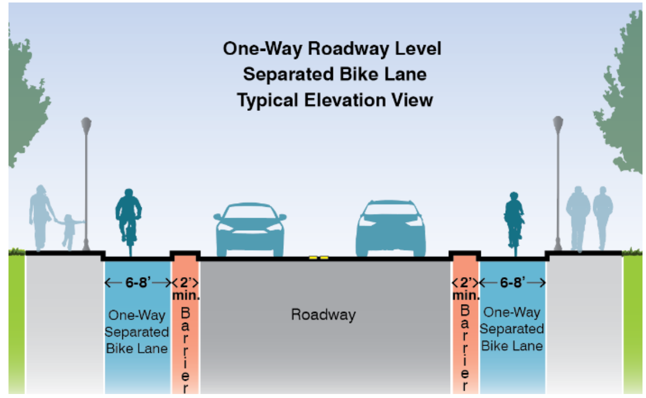


Figure 5-2 Paired One-Way Separated Bike Lanes at Road Level

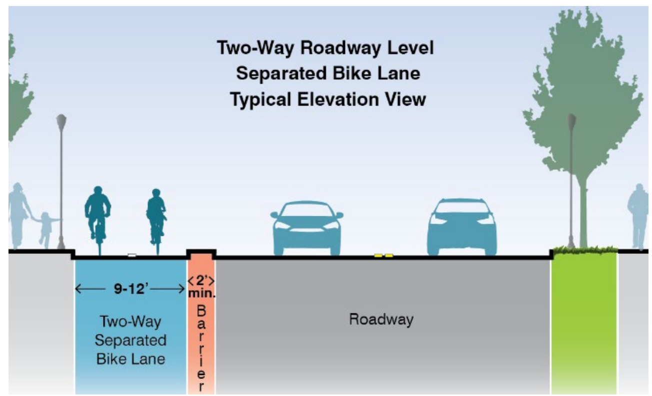


Figure 5-3: Two-Way Separated Bike Lane at Road Level

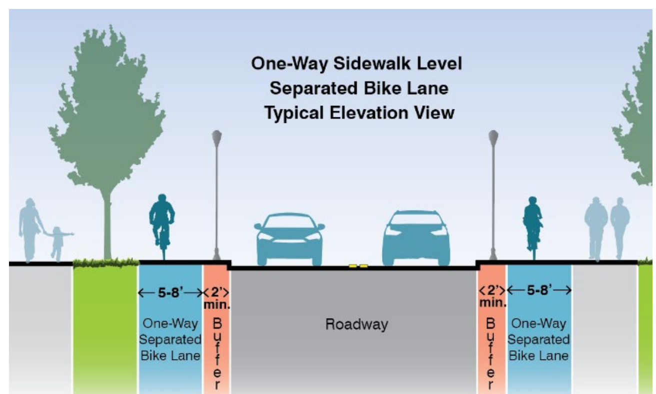


Figure 5-4: Paired One-Way Separated Bike Lanes at Sidewalk Level

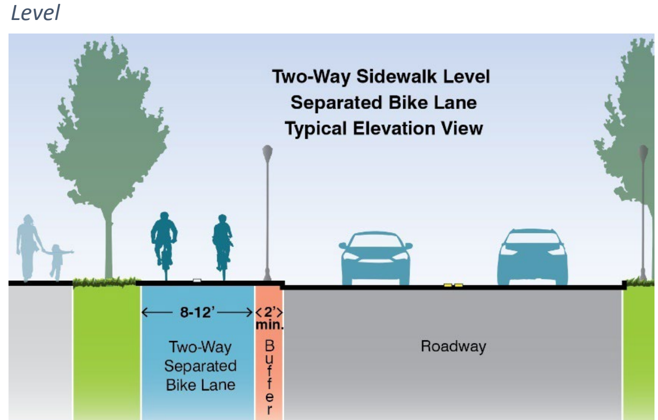


Figure 5-5: Two-Way Separated Bike Lane at Sidewalk Level

5.2 APPLICATION GUIDANCE

Table 9 below provides guidance on the application of separated bike lanes based upon traffic speed and volume conditions.

Table 9: Separated Bike Lane Application Guidance		
Traffic Volume	Exceeds Recommendation	10,000 ADT or less
	Recommended	10,000 ADT or more
85th Percentile Speeds	Exceeds Recommendation	30 mph or less
	Recommended	31 mph or more

5.3 DESIGN GUIDANCE

5.3.1 Width

Table 10 below provides guidance on determining appropriate separated bike lane width based upon anticipated usage. The recommended separated bike lane width is established by the projected peak hour bike traffic.

Table 10: Separated Bike Lane Width		
Bike Lane Type	**Minimum Width**	**Recommended Width**
One-Way	5 feet[1,2]	6 feet
Two-Way	8 feet[3]	10 feet

1. 6 feet is the minimum width where the bike lane is constrained on both sides by curbs or other vertical barriers.

2. Separated bike lanes may be narrowed to 4 feet for limited distances such as near bus stops if they are at sidewalk grade.

3. 9 feet is the minimum width where the bike lane is constrained on both sides by curbs or other vertical barriers.

5.3.2 Grade

Separated bike lanes can be at grade with the roadway or placed at sidewalk grade. Although the placement of separated bike lanes at an intermediate height between street and sidewalk level has been demonstrated in a number of projects throughout the country, this treatment is not recommended due to tripping hazards, accessibility constraints, and winter maintenance challenges.

5.3.3 Pavement

Separated bike lane pavement color or pavement materials should be distinct from sidewalk color or materials when a separated bike lane is placed directly adjacent to, and at grade with, a sidewalk. By example, asphalt is recommended for bike lane pavement adjacent to a concrete sidewalk.

5.3.4 Intersections

Separated bike lanes require specialized treatment at intersections to reduce potential conflicts.

- Turns on red shall be prohibited across separated bicycle lanes while bicyclists are allowed to proceed through the intersection.
- Two-way separated bike lanes shall utilize bicycle signal heads at all signalized intersections. The signal heads shall be oriented toward the approaching separated bike lane(s).
- In lieu of bicycle signal heads, separated bike lanes may be accommodated through the use of pedestrian signals at intersections that possess signal actuators that are accessible to bicyclists. Actuators should be located so as to be accessible to bicyclists without requiring them to dismount or without introducing conflict with pedestrians.

5.3.5 Transition to Non-Separated Facilities

Appropriate intersection treatments should be provided to assist bicyclists in moving between separated bike lanes and non-separated facilities. These transitions should be selected and designed based on differing factors for each facility and intersection. Transitions can be accomplished in three ways:

- Near-side transition: The transition from the separated bike lane to the non-separated facility is provided in advance of the intersection. Near-side transitions are preferred as bicyclists share the green light phase with roadway traffic, which reduces delay for bicyclists. This treatment also reduces conflict with pedestrians at crossings.
- Intersection transition: The transition from the separated bike lane to the non-separated facility within the intersection.
- Far-side transition: The transition from the separated bike lane to the non-separated facility is provided after the intersection.

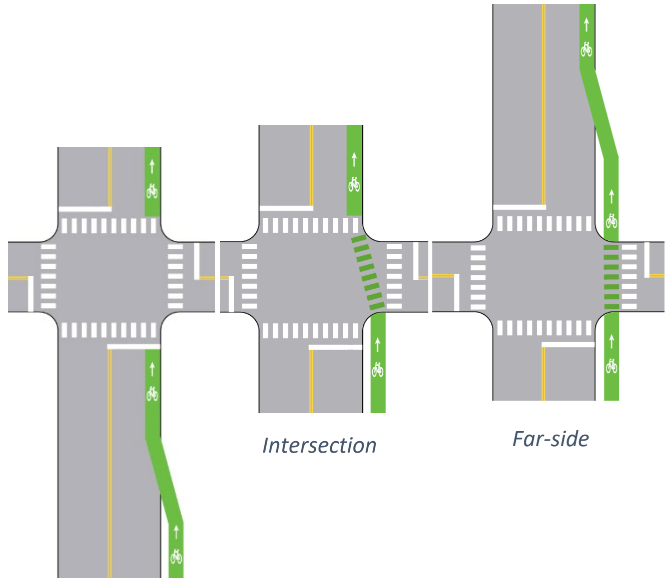


Figure 5-6: Transition to Non-Separated Facilities

Near-Side Transition

Separated bike lanes that are transitioned in advance of the intersection should have a protected segment a minimum of 20 feet in length where the separated bike lane enters the roadway to ensure adequate visibility of the bicyclist and provides time for bicyclists and drivers to react to one another.

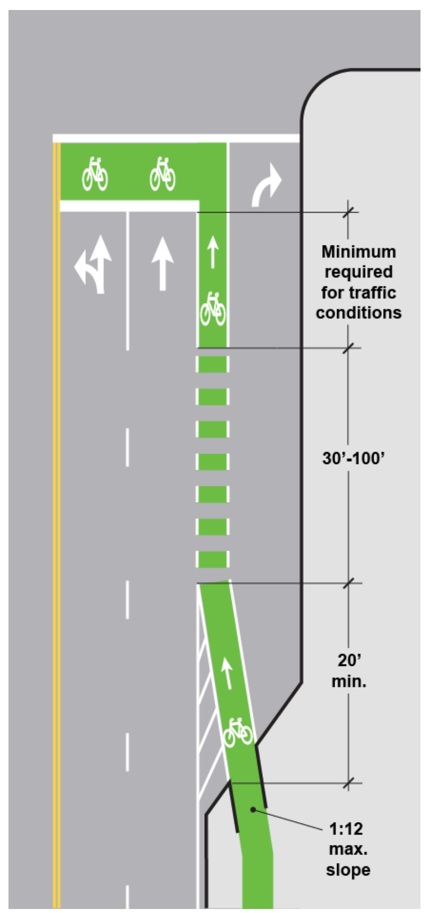


Figure 5-7: Near-side Transition

Intersection Transition

Separated bike lanes can also be transitioned to non-separated facilities at the intersection using protected intersection features where the separated bike lane terminates. Intersection crossing markings are used to continue a through bike movement from the separated bike lane to an on-road bicycle facility on the opposite side of the intersection. A two-stage left turn box should also be used to facilitate left turn movements.

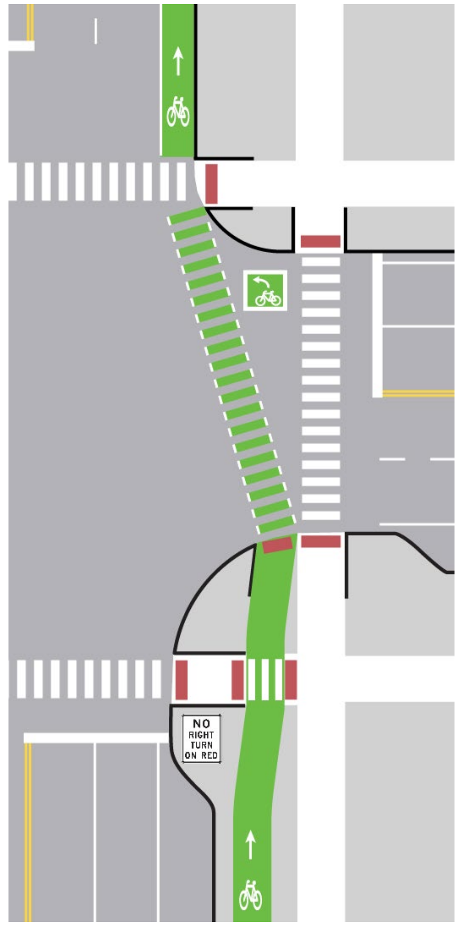


Figure 5-8: Intersection Transition

Far Side Transition

Far-side transitions introduce the separated bike lane to the far side of the intersection. The location where the bike lane enters the roadway should be spaced a minimum of 20 feet from the nearest crossing sidewalk or crossing roadway curb line (whichever is nearest) to improve the visibility of the bicyclist entering the roadway. Curb bumpouts are recommended at the intersection as a means of protecting the bike lane where it enters the roadway.

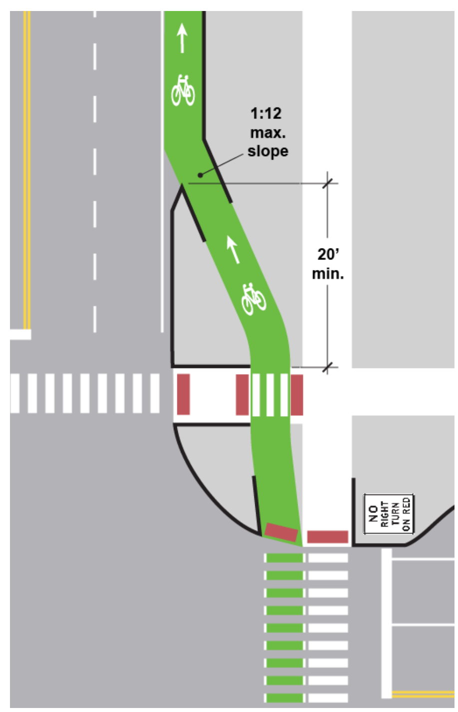


Figure 5-9: Far-side Transition

5.3.6 Roadway Buffer (Sidewalk Level Bike Lanes)

- The minimum width of the buffer (offset from the curb face) should be 2 feet. The provision of this space keeps cyclists away from the curb where there is risk of accidentally riding into the roadway. A 2-foot buffer space also provides the minimum space need to accommodate utility structures such as utility poles, light poles, traffic sign posts and fire hydrants. Buffer space less than 3 feet may require the separated bike lane to reduce grade at driveways to meet the driveway grade as it transitions from the roadway grade.
- The recommended minimum width of the buffer is 3 feet, which provides additional separation from traffic and additional space for traffic signs that require more than one post. The buffer also provides space for the provision of driveway aprons. A minimum buffer width of 3 feet is also required for areas where on-street parking is present to reduce door zone conflicts.

