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TRANSMITTAL LETTER

PUBLICATION:

Publication 13
April 2021 Edition

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4/21/2021

SUBJECT:

**Design Manual Part 2
Contextual Roadway Design
April 2021 Edition**

INFORMATION AND SPECIAL INSTRUCTIONS:

Publication 13, Design Manual Part 2, Contextual Roadway Design is to be issued with this letter.

The enclosed April 2021 Edition represents a new publication. The effective date of the April 2021 Edition is April 21, 2021.

Adopt these new policies on all new and existing designs as soon as practical without affecting any letting schedules.

Publication 13 is anticipated to ultimately include a total of twenty-four chapters.

This initial edition of Publication 13 includes an introduction (About Design Manual 2), a preface, and one chapter (Chapter 14, Bicycle Facilities). Publication 13, Chapter 14 replaces what was housed previously in Publication 13M, Design Manual Part 2, Highway Design, Chapter 16.

As chapters for Publication 13 are circulated and approved through the Clearance Transmittal (CT) review process, an update for Publication 13 will be issued. If a chapter in Publication 13 replaces an existing chapter in Publication 13M, an update for Publication 13M will also be issued.

ABOUT DESIGN MANUAL 2

*Issued as part of the initial edition.

PREFACE

*Issued as part of the initial edition.

CHAPTER 14 BICYCLE FACILITIES

*Issued design guidance to replace the guidance found previously in Publication 13M, Design Manual Part 2, Highway Design, Chapter 16, Bicycle Facilities.

Gender neutral language has been accounted for in all issued pages, i.e., About Design Manual 2, Preface, and Chapter 14.

Any comments or questions regarding the above revisions should be directed to the Highway Design and Technology Section, Highway Delivery Division, Bureau of Project Delivery.

CANCEL AND DESTROY THE FOLLOWING:

None

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DESIGN MANUAL PART 2

CONTEXTUAL ROADWAY DESIGN

PUBLICATION 13



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About Design Manual 2

This manual provides basic design guidance for the development of transportation projects in Pennsylvania. The purpose of this manual is not to reiterate design guidelines described in the American Association of State Highway and Transportation Officials' (AASHTO) manuals. Instead, it provides Pennsylvania-specific design guidance. Therefore, when design criteria presented in this manual differ from criteria presented in other sources, this manual will take precedence (with the exception of National Highway System (NHS) routes, where the AASHTO *A Policy on Geometric Design of Highways and Streets*, i.e., the Green Book, takes precedence if more conservative than DM-2).

Further, this manual does not attempt to incorporate the entire scope of other published literature relating to the formulation of highway design criteria, policies, and procedures. Some of the other resources that may complement the concepts contained within this manual include:

- AASHTO's *A Policy on Geometric Design of Highways and Streets, 6th Edition* commonly referred to as the "The Green Book" (published in 2011).
- AASHTO's *Highway Safety Manual (HSM)* (edition defined in Publication 638A).
- AASHTO's *Guide for the Development of Bicycle Facilities* (published in 2012).
- AASHTO's *Policy on Design Standards Interstate System* (published in 2016).
- AASHTO's *Roadside Design Guide* (published in 2011).
- PennDOT's Publication 408, *Specifications*.
- The Federal Highway Administration's (FHWA) *Manual on Uniform Traffic Control Devices (MUTCD)* (edition defined in Publication 46).
- The Transportation Research Board's *Highway Capacity Manual (HCM)* (edition defined in Publication 46).

A topic-specific list of references is included in each chapter.

Note that this manual obtained all graphic elements (e.g., photos, exhibits, charts, illustrations) from Commonwealth of Pennsylvania sources or from the references listed within the individual chapters, unless otherwise noted.

Updating this Manual

To uphold PennDOT's mission to provide a sustainable transportation system and quality services that are embraced by our communities and add value to our customers, it is important that design processes and procedures include state-of-the-art best practices. As practitioners, PennDOT's employees are the best resources for providing these updates.

PennDOT encourages staff and consultants to submit comments and suggestions for changes to the manual (by email or regular mail) to the Highway Design and Technology Section Chief at:

Pennsylvania Department of Transportation
Highway Design and Technology Section Chief
400 North Street, 7th Floor
Harrisburg, PA 17120

To assist in effectively coordinating comments and suggestions, please include the form on the following page with each submission.



Also, employees' ideas that have not been tried on a project can be submitted through IdeaLink. IdeaLink, PennDOT's web-based suggestion box, gathers employee feedback on how to improve efficiency and safety. All submittals to IdeaLink follow a comprehensive review process to determine their applicability.

Employees can also share design process modifications or best practices through PennDOT WorkSmart, an online bulletin board. PennDOT WorkSmart provides the opportunity for PennDOT employees to find common ground and collaborate with one another to help make the Department a safer, more efficient, and more cost-effective organization.



Highway Design and Technology Section staff review comments and suggestions in a timely manner. Their review is also coordinated with other PennDOT sections, as appropriate.

**Pennsylvania Department of Transportation
Suggestions and Comments for Incorporation into Design Manual 2**

Name of firm: _____

Firm address: _____

Person responsible
for suggestion: _____

Email and phone
number: _____

Suggestions and
comments: _____

(Comments or suggestions may be attached as marked-up copies of pages from the manual.)

Please complete the requested information on a copy of the sheet and return to:

Pennsylvania Department of Transportation
Highway Design and Technology Section Chief
400 North Street, 7th Floor
Harrisburg, PA 17120

Preface

Transportation professionals in the 21st century must be cognizant of the public's travel needs and an area's livability as projects progress from conception through construction. In the past decade, the term "complete streets" has become synonymous with the incorporation of multimodal principles into the physical configuration of roadways and associated facilities. Streets are made complete by addressing the needs of all system users and accommodating these unique needs through design, appearance, and the modes of travel. Depending upon local context and environmental conditions, different streets will require distinct physical design features to best address users' needs.

PennDOT's Mission

To provide a sustainable transportation system and quality services that are embraced by our communities and add value to our customers.

In addition to being complete, streets need to be livable, providing improved quality of life for the people using the space. Livable neighborhoods require that streets function as transportation facilities as well as viable public places. In addition, communities may wish to preserve historic or unique elements along main streets, invite new businesses and development, and energize public spaces for civic activities, community celebrations, and special events.

Preserving a community's sense of place allows PennDOT the opportunity to support and enhance elements that make a community livable, unique, and economically viable. Within the context of transportation projects, placemaking (the multi-faceted approach to planning, designing and management of public spaces) improves practical aspects of civic life, such as providing connections between homes and neighborhood centers. It also addresses harder-to-quantify livability issues, such as establishing socially cohesive neighborhoods and community identity. Transportation improvements alone cannot address every component of placemaking, but they can significantly bolster community efforts to create and preserve a rich and unique sense of place.

Complete livable streets are planned, designed, constructed, operated, and maintained to provide mobility for all users, appropriate to the function and context of the facility. Transportation professionals are responsible for designing with flexibility and employing context-sensitive approaches that consider the communities in which they are working, because construction today may be in place for decades to come.

Framework for the Development of Projects

Over the past twenty years, transportation professionals have made great strides in developing sophisticated components within the transportation network. However, as the priority had been investment in personal vehicle transport, some fragmentation of the transportation network has occurred. As funding for developing transportation projects becomes increasingly difficult to

obtain, it is critical to integrate existing systems to realize the full potential of the transportation network.

Further, the development of a project today should not become the limiting factor for additional modes to be accommodated through the same project area in the future. The framework presented in this section addresses the concepts of complete streets, context sensitive solutions, flexibility in design, and risk management. These concepts should be considered in the development of projects so that opportunities for today and in the future are not compromised.

Complete Streets

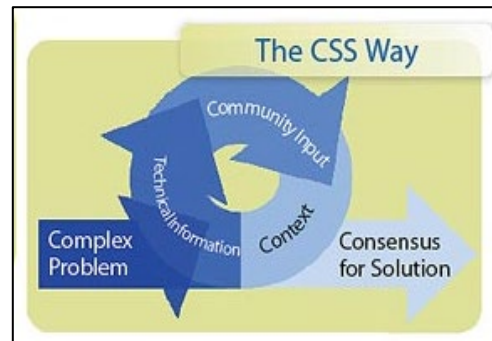
A complete streets approach challenges transportation professionals to routinely design and operate the entire right-of-way to enable safe access for all users, regardless of age, ability, or mode of transportation. This means that every transportation project should promote a street network better operationally and safer for drivers, transit users, pedestrians, and bicyclists, ultimately making each location a better place to live.



There is no singular design prescription for complete streets; each one is unique and responds to its community context. In a city, a complete street may include sidewalks, bike lanes or wide paved shoulders, special bus lanes, comfortable and accessible public transportation stops, frequent and safe crossing opportunities, median islands, accessible pedestrian signals, curb extensions, narrower travel lanes, and roundabouts. By contrast, a complete street in a rural area may look quite different yet share the same goal of balancing safety and convenience for everyone using the road. Additional information on complete streets is provided in Chapter 1.

Context Sensitive Solutions

The Context Sensitive Solutions (CSS) approach to project development assumes that all projects have a context that informs the development of solutions. The CSS process involves stakeholders, such as community members, elected officials, interest groups, as well as local, state, and federal agencies, in a collaborative, interdisciplinary, and holistic approach to developing transportation projects.



The process differs from traditional processes in that it considers a range of goals that extend beyond the transportation problem. It includes goals related to community livability and sustainability and seeks to identify and evaluate diverse objectives earlier in the process and with greater participation by those affected.

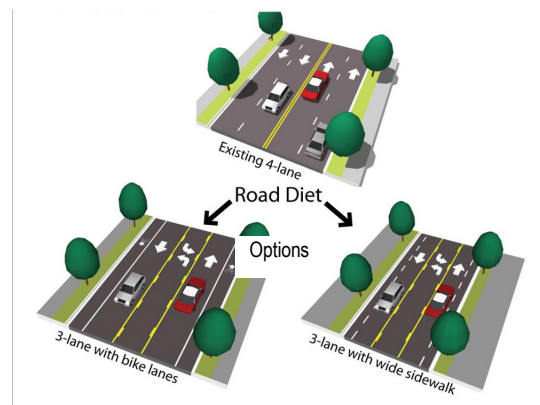
(Source: FHWA contextsensitivesolutions.org)

The CSS approach plans for and responds to the unique needs and qualities of individual communities. At each step, inclusiveness, flexibility, and creativity fuel development of fresh solutions and increase the prospects for success. Additional information on CSS is provided in Chapter 1.

Design Flexibility

Flexibility in design is a context sensitive concept that encourages transportation professionals to expand their consideration in applying the AASHTO Green Book and other design criteria.

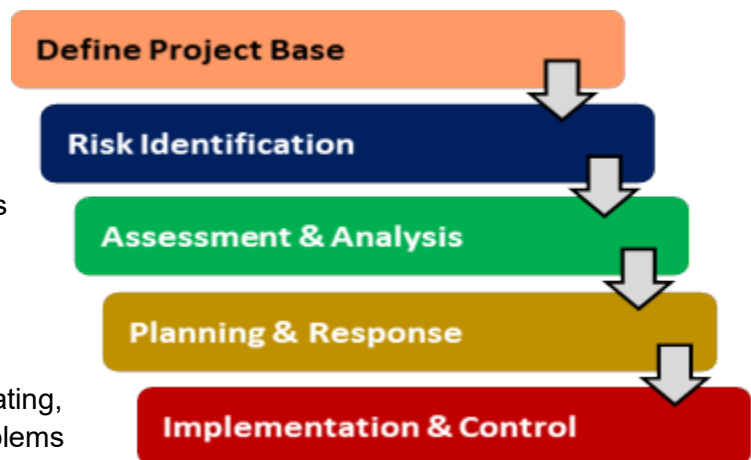
Flexible thinking is about making informed choices. Simply applying the highest or lowest value within a range of design values without explicit consideration of context might not always lead to the most informed choices that best meet a project's objectives. Applying flexibility in design encourages transportation professionals to consider the roadway context, implications for the safety and comfort of pedestrians and bicyclists, and implications for regional mobility. Additional information on design flexibility is provided in Chapter 1.



(Source: LSL Planning / Michigan Association of Planning)

Risk Management

Transportation projects come in a variety of sizes and use various financing and delivery methods. Work on such projects often involves the potential for schedule delays, budget overruns, and other unexpected problems or risks that affect project performance. Risk management, in the context of the planning and design of a transportation project, affords better understanding and optimized project performance by anticipating, planning for, and mitigating potential problems or risks and potential improvements or opportunities.



Complex relationships among entities such as PennDOT, project stakeholders, local governments, review agencies, and others are often inherent within projects. Therefore, flexibility in roadway design and managing related risks becomes paramount to the project development process. Additional information on Risk management for Project Development is provided in Publication 10X, Design Manual Part 1X, Appendix AH.

Glossary

Average Daily Traffic (ADT)	The total volume of traffic during a number of whole days, more than one day and less than one year, divided by the number of days in that period.
Auxiliary lane	A portion of the roadway adjoining the through lanes for speed change, turning, storage for turning, weaving, truck climbing, and other purposes that supplement through-traffic movement.
Bicycle lane / Bike lane	A portion of a roadway (typically four to five feet) designated for preferential use by bicyclists, delineated by pavement markings and signs. Bicycle lanes are one-way facilities that typically carry bicycles in the same direction as adjacent motor vehicle traffic.
Clear zone	The total roadside border area, starting at the edge of the motor vehicle travel lane, available for use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a non-recoverable slope, and/or a clear runout area. The desired width is dependent upon the traffic volumes and speeds, and on the roadside geometry.

Control Vehicle	A vehicle that uses a facility infrequently but must be accommodated. When using a Control Vehicle, encroachment into the opposing traffic lanes, multiple-point turns, or minor encroachment into the street side is acceptable
Crosswalk	Marked or unmarked portion of the roadway at an intersection included within the connections of lateral lines of the sidewalks on opposite sides of the highway, measured from the curbs or (in the absence of curbs) from the traversable roadway. Crosswalks may also occur at an intersection or elsewhere in the traveled way and travel lane (including bike lanes), such as mid-block crossings, distinctly indicated for pedestrian crossing.
Design Hourly Volume (DHV)	The Design Hourly Volume (DHV) is usually the 30th highest hourly volume for the design year, commonly 20 years from the time of construction completion. For situations involving high seasonal fluctuations in ADT, some adjustment of DHV may be appropriate.
Design speed	A selected rate of travel used to determine the various geometric features of the roadway.
Design vehicle	A vehicle that must be regularly accommodated without encroachment into the opposing traffic lanes or into the street side.
Divided highway	A highway divided into two or more roadways. Divided highways impede vehicular traffic between the roadways by providing an intervening space, physical barrier, or clearly indicated dividing section.
Expressway	A divided arterial highway for through traffic, with partial control of access and generally with grade separations at major intersections.
Freeway	A fully limited access highway for which the only means of ingress and egress is by interchange ramps.
Frontage road	A street or highway constructed adjacent to a higher classification street or other roadway network serving adjacent property to provide access.
Grade separated crossing	A crossing of two roadways, or a crossing of a roadway and a railroad or pedestrian pathway, at different elevations or levels.
High speed	Speeds of 50 mph or greater.
Horizontal clearance	Lateral distance from edge of the traveled way, shoulder or other designated point to a vertical roadside element.
Intersection	The general area where two or more streets or highways join or cross.

May	A permissive condition. The verb “may” is used to denote permissive usage.
Maintenance	A strategy of treatments to an existing roadway system that preserves the system, retards future deterioration, and maintains or improves its functional condition. Typically, maintenance projects do not include geometric enhancements or require right-of-way acquisition. Pavement repairs, such as seal coats, full width patching, crack sealing, or correcting minor irregularities, are generally considered maintenance activities.
New construction	A new transportation facility where one did not previously exist. The addition of new appurtenances to an existing facility, such as striping, signs, signals, or noise barrier, are not considered new construction.
Operating speed	The rate of travel at which vehicles are observed traveling during free-flow conditions.
Public transit	Passenger transportation service, local or regional in nature, that is available to any person. Public transit includes bus, light rail, and rapid transit.
Reconstruction	Reconstruction projects are projects that utilize an existing roadway alignment (or make only minor changes to an existing alignment), but involve a change in the basic roadway type. Changes in the basic roadway type include widening a road to provide additional through lanes or adding a raised or depressed median where none currently exists, and where these changes cannot be accomplished within the existing roadway width (including shoulders). The change in basic roadway type means that performance measures for the existing roadway may not be relevant to forecasting the performance of the future constructed roadway. However, retaining the existing alignment mean that the existing constraints in the current roadway environment will influence design decisions.
Rehabilitation	Improvements to remove and replace major structural elements of a highway or bridge to restore the structure to an acceptable condition.
Restoration	Improvements that restore pavement, shoulders, and bridges to an acceptable condition that ensures safe operations for a substantial period.
Resurfacing	Application of a new or recycled layer(s) of pavement material to existing pavements, shoulders, and bridge decks.

Resurfacing, Restoration and Rehabilitation (3R)	A 3R project is the improvement of an existing facility on similar alignment to extend the service life of the facility and/or improve the pavement structural and functional capacity. A 3R project typically does not address operational capacity improvements, major realignment, or major upgrading of geometric features. It may include selective improvements to highway geometry and other roadway features to address safety concerns and reconstruction of limited portions of the project's length.
Right-of-way (ROW)	A general term denoting land, property, or interest therein acquired or donated for transportation purposes. More specifically, land in which the state, a county, a transit authority, or a municipality owns the fee or has an easement devoted to, or required for, use as a public road.
Roadway	The portion of a street or highway including shoulders and bike lanes, for vehicular, and transportation uses. A divided highway has two or more roadways.
Shall	A mandatory condition. The verb "shall" is used when mandatory requirements must be met.
Shared use path	Paved facilities physically separated from motorized vehicular traffic by an open space or barrier. A shared use path may be within the highway right-of-way or within an independent right-of-way with minimal cross flow by motor vehicles. Users are non-motorized and may include pedestrians, bicyclists, skaters, and people with disabilities.
Should	An advisory condition. The verb "should" is used when a condition is recommended but not mandatory.
Slopes	A surface of which one end or side is at a higher elevation than another. Slopes are expressed as a ratio of vertical to horizontal (V:H). It can also be shown as a percentage.
State Transportation Improvement Plan (STIP)	Pennsylvania's official four-year listing of transportation projects mandated under federal law. The STIP comprises all of the TIPs.
Temporary Traffic Control (or Work Zone)	The area of a highway where construction, maintenance, or utility work activities are conducted and in which traffic control devices are required.
Transportation Improvement Program (TIP)	Four-year listing of transportation projects within the geographic boundary of each planning region in Pennsylvania. Interstate Highway System projects are managed in a separate Interstate Management TIP but are included in regional TIPs for public review and comment.

	Fund reserves for statewide programs, as well as line items for ongoing planning and administration projects, are managed in a separate Statewide Items TIP.
Traffic	Pedestrians, bicyclists, motor vehicles, streetcars, horse and buggies, and other conveyances (either singularly or combined) traveling any road open to public travel.
Traveled way	The portion of the roadway dedicated to the movement of vehicles, exclusive of shoulders, berms, sidewalks, bike lanes and parking lanes.
Travel lane	A designated portion of roadway marked to carry through-traffic and to separate it from opposing traffic or traffic occupying other traffic lanes. Generally, travel lanes equate to the basic number of lanes for a facility.
Twelve Year Transportation Program (TYP)	Pennsylvania's official 12-year listing of transportation projects mandated under state law. The first four years of the TYP are the STIP.
Vehicle	Every device upon, or by which any person or property is or may be transported or drawn upon, a traveled way, excepting devices used exclusively upon stationary rails or tracks. Vehicle examples include automobiles, bicycles and horse and buggies.
Work zone (or Temporary Traffic Control)	The area of a highway where construction, maintenance, or utility work activities are conducted and in which traffic control devices are required.

Chapter 1 – Context-Based Design (To be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.

Chapter 2 – Design Controls (To Be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.

Chapter 3 – New Construction and Reconstruction Projects (To Be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.

Chapter 4 – 3R and Pavement Preservation Projects (To Be Added Later)

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Chapter 5 – Bridge Projects (To Be Added Later)

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Chapter 7 – Interchanges (To Be Added Later)

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Chapter 8 – Road Diet (To Be Added Later)

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Chapter 9 – Maintenance and Protection of Traffic (To Be Added Later)

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Chapter 10 - Drainage (To Be Added Later)

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Chapter 11 – Erosion and Sedimentation Control (To Be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.

Chapter 12 – Guiderail, Median Barrier, and Roadside Safety Devices (To Be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.

Chapter 13 – Pedestrian Facilities (To Be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.

Chapter 14 – Bicycle Facilities

In this chapter there are references to future chapters that are currently not included in this Publication 13.

Until they are included in this Publication, please refer to relevant topics in Publication 13M.

Chapter 14 – Bicycle Facilities

14.0 – Introduction

Bikeways and bicycle facilities are an integral part of an interconnected multimodal transportation network, providing safe and convenient access to community goods and services for users of all ages and level of skill and abilities.

A bikeway is a facility intended for bicycle travel which designates space for bicyclists distinct from motor vehicle traffic. A bikeway does not include shared lanes, sidewalks, signed routes, or shared lanes with shared lane markings, but does include bicycle boulevards.

Bikeways differ from the more general term “bicycle facilities.” Bicycle facilities include parking and storage facilities, or shared roadways not specifically designed for bicycle use, but which support and encourage bicycle use. Adding to or enhancing bicycle facilities increases equitable access to jobs, schools, parks, and health care, especially for individuals that rely on transit or do not own motor vehicles.

Bicycles operating on Pennsylvania roadways are considered vehicles and should be expected on all of the Commonwealth’s roadways, with the exception of most limited access facilities or freeways. Therefore, the design criteria and treatment guidance provided in this chapter is intended to support the operation of bicycles as vehicles. In that light, the design of all PennDOT facilities, except those roadways where bicyclists are currently prohibited, shall include appropriate and reasonable accommodations for bicyclists.

The standards recommended in and presented as exhibits throughout this chapter have been successfully implemented in Pennsylvania or elsewhere in the United States. Within each section, treatments are covered with a brief description, specific design guidance, schematics/images, and references. By understanding the unique characteristics and needs of the interested but concerned cyclist, a designer can provide quality facilities that improve the non-motorized network, support access to community resources, and improve the level of comfort for users of all ages and abilities—all while minimizing user risk.