5.3.7 Roadway Barrier (Roadway Level Bike Lanes)

- A vertical barrier such as a curb, bollard system, guard rail, or other traffic barrier or wall system is required between the separated bike lane and adjacent traffic or parking lanes. Required roadway clear zones for traffic should be considered in the design and implementation of such systems.
- Where the separated bike lane is adjacent to a parking lane a 3-foot wide or greater buffer should be provided between the parking lane and bike lane to reduce door zone conflicts. Vertical barriers such as curbs may be used within the buffer.

5.3.8 Sidewalk Separation

- Bike lanes should be separated from sidewalks by a landscaped buffer, differing pavement materials, or grade. This separation is necessary to discourage pedestrians from using the bike lane and to keep bicycle traffic from using the sidewalk.
- Landscaped buffer separation: Where space allows, a landscaped buffer is recommended between the bike lane and sidewalk. This buffer should be a minimum of 3 feet wide, which provides sufficient space for landscaping. Buffers 4 feet or wider may also be used to accommodate street trees.
- Pavement material separation: Unique pavement materials may be used to distinguish bike lanes from sidewalks. By example, asphalt may be used for the bike lane where concrete is used for an adjacent sidewalk. Other treatments may include the use of painted or pigmented pavements for the bike lane to distinguish it from an adjacent sidewalk. Textured materials such as cobblestones or textured pavers may also be used to separate bike lanes from adjacent sidewalks. Where sidewalks are located directly adjacent to a bike lane, the sidewalk should be of sufficient width to accommodate pedestrian traffic to avoid pedestrian spill-over into the bike lane.
- Grade separation: Bike lanes may be separated from sidewalks through the use of a curb and grade separation. This places the bike lane at the roadway grade. Grade separation may present winter maintenance, drainage, and sweeping challenges.

5.3.9 Pavement Markings

- A single yellow 4" wide centerline shall be applied to two-way facilities. The line may be dotted where passing in the opposing lane is expected and allowed.
- When placed directly adjacent to a sidewalk of the same pavement material, a 4" wide white stripe shall be applied at the edge of the bike lane, adjacent to the sidewalk.
- Bike lane symbol pavement markings should be placed immediately after an intersection and spaced at intervals no greater than 1,000 feet.
- Bike lane symbol pavement markings should be placed in the center of each bike lane.
- Green-colored pavement may be installed for on segments of the separated bike lane when located on the roadway.
- If green-colored pavement is used within separated bicycle lanes on an independent alignment, it should be used only at the entrances to those facilities from roadways open to public travel or at conflict, weaving, or crossing locations.

5.3.10 Signage

- Standard bike lane signage is not required to delineate the bike lane.
- MUTCD R9-7 signage may be used where a separated bike lane is at grade with, and directly adjacent to, a sidewalk.
- Signalized intersections with concurrent bike crossings should include the MUTCD R10-15 sign to warn both motorists of crossing bicycle traffic.
- The MUTCD R10-24 sign should be used at signalized intersections that require bicyclists to use a pedestrian actuated signal.

MUTCD R9-7

MUTCD R10-15

MUTCD R10-24

Figure 5-10 Signs for use with Separated Bike Lanes

5.4 LIMITATIONS

Separated bike lanes have high implementation costs, significant space requirements, need for specialized intersection treatments, and present maintenance challenges. Contra-flow traffic associated with two-way separated bike lanes must be adequately addressed at side street and driveway intersections to reduce crash risk.

6.0 SIDEPATH

6.1 DESCRIPTION

Sidepaths facilities for the exclusive use of bicycles and pedestrians. Sidepaths are physically separated from motor vehicles by open space, a curb or a barrier and run adjacent to the roadway. They differ from separated bike lanes in that both bicyclists and pedestrians use them. Sidepaths often connect recreational pathways and are commonly found along the edge of parks and water features.

Sidepaths provide significant flexibility in accommodating bicyclists because the facility can be used by both pedestrians and bicyclists in lieu of a sidewalk and on-street bicycle lanes. A sidepath may be used along a corridor where a two-way separated bike lane may be desirable, but where physical or right-of-way constraints do not allow for the provision of a sidewalk and separated bike lane.

Sidepaths can create conflicts when they are located alongside a roadway with multiple driveways or frequent intersections. Turning motor vehicles may not expect crossing bicycle traffic in an area typically occupied by pedestrians when turning into or from a driveway or cross street.

Figure 6-1: Trout Brook Trail sidepath segment along Trout Brook Drive. Image Credit: Town of West Hartford

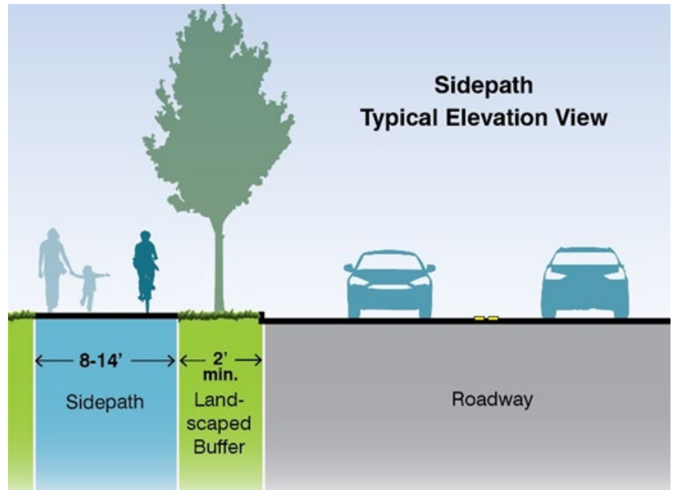


Figure 6-2: Sidepath Typical Elevation View

6.2 APPLICATION GUIDANCE

Sidepaths are most suitable for corridors with high traffic volume and moderate to high traffic speeds.

Table 11 : Sidepath Application Guidance		
Traffic Volume	Exceeds Recommendation	Less than 10,000 ADT
	Recommended	10,000 ADT or more
85th Percentile Speeds	Exceeds Recommendation	30 mph or less
	Recommended	31 mph or more

6.3 DESIGN GUIDANCE

6.3.1 Width

The recommended sidepath width is established by the projected peak hour bike and pedestrian traffic. See Table 12 below.

Table 12: Sidepath Width

Users per Peak Hour	Minimum Width	Recommended Width
<200	8 feet*	10 feet
200-500	10 feet	12 feet
>500	12 feet	14 feet

** Sidepaths may have a minimum width of 8 feet where the following conditions prevail:*

- *Pedestrian use of the facility is expected to be occasional only.*
- *Horizontal and vertical alignments provide frequent, well-designed passing and resting opportunities.*
- *The path will not be regularly subjected to maintenance vehicle loading conditions that would cause pavement damage.*

6.3.2 Grade

- Sidepaths may be at roadway grade or at sidewalk grade.
- The horizontal alignment and grade of sidepaths is primarily established by the adjacent roadway.

6.3.3 Buffer

- Sidepaths should be separated from the roadway by grade separation with use of a curb and/or by a landscaped buffer strip.
- The minimum recommended distance (buffer width) between the roadway (as measured from edge of pavement or face of curb) and sidepath is 5 feet to allow sufficient space for landscaping, utility structures, signage, and snow storage. The buffer may be reduced to a minimum of 2-feet, but only where conditions do not permit the use of a larger buffer.
- Adequate separation from motor vehicle traffic in an adjacent traffic lane is a primary consideration. Where a buffer width of 5 feet or more cannot be provided, consideration should be given to the adjacent roadway conditions including the presence of a marked shoulder, the width of a marked shoulder if present, and the width of the adjacent traffic lane if no shoulder is present. The primary consideration is the location of traffic relative to the sidepath, ensuring that there is a minimum of 5 feet of separation between the edge of moving vehicles and the sidepath.
- Where a curb or a buffer strip providing the minimum buffer width cannot be provided, physical barriers such as a traffic delineator posts, rigid bollards, or a concrete barrier with a railing or fence should be provided. Required roadway clearance from fixed objects should be considered in the design and implementation of barrier systems. Barrier systems less than 42 inches in height should be separated from the edge of the sidepath by a minimum distance of 2 feet to avoid bicyclist collisions with the barrier, which presents a potential fall hazard for bicyclists.

6.3.4 Driveway and Roadway Crossings

- Sidepaths should maintain grade across unsignalized driveway crossings.
- Crosswalk markings should be applied to all roadway crossings, signalized driveways, and driveways of major traffic generators.
- Concrete ramps and tactile warning strips should be used at the approach of all roadway crossings.

6.3.5 Pavement Markings

- A single yellow 4" wide centerline may be applied on curves or in high bicycle traffic areas. The line may be solid or dotted.
- Standard white pedestrian continental style crosswalk markings should be applied where required. The crosswalk should match or exceed the width of the approaching sidepath.

6.3.6 Signage

- An 18″ W11-15 bike/pedestrian sign may be used at the entrance of sidepaths following an intersection to notify users of the expected shared use of the pathway.
- Signalized intersections with concurrent bike crossings should include the MUTCD R10-15 sign to warn both motorists of crossing bicycle traffic.
- The MUTCD R10-24 sign should be used at signalized intersections that require bicyclists to use a pedestrian actuated signal.
- The MUTCD W16-21P Two-Way Bicycle Cross Traffic Warning Plaque should be installed below the stop sign of intersecting streets.

MUTCD W11-15

MUTCD R10-15

MUTCD R10-24

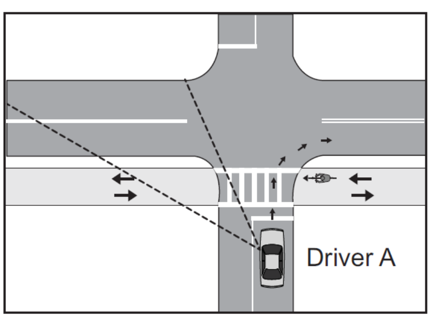
MUTCD W16-21P

Figure 6-3: Signs for Use with Sidepaths

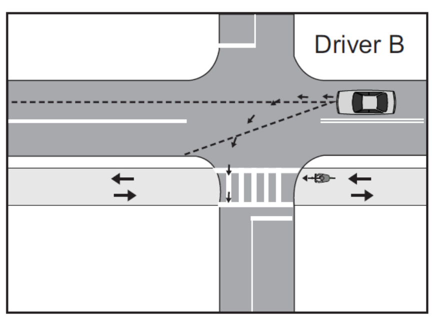
6.4 LIMITATIONS

Sidepaths are not ideal facilities for areas of high pedestrian volume and high potential bicycle use due to potential conflicts between the user groups. Like separated bike lanes, sidepaths require proper driveway and intersection treatments to reduce conflicts and protect users.

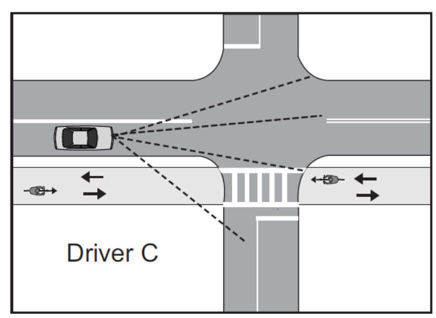
Sidepaths expose bicyclists to the crossing and turning movements of motor vehicles at driveways and unsignalized intersection. The planning and design of these facilities should account for, and take measures necessary, to reduce conflicts between bicyclists and motor vehicles (see Figure 6-4 below).



Right turning Driver A is looking for traffic on the left. A contraflow bicyclist is not in the driver's main field of vision.



Left turning Driver B is looking for traffic ahead. A contraflow bicyclist is not in the driver's main field of vision.



Right turning Driver C is looking for left turning traffic on the main road and traffic on the minor road. A bicyclist riding with traffic is not in the driver's main field of vision.

Figure 6-4: Potential Sidepath Conflicts at Road Crossings. Source: AASHTO Guide to Bicycle Facilities, 4th Edition

7.0 SHARED USE PATH

7.1 DESCRIPTION

Shared use paths, similar to sidepaths, provide a separated facility for the exclusive use of bicycles and pedestrians. Shared use pathways differ from separated bike lanes in that they are used by a range of users including bicyclists, pedestrians, and skaters. Shared use paths are typically recreational in nature but can also be effective facilities for transportation.

Shared use paths are typically physically separated from the roadway by a significant distance and have few roadway crossings. The paths often travel through open space areas and along natural features such as rivers and waterbodies.

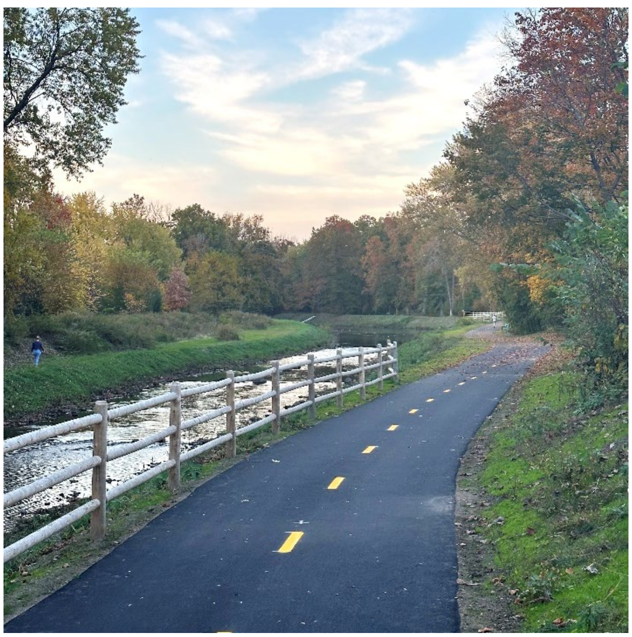


Figure 7-1: Trout Brook Trail, West Hartford, CT, Image Credit: Town of West Hartford

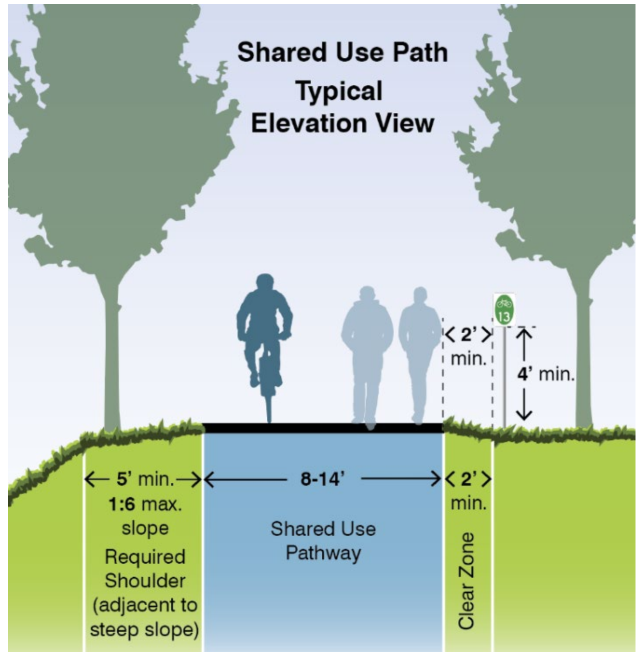


Figure 7-2: Shared Use Path Typical Elevation View

7.2 DESIGN GUIDANCE

7.2.1 Width

Table 13 on the following page provides guidance on the recommended shared use path width based upon projected peak hour bike and pedestrian traffic.

7.2.2 Design Speed

Design speed is used to determine geometric features of the shared use path. Once a design speed is selected, all relevant pathway features should relate to the design speed. In most situations, shared uses paths should be designed to accommodate the fastest typical user. When selecting an appropriate design speed for a path, or path segment, planners and designers should consider factors such as the environmental conditions, expected users, terrain, and path surface.

- Environmental Conditions: Urban, suburban, or rural; proximity to structures; frequency of crossings. Locations with more congestion and potential conflicts may, and in some conditions should, be designed for lower speeds.
- Expected Users: Recreational or commuting; less confident vs highly confident. Recreational paths that attract highly confident recreational users will require higher design speeds than paths that attract less confident users or commuters.

- Terrain: A path in hilly terrain should be designed for a higher speed.
- Path Surface: A lower design speed may be used on unpaved paths as bicycle speeds are slower on these facilities.

The range of bicycle travel speed on shared use paths is typically between 12 mph and 30 mph.

- For most paths in flat areas (grades less than 2%), a design speed of 18 mph is sufficient except on inclines where higher speeds can occur.
- In areas with hilly terrain and sustained steeper grades (6% or greater) the design speed should be selected based on anticipated travel speed of bicyclists travelling downhill. In all but the most extreme cases, 30 mph is the maximum design speed that should be used.

Design speed should be lowered at the approach to crossing or conflict points to allow the path user to better perceive the crossing situation and potential conflicts. Geometric features such as horizontal curvature may be used to reduce travel speeds approaching such conditions.

Table 13: Recommended Shared Use Path Width

Users per Peak Hour	Minimum Width	Recommended Width
<200	8 feet*	10 feet
200-500	10 feet	12 feet
>500	12 feet	14 feet

** Shared use paths may have a minimum width of 8 feet where the following conditions prevail:*

- *Pedestrian use of the facility is expected to be occasional only.*
- *For a short distance due to a physical constraint such as an environmental feature, bridge abutment, utility structure fence and such.*
- *Horizontal and vertical alignments provide frequent, well-designed passing and resting opportunities.*
- *The path will not be regularly subjected to maintenance vehicle loading conditions that would cause pavement damage.*

7.2.3 Horizontal Curves

The appropriate horizontal curve of a path is a function of design speed, which is selected in response to factors described in Section 7.2.2. Table 14 at right provides the recommended minimum horizontal radii based upon a range of design speeds. The AASHTO guide should be consulted to calculate values for a precise speed not listed at right and for additional information regarding factors related to design speed.

Table 14: Design of Horizontal Curves Based Upon Design Speed

Design Speed (mph)	Minimum Curve Radius (ft)
12	27
14	36
16	47
18	60
20	74
25	115
30	166

Other factors affect design speed and horizontal alignment such as cross slope and pavement materials. The other primary factor in designing the horizontal alignment of paths is the grade of the path (which is also a factor in selecting design speed).

7.2.4 Vertical Curves

Vertical curves are established by stopping sight distance for which the primary factor is design speed. The AASHTO guide should be consulted in determining appropriate vertical curves.

7.2.5 Grade

Pathways grades should not exceed 5%. Where a shared use path runs along a roadway with a grade that exceeds 5%, the path grade may exceed 5% but must be less than or equal to the roadway grade. Grades steeper than 5% are undesirable because of accessibility concerns, the ascents are difficult for many path users, and the descents cause some users to exceed the speeds at which they are competent or comfortable.

7.2.6 Cross Slope and Superelevation

Cross slopes should be designed to accommodate users with mobility impairments. The following standards should be applied:

- Cross slopes of 1% are recommended for shared use paths.
- Cross slopes should not exceed 2%. If cross slopes exceeding 2% are needed, they should be sloped to the inside of horizontal curves regardless of the drainage condition.
- Cross slopes should follow the existing terrain.
- Superelevation is not required for horizontal curves.
- A center crown with not more than 1% cross slope in either direction may be used.

7.2.7 Shoulder & Barrier Requirements

A minimum 5-foot-wide shoulder is recommended along the path in areas adjacent to bodies of water or downward slopes of 1:3 or greater (vertical to horizontal). The maximum slope of the shoulder should be 1:6. A fence, railing, or dense shrubbery should be provided if conditions adjacent to the pathway are determined to pose significant risk or under the following conditions if a 5-foot-wide shoulder cannot be provided:

- Slopes of 1:3 (vertical to horizontal) or steeper with a drop of 6 feet or greater.
- Slopes of 1:3 or steeper adjacent to a parallel body of water or other substantial obstacle.
- Slopes of 1:2 or steeper with a drop of 4 feet or greater.
- Slopes of 1:1 or steeper with a drop of 1 foot or greater.

7.2.8 Fence or Railing

See Section 10.11 Fences and Railings.

7.2.9 Vertical Clearance

- The recommended vertical clearance is 10 feet.
- The minimum vertical clearance is 8 feet.

7.2.10 Path Surface

- Asphalt or concrete path surfaces are preferred.
- Crushed stone surfaces may be appropriate on rural paths where the intended use of the path is primarily recreational. An example of a primarily recreational facility is a facility that does not directly connect residential areas to employment centers or schools. Crushed stone surfaces must comply with accessibility standards.
- A crushed stone shoulder may be provided along the edge of the path to accommodate users that prefer an unpaved surface. When provided for this purpose, the minimum recommended width is 3 feet. This area does not contribute to the required minimum width of the pathway.

7.2.11 Pavement Markings

- A 4-inch solid yellow line may be used to separate the two directions of travel where passing is not permitted.
- A 4-inch dotted yellow line (3-foot segment/9-foot gap) may be used where passing is permitted.
- Yellow pavement markings should be used at the location of obstructions in the center of the path, including vertical elements intended to physically prevent unauthorized motor vehicles from entering the path.
- "ROAD XING" pavement marking may be placed on a path 50 feet in advance of a roadway crossing to enhance awareness of the crossing.

7.2.12 Signage

- Signs should be located a minimum of 2 feet from the edge of pathway.
- Signs should be a minimum of 4 feet above surface of pathway (to avoid bicyclists' hands and handlebars from colliding with sign).

7.2.13 Access Control

Pathway access points should be designed to prevent undesirable motor vehicle access while allowing for safe and comfortable bicyclists and pedestrian use and service and emergency vehicle access. Multiple measures can be used to manage access. These include:

- Bollards: Bollards should only be used in areas where there is the likelihood or history of motor vehicle intrusion.
    - Bollards should be placed a minimum of 20 feet from intersections to allow path users to cross the intersection before negotiating the barrier posts.
    - Bollard should be 30 to 48 inches tall and should be marked with retroreflective material.
    - The minimum unobstructed pathway width on either side of the bollard should be 4 feet.
    - If more than one bollard is needed to control access, three bollards should be used. Two bollards should not be used as this application would place the bollards in the center of the bicyclist path of travel.
    - Bollards should be designed to be knock-down, removable, or hinged to permit entrance by emergency and service vehicles.
- Median Islands: Median islands should be used in areas where there is low likelihood or little history of motor vehicle intrusion.
    - The pathway surface on either side of the median should be no less than 5 feet.
    - Low level perennial (not woody) plants may be used within the landscaped bed.
    - The median should be no wider than 4 feet and the surrounding curb should be no greater than 4 inches tall to allow emergency and service vehicles to mount or straddle the bed.
- Signs: "No Motor Vehicles" signage (MUTCD R5-3) should be used to reinforce regulatory access rules.

Figure 7-3: Median island pathway access.
Image Credit: Weston & Sampson

8.0 INTERSECTION TREATMENTS

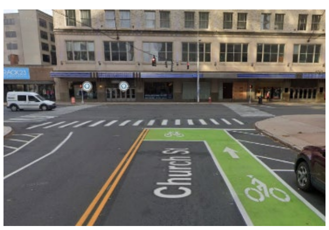
Bicycle facilities require specialized intersection treatments to improve the safety and operation of bicyclists traveling through intersections. These treatments vary based upon the approaching bicycle facility and the characteristics of the intersection.

Image Credits

Combined Lanes: Credit: NACTO
Bike Pockets: Hartford, CT, Credit: FHI Studio
Bike Boxes: Hartford, CT, Credit: Google Street View
Two-Stage Left Turn Boxes: City of Cambridge, MA
Mid-Block Crosswalk: AASHTO

Combined Lanes: Combined lanes feature the shared use of intersection queuing lanes by bicyclists and motor vehicles. Combined lanes are delineated by sharrow markings.

Bike Pockets: Bike pockets are striped bicycle lanes between thru-traffic and/or turning lanes at intersections.



Bike Boxes: Bike boxes are used at signalized intersections to provide a dedicated space, between stopped traffic and the intersection, for bicyclists while they wait for a green light or to make a left turn.

Two-Stage Turn Boxes: Turn boxes are intersection design treatments that help facilitate left turns of bicyclists. The turn box is located on the far side of the intersection to the right of auto and bicycle traffic. They offer bicyclists a safer alternative to making left turns at signalized intersections by splitting the turning movement into two separate through movements.

Intersection Crossing Markings: Pavement markings that are applied within an intersection or across a roadway to guide bicyclists through the intersection and increase driver awareness.

Mid-Block Crossings: Mid-block crossing treatments are primarily used with shared use pathways as path routes often diverge from, but cross, road networks. They use treatments that are similar to mid-block pedestrian crosswalks.

8.1 INTERSECTION TREATMENT SELECTION

Intersection treatments are specific to the conditions of each intersection. The selection of appropriate treatments is conditional upon the approaching or intersecting bicycle facility. Additional considerations include the number and configuration of traffic lanes, intersection traffic control, and the presence of sidewalks and pedestrian crossings. Table 15 below provides guidance on which intersection treatments are typically used with the bicycle facilities identified in this manual. Application may vary based upon actual intersection conditions.

Table 13: Recommended Intersection Treatment Selection

	Combined Lanes	Bike Pockets	Bike Boxes	Two-Stage Turn Boxes	Intersection Crossing Markings	Mid-Block Crossings
Shared Roadway	✓	✓	✓		✓	
Bike Lane	✓	✓	✓	✓	✓	
Buffered Bike Lane	✓	✓	✓	✓	✓	
Separated Bike Lane				✓	✓	
Sidepath				✓		
Shared Use Path						✓

8.2 COMBINED LANES

Combined lanes (referred to as mixing zones in the MUTCD) are used to reduce bicycle conflicts with right-turning motor vehicle traffic. Combined lanes provide markings that guide a bicyclist through an intersection along the left side of a right-turn lane or a thru-right traffic lane. This allows thru-bicyclists to travel with slower moving right-turning traffic. Cyclists making a right turn may ride at the right side of the combined lane. The combined lane creates a mixing zone between the two modes. Combined lanes are recommended at intersections lacking sufficient space to accommodate a bike pocket.