Americans with Disabilities Act Standards for Transportation Facilities

In addition to the design criteria provided in this chapter, the 2006 Americans with Disabilities Act Standards for Transportation Facilities (as required by 49 CFR 37.41 or 37.43) impose additional requirements for the design and construction of facilities, such as shared-use paths and structures that include provisions for pedestrians.

Providing the correct bicycle facility type for a corridor also requires an understanding of the intended users, transportation facility’s context and key design components.

The designer should ask these important context questions:

- Is this bicycle facility in an urban or rural setting?
- Is this bicycle facility identified in a local, state, or regional transportation plan (indicating its importance to local bicyclists)?
- What types of bicyclists are desired for the facility (e.g., commuters, young or inexperienced bicyclists, touring bicyclists, recreational bicyclists, disabled bicyclists)?
- Will the facility accommodate and be intuitive for the most vulnerable users, including children, inexperienced bicyclists, and physically or intellectually disabled bicyclists?
- Will this facility be used by others (e.g., pedestrians, equestrians, skaters, dog walkers)?

Key design components include:

- **Working to Minimize Conflict Points** – Dangerous conflicts can arise between bicyclists and motorists at intersections when they share space on the roadway. The designer should consider designs that include physical infrastructure improvements that reduce motorized vehicle speeds (such as appropriate traffic calming measures) or eliminate identified conflict points. At a minimum, the design should include sign placement and pavement markings for bicycle lanes, especially those that enable the person riding a bike to safely and conveniently access and navigate the intersection. For example, Single-Point Urban Interchanges (SPUIs) are difficult for bicyclists to negotiate; separate facilities may be the best option for non-motorized users. If SPUIs must be used, signal timing should be adjusted to accommodate bicyclists. The designer must take care to properly mark, sign, and signalize those areas where the trail and roadway intersect, as well as avoid using one facility to accommodate both motor vehicles and bicycles (where possible and appropriate).
- **Being Cognizant of Barriers** – Numerous obstacles can present significant barriers to bicycles, especially when compared to those encountered by motorists. Furthermore, obstacles that may appear minor for able-bodied bicyclists can be insurmountable for disabled bicyclists (who may account for up to 15% of an urban bicycling community). For example, many disabled bicyclists live with chronic pain conditions, and cycling can be a less painful experience for these bicyclists than walking, except where they must cross humps, rumble strips, or other engineered uneven surfaces.

Other barriers include: shoulders (which should be of adequate width with a smooth surface), on-street parking (which can limit sight distance, making it difficult to maneuver through traffic - especially when lane widths are narrow), railroad tracks, rough pavement, drainage grates, and bridge expansion joints (which can trap bicycle tires).

- **Working Toward Continuity and Connectivity** – Continuity of facilities is key to convenient utilitarian bicycle use. The designer should evaluate the way in which a bicycle facility ties into other bicycle paths and routes in the region and to transit service. As much as practical, the designer should consider consistency in width and user expectations.

Providing continuity that supports bicycle trips to community resources, such as schools, employment centers, and parks, may take additional project development time and require the acquisition of additional right-of-way, but these efforts ultimately support Department goals and should be considered. Project managers should also consult local, regional, and statewide plans to determine if there are existing or planned bicycle routes that the project could enhance with additional work.

14.0.1 Resources and References

Bicycle facility design is rapidly evolving as communities across the United States innovate and develop creative solutions to common transportation challenges. Many design resources at the federal and state levels incorporate the latest proven practices and encourage further implementation.

The development and design of bikeways within the Department's right-of-way should utilize a wide range of street design guidance to identify the treatment that best fits the project's context. The following is a list of available resources currently recognized by PennDOT as acceptable design guides.

- *Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts* (2015), FHWA.
- *Bikeway Selection Guide* (2019), FHWA.
- *Guide for Incorporating On-Road Bicycle Networks in Resurfacing Projects* (2015), FHWA.
- *Guide for the Development of Bicycle Facilities* (2012), AASHTO.
- *Roadside Design Guide* (2011), AASHTO.
- *Separated Bike Lane Planning & Design Guide* (2015), FHWA.
- *Small Town and Rural Multimodal Networks* (2016), FHWA.
- *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations* (2018) FHWA.

The following resources provide the designer additional direction in the design and development of bicycle facilities. The use of some treatments in these resources, including any treatment outside of this chapter, will require special approval by the Director of the Bureau of Project Delivery, in coordination with the Bureau of Maintenance and Operations and the Multimodal Deputate.

- *Bicycle Boulevard Design Tools and Guidelines* (2000), City of Berkeley, California.
- *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach* (2010), Institute of Transportation Engineers.
- *Iowa Bicycle and Pedestrian Long-Range Plan* (2018), Iowa Department of Transportation.
- *On-Street Motor Vehicle Parking and the Bikeway Selection Process* (2021), FHWA.
- *Technical Analysis and Intersection Considerations to Inform Bikeway Selection* (2021), FHWA.
- *Transit Street Design Guide* (2016), National Association of City Traffic Officials (NACTO).
- *Urban Bikeway Design Guide* (2014), NACTO.
- *Urban Street Design Guide* (2013), NACTO.

Various text and graphics have been provided by the Tri-County Regional Planning Commission in Harrisburg, Pennsylvania, from their *Regional Bicycle Connections Study* (with permission from Alta Planning and Design).

14.1 – The Bicycle as a Design Vehicle

Most design criteria for roadways will not be affected by the bicycle as a design vehicle, except for the addition of space for a bike lane or paved shoulder. However, the bicycle as a design vehicle is an important consideration in the design of bicycle facilities themselves.

On a shared-use path, the bicycle and other non-motorized modes are applied as design vehicles. As with motor vehicles, bicyclists and their bicycles exist in a variety of sizes and configurations. These variations include vehicle type (such as a conventional bicycle, a recumbent bicycle, or a tricycle) and behavioral characteristics (such as the comfort level of the bicyclist). The design of a bikeway should consider expected bicycle types and utilize the appropriate dimensions.

Exhibit 14.1.1 illustrates the operating space and physical dimensions of a typical adult bicyclist, which is the basis for typical facility design. Bicyclists require clear space to operate within a facility and additional shy distance. Therefore, the minimum operating width is always greater than the physical dimensions of the bicyclist. Bicyclists prefer 5 feet or more operating width, although 4 feet is minimally acceptable.

In addition to the design dimensions of a typical bicycle, there are other commonly used pedal-driven cycles and accessories to consider when planning and designing bicycle facilities. The most common types include tandem bicycles, recumbent bicycles, and trailer accessories. Disabled cyclists may use wheelchair tandem pedalcycles, or side-by-side tandem bicycles, all

of which require additional width. **Exhibit 14.1.2** summarizes typical dimensions for most bicycle types.

Exhibit 14.1.1 – Standard Bicycle Rider Dimensions

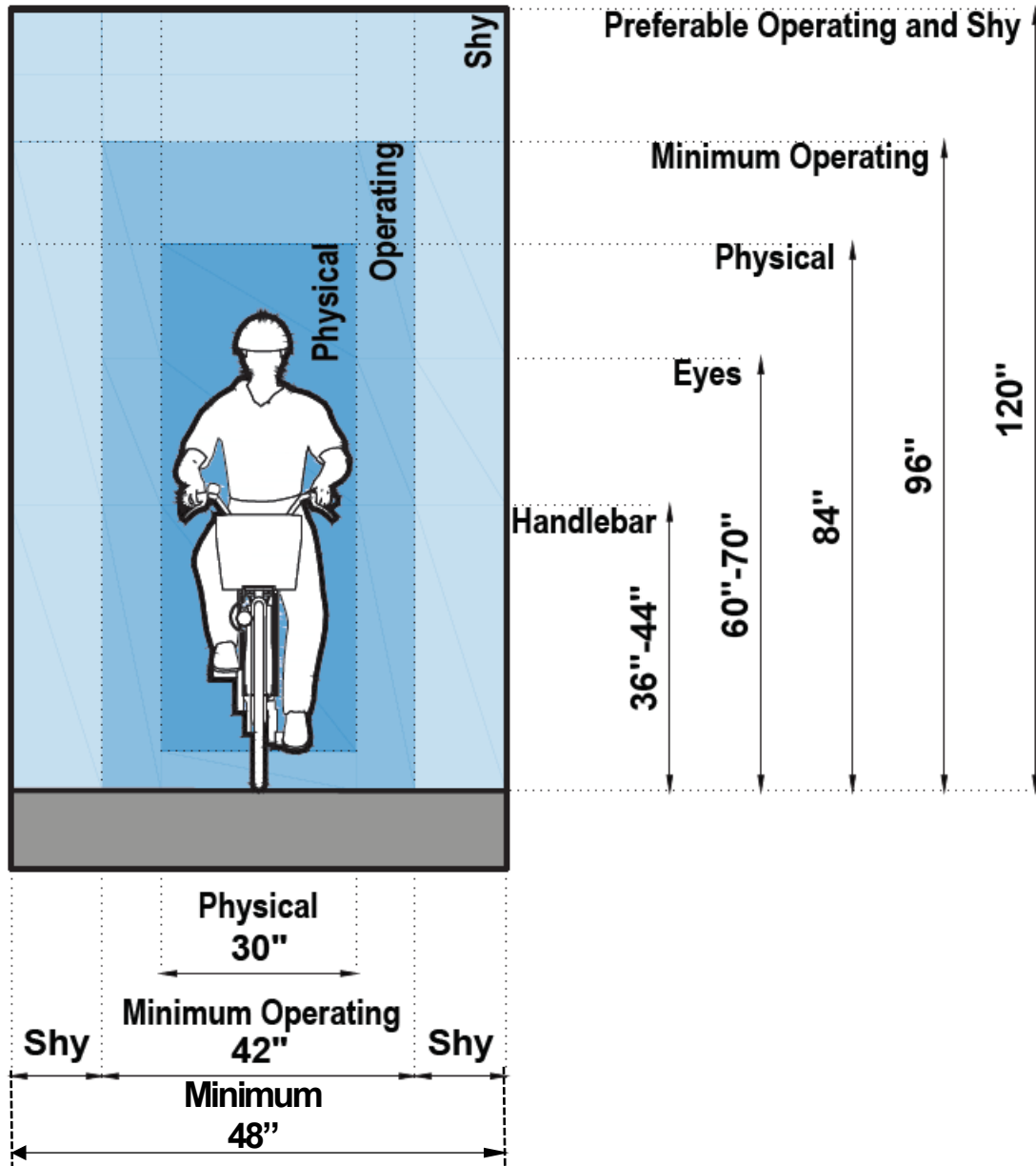
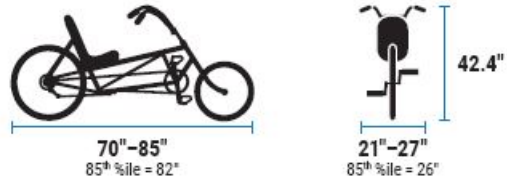


Exhibit 14.1.2 – Typical Bicycle Dimensions

Adult Typical Bicycle



Adult Single Recumbent Bicycle



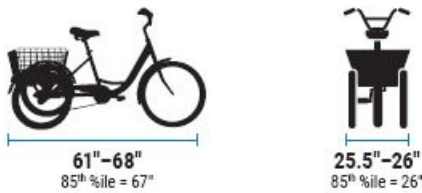
Adult Tandem Bicycle



Trailer Bicycle



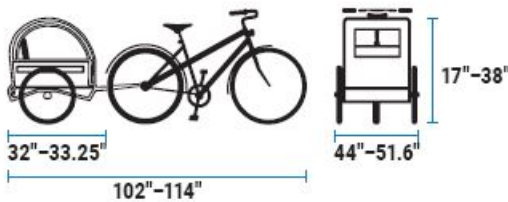
Adult Tricycle



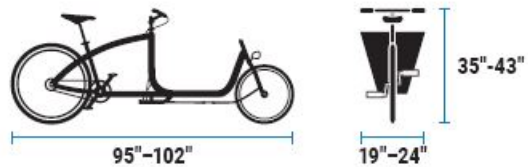
Adult Longtail Cargo Bicycle



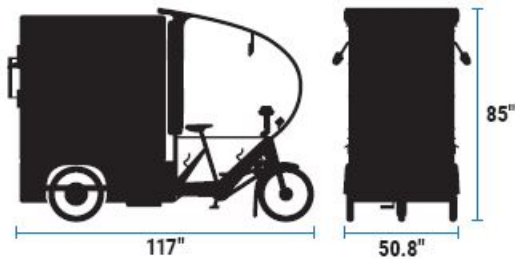
Child Trailer



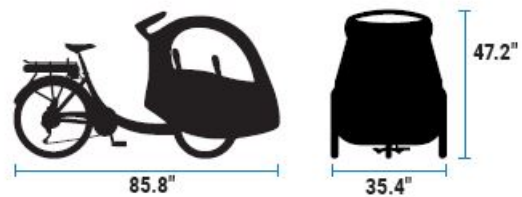
Adult Box Bicycle



E-Assist Delivery Trike



Adult Cargo Bike



The expected speed that different types of bicyclists can maintain under various conditions also influences the design of facilities. **Exhibit 14.1.3** provides bicyclist design speeds for a variety of types and conditions. For signal timing purposes, lower design speeds (as low as 8 mph) should be used to account for lower-speed users. Design speeds that exceed 30 mph should rarely be used.

Exhibit 14.1.3 – Bicycle Design Speed Expectations

Bicycle Type	Feature	Typical Speed
Upright Adult Bicyclist	Paved level surfacing	15 mph
	Crossing Intersections	10 mph
	Downhill	30 mph
	Uphill	5-12 mph
Recumbent Bicyclist	Paved level surfacing	18 mph

*Tandem bicycles and bicyclists with trailers have typical speeds equal to or less than upright adult bicyclists.

14.2 – Selecting the Appropriate Bicycle Facility

Throughout Pennsylvania, the appearances of bicycle networks vary considerably, depending on the context, user groups, date of construction, and facility types. Different facility types serve different purposes, and designs and dimensions can vary significantly due to the surrounding context. Thus, the bicycle facility type within a project depends on the surrounding environment (e.g., automotive speed and volume, topography, adjacent land use) and expected bicyclist needs (e.g., bicyclists commuting on a highway versus students riding to school on residential streets).

PennDOT supports the inclusion of a variety of facility types based on individual project needs. Studies have found that the most significant factors influencing a corridor’s use by bicycles are traffic volumes and speeds. Other factors beyond speed and volume that affect facility selection include the traffic mix of automobiles and heavy vehicles, the presence of on-street parking, intersection density, surrounding land use, topography, and roadway sight distance. Additionally, the consistent use of treatments and applications along a bikeway facility allow users to anticipate whether they would feel comfortable riding on a particular facility and plan their trips accordingly.



14.2.1 – Facility Classification

The following classifications, which are consistent with bicycle facility classifications throughout the nation, identify facility types by their degree of separation from motor vehicle traffic.

- **Shared Roadways** – Shared roadways are roadways where bicyclists and cars operate within the same travel lane, either side by side or in single file, depending on roadway configuration. This category includes utilizing the shoulder and bicycle boulevards. These types of roadways do not accommodate the majority of people riding bicycles or other personal mobility devices and are far less desirable in urban and suburban contexts without the treatments discussed below.



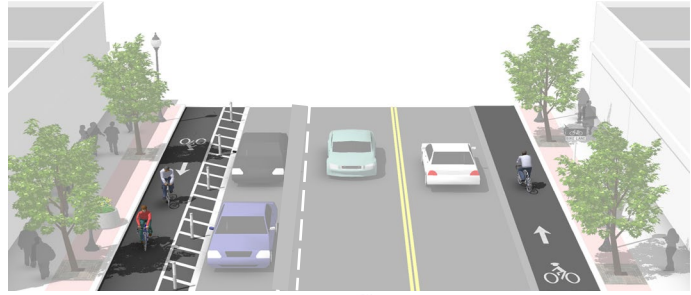
Except where prohibited, all roadways are shared roadways. Certain circumstances/constraints may warrant the consideration of shared lane signing/markings. The most basic type of bikeway is a shared roadway. This facility provides continuity with other bicycle facilities (usually bike lanes) or designates preferred routes through high-demand corridors.

Shared roadways can incorporate various roadway treatments to enhance the shared-lane environment for both bicycles and motor vehicles. Treatments may include pavement markings, signage, and other treatments (including directional signage, traffic diverters, chicanes, chokers, and/or other traffic calming devices) to reduce vehicle speeds or volumes.

- **Visually Separated Bikeways** – Visually separated bikeways, such as bike lanes or buffered bike lanes, use signage and pavement markings to delineate the right-of-way assigned to bicyclists and motorists. These bikeways encourage predictable movements by both bicyclists and motorists. However, they do not provide the physical protection from motor vehicles desired by the majority of people who ride bicycles.



- **Physically Separated Bicycle Lanes** – Physically separated bicycle lanes are exclusive facilities that combine the user experience of a separated path with the on-street infrastructure of a conventional bike lane.



- **Shared-Use Paths** – Shared-use paths are facilities separated from roadways for use by bicyclists and pedestrians.

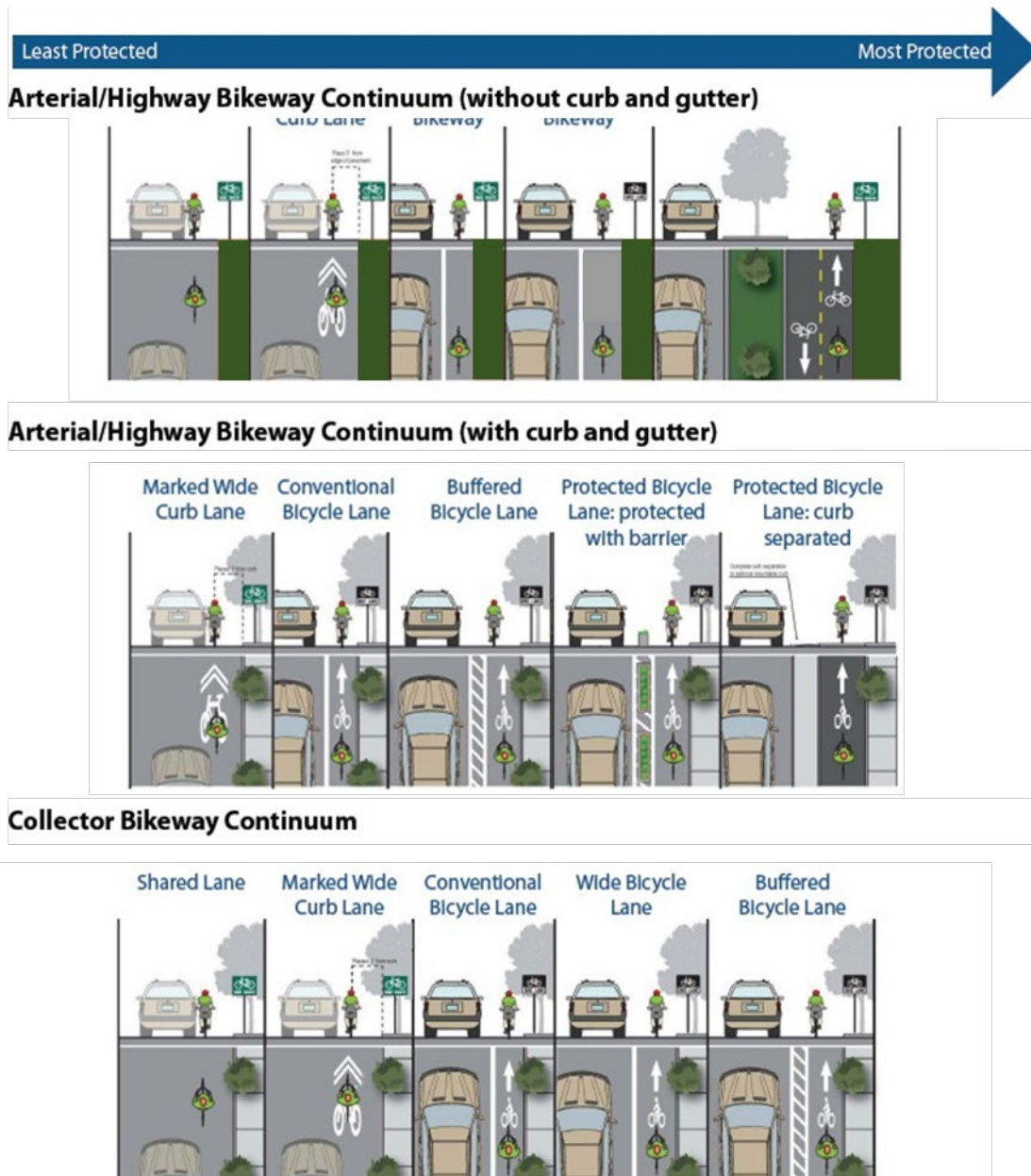


14.2.2 – Bikeway Treatments for Various Roadway Environments

Exhibit 14.2.1 illustrates the range of bicycle facilities applicable to various roadway environments, based on the roadway type and desired degree of separation. The designer should use engineering judgment, traffic studies, previous municipal planning efforts, community input, and local context to refine criteria when developing bicycle-facility recommendations.

While the exhibit provides examples on how a bicycle facility might interact with various roadway classifications, some bicycle facilities may be a better fit with a particular roadway classification, depending on vehicle speeds, volumes, and surrounding land-use context. For example, in some corridors it may be desirable to construct facilities to provide a higher degree of separation from motor vehicle traffic to enhance user safety and comfort. In other cases, existing and/or future motor vehicle speeds and volumes may not justify the recommended level of separation, and a less intensive treatment may be acceptable.