Combined lanes can be used as a continuation of a shared roadway, striped bike lanes, or buffered bike lanes. Connecticut statute allows thru-bicyclists to position themselves in the far-left edge of a right turn lane, whether a sharrow marking is present or not. The addition of a sharrow, however, assists bicyclists in positioning themselves properly and alerts motorist to their potential presence.

8.2.1 Use With

- Shared Roadways
- Bike Lanes
- Buffered Bike Lanes

8.2.2 Design Guidance

- Sharrow pavement markings shall be used to indicate bicyclist position within the combined lane. Sharrows should be placed a maximum of 50 feet apart. If the lane is a turning lane, a turn arrow shall be provided.
- The width of the combined lane should be 10 to 14 feet.
- A dotted white stripe should be used to mark the transition to an exclusive right-turn combined lane and should extend for a maximum of 100 feet.
- Where a taper is provided for a dedicated right turn lane, the taper angle should be no more than 1:8 (1 foot perpendicular to the roadway per 8 feet parallel to the roadway).
- "Begin Right Turn Lane Yield to Bikes" (MUTCD R4-4) sign should be used at the beginning of the turn lane and the "Right Lane Must Turn Right" (MUTCD R3-7R) sign with "Except Bikes" Plaque should be provided at the end of the transition area.
- Where a general-purpose turn lane is controlled by a traffic control signal, through bicycle movements shall not be accommodated in the turn lane unless the turning movement is always permitted to proceed simultaneously with the adjacent through movement.

Figure 8-1: Combined lane markings. Image credit: NACTO

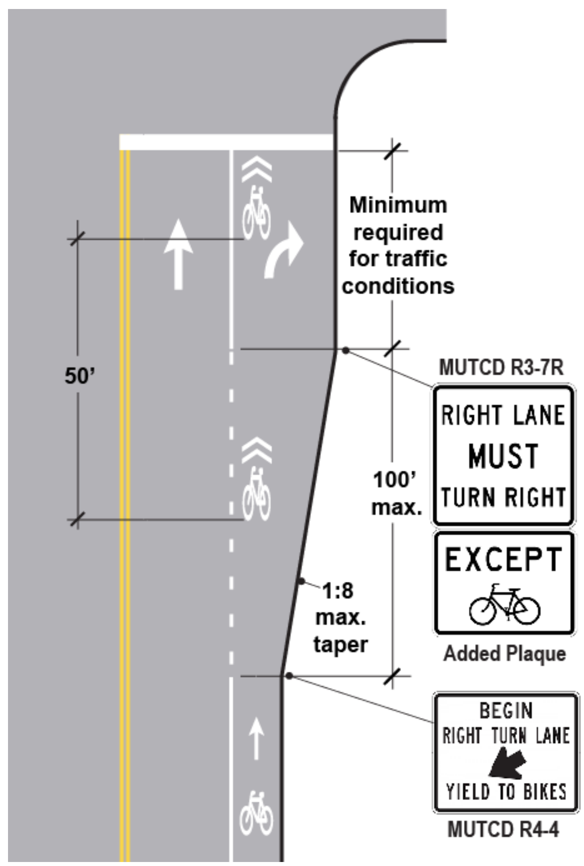


Figure 8-2: Combined lane markings and signage

8.3 BIKE POCKETS

Bike pockets are design treatments used to reduce bicycle conflicts with right-turning motor vehicle traffic. Bike pockets are placed between right-turn lanes and through travel lanes to clearly distinguish the path for bicyclists traveling straight through the intersection. Bike pockets should be incorporated into intersections in favor of discontinuing bicycle facilities prior to an intersection and resuming bicycle facilities following an intersection.

8.3.1 Use With

- Shared Roadways
- Bike Lanes
- Buffered Bike Lanes

8.3.2 Design Guidance

- The bike pocket should have a minimum width of 5 feet; the preferred width is that of the approaching bike lane.
- At least one bike lane symbol pavement markings should be used to identify the bike pocket and should be located a maximum of 50 feet apart. Bike lane symbols are not required within dotted segments of the bike pocket if green paint is used.
- A dotted white stripe should be provided on both sides of the bike pocket extending for a maximum distance of 100 feet.
- Where a taper is provided for a dedicated right turn lane, the taper angle should be no more than 1:8 (1 foot perpendicular to the roadway per 8 feet parallel to the roadway).
- Green pavement marking is recommended within the bike pocket in areas of high right turn volume.
- “Begin Right Turn Lane Yield to Bikes” (MUTCD R4-4) sign should be used at the beginning of the turn lane.

Figure 8-3: Bike pocket, Hartford, CT. Image credit: FHI Studio

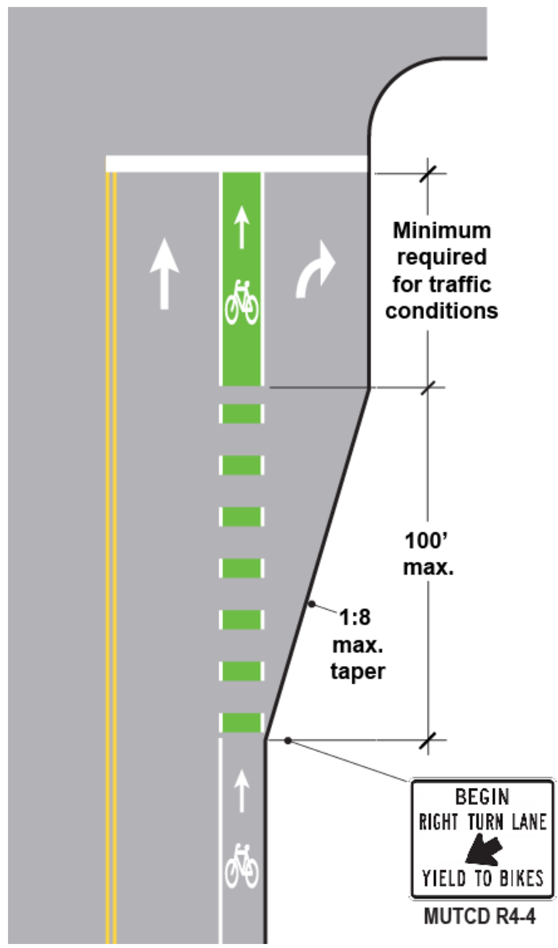


Figure 8-4: Bike Pocket

8.4 BIKE BOXES

Bike boxes are used at intersections to provide a dedicated space for bicyclists to queue for through movement or turns. Bike boxes enhance the visibility of bicyclists by positioning bicyclists at the front of motor vehicle lanes to get ahead of queuing vehicles during the red signal phase.

Although bike boxes are used to enhance visibility, conflicts can arise between bicyclists and motor vehicles, particularly when a traffic light is about to turn green for the corresponding approach. Additionally, bike boxes are not helpful to a bicyclist approaching an intersection during a green signal phase for the desired approach.

8.4.1 Use With

- Shared Roadways
- Bike Lanes
- Buffered Bike Lanes

8.4.2 Design Guidance

- Bike boxes should not be placed across more than two lanes of traffic due to the amount of lateral movement required of bicyclists to navigate the box and the risk of maneuvering while the traffic signal turns green.
- Turns on red shall be prohibited from the lane in front of which bike box is placed and a "No Turn on Red" (R10-11a) sign shall be provided.
- A "Stop Here on Red" (R10-6a) sign should be posted at the motor vehicle stop line to reinforce observance of the proper stop line and should be accompanied by an "Except Bicycles" (R3-7bP) sign.
- The distance from the upstream edge of the bike box that is nearest to the stop line for motor vehicles to the downstream edge of the bicycle box that is nearest the crosswalk or intersection shall be at least 10 feet.
- At least one bicycle symbol marking shall be used in the bike box. One symbol per traffic lane is recommended. An arrow should not be used with the bike symbol.
- Where an existing stop line for motor vehicles is relocated upstream to install a new bike box, the yellow change and red clearance intervals shall be recalculated and if necessary, reprogrammed to accommodate the length of the bike box.

Figure 8-5 Bike Box, Hartford, CT.
Image Source: Google Earth

- Where a bike box crosses more than one traffic approach lane, Countdown pedestrian signals for the crosswalk or pedestrian crossing movement that crosses the approach shall be provided. The countdown pedestrian signal shall display the pedestrian change interval countdown without the need for actuation.
- Green-colored pavement may be used in a bike box. If used, green-colored pavement shall cover the full limits of the bike box.
- A bike box should not be contiguous with a crosswalk. A stop line on the downstream end of the bicycle box should be used to mark the location where bicycles are required to stop. The stop bar should be a minimum of 1 foot wide (longitudinally) and spaced a minimum of 1 foot from a crosswalk if present.

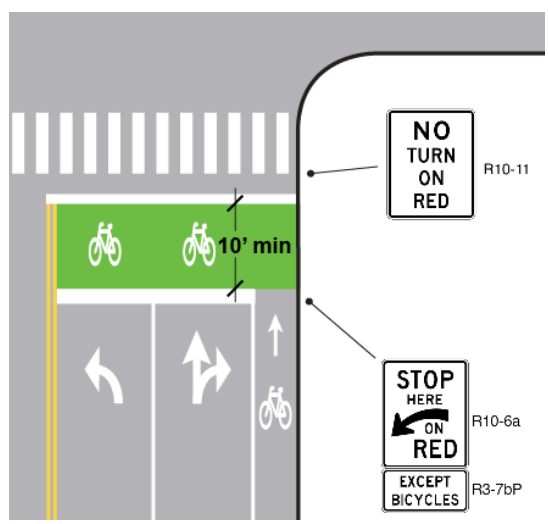


Figure 8-6: Bike Box

8.5 TWO-STAGE TURN BOX

Two-stage turn boxes (turn boxes) are intersection design treatments that facilitate left turns for bicyclists when approaching an intersection during a green phase for that approach. This type of bicycle maneuver is permitted by Connecticut state law. The maneuver eliminates the need for the bicyclist to merge into a left lane to make a left turn.

To facilitate left turns, the turn box is typically placed on the far side of the intersection to the right of a traffic or bicycle lane. Once the bicyclist arrives at the left turn box, they make a second through movement to complete their left turn once the intersection is clear. Use of the turn box at signalized intersections may result in delay for bicyclists because bicyclists need to wait for the green phase of the approach behind the turn box.

Situations in which a turn box might be necessary to facilitate turns include, but are not limited to, those in which:

- A separated bicycle facility is provided where upstream access to a lane used to facilitate turns by motor vehicle traffic is physically inaccessible to bicycles;
- Left turns are prohibited from the left-most lane, or right turns are prohibited from the right-most lane, at an intersection; or
- Locations where physical or operational conditions make it impracticable or unsafe for a bicyclist to merge and make the appropriate turn as would any other vehicle.

8.5.1 Use With

- Bike Lanes
- Buffered Bike Lanes
- Separated Bike Lanes

Figure 8-7: Left Turn Box, Cambridge, MA.
Image Credit: City of Cambridge, MA

8.5.2 Design Guidance

- Two-stage bicycle turn boxes shall be located:
  - In an area between the closest through bicycle or motor vehicle movement and the parallel crosswalk,
  - In an area between the through bicycle movement and the parallel pedestrian crossing movement if no crosswalk is established,
  - On the innermost side of the bicycle facility provided that the two-stage turn box is located in a portion of the intersection where parallel or motor vehicle traffic does not travel, such as projections of islands or parking lanes, or
  - In an area between the through bicycle movement and a pedestrian facility for T-intersections.
- A turn box shall consist of at least one bicycle symbol pavement marking and at least one pavement marking arrow.
- A turn arrow in the appropriate direction shall be used if a turn box is used with a one-way bicycle lane, and a through arrow in the appropriate direction shall be used if a turn box is used with a two-way bikeway.
- A turn box shall be bounded on all sides by a solid white line. Green colored pavement may be used within the box and if used shall encompass all of the box.
- For turn boxes that facilitate turns from a one-way bikeway, the bicycle symbol shall precede the pavement marking turn arrow in the direction of bicycle travel.

- Passive detection of bicycles in the two-stage bicycle turn box shall be provided if the signal phase that permits bicycles to enter the intersection during the second stage of their turn is actuated.
- Where the path of vehicles lawfully turning on red would pass through a two-stage bicycle turn box, a full-time no-turn-on-red prohibition shall be provided for the crossroad approach and the accompanying R10-11, R10-11a, and/or R10-11b signage shall be provided in accordance with Section 2B.60 of the 11th edition of the MUTCD.
- A left turn box may be used in combination with a bike box. This application provides bicyclists with the greatest range of options for the conditions present.
- Turn boxes should be a minimum of 6 feet x 6 feet; 8 feet x 8 feet is preferred. Engineering judgment should be used to develop the size of the turn box.

8.5.3 Signage

- Where bicycles are required to use a turn box, the Bicycles All Turns from Bike Lane (R9-23) or Bicycle Left Turn from Bike Lane (R9-23a) advance regulatory sign shall be mounted in advance of the intersection, and at least one Bicycle Turn Must Use Turn Box (R9-23b or R9-23c) sign shall be used at the intersection.
- Where used, the Bicycle Turn Must Use Turn Box (R9-23b) sign shall be mounted at the near side of the intersection.
- Where used, the Bicycle Turn Must Use Turn Box location (R9-23c) sign shall be mounted at the far side of the intersection.

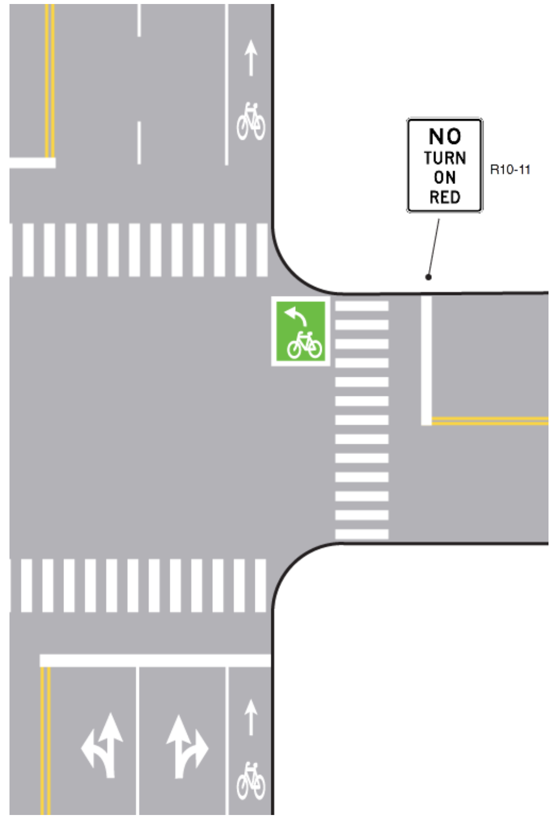


Figure 8-8: Two Stage Turn Box

8.6 INTERSECTION CROSSING MARKINGS

Intersection crossing markings are pavement markings that may be applied within an intersection or across a roadway to guide bicyclists through the intersection and increase awareness of drivers. Specific marking types include: intersection sharrow markings, dotted stripes, and dashed green markings. Intersection markings are optional.

8.6.1 Use With

- Bike Lanes
- Buffered Bike Lanes
- Separated Bike Lanes

8.6.2 Green Markings

- For use with Separated Bike Lanes.
- Green pavement marking should be bordered by dotted edge lines.
- White, dotted edge lines should be used.
- Edge lines should be spaced consistently. Spacing should not exceed 2.5 times that of line length.
- The width of the dotted green marking, inclusive of edges stripes should match that of the approaching bike lane or bike lane ramp.
- When adjacent to a crosswalk, dotted green markings should be aligned with crosswalk markings.

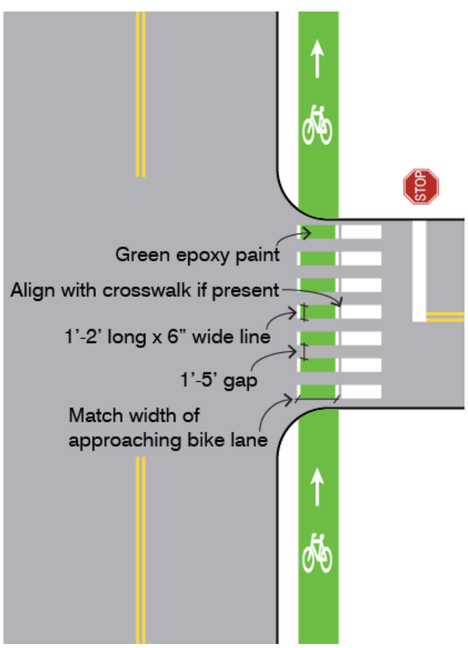


Figure 8-9: Green markings

8.6.3 Dotted Lines

- For use with Bike Lanes or Buffered Bike Lanes.
- The distance between the center of the two dotted lines should match the width of the approaching bike lane.
- Lines should be 2 feet long and spaced 2.5 feet apart.
- The bicycle symbol and arrow marking may be used within the dotted lines.

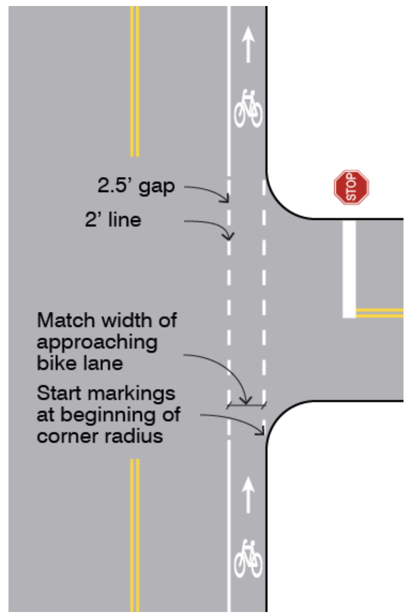


Figure 8-10: Dotted lines

8.7 MID-BLOCK CROSSINGS

Mid-block crossing treatments are primarily used with shared use paths where they cross roadways away from intersections. Design and application of these facilities is similar to mid-block pedestrian crosswalks. Treatment for mid-block crossings include marked crosswalks, crosswalks with median refuge islands, signalized crosswalks, and grade separated crossings. Recommended crossing treatments for different roadway conditions are identified in Table 16. Because conditions are unique at all crossings, engineering judgement should be used in selecting appropriate crossing treatments.

8.7.1 Geometric Design Considerations

- The intersection should be conspicuous to both road and path users.
- Adequate sight lines should be maintained.
- Crossings and approaches should be on relatively flat grades.
- Crossings should be as near 90 degrees as possible, but no less than 60 degrees.
- Crossings should be located outside of the functional area of adjacent intersections.

8.7.2 Sight Triangle

Sight distance between crossing bicyclists and roadway traffic is a critical factor in the safety of the crossing. Required sight distance is a function of path design speed and roadway traffic speed. Other factors such as roadway width and grade also impact sight distance. The AASHTO guide should be consulted to determine required site distances.

8.7.3 Traffic Control of Crossings

The selection of appropriate traffic control is primarily based upon roadway and path volumes and sight lines and should consider the likely or desired behavior of path users relative to the surrounding conditions. Generally, the least traffic control that is effective should be selected to improve the likelihood of conformance with the traffic control measure.

- Paths should be stop controlled at unsignalized roadway crossings unless otherwise meeting the conditions as specified below:
- Yield control of paths may be used for road crossings with two or fewer lanes, with an ADT below 5,000, 85th percentile speeds of 30 mph or less, and where yield sight triangles meet the requirements of the AASHTO guide.
- Paths may be uncontrolled where the following conditions are met: local road or driveway crossings with two or fewer lanes, ADT below 1,000, 85th percentile speeds of 30 mph or less, yield sight triangles meet the requirements of the AASHTO guide.

Figure 8-11: Mid-Block Crossing, Image Source: AASHTO

8.7.4 Selection of Mid-Block Crossing Treatments

Table 16 below provides guidance on the selection of mid-block crossing treatments. This guidance is extrapolated from FHWA's 2018 *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations* and CT DOT's *Pedestrian Safety Countermeasure Guidance at Marked Uncontrolled Crosswalks* and is based upon traffic volume, lane configuration, and posted speed limit. Engineering judgement should be used in the selection of appropriate crossing facilities and other significant factors such as sight and stopping distance and expected bicycle and pedestrian crossing volumes should be considered.

Table 14: Recommended Mid-Block Crossing Treatments

	ADT < 9,000									ADT 9,000-15,000									ADT >15,000								
	2 lanes			3 lanes			4+ lanes			2 lanes			3 lanes			4+ lanes			2 lanes			3 lanes			4+ lanes		
Treatment	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph	≤ 30 mph	35 mph	≥ 40 mph
Crosswalk	Recommended Treatment	Recommended Treatment		Recommended Treatment	Recommended Treatment					Recommended Treatment	Recommended Treatment								Recommended Treatment								
Crosswalk w/RRFB		Potential Candidate	Recommended Treatment	Potential Candidate	Potential Candidate			Recommended Treatment			Potential Candidate	Recommended Treatment	Potential Candidate	Recommended Treatment					Potential Candidate	Potential Candidate		Potential Candidate			Recommended Treatment		
Crosswalk w/HAWK Beacon		Potential Candidate	Recommended Treatment	Potential Candidate	Potential Candidate	Recommended Treatment	Potential Candidate	Potential Candidate	Recommended Treatment		Potential Candidate	Recommended Treatment	Potential Candidate	Recommended Treatment	Recommended Treatment	Potential Candidate	Recommended Treatment	Recommended Treatment	Potential Candidate	Potential Candidate	Recommended Treatment	Potential Candidate	Recommended Treatment	Recommended Treatment	Recommended Treatment	Recommended Treatment	Recommended Treatment
Raised Crosswalk	Potential Candidate			Potential Candidate																							
Crosswalk w/ Median Refuge Island	Potential Candidate	Potential Candidate	Potential Candidate	Potential Candidate	Potential Candidate	Potential Candidate	Potential Candidate	Recommended Treatment	Recommended Treatment	Potential Candidate	Potential Candidate	Potential Candidate	Potential Candidate	Potential Candidate	Potential Candidate	Recommended Treatment	Recommended Treatment	Recommended Treatment	Potential Candidate	Potential Candidate	Potential Candidate	Potential Candidate	Potential Candidate	Potential Candidate	Recommended Treatment	Recommended Treatment	Recommended Treatment
Crosswalk w/Median Refuge Island & RRFB					Potential Candidate	Recommended Treatment	Potential Candidate	Potential Candidate					Potential Candidate	Recommended Treatment	Recommended Treatment	Potential Candidate	Recommended Treatment					Potential Candidate	Recommended Treatment		Recommended Treatment		
Crosswalk w/Median Refuge Island & PHB					Potential Candidate	Recommended Treatment	Potential Candidate	Potential Candidate	Recommended Treatment				Potential Candidate	Recommended Treatment	Recommended Treatment	Potential Candidate	Recommended Treatment	Recommended Treatment	Potential Candidate	Potential Candidate	Recommended Treatment	Potential Candidate	Recommended Treatment	Recommended Treatment	Recommended Treatment	Recommended Treatment	Recommended Treatment
Roadway Stop Control	Potential Candidate	Potential Candidate	Potential Candidate							Potential Candidate	Potential Candidate	Potential Candidate							Potential Candidate	Potential Candidate	Potential Candidate						
Signalized Crosswalk		Potential Candidate	Recommended Treatment	Potential Candidate	Potential Candidate	Recommended Treatment	Potential Candidate	Potential Candidate	Recommended Treatment		Potential Candidate	Recommended Treatment	Potential Candidate	Recommended Treatment	Recommended Treatment	Potential Candidate	Recommended Treatment	Recommended Treatment	Potential Candidate	Potential Candidate	Recommended Treatment	Potential Candidate	Recommended Treatment	Recommended Treatment	Recommended Treatment	Recommended Treatment	Recommended Treatment
Grade Separated Crossing															Potential Candidate			Potential Candidate					Potential Candidate	Potential Candidate		Potential Candidate	Potential Candidate

Potential Candidate for Use

Recommended Treatment

8.7.5 Crosswalk

Marked crosswalks with crossing signage are suitable for low-speed two-lane crossings.

- Crosswalk markings should be a minimum of 8 feet wide and should match or exceed the width of the approaching pathway.
- Longitudinal bars (continental style) crosswalk markings are recommended. Bar width should be 16 inches and spaced 24 inches apart.
- Tactile warning pads should be provided in advance of the crosswalk.
- An 18-inch stop or yield sign should be used and installed in advance of the roadway or crossing sidewalk if present. Stop bars or yield triangles should be provided on the pathway adjacent to the stop or yield sign.
- MUTCD W11-15/W16-7P should be used at the crossing on both sides of the roadway and sign faces should be provided on both sides of the sign assembly. The recommended location is within 10 feet in advance of the crosswalk.
- Where sight lines between approaching motor vehicles and the crosswalk are limited, crosswalk warning signage (MUTCD W11-15/W16-9P) should be placed a minimum of 100 feet in advance of the crosswalk (see MUTCD Table 2C-4 for additional guidance).
- A sight line clear zone should be provided in accordance with AASHTO Guide to Bicycle Facilities, 4th Edition, Section 5.3.2.
- Crossings should be a minimum of 60 degrees (30 degrees off perpendicular of the roadway). Perpendicular (90 degree) crossings are recommended.

8.7.6 Crosswalk with Rectangular Rapid Flashing Beacon

Rectangular rapid flashing beacons (RRFBs) enhance the conspicuity of crosswalks and are used with a pedestrian and/or bicycle crossing warning sign to improve safety at uncontrolled, marked crosswalks. The device includes two rectangular shaped yellow indications, each with an LED-array-based light source, that flash with high frequency when activated. RRFB's should be used at the crossing on both sides of the roadway. The recommended location is within 10 feet in advance of the crosswalk.

8.7.7 Crosswalk with Pedestrian Hybrid Beacon

The pedestrian hybrid beacon (PHB) is a traffic control device designed to help pedestrians safely cross higher-speed roadways at midblock crossings and uncontrolled intersections. The beacon head consists of two red lenses above a single yellow lens. The lenses remain "dark" until a pedestrian desiring to cross the street pushes the call button to activate the beacon, which then initiates a yellow to red lighting sequence consisting of flashing and steady lights that directs motorists to slow and come to a stop. This provides the right-of-way to the pedestrian to safely cross the roadway before the signal goes dark again.