Exhibit 14.2.1 – Range of Bicycle Facilities Applicable to Various Roadway Environments



14.2.3 – Urbanized Area Contextual Guidance

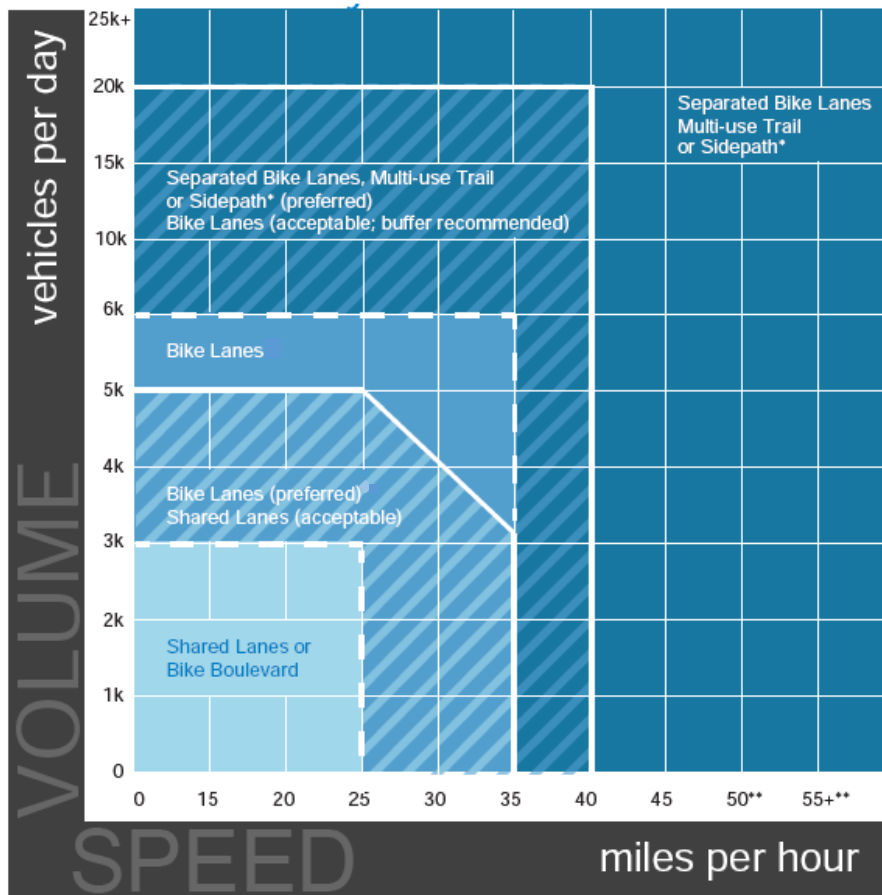
Selecting the best bikeway facility type for a given roadway can be challenging. This is due in part to factors that influence bicycle users' comfort and safety, such as when the speed differential between bicyclists and motor vehicle traffic is high and/or separation is low.

As a starting point, the designer should identify the anticipated or desired end user, then work to identify a preferred facility. Keeping in mind other considerations discussed in this chapter,

Exhibit 14.2.2 can be helpful in determining the recommended type of bikeway for the end user based upon roadway speed and volume. In using the chart, the designer identifies the daily traffic volume and travel speed on an existing or proposed roadway, then locates the facility type indicated by those key variables.

Although **Exhibit 14.2.2** provides bicycle facility guidance, the other factors discussed in section 14.2. of this chapter should be considered in the facility selection and design process.

Exhibit 14.2.2 – Urban and Suburban Facility Selection Matrix (Shoulder use is discussed in section 14.3.1)



- ◆ To determine whether to provide a multi-use trail/sidepath or separated bike lane, consider pedestrian and bicycle volumes or, in the absence of volume, consider land use.
- ◆◆ Speeds 50 mph or greater in urban areas are typically found in urban/rural transition areas.

Source: Iowa Bicycle and Pedestrian Long-Range Plan

14.2.4 – Performance Measurement

The *Highway Capacity Manual* (HCM) establishes an objective method for determining the level of bicycle accommodation (i.e., Level Of Service or LOS) based upon the geometric and operational characteristics of the roadway analyzed. This method is based upon numerous research projects that quantified which factors influence how bicyclists perceive a roadway’s

safety and comfort. The model for links (i.e., roadway segments between intersections) includes the following factors:

- Width of the outside through lane
- Presence and width of a paved shoulder or bike lane
- Geometric encroachments into the bike lane
- Presence and width of a parking lane
- Percentage of parking occupied by parked vehicles
- Pavement condition
- Operating speeds on the roadway
- Traffic volume on the roadway
- Percentage of heavy vehicles on the roadway

Other options for measuring the level of accommodation include level of traffic stress and quantitative indices, as the HCM system does not fully address user experience beyond LOS. The HCM addresses the typical bicyclist, rather than advanced/proficient cyclist, and therefore may suggest that a LOS C provides adequate accommodations for the desired end user.

The primary geometric conditions that influence the level of accommodations are the width of the outside lane, presence and width of a paved shoulder, presence of guiderail or curb and gutter, existing bike lanes and their possible widths, and geometric encroachments into the bike lane or shoulder (such as a turn lane). It is likely that shoulders and/or bike lanes will be the facility of choice for accommodating bicycles in more-rural areas. However, a shared lane or wide outside through lane may be adequate.

On some projects, the pavement cannot be widened or restriped to provide shoulder or bike lane width. On these roads, the designer should analyze the available roadway space and traffic conditions to determine if bicycle accommodation can be achieved by adjusting lane widths or by removing travel lanes to provide widened shoulders or other engineering treatments. It is important to note that wider curb lanes (i.e., lanes adjacent to a curb) are not a preferred design because they support increased motor vehicle speeds, reducing safety and comfort for bicyclists.

Application of performance measurement for bicycle facility projects, whether qualitative or quantitative, is based on the context of the project and community desires.

14.2.5 – Bike Routes

A bike route is not an actual facility type. Rather, a bike route designates a facility (or collection of facilities) that links origins and destinations that have been improved or are considered preferable for bicycle travel. Bike routes include a system of wayfinding and route signs that provide at least the following basic information:

- Destination of the route
- Distance to the route's destination
- Direction of the route

Bike routes can be designated as general routes or number routes. General routes are links with a single origin and a single destination. Number routes form a network of bike routes that connect several origins to several destinations.

14.2.5.a – General Bike Routes

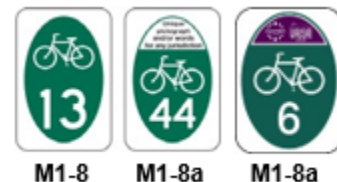
General routes connect users to destinations within a community. Typical destinations include attractions (such as stadiums and parks), neighborhoods (such as downtown and historic districts), and trail networks or trailheads.

Bicycle guide signs may be provided along designated bicycle routes to inform bicyclists of route direction changes and to confirm route direction, distance, and destination. The MUTCD provides several different types of signs that can be used to provide guidance along bike routes. Messages and installation of bicycle guide signs should follow the Tourist Oriented Directional Signs Policy described in Publication 46, *Traffic Engineering Manual*.



14.2.5.b – Numeric, Alpha, or Alphanumeric-Labeled Bike Routes

Some communities may implement a numeric-, alpha-, or alphanumeric-labeled system of bike routes. These routes should be designated using bicycle route signs per the MUTCD and Publication 236, *Handbook of Approved Signs*.



M1-8a

Bicycle route signs can be customized by adding a specific community logo in the upper portion of the ellipse. However, the Chief of the Highway Safety and Traffic Operations Division must approve customized signs.

There are several designated and labeled state bicycle routes throughout the Commonwealth and in the United States bicycle route system. Publication 236 provides sign design and location guidance for projects that include these routes.

Where a designated bicycle route extends through two or more states, the affected states send a coordinated submittal to the American Association of State Highway and Transportation Officials (AASHTO). AASHTO will then assign it a US bicycle route number. A system of proposed US Bicycle Routes is being developed. The US BIKE ROUTE sign (M1-9) is used to designate these routes; the MUTCD provides design details for this sign.



M1-9

14.3 – On-Road Bicycle Facility Design Considerations

On-road bicycle facilities are bicycle routes that use part of the roadway, either in a shared or dedicated space. Cyclists using on-road facilities are considered vehicles and shall obey all traffic rules.

The design of on-road facilities shall consider how motorists and cyclists may interact and reduce conflicts to the extent practicable. The designer should bear in mind available space and the potential for additional space when considering the inclusion of an on-road bicycle facility.

Strategies for finding extra space for on-road bicycle facilities include:

- Installing pavement markings and signage on existing paved shoulders.
- Physically widening the roadway as necessary to include bicycle facilities.
- Restriping the roadway to provide additional room (i.e., road diets).
- Removing a travel lane to provide additional room (i.e., road diets).

PennDOT recognizes four types of on-road bicycle facilities, which organized from least-protected to most-protected include:

- Shared Roads
- Bicycle Boulevards
- Visually Separated Bike Lanes
- Physically Separated Bike Lanes

14.3.1 – Shared Roads

On shared roadways, bicyclists and motor vehicles use the same roadway space. These facilities are typically used on roads with low speeds and low traffic volumes; however, they can be used on higher-volume roads with wide outside lanes or shoulders.

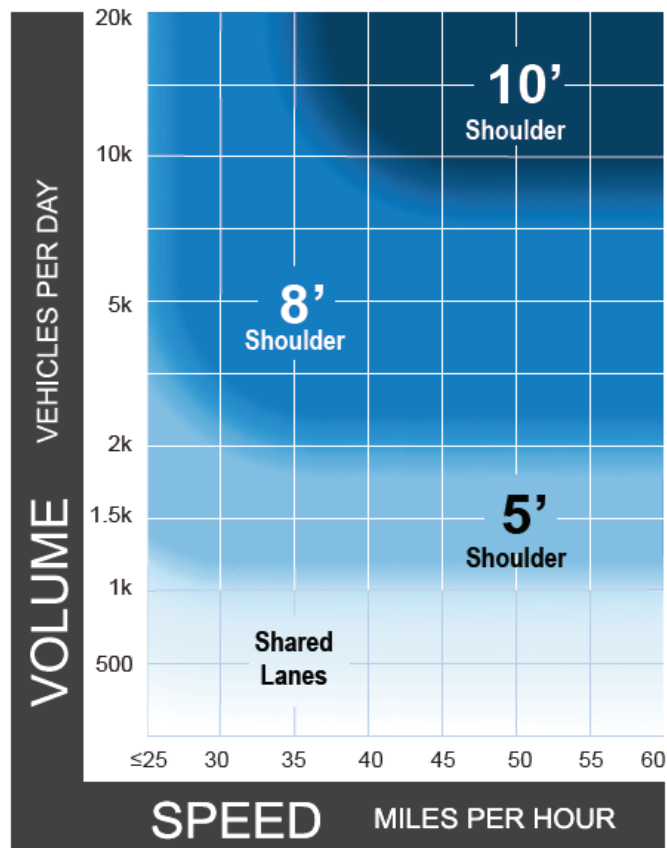
Shared roadways employ a variety of treatments from simple (e.g., no signage or markings or simple signage and shared-lane markings) to complex (e.g., use of directional signage, traffic diverters, chicanes, chokers, and/or other traffic calming devices to reduce vehicle speeds or volumes).

14.3.1.a – Rural Conditions

In rural areas, bicycles will most often be accommodated through a shared roadway with no signing or markings. However, the suitability of a shared roadway decreases as traffic speeds and volumes increase, particularly on roads with sight-distance challenges. Where bicycle use or demand is potentially high and motor vehicle volumes and speeds are high, roads should be either physically widened or via striping to include paved shoulders or shoulder bikeways (shoulder bikeways are part of an intentional bikeway network and have intersection treatments).

Exhibit 14.3.1 illustrates recommended shoulder widths for accommodating bicycles based on corridor speed and volume. Chapter 12 of this manual provides details on the design of rumble strips.

Exhibit 14.3.1 Shoulder Width Considerations for Rural, Rural Town, and Suburban Bicycle Accommodations



Notes

- 1 This chart assumes the project involves reconstruction or retrofit in constrained conditions. For new construction, follow recommended shoulder widths in the AASHTO Green Book.
- 2 A separated shared use pathway is a suitable alternative to providing paved shoulders.
- 3 Chart assumes operating speeds are similar to posted speeds. If they differ, use operating speed rather than posted speed.
- 4 If the percentage of heavy vehicles is greater than 10%, consider providing a wider shoulder or a separated pathway.

Source: FHWA Bikeway Selection Guide

14.3.1.b – Signing

The BICYCLE MAY USE FULL LANE sign (R4-11) may be used on roadways where the lanes are too narrow for bicyclists and motorists to operate side by side within a single lane or on roadways with significant volumes (where motorists would likely be delayed while waiting for a gap to pass the bicyclist). The sign informs users that bicyclists have the legal right to claim the lane if the right-hand lane is not wide enough to be safely shared with motor vehicles. Both the MUTCD and Publication 236 provide guidance on sign R4-11.



R4-11

The designer may consider using the SHARE THE ROAD sign (W16-101) where there is a need to warn drivers to watch for bicycles traveling along the roadway, or where the limited available lateral clearance makes it likely that bicyclists will either travel on the roadway or on the shoulder near the roadway. However, this sign is often minimally effective and should not be used alone or to avoid implementing higher-level roadway improvements. The sign is not to be used for long stretches of roadway. It is more useful at key locations or pinch points.



W16-101

For maximum effect, these signs should be used with discretion.

The designer should consider their placement where:

- A relatively high number of cyclists can be expected on the roadway.
- The road narrows for a short distance (such as at the end of a bike lane or bridge approach), and a motorist and bicyclist may unexpectedly find themselves very near each other on the roadway.
- There is a history of bicycle crashes.
- Designated bicycle trails are located on short stretches of a major roadway that has not been improved for bicycling.
- A known conflict exists on the roadway.
- There are sections of roadway adjacent to shared-use paths where some bicyclists choose to ride on the roadway.

Both the MUTCD and Publication 236 provide guidance on sign W16-101. Additionally, Chapter 9 of the MUTCD and AASHTO's *Guide for the Development of Bicycle Facilities* provide information pertaining to signing and pavement markings for bicycle facilities.

14.3.1.c – Suburban and Urbanized Conditions

Many suburban and urban streets can function as shared roadways when traffic speeds and volumes are commensurate to the bicycle facility type. Further, there are many traffic calming techniques that can make these streets more comfortable for both bicyclists and motorists.

Road markings, known as sharrows, are typically used in urban settings to indicate a shared-lane environment for bicycles and motor vehicles.

Sharrows are often used when there is inadequate roadway width or right-of-way to accommodate a separate bicycle facility. These markings assist a bicyclist with lateral positioning in a shared lane that is too narrow for a motor vehicle and a bicycle to travel side-by-side within the same traffic lane. Sharrows alert road users of the lateral location bicyclists are likely to occupy within the traveled way.

Sharrows typically work best on low-speed and low-volume roadways, or to connect short distances between other bicycle facilities. These facilities typically are not major biking routes, but serve as short connections between major routes, into communities, or to other cycling networks.

Publication 111, Chapter 9 of the MUTCD, and AASHTO's *Guide for the Development of Bicycle Facilities* provide guidance on sharrow design and placement.



14.3.1.d – Signed Shared Roadways

Signed shared roadways are facilities shared with motor vehicles and are signed to make drivers aware of possible bicycle presence. They are typically used on roads with low speeds and traffic volumes; however, if appropriate, these facilities can be used on roads with higher volumes or speeds.

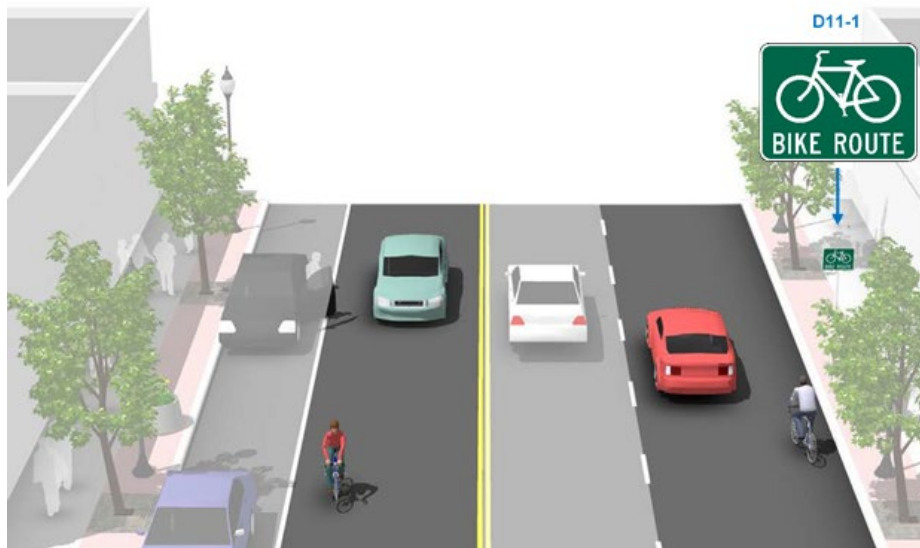
Usually, a motorist will have to cross into the adjacent travel lane to pass a bicyclist, unless a wide outside lane or shoulder is provided.

Signed shared roadways provide continuity with other bicycle facilities (usually bike lanes) or designate preferred routes through high-demand corridors. These facilities provide directional guidance and a wayfinding element for bicyclists, as well as alert motorists to the presence of bicyclists. However, the bicyclist is not provided with lane positioning guidance otherwise afforded through lane markings or sharrows.

Guidance

Bike route signage (i.e., D11-1 sign) should be applied at intervals frequent enough to remind motorists of the presence of bicyclists. Commonly, this includes placement at:

- The beginning or end of a bicycle route.
- At major changes in direction or at intersections with other bicycle routes.
- At intervals along a bicycle route, not to exceed 0.5 miles.



14.3.1.e – Marked Shared Roadways

A marked shared roadway is a general-purpose travel lane delineated with shared-lane markings and possibly signed as a bike route to encourage proper positioning within the lane.

In constrained conditions, shared-lane markings are placed in the middle of the lane. On a wide outside lane, shared-lane markings can be used to promote bicycle travel to the right of motor vehicles. Shared-lane markings should always be placed outside of the door zone of parked cars.

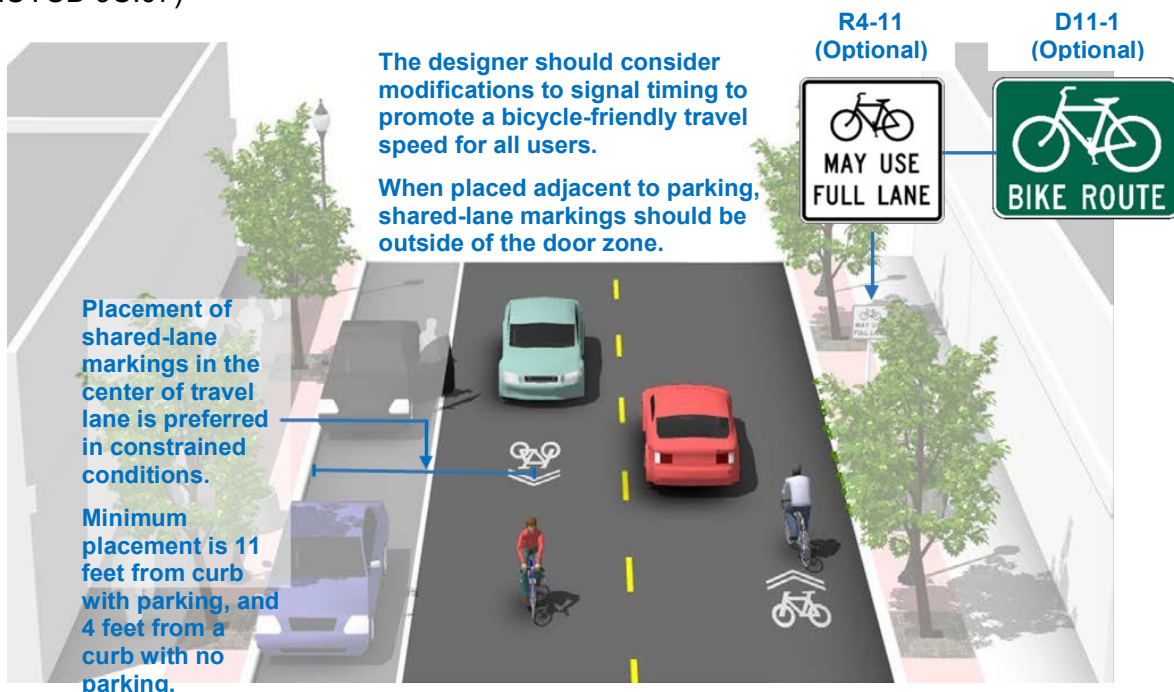
On a collector or arterial roadway, shared-lane markings should not be a substitute for dedicated bicycle facilities if space is available.

The designer should consider bike lanes on roadways with outside travel lanes wider than 14 feet, or where other lane narrowing, or removal strategies may provide adequate road space.

Shared-lane markings shall not be used on shoulders, in designated bike lanes, or to designate bicycle detection at signalized intersections. (MUTCD 9C.07)

Guidance

- Shared-lane markings may be used on streets with a speed limit of 35 mph or lower (with a speed limit lower than 30 mph preferable).
- In constrained conditions, the preferred placement of shared-lane markings is in the center of the travel lane. This minimizes wear and promotes single-file travel.
- The minimal placement of the shared-lane marking centerline is 11 feet from the edge of a curb with on-street parking and 4 feet from the edge of a curb with no parking. If the parking lane is wider than 7.5 feet, the shared-lane marking should be moved out accordingly.



14.3.1.f – Shared Roadway Adjacent to Diagonal Parking

In areas with high parking demand, such as urban commercial centers, diagonal parking (also called angle parking) can be used to increase parking supply.