PHBs are typically used where it is difficult for pedestrians to cross a roadway, such as when gaps in traffic are not sufficient or speed limits exceed 35 miles per hour. They are highly effective at locations with three or more lanes or traffic volumes above 9,000 annual average daily traffic. Installation of a PHB must also include a marked crosswalk and pedestrian countdown signal.

8.7.8 Raised Crosswalk

A raised crosswalk may be used for crossings of roadways with up to three lanes and posted speeds of 30 mph or less. See FHWA's 2018 *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations*.

Figure 8-12: RRFB Sign Assembly

8.7.9 Crosswalk with Median Refuge Island

Median refuge islands are most useful on higher speed and multi-lane corridors. They allow bicyclists to break the crossing movement into two movements and provide a protected place to wait while crossing. Median refuge islands also provide space for crosswalk warning signage and can have a traffic calming effect.

- Refuge islands should be a minimum of 6 feet in width (measured across the roadway), 8 feet is the preferred minimum width.
- Refuge island should be a minimum of 6 feet long on either side of the crosswalk opening (measured along roadway).
- Crosswalk openings should match or exceed the width of the approaching pathway.
- Refuge islands may be landscaped, low level landscaping (less than 3 feet in height) is recommended to protect sight lines.
- MUTCD R1-6 or R1-6a signs should be placed at both ends of the median at two-lane crossings.
- MUTCD W11-15 should be placed at both ends of the median at multilane (3 or more) crossings.

8.7.10 Crosswalk with Median Refuge Island and RRFB or PHB

Crosswalks may be enhanced with median refuge islands and RRFBs or PHBs. The combination of these facilities and devices improves the conspicuity of crossing bicyclists and pedestrians and is beneficial on multilane corridors and in higher traffic speed and volume conditions.

Figure 8-13: Crosswalk with median refuge island and a Pedestrian Hybrid Beacon. Cheshire, CT.
Image Source: Google Street View

8.7.11 Roadway Stop Control

Crosswalks may be stop controlled if the traffic conditions warrant stop control. Stop control is not recommended on multi-lane roadways (3 or more lanes).

- Stop bars should be provided and placed approximately 10 feet in advance of the crosswalk.

8.7.12 Signalized Crosswalks

Crosswalks may be signalized if the traffic conditions warrant a traffic signal. This treatment is most appropriate on multi-lane corridors and higher traffic speed and volume corridors.

- Stop bars should be provided and placed approximately 10 feet in advance of the crosswalk.
- Pedestrian signal heads and signal actuators should be used on pathway approaches.
- Pedestrian signal heads may be accompanied by bicycle signal heads.

8.7.13 Grade Separated Crossings

Grade separated crossings should be considered where grade differences between the pathway and roadway present a challenge to providing ADA compliant pathway grades and/or where the pathway grade lends itself to a crossing below or above the roadway. Grade separated crossings may also be appropriate for high volume pathways that cross multilane, high speed, and/or high-volume roadways.

- Grade separated crossing should meet accessibility standards including, but not limited to the following:
  - Grades should not exceed 8.3% (1 inch rise per foot of run).
  - Grades exceeding 5% should not exceed more than 30 inches rise per run.
  - Landings should be a minimum of 5 feet in length and should not exceed a slope of 2% (1 inch of rise per four feet of run).
- Elevated grade crossings should include railings a minimum of 48 inches high.
- Tunnel crossings should provide a minimum vertical clearance of 8 feet.

9.0 SPECIAL DESIGN CONSIDERATIONS

There are multiple conditions that require the use of special techniques to accommodate bicyclists. Likewise, there are special treatments that may be used in appropriate conditions to improve the comfort and safety of bicyclists.

9.1 CONTRA-FLOW BIKE FACILITIES

Section 14-286b of the Connecticut General Statutes allows bicyclists to operate in contra-flow facilities. Contra-flow facilities are facilities that allow for bicycle travel that is opposite of vehicular travel adjacent to the bicycle facility. Examples include:

- A bike lane opposing traffic on a one-way roadway
- A two-way buffered bike lane or separated bike lane located on one side of a roadway

Design Guidance

- Contra-flow bicycle lanes located at the edge of the roadway shall use double yellow center line pavement markings, a painted or raised median island, or some form of physical separation where the speed limit is 30 mph or less.
- For speed limits 35 mph or greater, a buffer, a painted or raised median island, or some form of physical separation shall be used to separate a contra-flow bicycle lane from the adjacent travel lane.
- Lane extension markings should be used where contra-flow bicycle movements cross intersections.
- Contra-flow bicycle lanes should not be located between a traffic lane and an on-street parallel parking lane.
- Where intersection traffic controls are provided (such as STOP signs or traffic signals), appropriate devices shall be provided and oriented toward bicyclists in the contra-flow lane.
- At signalized locations, appropriate bicycle signalization shall be provided and oriented toward bicyclists in the contra-flow lane, including a method for bicyclists to actuate the green phase for the contra-flow movement.

9.2 PAIRED BICYCLE FACILITIES

Bicycle facilities may be "paired" with different facilities on a roadway. The use of paired facilities of different types is acceptable when conditions differ on either side of a roadway or where space is limited due to roadway or right-of-way width constraints and the space allocated to bicyclists cannot be evenly distributed to both sides of the roadway. The best practice is to provide the same or comparable facility on both sides of the roadway.

Examples of paired facilities:

- Bike lane on uphill side of roadway/shared lane on downhill side
- Bike lane on lower volume side of roadway/buffered bike lane on higher volume side of roadway
- Buffered bike lane opposing traffic on a one-way roadway/bike lane in the direction of traffic

Paired facilities should not differ significantly in their level of accommodation. For example, a one-way separated bike lane should not be paired with a shared lane (see Table 17 below). Facilities that differ significantly in their level of accommodation encourage wrong-way riding in the more separated facility. Wrong-way riding is strongly associated with higher crash risk.

Table 15: Acceptable Combinations for Paired Bicycle Facilities

	Shared Lane	Bike Lane	Buffered Bike Lane	One-Way Separated Bike Lane
Shared Lane	✓	✓	✓	
Bike Lane	✓	✓	✓	
Buffered Bike Lane	✓	✓	✓	✓
One-Way Separated Bike Lane			✓	✓

9.3 ON-STREET PARKING

Bike lanes should be properly separated from parking lanes to avoid door zone conflicts or conflicts with maneuvering vehicles. On-street parking may also be used, under the proper conditions, as a barrier between traffic and bicyclists.

9.3.1 Parallel Parking

While curbside parking lanes typically vary from 7 to 9 feet wide, the functional operation of on-street parking requires space outside of the parking lane for drivers and passengers to exit and enter vehicles. The typical distance of the driver side of a parked vehicle from the edge of roadway where a curb is present is up to 7 feet (0.5 feet spacing from curb plus 6.5-foot vehicle width for a large SUV or full-size truck). A typical passenger vehicle door opens approximately 3.5 feet, this places a typical driver side opened door at approximately 10 feet from the edge of curb.

Where bike lanes are located between a parking and traffic lane, the outside edge of the bike lane should be located a minimum of 13 feet from the face of curb to provide adequate space for bicyclists to avoid door zone conflicts without entering the traffic lane. The separation provided between a bike lane and an on-street parking lane should be increased or reinforced by a painted buffer in areas of high parking turnover such as metered or time limited parking spaces or parking spaces in retail districts.

When a bike lane is placed on the right (curb) side of a parking lane, a passenger side door zone should be provided to avoid door zone conflicts as bicyclists are physically constrained to the bike lane by a curb or road edge. In this case, the minimum distance between the parking lane and face of curb or edge of roadway should be 8 feet.

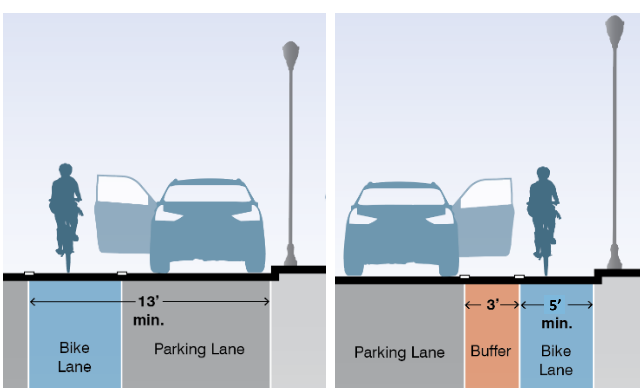


Figure 9-1: Bike Lanes and Parallel On-Street Parking

9.3.2 Angled On-Street Parking

Bike lanes should also be adequately separated from angled on-street parking where present. The minimum recommended distance between the face of curb, edge of pavement, or wheel stop and the bike lane is 20 feet as measured perpendicularly across the roadway (see Table 18 below). This distance provides the minimum separation needed to provide bicyclists and drivers with space and time to identify and react to each other and to avoid collisions.

Back-in angled on-street parking has potential safety benefits in reducing collisions between bicyclists and motor vehicles and should be considered over pull-in angled parking in areas with bike lanes and high-volume bicycle traffic or high parking turnover such as areas with metered or time-limited parking spaces. Bicyclist safety in areas of pull-in angled parking can be improved by providing adequate separation between the bike lane and parked vehicles as specified in Table 18 below.

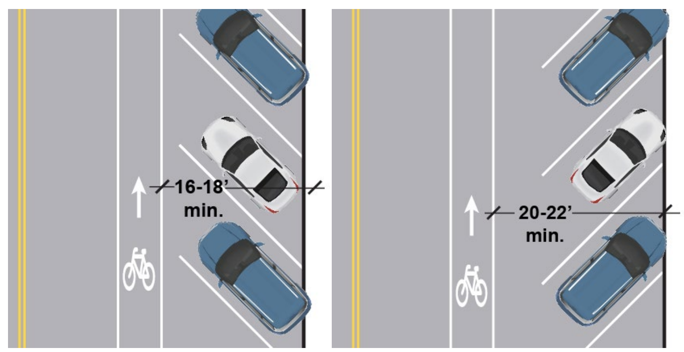


Figure 9-2: Bike Lane Offset from Back-In (left) and Pull-In (right) Angled Parking

Table 16: Bike Lanes and Angled On-Street Parking

Parking Angle	Minimum Bike Lane Offset Pull-In Angled Parking*	Minimum Bike Lane Offset Back-In Angled Parking*
45 degrees	20 feet	16 feet
60 degrees	22 feet	18 feet

**As measured from face of curb, edge of pavement, or wheel stop to nearest lane stripe of bike lane.*

9.4 BIKE SIGNALS

Bike signals shall be selected and installed in accordance with Chapter 4H of the 11th edition of the MUTCD. The following guidance provides a summary of the guidance provided in the MUTCD.

A bicycle signal face may be used to provide separate control of a bicyclist movement for various situations, including the following:

- To provide a protected bicycle signal phase or a leading or lagging bicycle interval;
- To continue a through bicycle lane on the right-hand side of a mandatory right-turn lane (or on the left-hand side of a mandatory left-turn lane);
- To provide a bicycle interval for a contra-flow bicycle facility; or
- To provide for unusual or unexpected arrangements of the bicyclist movement through complex intersections, conflict areas, or signal control.

A bicycle signal face may also be used at a mid-block traffic control signal where there are no motor vehicle movements parallel to the bicycle crossing.

9.4.1 Use of Bike Signal Faces

- A bicycle signal face shall only be used to control bicyclist movements from a designated bicycle lane or from a separated facility, such as a separated bicycle lane, sidepath, or shared-use path.
- A bicycle signal face shall only be used to control bicyclist movements where bicyclists moving on a GREEN BICYCLE or YELLOW BICYCLE signal indication are not in conflict with any simultaneous motor vehicle movement at the signalized location, including right (or left) turns on red.
- If used where motor vehicle traffic can make the same movements as bicyclists, a bicycle signal face should only be used if the bicyclist movement controlled by the bicycle signal face is sometimes allowed to proceed or sometimes required to stop at times when motor vehicle traffic, making the same movement and controlled by other vehicular signal faces, is required to stop or allowed to proceed, respectively.

Figure 9-3: Bicycle Signal Head (Kalamazoo, MI)
Image Source: mlive.com

9.4.2 Prohibited Use of Bike Signal Faces

- Bicycle signal faces shall not be used to control conflicting bicyclist movements from perpendicular or nearly perpendicular directions.
- Bicycle signal faces shall not be used for controlling any bicyclist movement that is sharing an approach lane with motor vehicle traffic.
- Bicycle signal faces shall not be used in any manner with respect to the design and operation of a hybrid beacon.

9.4.3 Additional Guidance

See Chapter 4H of the 11th edition of the MUTCD for additional guidance on the following:

- Bicycle Signal Signs
- Application of Bicycle Symbol Signal Indications during Steady (Stop-and-Go) Operation
- Application of Bicycle Symbol Signal Indications during Flashing Operation
- Layout of Bicycle Signal Faces
- Size of Bicycle Symbol Signal Indications
- Placement of Bicycle Signal Faces
- Mounting Heigh of Bicycle Signal Faces
- Intensity of Light Distribution of Bicycle Signal Faces
- Yellow and Red Clearance Intervals for Signal Faces
- Bicycle Push Buttons

9.5 FENCES AND RAILINGS

The AASHTO Guide for the Development of Bicycle Facilities specifies a minimum safety rail height of 42 inches. A minimum 4-foot (48 inch) high bicycle railing is, however, recommended to better protect cyclists from falls. (NCHRP Determination of Appropriate Railing Heights for Bicyclists, 2004).