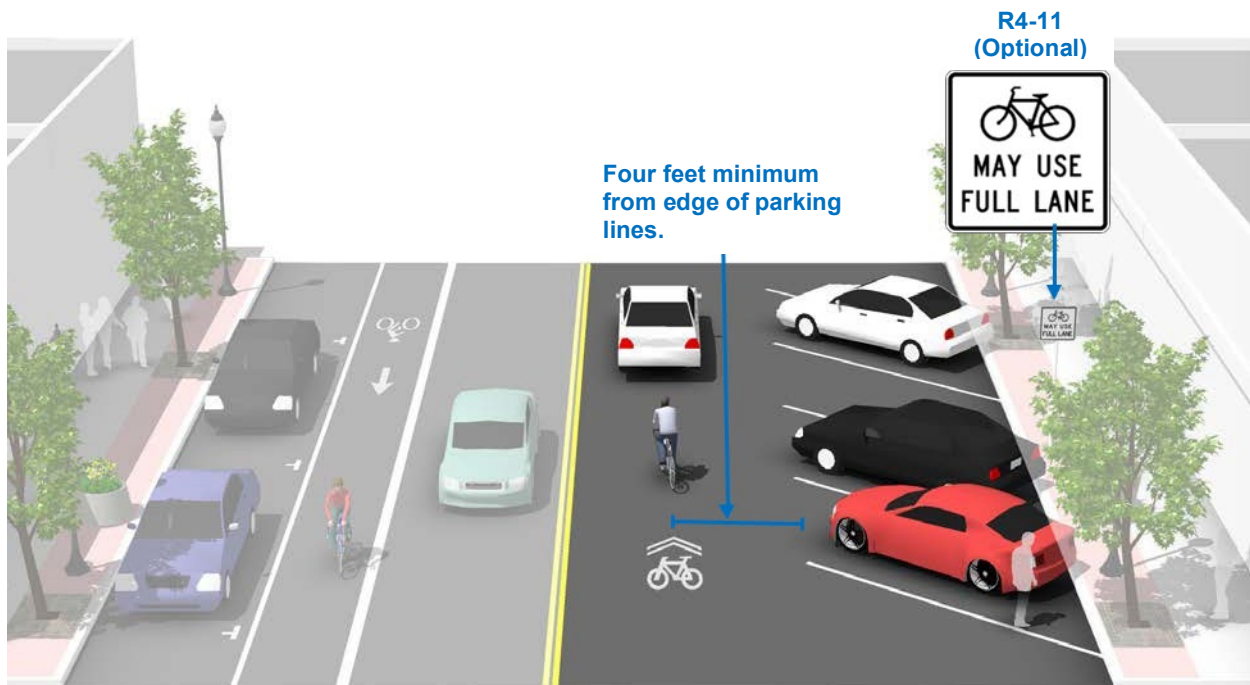
When compared to conventional front-in diagonal parking, front-out diagonal parking improves sight distances between drivers and bicyclists. Front-out diagonal parking also provides additional benefits, including loading and unloading of the trunk at the curb rather than in the street.

Front-out diagonal parking is typically an easier maneuver for drivers than conventional parallel parking. However, there may be encroachment into the sidewalk or pedestrian zone if an insufficient buffer is provided.

Conversely, front-in diagonal parking is not compatible or recommended in conjunction with high levels of bicycle traffic, as drivers backing out may have poor visibility in regard to approaching bicyclists.

Guidance

- In constrained conditions, the preferred placement is in the center of the travel lane to minimize wear and promote single file travel.
- Minimum placement of the shared-lane marking centerline is 4 feet from the edge of parking lines.



14.3.2 – Bicycle Boulevards

Bicycle Boulevards, also known as Neighborhood Greenways, take the shared roadway bike facility to another level by creating a convenient and comfortable bicycling environment for cyclists of all ages and skill levels.

Bicycle boulevards are low-volume and low-speed streets optimized for bicycle travel with treatments such as traffic calming and traffic reduction, signage and pavement markings, and improved intersection crossings. These treatments allow through movements for bicyclists while discouraging similar trips by non-local motorized traffic. They also maintain reasonable motor-vehicle access to properties along the route and to adjacent collector and arterial roads.

Although bicycle boulevards vary greatly in their individual design elements, each shares the common theme of reducing the volume and speed of motor vehicle traffic (particularly non-local, cut-through traffic), and creating a comfortable space where bicyclists, and often pedestrians, have priority along the street.

The primary characteristics of a bicycle boulevard include:

- Low motor vehicle volumes.
- Low motor vehicle speeds.
- Logical, direct, and continuous routes that are well marked and signed.
- Convenient access to desired destinations.
- Minimal bicyclist delay.
- Comfortable and safe crossings for cyclists at intersections.



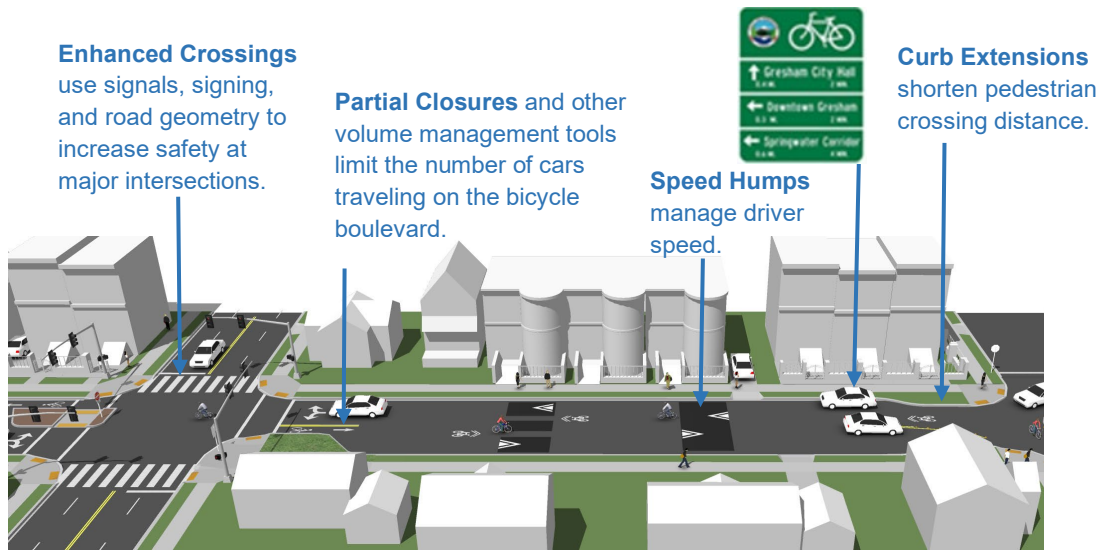
Some local streets may already provide optimal traffic conditions for a bicycle boulevard, requiring little more than signage and pavement markings to create the bikeway. Other streets, particularly roadways used frequently by motorists for through-trips, require features that reduce motor vehicle speeds and volumes and assist bicyclists in crossing busy intersections.

The specific design elements for creating a bicycle boulevard must be tailored to the unique conditions of each corridor. A variety of design options are available, including traffic calming, signage and pavement markings, traffic reduction strategies, intersection treatments, and prioritization of bicyclist travel. All or some of these elements may be employed on a single corridor depending on how favorable existing conditions are for bicycle travel.

Transportation professionals must employ good engineering judgment in selecting the combination of treatments to create the ideal conditions for a bicycle boulevard. The National Association of City Transportation Officials' *Urban Bikeway Design Guide* provides additional guidance in creating bicycle boulevards.

Guidance

- Signs and pavement markings are the minimum treatments necessary to designate a street as a bicycle boulevard.
- Bicycle boulevards ideally should have a maximum posted speed of 25 mph.
- A speed differential between motor vehicles and cyclists of no more than 15 mph is desirable.
- Volume control treatments should be based on the context of the bicycle boulevard, using engineering judgement. Target motor vehicle volumes is less than 3,000 vehicles per day.
- Intersection crossings should be designed to enhance safety and minimize delay for bicyclists.
- Messages and installation of bicycle guide signs should follow the Tourist Oriented Directional Signs Policy described in Publication 46.



Bicycle Boulevards (Neighborhood Greenways) are not recommended for streets with traffic volumes higher than 3,000 vehicles/day. However, a segment of a neighborhood greenway may accommodate more traffic for a short distance, if necessary, to complete the corridor. Providing additional separation with a bike lane, protected bike lane, or other treatment is recommended where traffic calming or diversion cannot reduce volumes below this threshold.

14.3.2.a – Basic Treatments

At a minimum, signs and pavement markings are a necessity in designating a street as a bicycle boulevard or neighborhood greenway for both bicyclists and motorists. Signs and pavement markings also help bicyclists remain on the designated route.



Wayfinding signs displaying destinations, distances, and riding time can help to dispel common misperceptions, while increasing users' comfort and accessibility to the neighborhood greenway network.

In addition, signs can direct bicyclists to key destinations, including commercial districts, transit hubs, schools and universities, and other bikeways.

Guidance

Pavement Markings

- Symbols should be placed every 250 to 800 feet along a linear corridor, as well as after every intersection.
- Pavement markings should be placed in the center of the travel lane every 50 to 100 feet on narrow streets where a motor vehicle cannot pass a bicyclist within one lane of traffic.
- The Shared Roadway section of this chapter provides additional information on the use of shared-lane markings.

Signs

- Some cities have developed unique logos or colors for wayfinding signs that help brand their neighborhood greenways. Guidance on Bikeway Signing is contained within the Tourist Oriented Directional Signs Policy described in Publication 46.
- Sign content, design, and intent must be consistent. Colors reserved by the MUTCD for regulatory and warning road signs are not permitted.
- Signs can include information about intersecting bikeways, as well as distance and time information for key destinations.
- A bicycle sign, along with distinctive coloration, can be added to a standard road sign.

14.3.2.b – Vertical Traffic Calming

Speed affects the frequency at which motor vehicles pass bicyclists and the severity of potential crashes. Maintaining motor vehicle speeds closer to that of bicyclists greatly improves bicyclist's comfort on a street. Slower vehicular speeds also improve motorists' ability to see and react to bicyclists and to minimize conflicts at driveways and other turning locations.

Vertical speed control measures include slight rises in the pavement. To cross these rises, motorists and bicyclists must reduce their speed.



Guidance

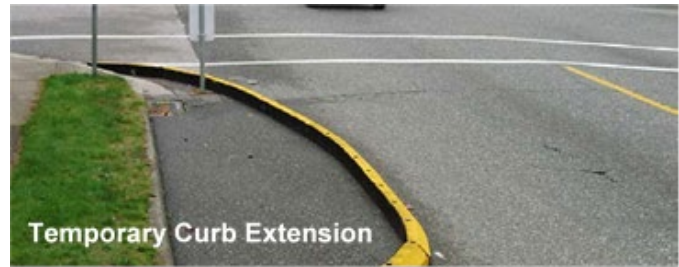
- Bicycle Boulevards (Neighborhood Greenways) should have a maximum posted speed of 25 mph.
- Speed humps are raised areas usually placed in a series across both travel lanes. Speed humps can be challenging for bicyclists. They can force an unavoidable camber that tips over a three-wheeled pedal cycle or acts as a barrier to bicyclists with a chronic pain condition. Gaps can be provided in the center or by the curb to aid bicyclists and to improve drainage.
- Speed humps or cushions can be offset or contain gaps to accommodate the wheel tracks of emergency vehicles. A 14-foot long hump reduces impacts to emergency vehicles.
- Flat-topped speed tables are longer than speed humps. Raised crosswalks are speed tables that are marked and signed for a pedestrian crossing.
- The designer can refer to Chapter 18 of this manual for guidance on vertical traffic calming and specific design dimensions.

14.3.2.c – Horizontal Traffic Calming

Horizontal traffic calming devices cause drivers to slow down by constricting the roadway space or requiring careful maneuvering. Such measures may reduce the design speed of a street and can be used in conjunction with reduced speed limits to reinforce the expectation of lowered speeds.

Horizontal speed control measures should not infringe on bicycle space. Where possible, the design should provide a bicycle route outside of the measure, so bicyclists can avoid having to merge into traffic at a narrow pinch point.

These measures can be implemented on a trial basis. Vehicle volumes on adjacent streets should be monitored to determine whether traffic calming results in undesirable traffic diversion. Please see Chapter 18, Traffic Calming, for further information.



Guidance

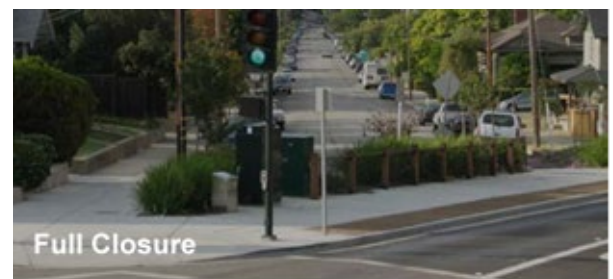
- The design should maintain a minimum clear width of 20 feet (or 28 feet with parking on both sides), with a constricted length of at least 20 feet in the direction of travel.
- Chicanes are a series of raised or delineated curb extensions, edge islands, or parking bays on alternating sides of a street forming a S-shaped curb. They reduce vehicle speeds by requiring motorists to shift laterally through narrowed travel lanes.
- Pinch points are curb extensions placed on both sides of the street, narrowing the travel lane and encouraging all road users to slow down. When placed at intersections, pinch points are known as chokers or neckdowns. They reduce curb radii and further lower motor vehicle speeds.
- Mini-roundabouts can be used at minor street intersections in low speed environments. Mini-Roundabouts are small roundabouts with a fully traversable central island and splitter islands that are raised or delineated.

14.3.2.d – Traffic Diversion

Motor-vehicle traffic volumes affect the operation of a Bicycle Boulevard (Neighborhood Greenway). Higher vehicle volumes reduce bicyclists' comfort and can result in more conflicts. Using engineering judgment, the designer should implement volume control treatments based on the context of the neighborhood. Target motor vehicle volumes should be less than 3,000 vehicles per day. Above these volumes, the route should be striped as a bike lane or considered for a signed shared roadway.

Guidance

- Traffic diversion treatments reduce motor vehicle volumes by completely or partially restricting through-traffic on a neighborhood greenway.
- Partial closures allow full bicycle passage while restricting vehicle access to one-way traffic.
- Diagonal diverters require all motor vehicle traffic to turn.
- Median diverters provide a refuge for bicyclists to cross in two stages by restricting through motor vehicle movements.
- Street closures create a “T” that blocks motor vehicles from continuing on a neighborhood greenway, while allowing bicycle travel to continue unimpeded. Full closures can accommodate emergency vehicles by using mountable curbs that are a maximum of 6 inches high.



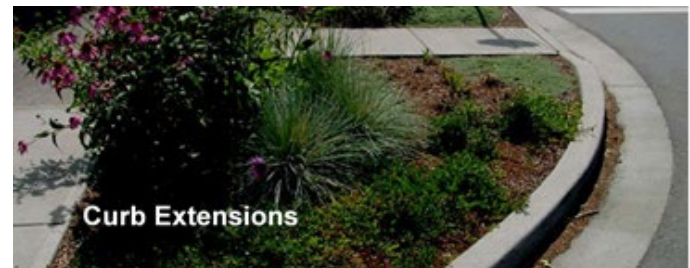
14.3.2.e – Minor Intersection Treatments

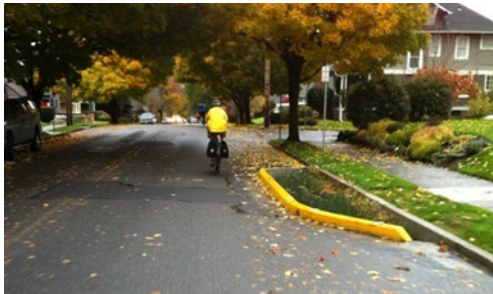
Treatments at minor roadway intersections (typically stop, yield or uncontrolled traffic control intersections) are designed to improve the visibility of a Bicycle Boulevard (Neighborhood Greenway), raise motorists' awareness that they are likely to encounter bicyclists, and enhance safety for all road users.

Stop signs increase bicycling time and energy expenditure, frequently leading to bicyclists' and motorists' non-compliance and/or use of other less-desirable routes. Bicycle boulevards should have fewer stops and delays than other local streets.

According to Berkeley, California's *Bicycle Boulevard Design Tools and Guidelines*, a typical bicycle trip of 30 minutes can increase to 40 minutes if there is a stop sign at every block.

However, stop sign removal should be carefully evaluated beforehand. The warrants for stop signs should be re-evaluated to determine possible removal.





Guidance

- On a Bicycle Boulevard (Neighborhood Greenway), most intersections with minor roadways should stop-control cross traffic to minimize bicyclist delay. This will maximize bicycling efficiency.
- Mini-roundabouts can be used at minor street intersections in low speed environments. Roundabouts reduce conflict potential and severity while providing traffic calming in the corridor.
- Roundabouts are yield controlled, typically have pedestrian access, give priority to circulating vehicles, and allow only counter-clockwise circulation.
- If a STOP sign is present on the bicycle boulevard, a second stop bar for bicyclists can be placed closer to the centerline of the cross street than the motorist stop bar. This treatment increases the visibility of bicyclists waiting to cross the street.
- Curb extensions can be used to move bicyclists closer to the centerline. This treatment improves visibility and encourages motorists to let bicyclists cross.

14.3.2.f – Major Intersection Treatments

The quality of treatments at major intersections (one or more major roadway, typically signal-controlled) along a bicycle boulevard that do not include adequate treatments to accommodate all ages and abilities of people on bicycles will become impassible barriers to non-motorized travel and directly conflict with the goals and vision of the Department's Active Transportation Plan. Without treatments for bicyclists, these intersections can become major barriers along the bicycle boulevard and compromise the effectiveness of the route.



Bicycle Boulevard retrofits are typically located on local streets without existing signalized accommodation at collector and arterial roadway crossings. The designer should consider signal warrants (i.e., traffic-control signal needs studies) for crossings of major streets.

Guidance

- A bike box is a designated area at the head of a traffic lane at a signalized intersection that provides bicyclists with a safe and visible way to get ahead of queuing traffic during the red signal phase. Where no separate bicycle signal or regulation exists that allows riders to proceed with the pedestrian signal, the designer should use the upper end of the recommended depth (12-16 feet) for the bike box (*NACTO Urban Bikeway Design Guide*).
- Median islands, provided at uncontrolled intersections of Bicycle Boulevards and major streets, allow bicyclists to cross one direction of traffic at a time as gaps in traffic occur. Again, care must be taken to ensure that the design allows pedal cyclists to use the facility.
- The National Cooperative Highway Research Program's (NCHRP) Report #562, *Improving Pedestrian Safety at Unsignalized Crossings*, offers guidance on the appropriate use of crossing treatments. Treatments are designed to improve visibility and encourage motorists to stop for pedestrians. With engineering judgement, many of the same treatments are appropriate for use along Neighborhood Greenways.

14.3.3 – Visually Separated Bike Lanes

Visually separated bikeways are designated exclusively for bicycle travel. They are generally segregated from vehicle travel lanes by striping and can include pavement markings and other treatments. Visually separated bikeways are most appropriate on arterial and collector streets where higher traffic volumes and speeds warrant greater separation.

See Appendix 14A for bike lane request procedures for new bike lanes.

Visually separated bikeways can increase safety and promote proper riding by:

- Defining road space for bicyclists and motorists, reducing the possibility that motorists will stray into the bicyclists' path.
- Discouraging bicyclists from riding on the sidewalk.
- Reducing the incidence of wrong way riding.
- Reminding motorists that bicyclists have a right to the road.



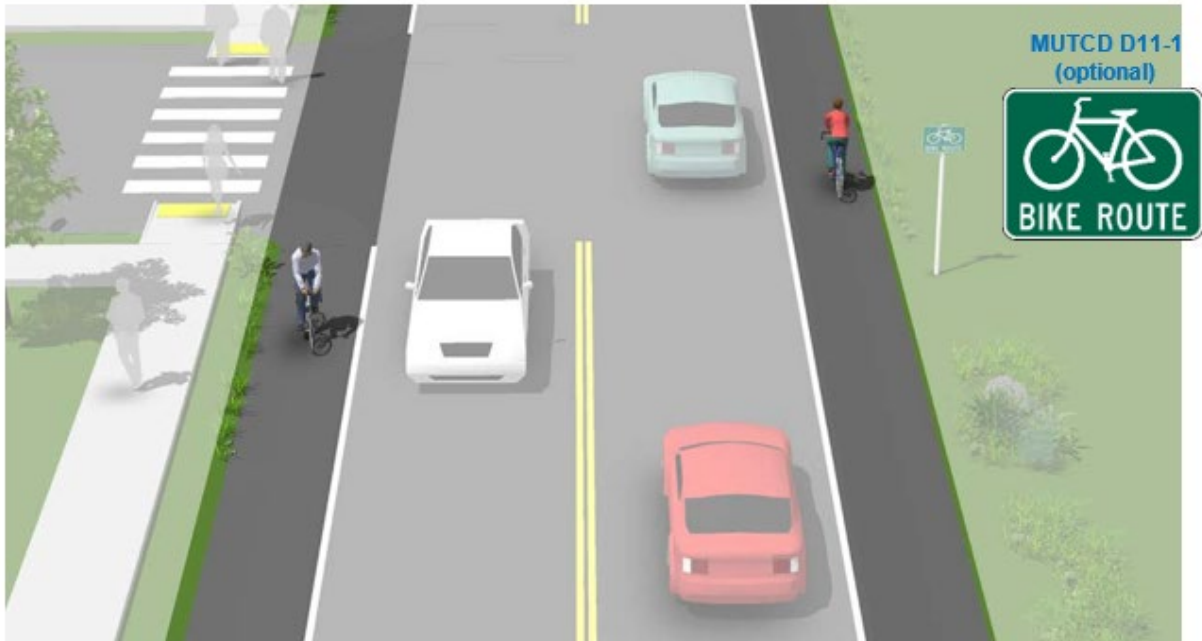
14.3.3.a – Shoulder Bikeways/Bike Lanes

Besides providing an area for bicyclists to ride on, paved shoulders are provided on rural highways for a variety of safety, operational, and maintenance reasons (including emergency stopping for motorists, escapes from potential crashes, and stormwater discharge).

Typically found in less-dense areas, shoulder bikeways are paved roadways with striped shoulders wide enough for bicycle travel (i.e., 4 feet or more). Shoulder bikeways may (but not always) include signage alerting motorists to expect bicycle travel along the roadway.

Guidance

- If 4 feet or more is available for bicycle travel, the full bike lane treatment including signs, pavement markings, and a 6-inch lane line would be provided.
- Rumble strips are not recommended on shoulders used by bicyclists unless there is a minimum 4-foot clear path.
- The minimum functional width for a paved shoulder used by bicyclists is 4 feet (especially if placed between rumble strips and the edge of pavement).



14.3.3.b – Conventional Bike Lanes

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

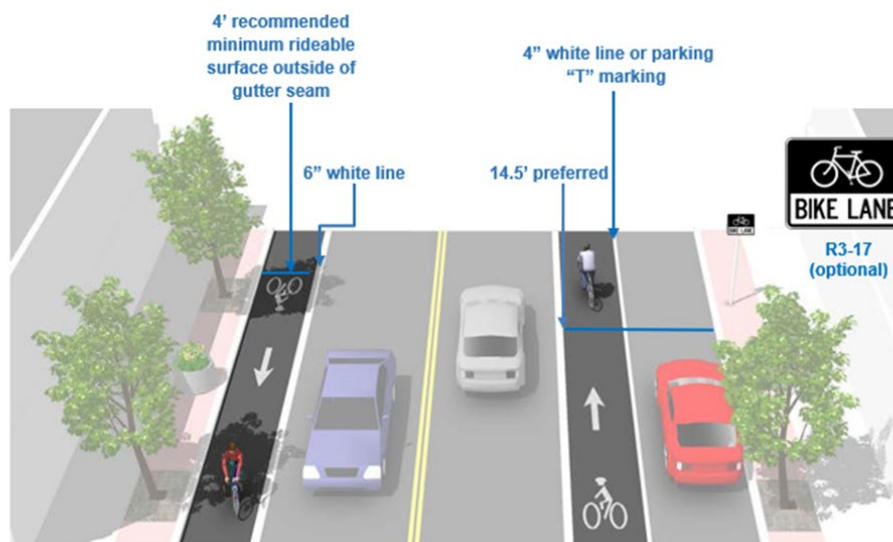
Many bicyclists, particularly less experienced riders, are more comfortable riding on a busy street if it has a striped, signed, and physically separated bikeway.

Wider bicycle lanes are desirable in certain situations, such as on arterials with speeds exceeding 45 mph. In these situations, the use of a wider bicycle lane increases separation between passing vehicles and bicyclists.

Appropriately signing and pavement marking of wide bicycle lanes is important to ensure motorists do not mistake the bicycle lane for a vehicle lane or parking lane. The designer should consider buffered and separated bike lanes when further separation is desired.

Guidance

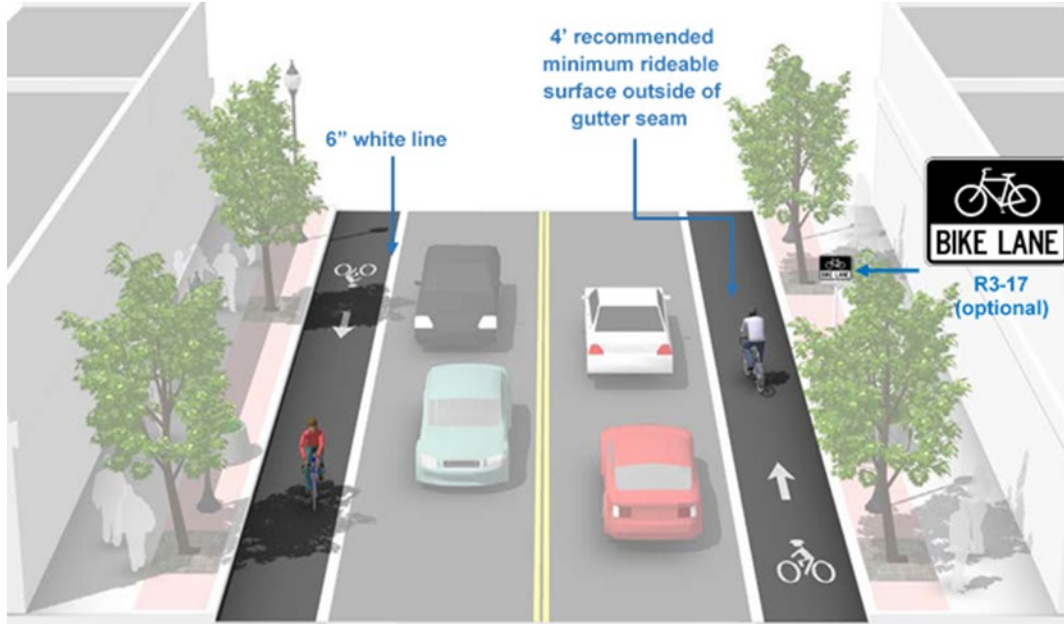
- The minimum bike lane width should be 4 feet when no curb is present or 5 feet if there is curb without gutter.
- When adjacent to a vertical curb and gutter, the width of bike lane shall be a minimum of four feet and will not include the gutter seam.
- The minimum width from the curb face to the edge of the bike lane should be 12 feet (with a preferred width of 14.5 feet if a 4-foot bike lane width is used) when on-street parking is present.
- The maximum width of the bike lane should be 7 feet when adjacent to arterials with high travel speeds. Greater widths may encourage motor vehicle use of bike lane.
- Bike lanes can be configured as buffered bicycle lanes when a wider facility is desired.



14.3.3.c – Bike Lane Without On-Street Parking

Wider bicycle lanes are desirable in certain situations, such as on arterials with speeds exceeding 45 mph. In these situations, the use of a wider bicycle lane would increase separation between passing vehicles and bicyclists.

Appropriately signing and pavement marking of wide bicycle lanes is important to ensure motorists do not mistake the bicycle lane for a vehicle lane or parking lane. The designer should consider buffered and separated bike lanes when further separation is desired.

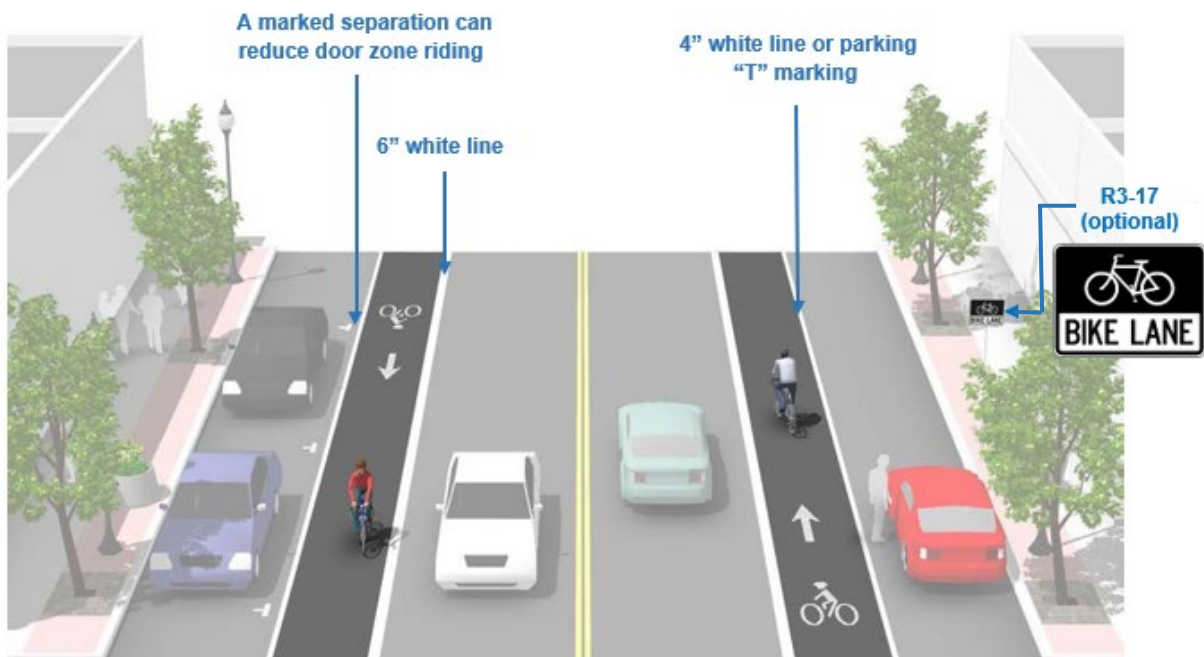


14.3.3.d – Bike Lane Adjacent to On-Street Parallel Parking

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

Bike lanes adjacent to on-street parallel parking require special treatment to avoid crashes caused by an open vehicle door. The bike lane should have sufficient width to allow bicyclists to maneuver out of the door zone. Note the door zone is typically 4 feet wide and may consist of the parking width markings area, a buffer area between parking area and the bike lane, and/or a portion of the bike lane. The minimum width from the curb face to the edge of the vehicle travel lane / bike lane should be 12 feet. The preferred width is 14.5 feet if a 4-foot bike lane width is used.

Parking stall markings (i.e., parking “T” markings) create a parking-side buffer that encourages bicyclists to ride farther away from the door zone and motorists to park closer to the curb. However, there is often limited room available and the full width of the bike lane cannot be provided. This should not discourage placement of a narrower bike lane, as drivers and vehicle occupants have a responsibility to confirm bicyclists are not at risk of being “doored” when exiting their vehicle. The minimum distance between the “T” markings and the line lane marking is 6 inches.



14.3.3.e – Bike Lanes and Diagonal Parking

Front-out diagonal parking is strongly preferred (as compared to front-in diagonal parking), as it improves sight distances between drivers and bicyclists. Front-out parking is best paired with a dedicated bicycle lane.

Conventional front-in diagonal parking is not compatible or recommended with the provision of bike lanes, as drivers backing out have limited visibility of approaching bicyclists. Under these conditions, shared-lane markings should be used to guide bicyclists away from reversing automobiles.

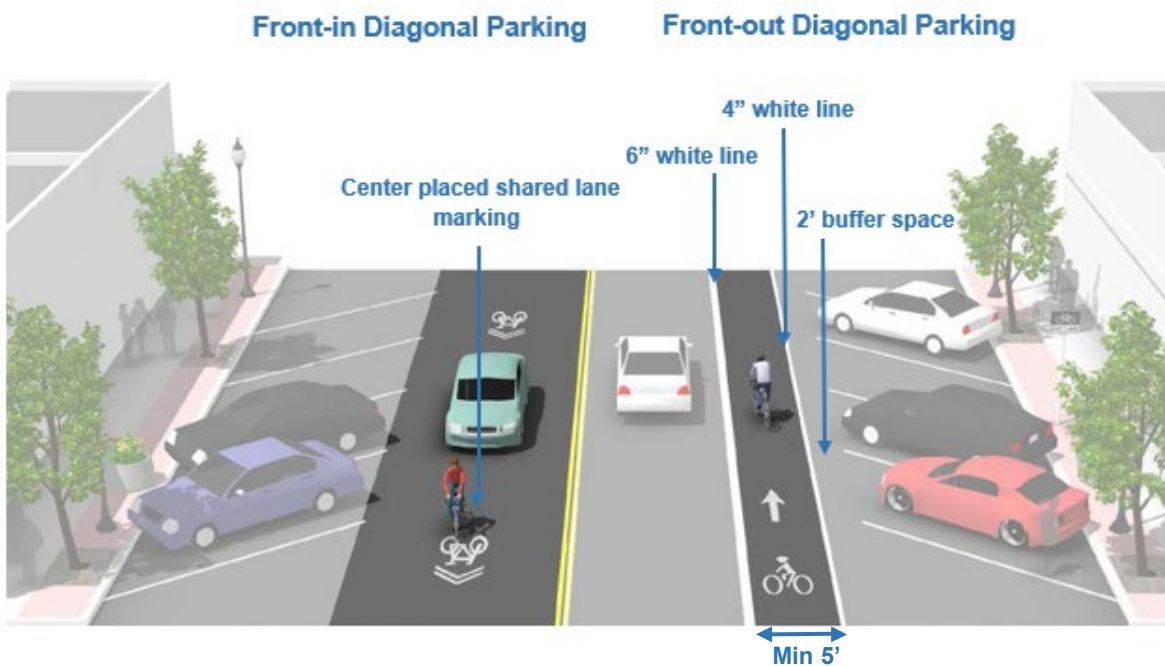
Guidance

Front-in Diagonal Parking

- Shared-lane markings are the preferred facility type.

Front-out Diagonal Parking

- The bike lane has a minimum 5-foot marked width.
- Parking bays are sufficiently long to accommodate most vehicles (so vehicles do not block the bike lane).



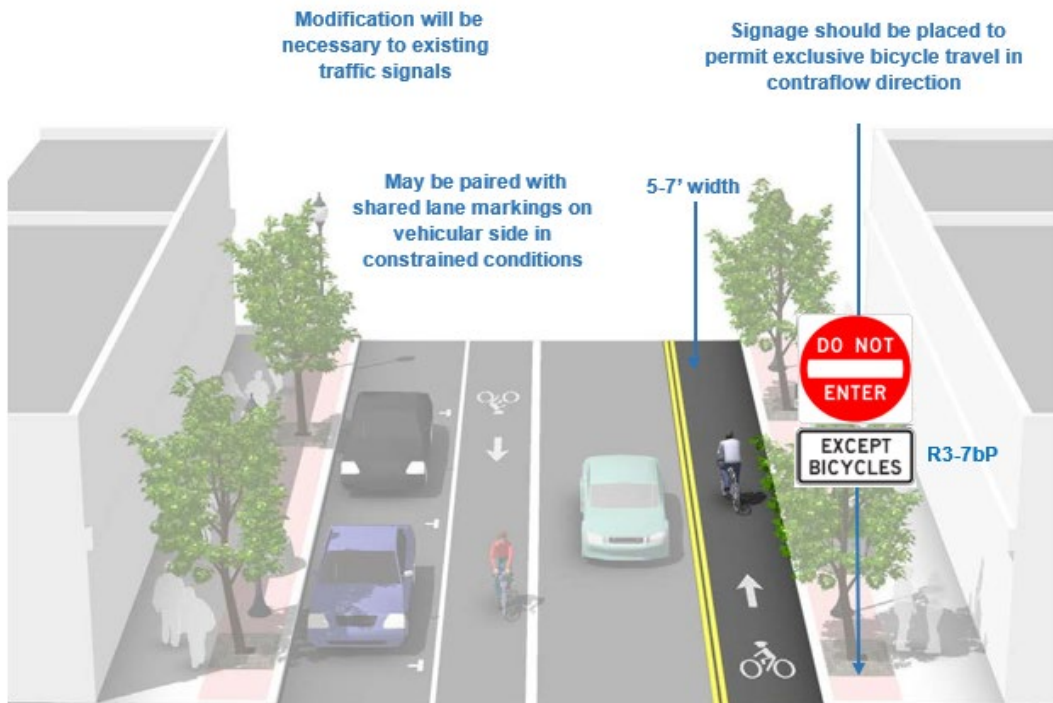
14.3.3.f – Contraflow Bike Lanes

Contraflow bike lanes provide bidirectional bicycle access on a roadway that is one-way for motor vehicle traffic. This treatment can provide direct access and substantially increase network connectivity for people on bicycles. Creating a one-way road from a two-lane roadway by replacing a motor vehicle travel lane with a contraflow bike lane can reduce traffic volumes and speeds in residential neighborhoods. Contraflow lanes should be on the left side from the direction of motor vehicle travel for the road.

Because of the opposing direction of travel, contraflow bike lanes increase the speed differential between bicyclists and motor vehicles in the adjacent travel lane. If space permits, the designer should consider a buffered bike lane or protected bike lane configuration to provide additional separation.

Guidance

- The contraflow bike lane should be 5 to 7 feet wide and marked with a solid double yellow line and appropriate signage. Bike-lane markings should be clearly visible to ensure that the contraflow lane is exclusively for bicycles. The designer should consider coloration in the bike lane.
- Signage specifically allowing bicycles at the entrance of the contraflow lane is necessary.



14.3.3.h – Buffered Bike Lanes

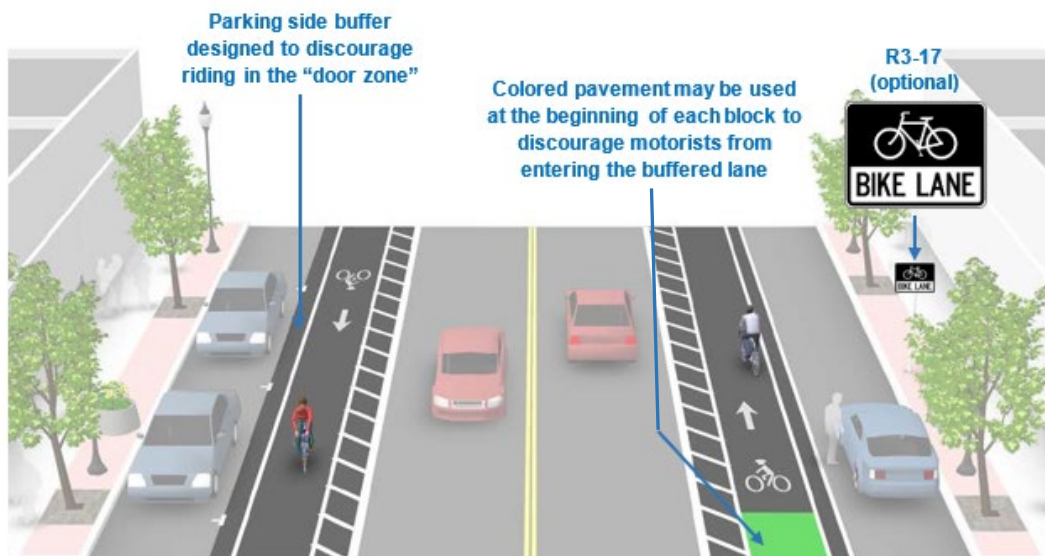
Buffered bike lanes are conventional bicycle lanes paired with a designated buffer space, separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane. Buffered bike lanes follow general guidance for buffered preferential vehicle lanes as per MUTCD guidelines.

Buffered bike lanes are designed to increase the space between the bike lane and the travel lane and/or parked cars. This treatment is appropriate for bike lanes on roadways with high motor vehicle traffic volumes and speed, adjacent to parking lanes, or a high volume of truck or oversized vehicle traffic.

The frequency of right turns by motor vehicles at major intersections should determine whether continuous or truncated buffer striping should be used approaching the intersection. The MUTCD recommends 50 to 200 feet of dotted line in advance of the intersection, depending on the presence of bus stops and the volume of right turns. Commonly configured as a buffer between the bicycle lane and motor vehicle travel lane, a parking side buffer may also be provided to help bicyclists avoid the door zone of parked cars.

Guidance

- The minimum bicycle travel area (not including buffer) is 4-feet wide, 5 to 7 feet preferred to allow passing.
- Buffers should be at least 2-feet wide. Buffers 3 feet or wider should contain gore markings. For clarity at driveways or minor street crossings, the designer should consider a dotted line for the inside buffer boundary where cars are expected to cross.
- Buffered bike lanes can buffer just the travel lane, or just the parking lane depending on available space and the objectives of the design.
- The MUTCD recommends 50 to 200 feet of dotted line in advance of the intersection if needed to accommodate bus stops and/or vehicular right turns at the intersection.



14.3.4 – Physically Separated Bike Lanes

Physically separated/protected bike lanes are considered among the most desirable and safest of all on-road bicycle facilities. These facilities are considered protected because they separate bicycle travel from both motor vehicle lanes and pedestrian facilities through a physical form of vertical separation (e.g., delineators) and horizontal separation as necessary and appropriate. This type of facility is most suitable for urban roadways where high traffic volumes or speed warrant increased separation between bicycles and motor vehicles. However, the designer may consider this facility in suburban or even rural contexts, if warranted.



Depending on the roadway context, separated bike lanes may be designed for two-way or one-way bicycle travel along either side of a roadway. These facilities can be constructed at the street level, at the intermediate level between the sidewalk and the street, or at the same elevation as the sidewalk.

Depending on the roadway context and the comfort level required by facility users, the form of separation may contain one or a combination of the following applications:

- Painted Buffer Zone with Flexible Delineators
- Raised Curb or Median

The designer may consider other similar separation applications, but these features will require the Director of Bureau of Project Delivery approval. These facilities are also required to go through the formal request process for installation of a bicycle lane. When introducing any barrier/fixed object, the designer must consider safety as it relates to all modes.



Additionally, the designer needs to address changes in drainage patterns and ADA considerations, as well as assess maintenance impacts, prior to the implementation of any of the separation applications. AASHTO's *Roadside Design Guide* does allow flexibility in the use of barriers on low-speed roadways.

Although separated bike lanes help to protect cyclists from potential conflicts with motor vehicles, they may also restrict the cyclists' ability to make left turns or access mid-block destinations. To accommodate turning movements for all modes, the design should consider traffic signalization at intersections or expected crossing points, if warranted.

Contraflow bike lanes may also be designed as separated bike lanes. As previously discussed, a contraflow bike lane is a dedicated lane that travels in the opposite direction of traffic. These are most often used on one-way streets. Contraflow lanes should be on the left side from the direction of motor vehicle travel for the road.

When installing either a contraflow or a two-way separated bike lane, signage and pavement markings are vital for informing roadway users to expect opposing bicycle traffic and to ensure that only bicyclists use the bicycle facility.

The designer should address sight distances at intersections and driveways. Furthermore, on-street parking, vegetation, and other street appurtenances should be evaluated and potentially removed at conflict points to maintain sight distances.

Two-way separated bikeways intended for contraflow require a higher level of control at intersections to allow for a variety of turning movements. These movements should be guided by separated signals for bicycles and motor vehicles.



Transitions into and out of two-way protected bike lanes should be simple and easy, deterring bicyclists from continuing to ride against the flow of traffic.

At driveways and minor intersections, bicyclists riding against roadway traffic in two-way protected bike lanes may surprise pedestrians and drivers not expecting bidirectional travel. To minimize risks, the design requires appropriate signage.

14.3.4.a – Bikeway Separation and Placement

Separation is provided through physical barriers. Separated bike lanes using these protection elements typically share the same elevation as adjacent travel lanes.

Raised and separated bike lanes may be level with the adjacent sidewalk or set at an intermediate level between the roadway and sidewalk to separate the bikeway from the pedestrian area.

Sidewalks or other pedestrian facilities should rarely be narrowed to accommodate the protected bike lane, as pedestrians will likely walk on the bike lane if sidewalk capacity is reduced. Visual and physical cues (e.g., pavement markings and signage) should be used to clearly indicate where bicyclists and pedestrians should travel. If possible, the design should

separate the protected bike lane and pedestrian zone with a furnishing zone. The designer can also refer to Chapter 13 for more information on ADA guidance for more information.

Guidance

- Protected bike lanes should ideally be placed along streets with long blocks and few driveways or mid-block motor vehicle access points.
- Protected bike lanes located on one-way streets have fewer potential conflict areas than those on two-way streets.
- In situations where on-street parking is allowed, protected bike lanes shall be located between the parking lane and the sidewalk.