Railings are recommended for use in the following conditions:

- Immediately adjacent to the edge of a highway bridge.
- Between a shared use path (or sidepath) and a travel lane on a bridge or highway where a bicyclist may fall into the path of oncoming traffic. If the edge of the travel lane is greater than 5 feet from the edge of the shared use path, a railing is not required.
- On a bikeway bridge with a drop-off of 2 feet or greater.
- On a shared use path (or sidepath) adjacent to a hazard where the bicyclist could be severely injured if they were to fall. Typical hazards would include cliffs, water bodies or rocks.

Long narrow corridors constrained by fences on both sides should be avoided as this creates access issues and prevents path users from leaving the path in the event of an emergency.

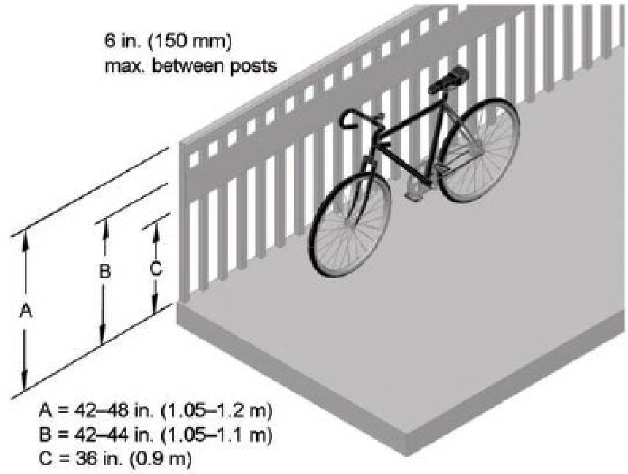
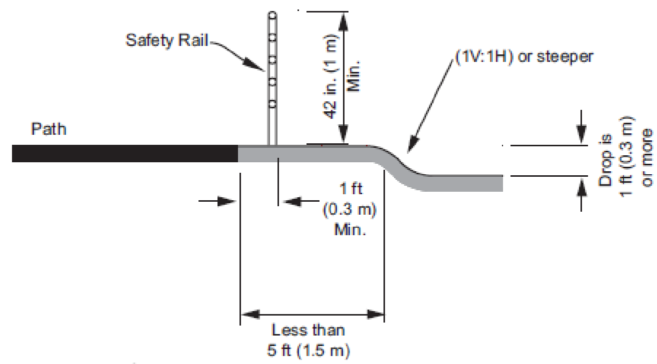
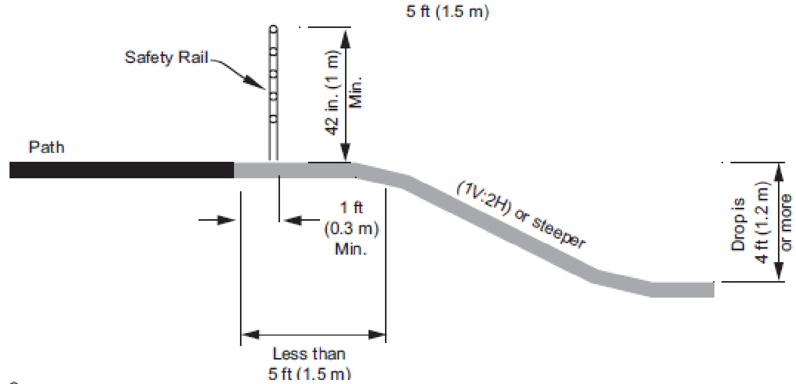


Figure 9-4: Bridge Railing. Source AASHTO Guide for the Development of Bicycle Facilities





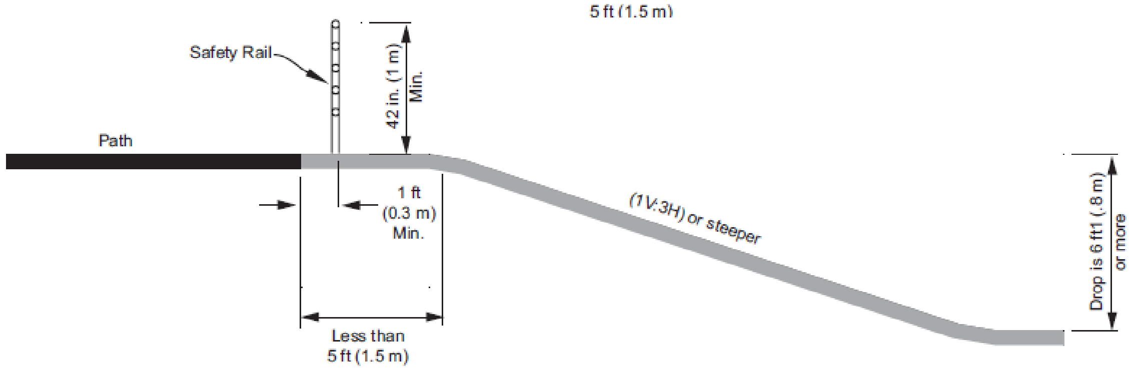


Figure 9-5: Safety Rail Adjacent to Slopes: Source AASHTO Guide for the Development of Bicycle Facilities

9.6 TRAFFIC BARRIERS

Multiple types of physical barriers can be deployed to provide physical separation from a bike lane or pathway and traffic. The selection of a barrier system should be based on factors such as the presence of on-street parking, buffer width, cost, durability, aesthetics, traffic speeds, emergency vehicle and service access needs, drainage, and maintenance considerations. Intermittent (spaced) barriers may be preferred in some conditions over continuous barriers due to the potential drainage impacts of a continuous barrier. A combination of separation treatments may be used to improve the effectiveness of the barrier system.

Typical barriers include the following:

Curbs and raised medians: An asphalt, concrete, or granite curb, typically 6 inches in height, may be used to separate bike lanes or pathways from traffic in combination with a buffer area. For bicycle facilities at road grade, a raised median a minimum of 2 feet in width may be used to provide separation. The median should be approximately 6 inches in height with an integrated asphalt, concrete, or granite curb. The median may be planted or hardscaped.

Figure 9-6: Landscaped raised median. Source: Planetizen

Traffic delineator posts: Traffic delineator posts have low installation cost and have high visibility. However, these devices are not durable and require periodic replacement. Delineators are typically placed within a buffer area and may be located in the center or to one side or the other as site conditions dictate (such as street sweeper width or vehicle door opening). Typical post spacing is 10 feet to 40 feet.

Figure 9-7: Traffic delineator posts. Source: Developtech.com

Concrete barriers: Concrete barriers provide the highest level of crash protection among these separation types. However, this barrier type may not be suitable for aesthetic purposes and gaps in the barrier system should be provided to allow for emergency vehicle and maintenance vehicle access. Concrete barriers are typically located within a buffer space between a roadway and bicycle facility. Bicycle lanes or pathways should be located a minimum of 2 feet from a concrete barrier (assuming the barrier is less than 42 inches in height) to avoid fall hazards associated with collisions. If a 2-foot separation cannot be provided, a steel railing should be installed on top of the concrete barrier to provide a total barrier height of 42 inches.

Figure 9-8: Decorated concrete barrier with steel railing. Source: Curbed New York

Planters: Planters may be used within a buffer area to provide physical separation between traffic and a bicycle facility. While more aesthetically pleasing than other barrier types, planters require regular maintenance and therefore may be suitable only for locations where aesthetics are a priority. Planters should be spaced consistently a distance of up to 40 feet apart.

Figure 9-9: Planters in buffer. Source: Minneapolis Street Design Guide

Guard rail systems: Guard rail (or guide rail) systems may be used to provide separation from traffic. Square beam steel rail, W-beam steel rail, or a timber rail system may be used. These systems are typically 30 inches tall. Bicycle lanes or pathways should be located a minimum of 2 feet from a guard rail system to avoid fall hazards associated with collisions. Breaks in the system should be provided to allow for emergency and maintenance vehicle access.

Figure 9-10: Timber guard rail. Source: Google Earth

Low linear barriers: These systems are relatively inexpensive, can provide near continuous separation, and are a good solution when minimal buffer width is available.

Figure 9-11: Low linear barrier. Source: Greater-Greater Washington

Parking lanes: Parking lanes may be used to provide separation between traffic and a bicycle facility. Parking lanes are typically used in combination with other barrier measures such as a curb, raised median, traffic delineator posts, or bollards to prevent parking vehicles from encroaching upon the bicycle facility. Barrier types that obstruct the opening of car doors or create tripping hazards should be avoided. A minimum buffer width of 3 feet is required between the bicycle facility and parking lane to allow for the opening of doors and other maneuvers.

Figure 9-12: Parking buffered bike lane with traffic delineator posts. Source: League of American Bicyclists

9.7 BICYCLE PARKING

Bicycle parking is an integral component of the bicycle transportation network. Bicycle parking should be located in close proximity to the locations in which they are intended to serve. If that location is a building, bicycle parking should be located as close to entrances as feasible. In retail areas with multiple buildings or storefronts, bicycle parking should be located in multiple areas in favor of a single centralized location.

While bicycle parking can take many forms such as bike lockers and indoor storage facilities, bicycle racks are most typical of a municipal system. Racks may be located outside or in a sheltered location. Racks should be located so they are highly visible and in frequented areas to discourage theft or vandalism of parked bicycles. Racks should be easily accessed from bicycle facilities, sidewalks, or other pedestrian areas, but should be installed so as not to obstruct pedestrian or bicycle traffic.

There are multiple styles and designs of bicycle racks that are available and commonly used. Bicycle racks should be selected so that they:

- Support the bicycle upright by its frame in two places.
- Prevent the wheel of the bicycle from tipping over.
- Enable the frame and one or both wheels to be secured.
- Support bicycles that lack a horizontal top tube (step through bicycles).
- Allow front-in parking: a U-lock should be able to lock the front wheel and the down tube of an upright bicycle.
- Allow back-in parking: a U-lock should be able to lock the rear wheel and seat tube of the bicycle.

Comb, toast, schoolyard, and other wheel bending racks that provide no support for the bicycle frame should not be used. The rack element should resist being cut or detached using common hand tools such as bolt cutters, pipe cutters, wrenches, and pry bars.

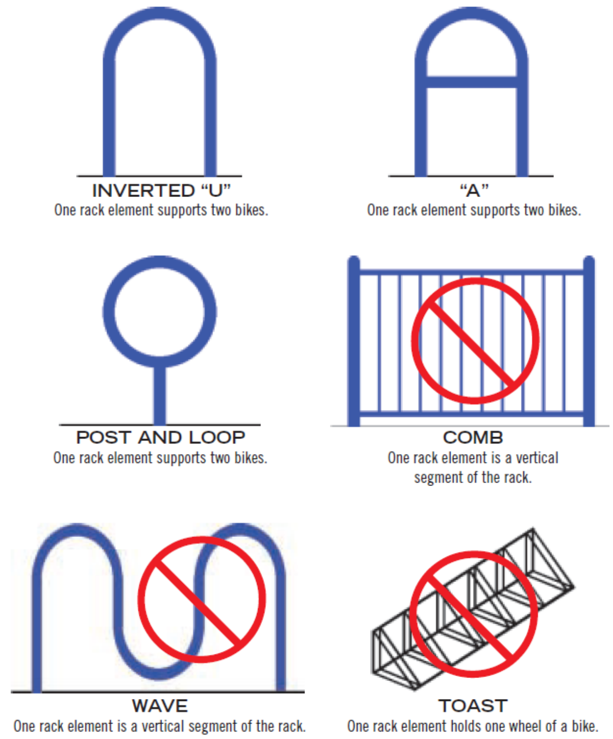


Figure 9-9: Bicycle Rack Types. Source: APBP

Bicycle racks should be located on in areas that are free from obstructions. The minimum storage depth to allow for parking of a bicycle is 6 feet (as measured along the length of the parked bicycle). Individual bicycle rack elements may serve two bicycles, but those elements should be spaced at least 30 inches apart. Additionally, a minimum clear area of 2 feet should be provided between the side of a rack and a fixed element such as a wall to ensure user access. If racks are located in parallel rows (such as the spaces to the left and right in a parking lot) bicycle racks should be spaced so that an aisle of no less than 4 feet is provided between the tires of parked bicycles.