14.3.4.b – One-Way Separated Bike Lanes

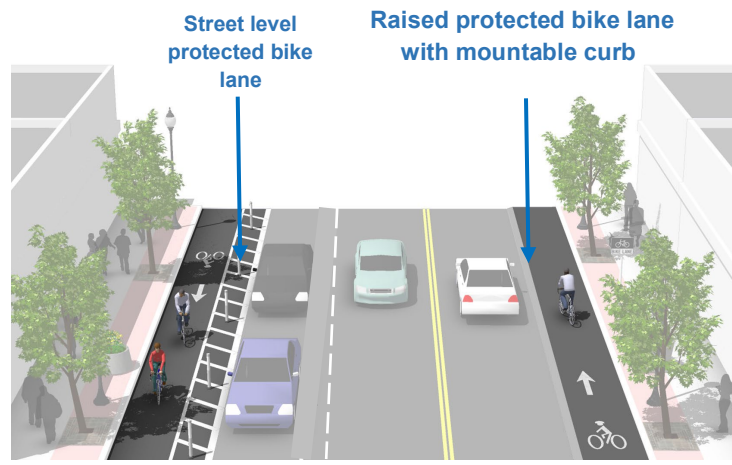
One-way separated bike lanes are physically separated/protected from motor vehicle traffic and distinct from the sidewalk. Protected bike lanes are either raised or at street level and use a variety of elements for physical protection from passing traffic.

Special consideration should be given in managing bicycle and pedestrian interactions at transit stops. Guidance for these locations is provided in the Federal Highway Administration's (FHWA) *Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts* and the National Association of City Traffic Officials' (NACTO) *Transit Street Design Guide*.

Driveways and minor street crossings present unique challenges to protected bike-lane design. To improve visibility, parking should be prohibited within a range of 30 to 60 feet of the intersection, depending upon the speed of turning vehicles and the driveway or intersection geometry. Color, yield markings, and yield to bikes signage should be used to identify the conflict area and make it clear that the protected bike lane has priority over entering and exiting traffic. If configured as part of a raised protected bike lane, the crossing should be raised so that the sidewalk and protected bike lane maintain their elevation through the crossing.

Guidance

- The minimum width of a one-way separated bike lane is 4 feet (preferred 5 to 7 feet to allow passing).
- When placed adjacent to parking, the parking buffer should be at least 2-feet wide. Buffers 3 feet or wider should contain gore markings.
- When placed adjacent to a travel lane, one-way raised protected bike lanes may be configured with a mountable curb. This allows entry and exit from the bicycle lane for passing other bicyclists or to access vehicular turn lanes.



14.3.4.c – Two-Way Separated Bike Lanes

Two-way separated bike lanes are physically partitioned bike lanes that allow bicycle movement in both directions on one side of the road. Two-way protected bike lanes share some of the same design characteristics as one-way protected bike lanes but may require additional considerations at driveways and side-street crossings.

A two-way protected bike lane may be configured as a separated bike lane at street level with a barrier between the bikeway and the motor vehicle travel lane, or as a raised and physically separated bike lane to provide vertical separation from the adjacent motor vehicle lane.

Two-way protected bike lanes require a higher level of control at intersections to allow for a variety of turning movements. These movements should be guided by separated signals for bicycles and motor vehicles. Transitions into and out of two-way protected bike lanes should be simple and easy to use and should clearly deter bicyclists from continuing to ride against the flow of traffic.

At driveways and minor intersections, bicyclists riding against roadway traffic in two-way protected bike lanes may surprise pedestrians and drivers not expecting bidirectional travel. Therefore, appropriate signage is required. In some cases, the designer may need to consider signalization with separate phasing for bicycles and vehicular left turns, depending on volumes and potential safety concerns.



Guidance

- The minimum width for a two-way facility is 10 feet, with a preferred width of 11 feet.
- In constrained locations for short distances, the minimum width can be reduced to 8 feet.
- When placed adjacent to parking, the parking buffer should be at least 2-feet wide. Buffers 3 feet or wider should contain gore markings.
- The designer should consider bicycle design speeds of 15 mph (unless geometry indicates higher speeds) for sight distance purposes at intersections.

14.3.4.d – Driveways and Minor Street Crossings

The separation provided by protected bike lanes constitutes that additional intersection considerations be addressed.

At driveways and minor street crossings, bicyclists should not be expected to stop at these minor intersections if motorized traffic on the major street does not stop.

However, bicyclist visibility is important at these locations, as a buffer of parked cars or vegetation can reduce the visibility of a bicyclist traveling in the protected bike lane. Markings and signage should be present, alerting all travelers to where bicyclists and pedestrians should be travelling.

Access management should be used to reduce the number of driveway crossings on a protected bike lane because driveway consolidations and restrictions on motorized traffic movements reduce the potential for conflict.

Guidance

- If raised, the height of the protected bike lane should be maintained through the crossing, requiring automobiles to cross over it.
- Parking should be removed 30 feet prior to the intersection.
- Colored pavement markings and/or shared-lane markings should be used through the conflict area.
- Warning signage should be placed to identify the crossing.

14.3.4.e – Major Street Crossings

Separated bike lanes approaching major intersections must minimize or mitigate potential conflicts and provide connections to intersecting facility types.

Maintaining separation between bicyclists and motor vehicle traffic leading up to and through the intersection via a protected intersection design is the best way to improve safety for all roadway users. This prevents several of the most common crash types, including the right hook, left hook, and overtaking, and is supported by research indicating that motorists regularly fail to appropriately scan for pedestrians or cyclists before making turning movements in urban environments.

This treatment includes the use of a bicycle signal phase, which reduces conflicts with motor vehicles by separating bicycle movements from conflicting motor vehicle movements.

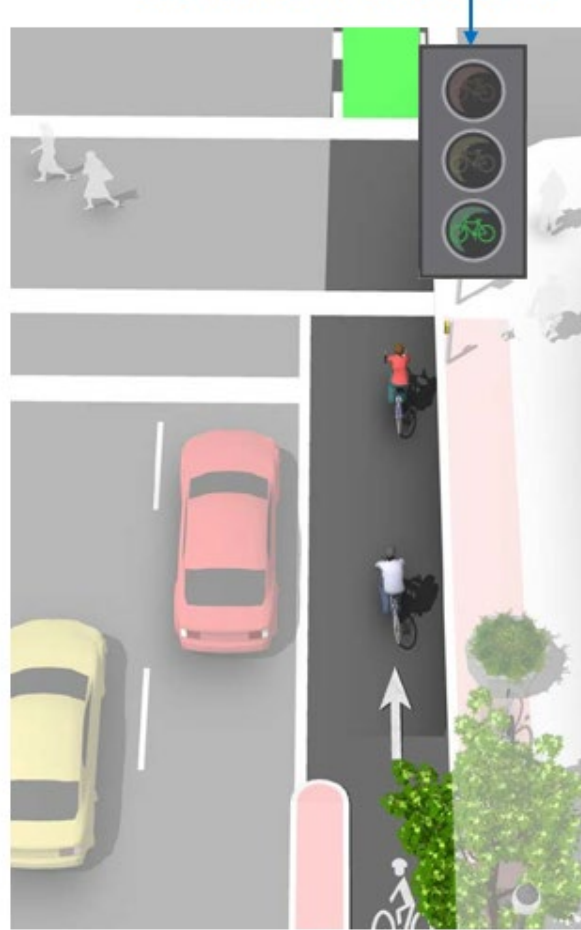
A bicycle signal head can also be set to provide protected bike lane users a green phase in advance of vehicle phases. The length of the signal phase will depend on the width of the intersection. The FHWA Interim

Approval MUTCD IA-16, provides guidance regarding the use of a bicycle signal face, including information about bicycle signal indications, application parameters, design and location of bicycle signal faces, operation, and regulatory signing requirements. Additionally, the guidance provides prohibitions on the use of a bicycle signal face.

Additional bicycle signalization details are provided in Section 14.7.4.d.

Similar conflicts exist at non-signalized intersections. Warning signs, special markings, and the removal of on-street parking in advance of the intersection can raise visibility and awareness of bicyclists.

Demand-only bicycle signals can be implemented to reduce vehicle delay and to prevent an empty signal phase from regularly occurring.



Guidance

- The protected bike lane buffer should be dropped and transitioned to a bike lane 16 feet in advance of the intersection.
- Parking should be removed 16 to 50 feet in advance of the buffer termination.
- A bike box or advanced stop line treatment should be used to place bicyclists in front of traffic.
- Colored pavement markings should be used through the conflict area.
- Two-stage turn boxes should be provided for left-turning movements.
- A protected phase bicycle signal might be considered to isolate conflicts between bicyclists and motor vehicle traffic.
- In constrained conditions with right-turn-only lanes, transitioning to a shared bike lane/turn lane might also be considered.

14.4 – Intersection Treatment Considerations

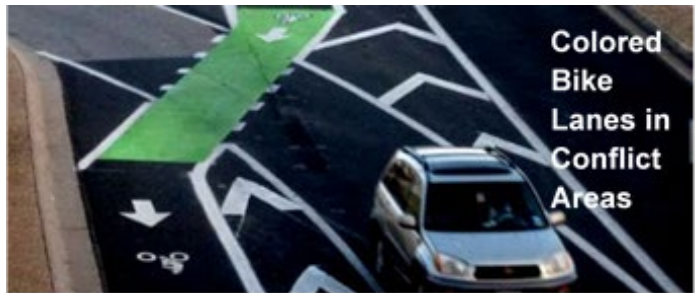
Intersections are junctions where different modes of transportation meet, and facilities overlap. An intersection facilitates the interchange between bicyclists, motorists, pedestrians, and other modes to advance traffic flow in a safe and efficient manner.

Designs for intersections with bicycle facilities should reduce conflict between bicyclists (and other vulnerable road users) and vehicles by heightening the level of visibility, denoting clear right-of-way, and facilitating eye contact and awareness. Intersection treatments can improve both queuing and merging maneuvers for bicyclists and are often coordinated with timed or specialized signals.

The configuration of a safe intersection for bicyclists may include elements such as color, signage, medians, signal detection, and pavement markings. Intersection design should take into consideration existing and anticipated bicyclist, pedestrian, and motorist movements.

In all cases, the degree of mixing or separation between bicyclists and other modes is intended to reduce the risk of crashes and increase bicyclist comfort. The level of treatment required for bicyclists at an intersection will depend on the bicycle facility type used, whether bicycle facilities are intersecting, and the adjacent street function and land use.

Details pertaining to these treatments are provided in AASHTO's *Guide for the Development of Bicycle Facilities*, the MUTCD, and NACTO's *Urban Bikeway Design Guide*.

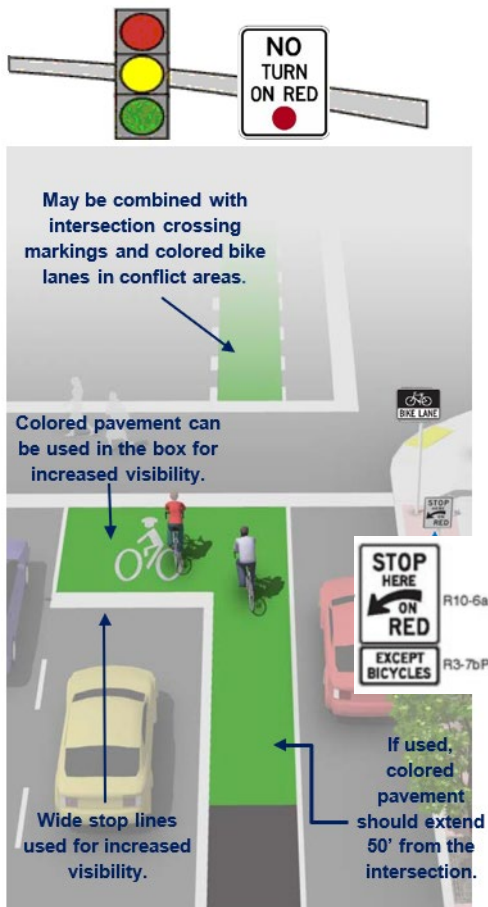


14.4.1 – Bicycle Box

A bicycle box is a designated area located at the head of a traffic lane at a signalized intersection. It provides bicyclists with a safe and visible space to get in front of queuing motorized traffic during the red signal phase. Motor vehicles must queue behind the white stop line at the rear of the bicycle box.

Bicycle boxes should be used in locations with a large volume of bicyclists and are best utilized in central areas where traffic is usually moving more slowly. A bicycle box is not needed if a separated or protected facility is extended to the intersection.

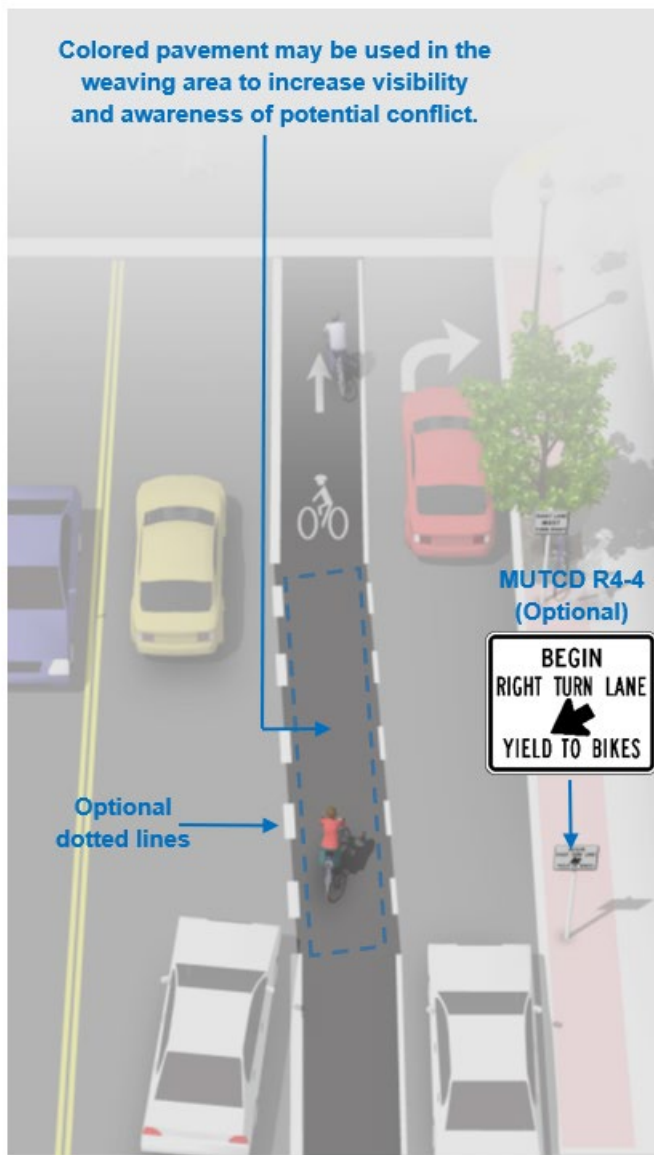
Bicycle boxes should be placed only at signalized intersections, and right turns on red shall be prohibited for motor vehicles. Prohibiting right turns on red improves safety for bicyclists yet does not significantly impede motor vehicle travel. Details about bicycle boxes are provided in the FHWA Interim Approval MUTCD IA-18.



Guidance

- A bicycle box shall be formed by an advance stop line placed at least 10 feet in advance of the intersection stop line.
- At least one bicycle symbol shall be placed within a bicycle box (MUTCD IA-18 provides placement details).
- Where a bicycle box is provided across multiple lanes of an approach, countdown pedestrian signals (per MUTCD Section 4E.07) shall be provided for the crosswalk across the approach on which the bicycle box is located. This informs bicyclists whether there is adequate time remaining to cross to an adjacent lane before the onset of the green signal phase for that approach.
- Turns on red shall be prohibited from the approach where a bicycle box is placed using a NO TURN ON RED (R10-11 series) sign.
- At least 50 feet of bicycle lane should be provided on the approach to a bicycle box.
- A STOP HERE ON RED (R10-6 or R10-6a) sign should be provided at the advance stop line, with an EXCEPT BICYCLES (R3-7bP) plaque below (per MUTCD IA-18).
- Green-colored pavement (per MUTCD IA-14) may be used within a bicycle box and the bicycle-approach lane.

14.4.2 – Bike Lanes at Right-Turn Only Lanes



See the MUTCD for signing and pavement marking details.

The designer should consider eliminating the right-turn-only lane where right-of-way is insufficient to extend the bikeway to the intersection. Or, use a shared bike/turn lane.

Another treatment at right-turn lanes is to place the bike lane between the right-turn lane and the rightmost through lane or, where right-of-way is insufficient, to use a shared bike lane/turn lane.

The graphic on the left illustrates a bike lane pocket, with signage indicating that motorists should yield to bicyclists through the conflict area.

Sections 14.3 and 14.4 of this chapter offer more discussion on potential approaches to providing accommodations for bicyclists at intersections with turn lanes.

The MUTCD, NACTO *Urban Bikeway Design Guide*, Publication 111, and Publication 236 provide more information on signing and pavement marking details.

Along many of Pennsylvania's rural corridors, separate bicycle lanes are not warranted which typically results in bicyclists riding on the shoulder. At intersections along these roadways, the shoulder area is sometimes narrowed to provide room for turn lanes or is completely replaced by them. At these locations, appropriate intersection designs should be used to encourage safe interactions.

Configuration as an On-Street Bike Lane – In this scenario, the shoulder is used as a bike lane and a right-turn lane is introduced to the right of the bike lane. Dotted line extensions should be used to define the tapered entrance into the right-turn lane from the shoulder, and signs should direct motorists to yield to bicyclists. For more information, refer to the guidance on bike lanes and the FHWA's MUTCD.

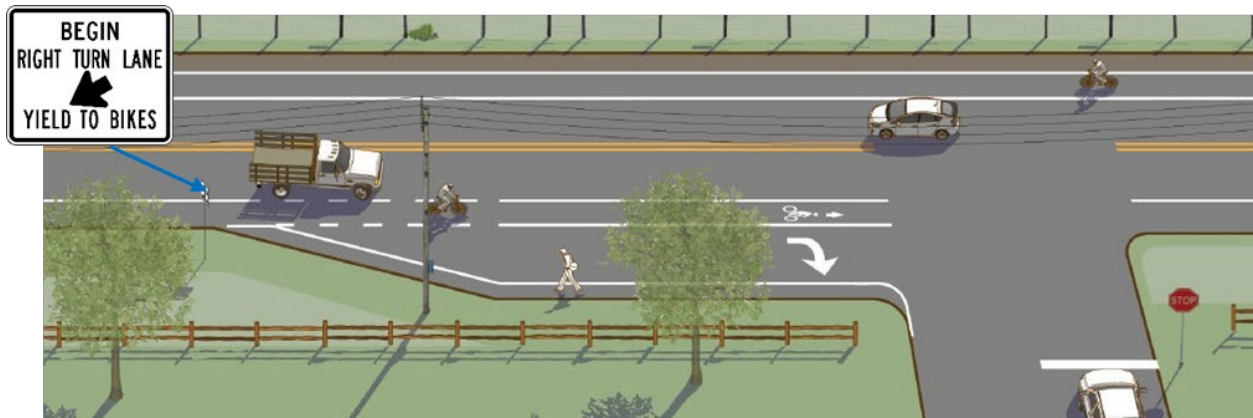
Guidance

At auxiliary right-turn only lanes

- The existing bike lane width should be continued, with a standard width of 5 to 6 feet (or 4 feet in confined locations).
- Signage should be used to indicate that motorists must yield to bicyclists through the conflict area.
- Colored conflict areas may be used to promote visibility of the mixing zone.

Where a through lane becomes a right-turn only lane

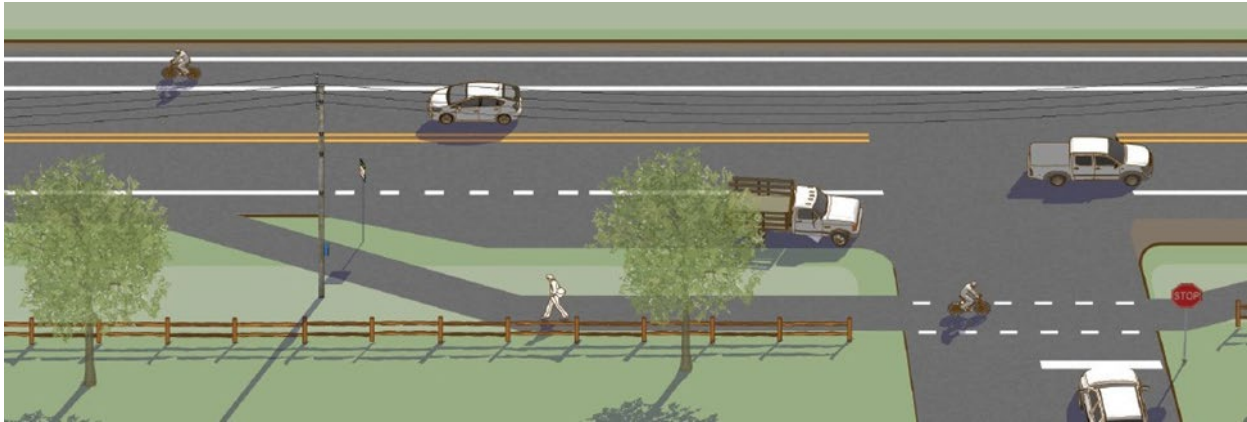
- A dotted-line merging path for bicyclists should not be defined.
- The bicycle lane should be dropped in advance of the merge area.
- Shared-lane markings should be used to indicate shared use of the lane in the merging zone.



Source: FHWA Small Town and Rural Design Guide

Configuration as a Separated Bike Lane or Shared-Use Path – Where a high degree of user comfort is desired, the shoulder may transition into a one-way separated bike lane or shared-use path in advance of intersections. Once established, the separated facility may maintain separation up to the crossing. This increased separation provides an opportunity for motorists to slow in advance of the turn and yield to bicyclists.

More information on separated bike lanes is provided in Section 14.3.1 of this chapter.



Source: FHWA Small Town and Rural Design Guide

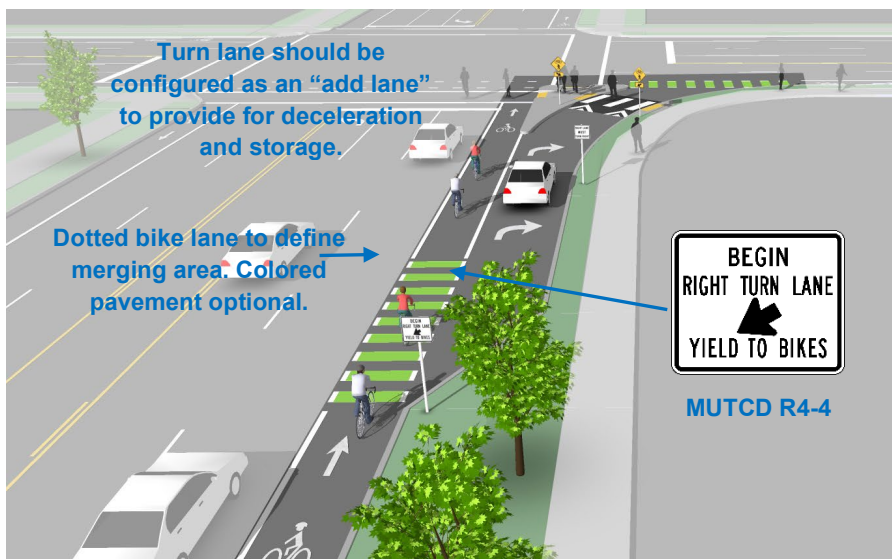
14.4.3 – Channelized Right-Turn Lanes

Traditional solutions, such as configuring the intersection with a channelized turn lane, support more vehicle through-put and reduce queueing. However, they do not improve safety and comfort for cyclists traveling through the intersection. The cyclist needs to pass through a mixing zone from a bicycle facility on the right side of the roadway to vehicular through lane.

As an alternative, the designer should avoid using the channelized free right turn and instead require queuing in stop or signal-controlled intersection before making a turn into the receiving lanes. The designs can include features that support traffic calming features that direct merging of all vehicles into a mixing zone where cyclists can utilize the right-turn lane to continue straight through or potentially the existing through lane. This also has the additional benefit of producing a safer environment for pedestrians.

Guidance

- The preferred angle of intersection between the channelized turn lane and the joined roadway is no more than 15 degrees. This allows for simultaneous visibility of pedestrians and potential roadway gaps.
- The design should incorporate a maximum 30- to 35-foot turning radius.
- Signing should include the PEDESTRIAN CROSSING sign assembly (i.e., W11-2) or YIELD sign (i.e., R1-2) to encourage yielding. The YIELD TO BIKES (i.e., R4-4) or similar signage should be used if bike lanes are present.
- Incorporating raised crossings in the channelized turn lane may slow driver speed through the turning area.

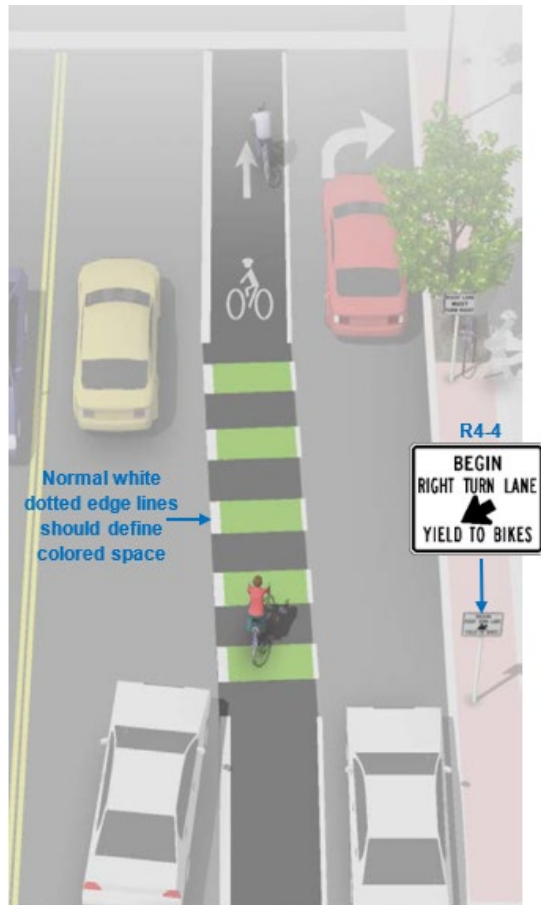


Add Lane Configuration Option



Slip Lane Configuration Option
(Not a preferred condition)

14.4.4 – Colored Bike Lanes in Conflict Areas



Colored pavement within a bicycle lane increases the visibility of the facility and reinforces bicyclist priority in conflict areas.

Like a zebra-style cross walk, these conflict zones are stand-alone pavement marking blocks that span the length of the bicycle/vehicle interaction area. Their green interior is bounded by white on the inside and outside, with an overall pavement marking at a width of around 2 feet and a length matching the connecting bike lanes. The white markings should be retroreflective to enhance visibility, while the green markings should meet current glass bead standards for pavement markings.

Although they can occur in other scenarios, bicycle-lane conflict-zone markings are predominantly used at intersections where a left- or right-turning vehicle crosses a bicycle through-movement.

The MUTCD, Publication 111, and Publication 236 provide details for signing and pavement marking details on colored bike lanes.

Guidance

- The colored surface should be skid resistant and retro-reflective.
- A YIELD TO BIKES (i.e., R4-4) sign should be used at intersections or driveway crossings to reinforce that bicyclists have the right-of-way in colored bike lane areas.

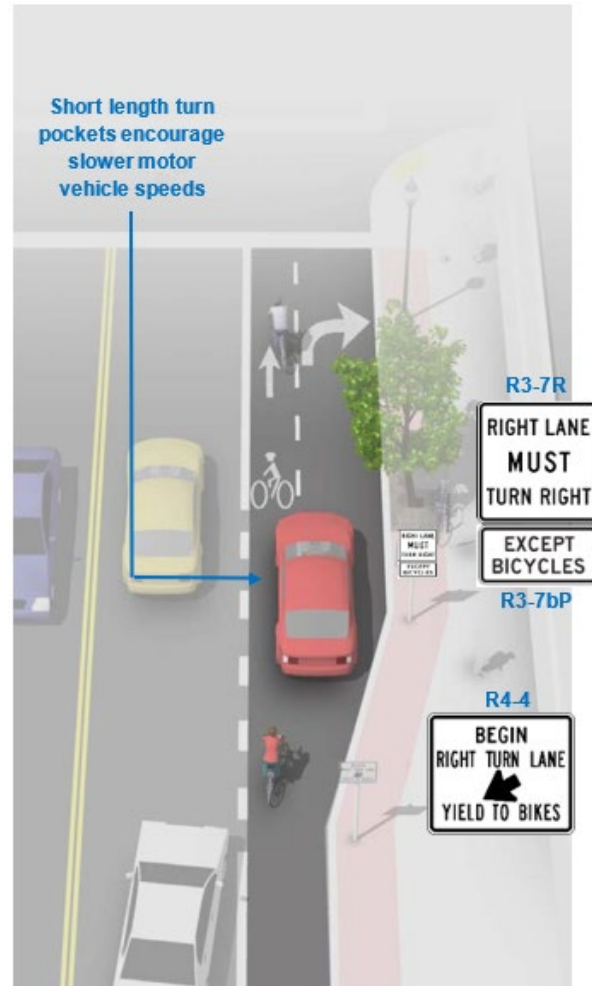
14.4.5 – Combined Bike Lanes/Turn Lanes

The combined bike lane/turn lane places a standard-width bike lane on the left side of a dedicated right-turn lane. A dotted line delineates the space for bicyclists and motorists within the shared lane. This treatment also includes signage, advising motorists and bicyclists of proper positioning within the lane.

This treatment is recommended at intersections lacking sufficient space to accommodate both a standard through-bike lane and right-turn lane.

Researchers with the Pedestrian and Bicycle Information Center at the University of North Carolina cite case studies demonstrating that this treatment works best on streets with lower posted speeds (i.e., 30 mph or less) and with lower traffic volumes (i.e., Average Daily Traffic [ADT] of 10,000 vehicles or fewer). Consequently, a combined bike lane/turn lane may not be appropriate for high-speed arterials, intersections with long right-turn lanes, or intersections with large percentages of right-turning heavy vehicles.

The MUTCD, Publication 111, and Publication 236 provide details for signing and pavement marking in these lanes.



Guidance

- The minimum shared turn lane width is 13 feet.
- The bike lane pocket should have a minimum width of 4 feet, with a preferred width of 5 feet.
- A dotted 4-inch line and bicycle lane marking should be used to clarify bicyclist positioning within the combined lane, without excluding cars from the suggested bicycle area.
- A RIGHT TURN ONLY (i.e., R3-7R) sign with an EXCEPT BICYCLES (i.e., R3-7bP) plaque is needed to legally permit through bicyclists to use a right-turn lane if the bike lane or shoulder becomes a right-turn lane and no other accommodation is made for cyclists to continue forward.

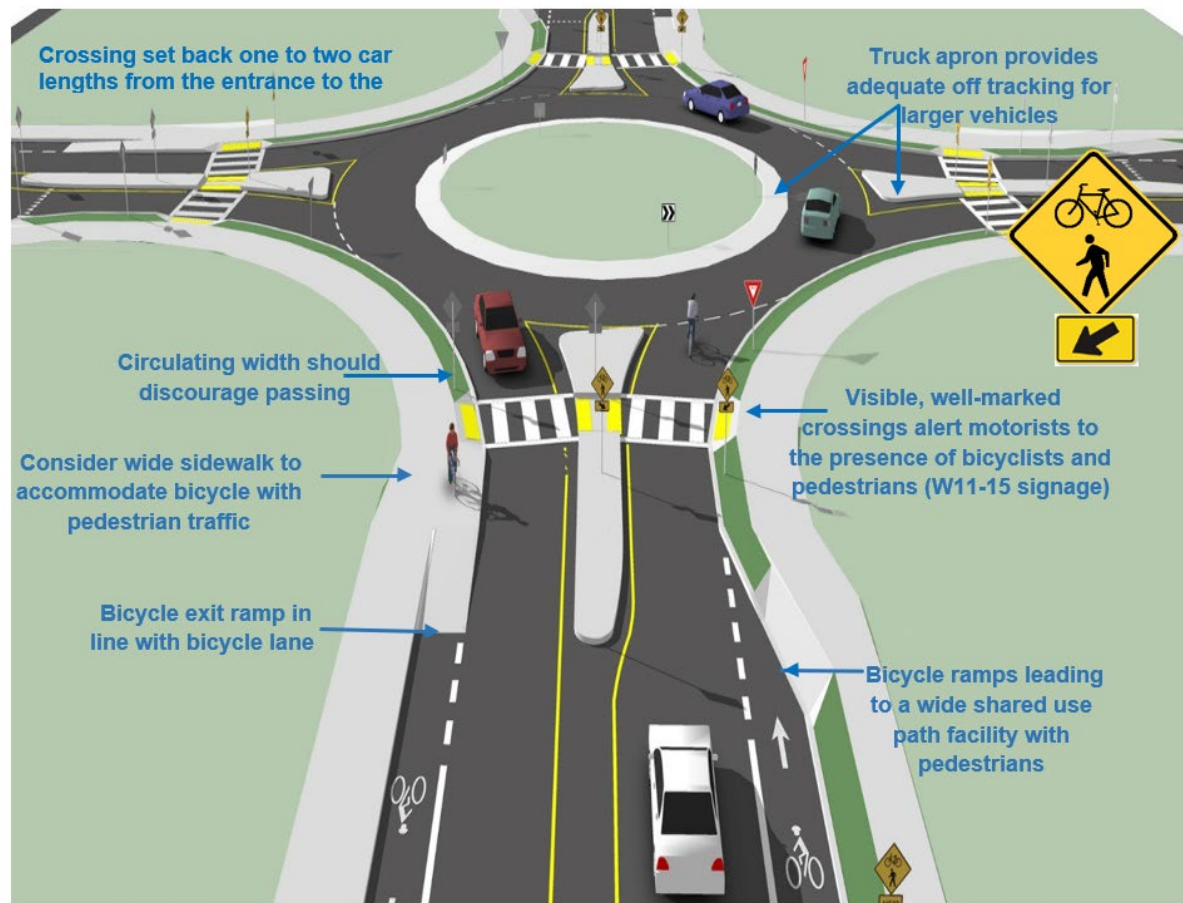
14.4.6 – Bicyclists at Roundabouts

In single-lane roundabouts, it is important to indicate to motorists, bicyclists, and pedestrians the right-of-way rules and the correct way to circulate using appropriately designed signage, pavement markings, and geometric design elements.

Research indicates that while single-lane roundabouts may benefit bicyclists and pedestrians by slowing traffic, multi-lane roundabouts may present greater challenges and increase safety concerns for these users. Providing bicycle ramps to allow users to self-select a route on a separate path can improve safety and accessibility for bicycle riders.

Guidance

- The circulating operating speed in a roundabout is typically less than 25 mph. Bicyclists should be encouraged to navigate the roundabout like motor vehicles and “take the lane.” The BICYCLE MAY USE FULL LANE (R4-11) sign may be considered on the approach to the roundabout.
- Separated facilities may be considered for bicyclists who prefer not to navigate the roundabout on the roadway.



14.4.7 – Bike Lanes at Ramp Lanes

Some arterials may contain high-speed freeway-style designs, such as merge (entrance) lanes and diverge (exit) ramps, which can create difficulties for bicyclists. The entrance and exit lanes typically have intrinsic visibility problems because of low approach angles and high-speed differentials between bicyclists and motor vehicles.

Strategies to improve safety emphasize removing these designs where possible, increasing sight distances, creating formal crossings, and minimizing crossing distances. The **layouts shown below** avoid the bike lanes using the gore areas and provide perpendicular crossings of the ramps.

Guidance

Entrance Ramps

- The bike lane should be configured to increase the approach angle with entering traffic.
- The crossing should be positioned before drivers' attention is focused on the upcoming merge.

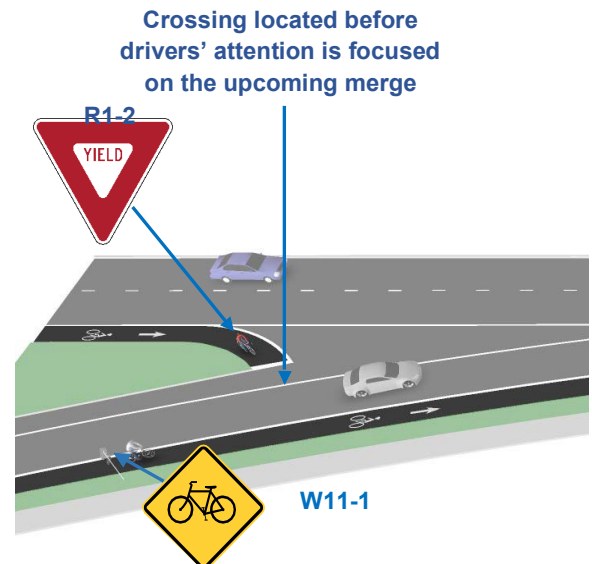
Exit Ramps

- A jug-handle turn should be used to increase the approach angle with exiting traffic and should include yield striping and signage on the bicycle

While the jug-handle approach is the preferred configuration at exit ramps, an option should be provided that allows through-bicyclists to perform a vehicular merge and proceed straight through under safe conditions. Additionally, stopping sight distances needs to be evaluated.

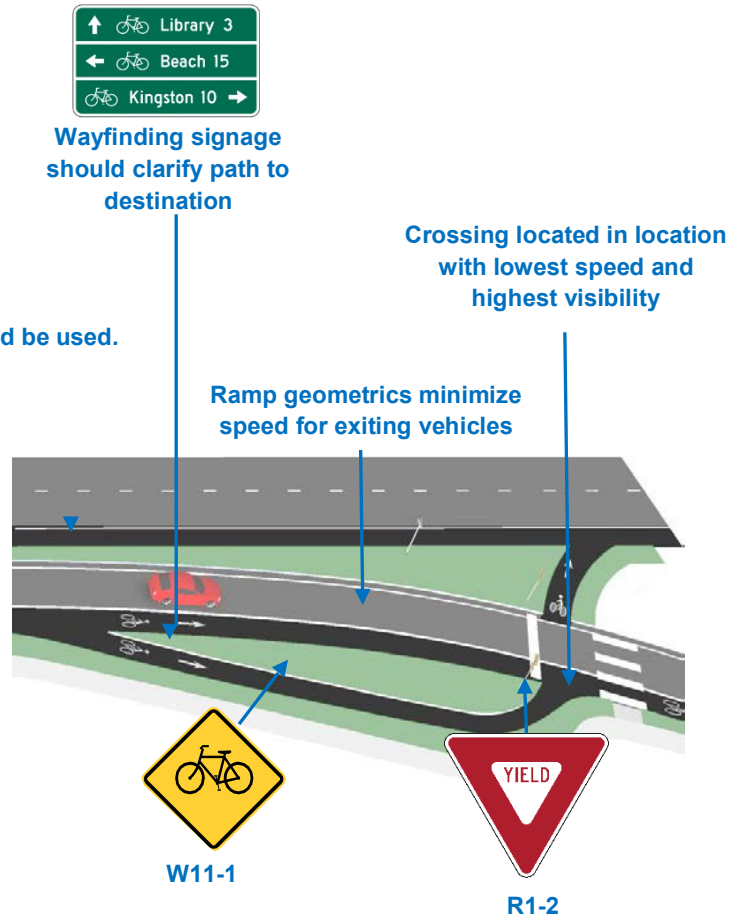
Example Entrance Ramp Layout

Note: Appropriate yield or stop bar should be used.



Example Exit Ramp Layout

Note: Appropriate yield or stop bar should be used.



Messages and installation of bicycle guide signs should follow the Tourist Oriented Directional Signs Policy described in Publication 46, *Traffic Engineering Manual*

14.5 – Shared-Use Path/Bikeway Crossings



At-grade roadway crossings can create potential conflicts between path users and motorists. However, well-designed crossings can mitigate many operational issues and provide a higher degree of safety and comfort for path users. This is evidenced by the thousands of successful facilities around the US with at-grade crossings.

In most cases, at-grade path crossings can be properly designed to provide a reasonable degree of safety and meet existing traffic and safety standards. Path facilities that cater to bicyclists require additional considerations due to the higher travel speed of bicyclists versus pedestrians.

Consideration must be given to adequate warning distance based on vehicle speeds and line of sight, with the visibility of any signs being critical. Directing the active attention of motorists to roadway signs may require additional alerting devices, such as a flashing beacon, roadway striping, or changes in pavement texture. Signing for path users may include a standard STOP or YIELD sign and pavement markings, possibly combined with other features, such as bollards or a bend in the pathway to prohibit motor vehicle access (but not to slow bicyclists, as these areas can be crash conflict areas). Care must be taken not to place too many signs at crossings lest they begin to lose their visual impact. The FHWA's *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations* contains significant and useful guidance on this topic.

A number of striping patterns to delineate path crossings have emerged over the years. Crosswalk striping is typically a matter of local and state preference and may be accompanied by pavement treatments to help warn and slow or stop motorists. In areas where motorists do not typically yield to crosswalk users, additional measures may be required to increase compliance.



14.5.1 – Bicycle Lanes at Railroad Grade Crossings

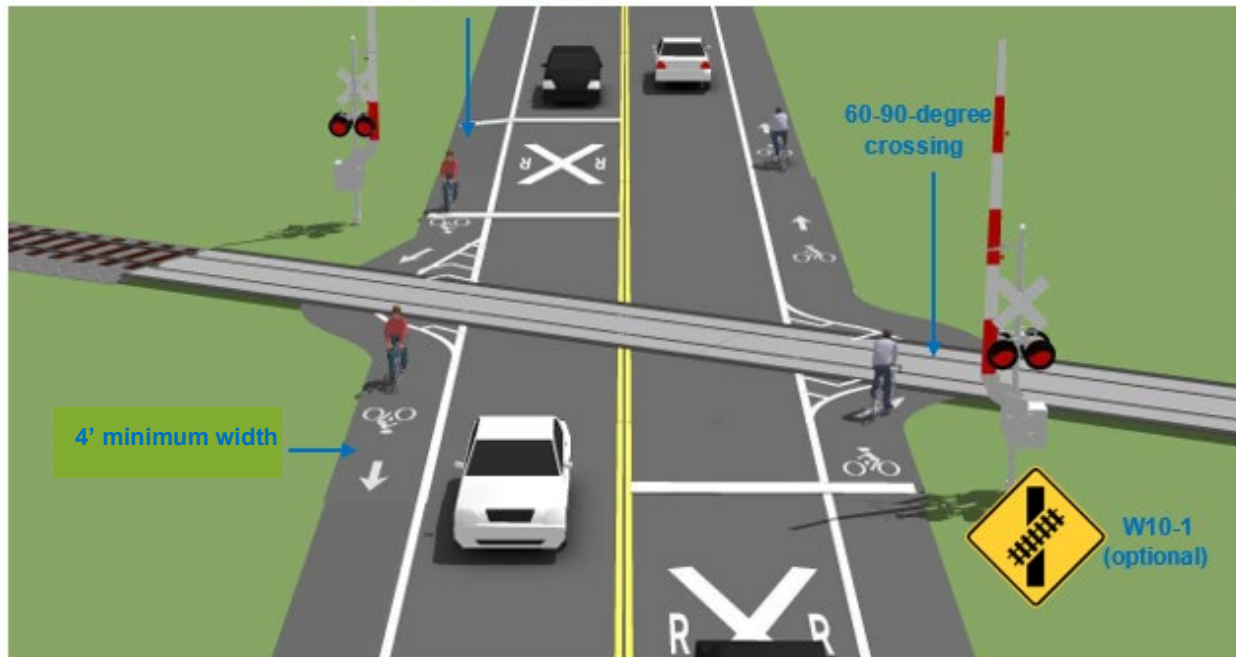
Bikeways that cross railroad tracks at a diagonal may cause steering difficulties or loss of control for bicyclists due to slippery surfaces, degraded rough materials, and the size of the flangeway gaps. Angled track crossings also limit sight triangles, impacting the ability to see oncoming trains.