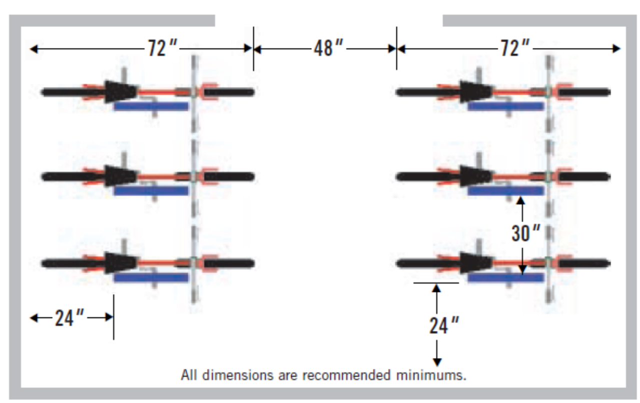


Figure 9-14: Bicycle Rack Spacing. Source: APBP

10.0 BICYCLE NETWORK PLAN

The bicycle network plan documents existing and planned bicycle routes that comprise the Town's bicycle network. The routes shown on Figure 10-1 on the following page provide a townwide bicycle network that places every resident in close proximity to a bicycle facility. The bicycle network is intended to serve a wide range of users although not all corridors or facility types will be suitable for all users. A wide range of facility types is recommended within the bicycle network. Those facilities are described in the preceding sections of this plan and are indicated on the map as follows:

- Planned Bike Lane to replace Existing Shared Lane
- Planned Bike Lane* on State Highway
- Planned Bike Lane*
- Planned Shared Lane
- Planned Shared-Use Pathway (Town)
- Planned Shared-Use Pathway (other)
- Existing Bike Lane*
- Existing Shared Lane
- Existing Shared-Use Pathway (Town, contributing to bike network)
- Existing Shared-Use Pathway (other, contributing to bike network)
- Connection to bicycle facility in adjacent town

**Bike Lane includes standard bike lane, buffered bike lane, or separated bike lane*

The map identifies routes on both Town and State roadways. While the Town does not have direct control over the planning, design, and construction of facilities on State roadways, this plan recommends that the Town coordinate with CTDOT to accommodate bicycle facilities on State roadways. Likewise, the bicycle network plan recommends shared use path connections that may require coordination with private property owners, procurement of easements, and/or property acquisition to successfully develop.

The map does not delineate between specific types of bike lanes (standard, buffered, or separated) on specific corridors. Engagement with stakeholders and further investigation of each corridor is required to identify the appropriate facility type.

This bicycle network plan is intended to be updated on a regular basis to document the implementation of new facilities and in response to investigation conducted by the Town to determine the viability of some routes and the facility type that has been identified for those routes. A full-scale version of the bicycle network plan is available on the Town's website.

Vision Zero Focus Area Streets

The map below identifies priority corridors identified by the Town's 2024 Vision Zero Plan. As recommended by the Vision Zero Plan, those corridors are a priority for safety improvements. Nearly all corridors identified as a priority in the Vision Zero Plan currently have, or are recommended for, bicycle facilities.

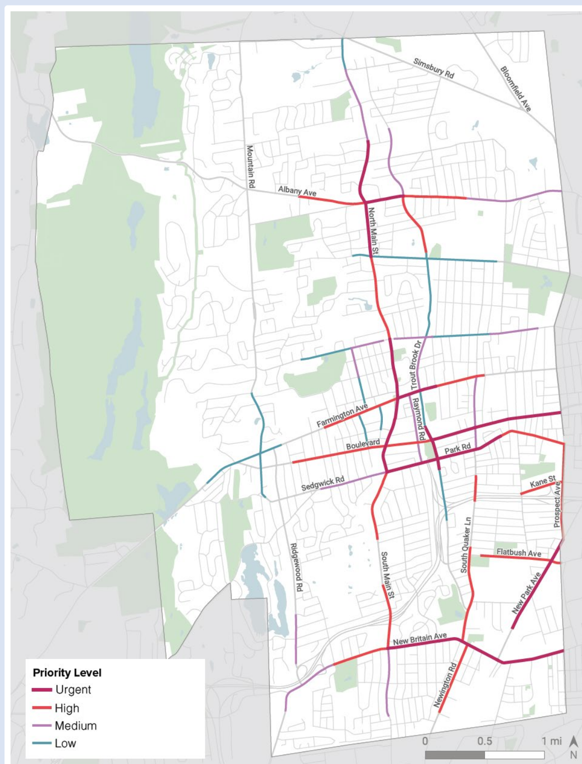


Figure 10-1 Vision Zero Focus Area Streets

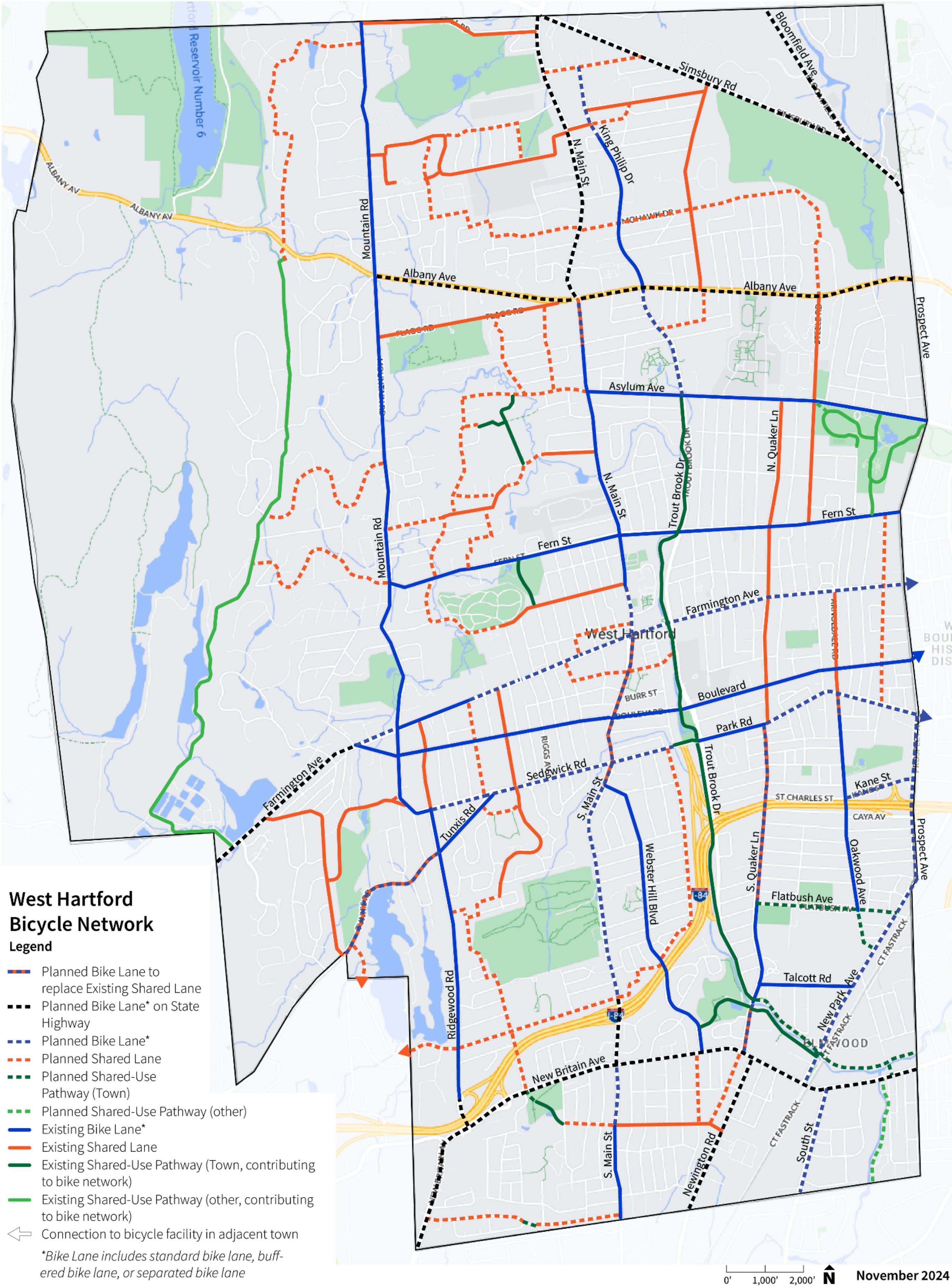


Figure 10-2 Bicycle Network Plan

Bicycle Plan Network Inventory

The following tables provide an inventory of the corridors shown on the Bicycle Network Plan. This inventory includes both existing and recommended facilities. Shared-use pathways are not included in this inventory.

Bike Lane Corridors
Albany Avenue
Asylum Avenue: N. Main St. to Prospect Av.
Boulevard
Farmington Avenue
Fern Street
Kane Street
King Phillip Drive
Mountain Road
New Britain Avenue
New Park Avenue
Newington Road
North Main Street
Oakwood Avenue
Park Road
Prospect Avenue
Quaker Lane South
Ridgewood Road
Sedgwick Road
Simsbury Road
South Main Street
South Street
Talcott Road
Tunxis Road
Webster Hill Boulevard

Sidepath/Shared Use Path Corridors
Flatbush Avenue
Trout Brook Drive

Shared Roadway Corridors
Arapahoe Road
Asylum Avenue: Fox Chase Ln. to No Main St.
Barksdale Road
Beacon Hill Drive
Beechwood Road
Belcrest Road
Bentwood Road
Berkshire Road
Blue Ridge Lane
Brace Road
Braeburn Road
Brookmoor Road
Brookside Boulevard
Brookside Drive
Buena Vista Road
Chamberlin Drive
Chapman Road
Chatfield Drive
Cliffmore Road
Cornerstone Drive
Day Road
Dayton Lane
East Maxwell Drive
Edmund Place
Fernbel Lane
Ferncliff Road
Flagg Road
Fox Chase Lane
Foxridge Road
Gallaudet Drive
Greenhouse Boulevard
Grove Street
Hartwell Road
Harvest Lane
Haynes Road
Highland Street
Hilldale Road
Hunter Drive
Hyde Road

Shared Roadway Corridors
King Road
Ledyard Road
Lemay Street
Maiden Lane
Mayflower Street
Miller Road
Mohawk Drive
Mohegan Drive
North Quaker Lane
North Steele Road
Old Meadow Road
Overbrook Road
Pocahontas Road
Richmond Lane
Richmond Road
Rustic Lane
Rye Ridge Parkway
Sheep Hill Drive
Shepard Road
Sidney Avenue
Somerset Street
South Highland Street
Steele Road
Still Road
Surrey Way
Tumblebrook Lane
Vanderbilt Road
Vandervere Road
Walden Street
Wardwell Road
West Ridge Drive
Westbrook Road
Westminster Drive
Westmont
White Hill Drive
Whitman Avenue
Willowbrook Drive
Wood Pond Road

Appendix A

Bicycle Facility Selection Worksheet

Bicycle Facility Selection Worksheet **7/12/2024**

Roadway Characteristics

Roadway:	
Extent:	
Distance:	
Average Daily Traffic (ADT):	
Posted Speed Limit:	
85th Percentile Speed:	
Bike Plan "Exceeds Recommendation" Bicycle Facility Type(s):	
Bike Plan "Recommended" Bicycle Facility Type(s):	
Bike Plan "Acceptable" Bicycle Facility Type(s):	

Are there constraints preventing the implementation of a recommended bicycle facility?

- ☐ No
- ☐ Yes, the following constraints:
  - ☐ Right-of-Way
  - ☐ Roadway Width
  - ☐ Required Travel / Turn Lanes Based on Vehicular Traffic Demand
  - ☐ On-Street Parking Demand Exceeds Nearby Capacity (inc. side streets and public off-street parking)
  - ☐ No Suitable Alternate Locations for Existing On-Street Parking
  - ☐ Parking Turnover, Bus Stops, and/or Curbside Activity Conflict
  - ☐ Driveway / Intersection Frequency
  - ☐ Curb Extensions or Median Islands
  - ☐ Utilities
  - ☐ Street Trees
  - ☐ Other: ___________________________

Notes:

Selected Bicycle Facility: ____

Endorsement Required ***only*** if Selected Bicycle Facility differs from Recommended Bicycle Facility Type(s):

West Hartford Engineering Division Representative: Date:	Pedestrian and Bicycle Commission (PBC) Chair: Vote Tally: Date: Meeting Date: ☐ Default Endorsement if No Response within 45 Days of Notice

Bicycle Facility Selection Worksheet

7/12/2024

EXAMPLE

Roadway Characteristics

Roadway:	Boulevard
Extent:	South Main Street to Mountain Road
Distance:	1.0 miles
Average Daily Traffic (ADT):	4,706
Posted Speed Limit:	35 mph
85^{th} Percentile Speed:	37 mph
Bike Plan “Exceeds Recommendation” Bicycle Facility Type(s):	
Bike Plan “Recommended” Bicycle Facility Type(s):	Buffered Bike Lane, Separated Bike Lane, or Sidepath
Bike Plan “Acceptable” Bicycle Facility Type(s):	Bike Lane

Are there constraints preventing the implementation of a recommended bicycle facility?

- ☐ No
- ☐ Yes, the following constraints:
  - ☐ Right-of-Way
  - ☒ Roadway Width
  - ☐ Required Travel / Turn Lanes Based on Vehicular Traffic Demand
  - ☐ On-Street Parking Demand Exceeds Nearby Capacity (inc. side streets and public off-street parking)
  - ☒ No Suitable Alternate Locations for Existing On-Street Parking
  - ☐ Parking Turnover, Bus Stops, and/or Curbside Activity Conflict
  - ☒ Driveway / Intersection Frequency
  - ☒ Curb Extensions or Median Islands
  - ☒ Utilities
  - ☐ Street Trees
  - ☐ Other: ______________________

Notes: Driveway and intersection frequency places constraints on development of a separated bike lane. Roadway width, curb extensions, and on-street parking demand constrain the ability to provide buffered bike lanes on both sides of the roadway.

Selected Bicycle Facility: Bike Lane/Buffered Bike Lane

Endorsement Required ***only*** if Selected Bicycle Facility differs from Recommended Bicycle Facility Type(s):

West Hartford Engineering Division	Pedestrian and Bicycle Commission (PBC)	
Representative:	Chair:	Vote Tally:
Date:	Date:	Meeting Date:
	☐ Default Endorsement if No Response within 45 Days of Notice	