Improvements to track placement, surface quality, flangeway opening width, and crossing angle can minimize risks to riders. Also, address any potential pedestrian conflicts if directing bicyclists to sidewalks.

Guidance

- The minimum shoulder/bike lane width is 4 feet (5 to 7 feet preferred).
- If the skew angle is less than 45 degrees, special attention should be given to the sidewalk and bicycle alignment to improve the approach angle to at least 60 degrees (or to a preferred angle of 90 degrees, where possible).
- W10-1 or W10-12 signs might be posted to alert bicyclists.

Allow bicyclists access to the full widened pavement area to allow them to choose the path that suits their needs best



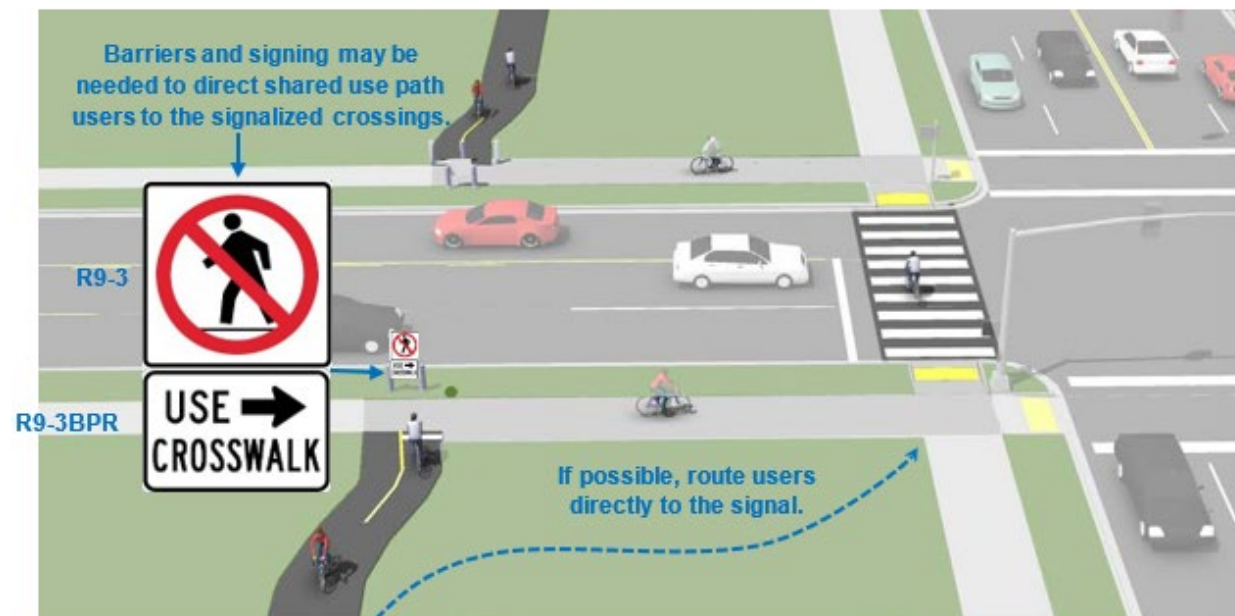
14.5.2 – Routing Users to Signalized Crossings

Path/trail crossings within the functional area of an existing signalized intersection are typically diverted to the signalized intersection to avoid traffic operation problems. For this restriction to be effective, barriers and signing may be needed to direct path users to the signalized crossing. If no pedestrian crossing exists at the signal, modifications should be made.

Guidance

Path crossings should not be provided within the functional area of an existing signalized intersection. If possible, the path should be routed directly to the signal.

The use of bicycles on trails and sidewalks is covered in **PA Title 75 Consolidated Statutes §3508**, which states, “A person riding a pedalcycle upon a sidewalk or pedalcycle path used by pedestrians shall yield the right-of-way to any pedestrian and shall give an audible signal before overtaking and passing a pedestrian.” The statute also states, “A person shall not ride a pedalcycle upon a sidewalk in a business district unless permitted by official traffic-control devices, nor when a usable pedalcycle-only lane has been provided adjacent to the sidewalk.”



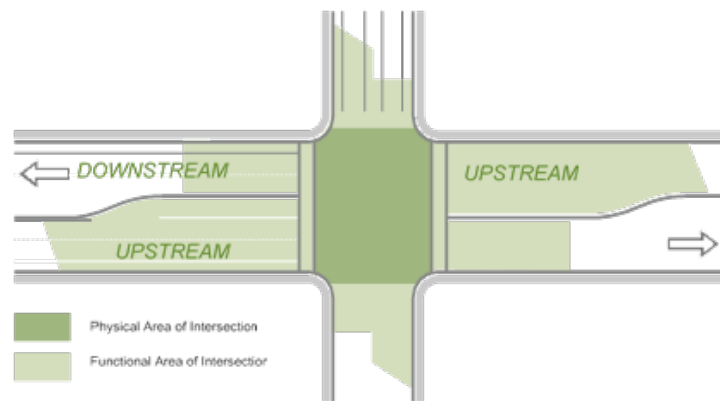
The functional area of an intersection, as illustrated in **Exhibit 14.5.1**, is the area beyond the physical intersection of two roadways (or roadway and path) that includes decision and maneuvering distance, plus any required vehicle storage length.

The functional area includes the length of road upstream from an oncoming intersection needed by motorists to perceive the intersection and begin maneuvers to negotiate it. The upstream

area includes distance for travel during perception-reaction time, travel for maneuvering and deceleration, and queue storage. The functional area also accounts for the length of road downstream from the intersection needed to reduce conflicts between through-traffic and vehicles entering and exiting a property.

Because of individual intersection characteristics, the functional area of an intersection varies from one location to another. Due to heightened safety concerns within the functional area of an intersection, bike/pedestrian crossings should be limited to the physical area of the intersection. Driveways and other mid-block crossings should be outside of the intersection's functional area.

Exhibit 14.5.1 – Functional and Physical Areas of an Intersection



To calculate the functional area of an intersection, it is important to understand the traffic dynamics as a driver approaches the intersection. As shown in **Exhibit 14.5.2**, an intersection's functional area accounts for perception-reaction time, deceleration, and queue storage, which all relate to design speed.

Exhibit 14.5.2 – Diagram of the upstream functional area of an intersection

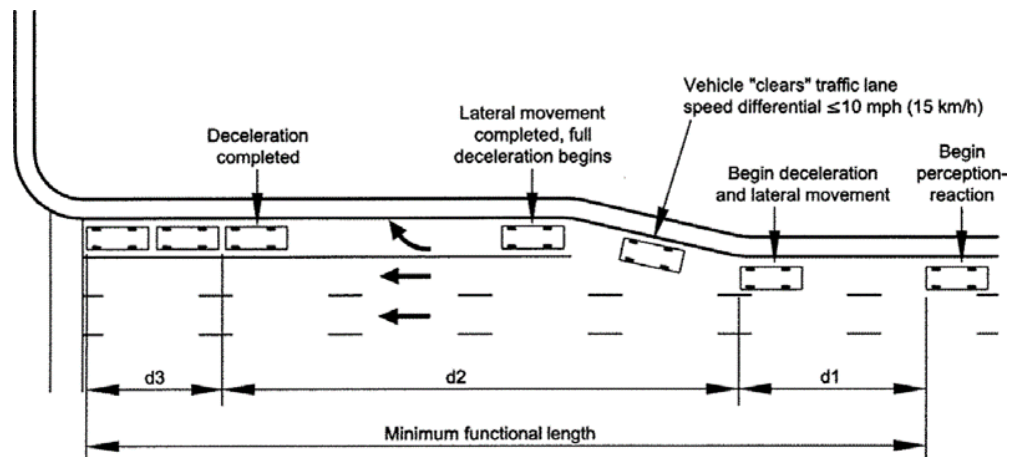


Exhibit 14.5.2 illustrates:

- **Distance d1** – Distance traveled during braking reaction time as a driver approaches the intersection, assuming a brake reaction time of 1.5 seconds for urban and suburban conditions and 2.5 seconds for rural conditions.
- **Distance d2** – Deceleration distance while the driver maneuvers to a stop upstream of the intersection.
- **Distance d3** – Queue storage at the intersection.

Calculations of d1 (brake reaction time) and d2 (braking distance) are located in the Green Book, Chapter 3 under Stopping Sight Distance. Methodology for estimating d3 (queue storage) is provided in Publication 46, *Traffic Engineering Manual*.

The downstream functional area is the distance immediately downstream of the intersection so that a driver can completely clear the intersection before needing to react to something downstream, stopping sight distance is the typical distance.

Example: Upstream Functional Area of an Intersection

There is an intersection on an urban roadway with a 35-mph speed limit. The intersection approach has -2% vertical grade. Assume a standard braking deceleration of 11.2 ft/s². What is the minimum functional length on the upstream approach to this intersection?

Distance d1:

$$d1 = 1.47Vt$$

[Stopping Sight Distance Chapter
of AASHTO Green Book]

V = design speed, mph

t = brake reaction time, s

Given: V = 35 mph; t = 1.5 s (use 1.5 seconds for urban and suburban conditions)

$$d1 = 1.47Vt = (1.47) * (35) * (1.5)$$

$$d1 = 77.175 \approx 77 \text{ ft}$$

Distance d2:

$$d2 = \frac{V^2}{30 \left[\left(\frac{a}{32.2} \right) \mp G \right]} \quad \text{[Stopping Sight Distance Chapter of AASHTO Green Book]}$$

V = design speed, mph

a = deceleration rate, ft/s²

G = roadway grade ft/ft

Given: V = 35 mph; a = 11.2 ft/s² (from AASHTO Green Book); G = -0.02

$$d2 = \frac{V^2}{30 \left[\left(\frac{a}{32.2} \right) \mp G \right]} = \frac{(35)^2}{30 \left[\left(\frac{11.2}{32.2} \right) - 0.02 \right]}$$

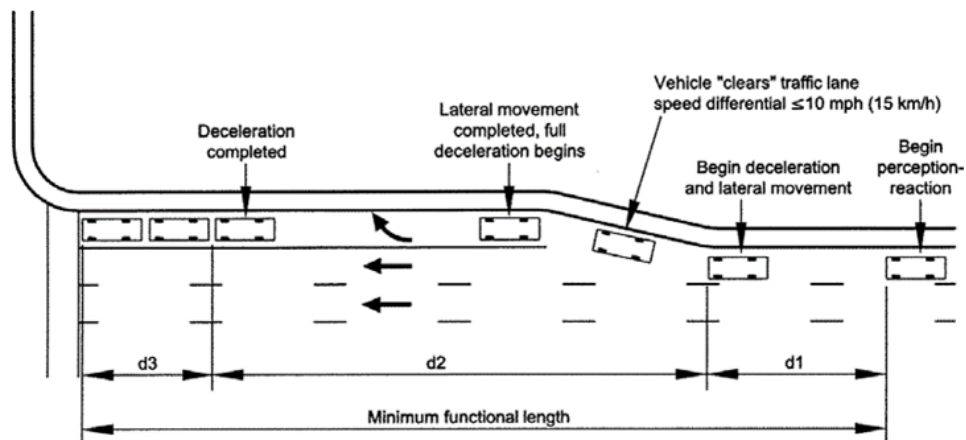
$$d2 = 124.559 \approx 125 \text{ ft}$$

Distance d3:

$$d3 = Q$$

Queue Storage at an intersection is generally accepted as the 95th percentile queue for a lane, as described in the Turn Lane Guidelines section of Publication 46, Traffic Engineering Manual. This is usually determined by using traffic engineering software packages. For use in this example problems it is assumed that software was used to find a 95th percentile queue of 150 ft.

$$d3 = Q = 150 \text{ ft}$$

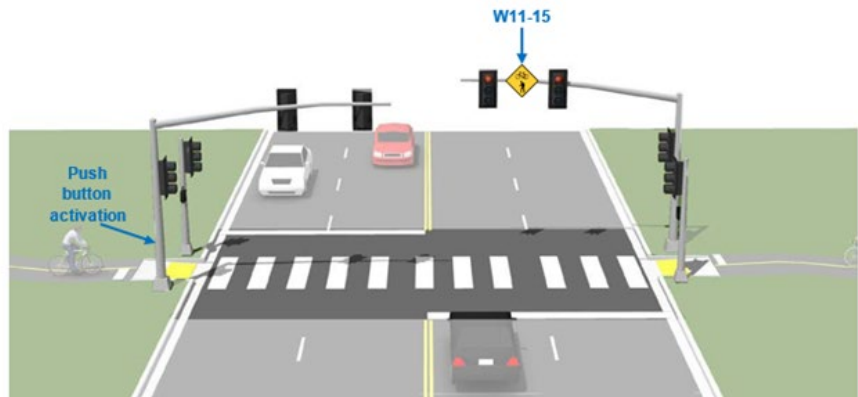


$$\text{Minimum Functional Length} = d1 + d2 + d3 = 77\text{ft.} + 125\text{ft.} + 150\text{ft.}$$

$$\text{Minimum Functional Length} = 352 \text{ ft}$$

14.5.3 –Traffic-Control Signalized Crossings

Traffic-control signalized crossings are traffic signal installations for bicycle and pedestrian crossings (typically shared-use paths intersecting with a roadway). This should not be confused with Pedestrian Hybrid Beacons (PHB) or “Hawk” beacons, which are currently not allowed in the



Commonwealth. Traffic-control signalized crossings utilize “typical” signal timing patterns, where PHB systems are dark (i.e., no light indication) until activated.

Signalized crossings provide the greatest protection for crossing-path users through the use of signal indication to stop conflicting motor vehicle traffic. However, the use of traffic control signals should be limited to only locations where less-restrictive traffic control devices provide inadequate crossing opportunities. Even at locations where traffic-control signals are warranted, other treatments (such as traffic calming) should be considered first because signals can increase delays, as well as certain crash types.

A full traffic signal installation treats the path crossing as a conventional four-way intersection and provides standard red, yellow, and green traffic signal heads for all legs of the intersection.

Shared-use path signals are normally activated by push buttons but may also be triggered by embedded loop, infrared, microwave, or video detectors. The **maximum** delay for activation of the signal should be 2 minutes, with minimum crossing times determined by the width of the street. (Note: Delays longer than 30 seconds can result in bicyclist or pedestrian impatience, potentially leading to unsafe crossings. Activation times of less than 2 minutes are preferred.)

Each crossing, regardless of traffic speed or volume, requires the designer to evaluate sight lines, potential impacts on traffic progression, timing with adjacent signals, capacity, and safety.

14.5.3.a - Determining Need

Designers have the flexibility to estimate future demand if, in the absence of a signal, existing conditions limit crossing opportunities. In some cases, the number of pedestrians and bicyclists crossing a street may be insufficient to satisfy a traffic-signal warrant. This may indicate people’s reluctance to use the crossing because of inadequate gaps in traffic and concern for their safety. For these locations, it is more appropriate to use an estimated crossing demand that assumes better crossing conditions, as research shows that once a street crossing is safer, individuals will cross in greater numbers.

A gap study can evaluate the availability and frequency of critical gaps for safe crossing. As defined in the HCM, a critical gap provides enough time for a person to cross a street at a normal walking or bicycling speed without conflict after the person perceives a gap in traffic. The HCM also provides a methodology to calculate the average pedestrian and bicyclist delays for an uncontrolled crossing. The critical gap is determined by calculating the pedestrian or bicyclist departure sight distance that allows a person enough time to judge a gap and complete a full crossing of the roadway.

14.5.3.b – Applicable Traffic Signal Warrants

The MUTCD offers information on traffic-control signal warrants to help in determining if a traffic-control signal should be installed. The designer has some flexibility in applying warrants to determine if a signal is needed at a bicycle crossing. For example, since bicyclists may operate as a vehicle or as a pedestrian at crossings, they may be counted as either for a traffic-signal warrant analysis.

The most applicable warrants for evaluating the need for traffic-control signals in assisting bicyclists crossing a street include:

- **Warrant 4 (Pedestrian Volume)** – This warrant may be considered for locations where pedestrians and bicyclists experience excessive delays in attempting to cross a high-volume street. Both pedestrians and bicyclists should be considered in this analysis. The criterion for Warrant 4 may be reduced as much as 50% if the 15th percentile crossing speed of pedestrians is less than 3.5 feet per second.
- **Warrant 5 (School Crossing)** – This warrant may be considered for locations where there is a desire for schoolchildren to cross and there are not adequate gaps for them to do so.
- **Warrant 7 (Crash Experience)** – This warrant may be considered for locations where a threshold of crashes that could be corrected by a traffic-control signal have occurred over a 12- or 36-month period. Thresholds vary depending upon the number of approach lanes, type of crash, and context. The MUTCD Interim Approval for Optional Use of an Alternative Signal Warrant – Crash Experience (IA-19) allows designers to consider alternative crash experience data.

14.5.4 – Undercrossings

Bicycle/pedestrian undercrossings provide critical non-motorized system links by joining areas separated by barriers, such as railroads and highway corridors. In most cases, these structures are built in response to user demand for safe crossings.

There are no minimum roadway characteristics for considering grade separation. Depending on the type of facility or the user group, grade separation may be considered in many types of projects.

Safety is a major concern with undercrossings. Shared-use path users may be temporarily out of sight from public view and may experience poor visibility themselves. To mitigate safety concerns, an undercrossing should be spacious, well-lit, and completely visible for its entire length.

Guidance

- The minimum width of an undercrossing is 14 feet, with greater widths preferred for lengths over 60 feet.
- The minimum height of an undercrossing is 12 feet.
- The undercrossing should have a centerline stripe, even if the rest of the path does not.
- Lighting should be considered for undercrossings in culverts and tunnels or locations with high anticipated use.



14.5.5 – Overcrossings

Bicycle/pedestrian overcrossings provide critical non-motorized system links by joining areas separated by barriers such as deep canyons, waterways, or major transportation corridors. In most cases, these structures are built in response to user demand for safe crossings.

There are no minimum roadway characteristics for considering grade separation. Depending on the type of facility or the desired user group, grade separation may be considered in many types of projects. Refer to Publication 15M, *Design Manual Part 4 -Structures* for fencing requirements.

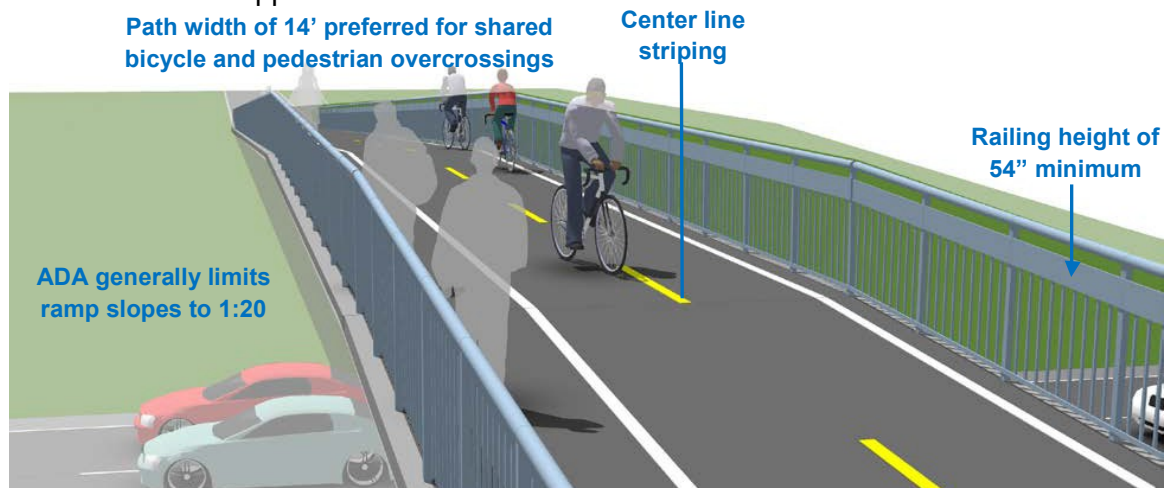
For new construction and reconstruction projects, the vertical clearance is 1 foot greater than the vertical clearance required for the highway over which the structure is located.

For 3R and pavement preservation projects, see chapters in this design manual on these topics to determine minimum vertical clearances.

Requirements for overcrossings for bicycles and pedestrians typically fall under the ADA, which strictly limits ramp slopes to 5% (1:20) with landings at 400-foot intervals or 8.33% (1:12) with landings every 30 feet. Overcrossings also pose potential design challenges related to visual impact and functional appeal.

Guidance

- Overcrossings shall provide a minimum 8 feet (10 feet desirable) horizontal clearance between railings (on low-volume bicycle use with occasional pedestrian use only paths), with 14 feet or greater preferred for other-volume or other-use paths).
- If the overcrossing borders scenic vistas, additional width should be provided to allow for stopping. A separate 5-foot localized pedestrian area may be provided for facilities with high bicycle and pedestrian use.
- Overcrossings should maintain 10 feet of headroom for the users.
- An overcrossing should have a centerline stripe even if the rest of the path does not.



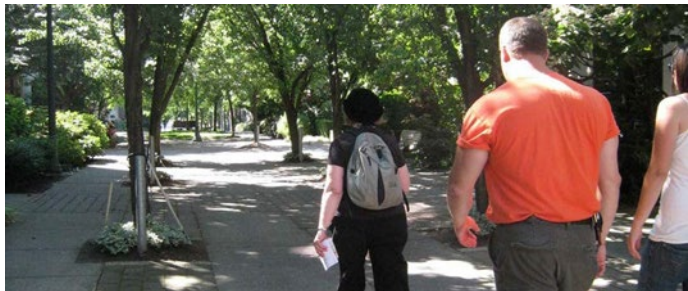
14.6 – Shared-Use Paths and Off-Street Bicycle Facilities

A shared-use path allows for two-way, off-street bicycle use and may be used by pedestrians, skaters, wheelchair users, runners, and other non-motorized users.

These facilities are frequently found in parks, along rivers and beaches, and in greenbelts or utility corridors where there are few conflicts with motorized vehicles. Path facilities can also include amenities such as lighting, signage, and fencing.

Key features of shared-use paths include:

- Frequent access points from the local road network.
- Directional signs that direct users to and from the path.
- A limited number of at-grade crossings with streets or driveways.
- Termination points easily accessible to and from the street system.
- Separation of pedestrians and bicyclists when heavy use is expected.



At-grade roadway crossings create potential conflicts between path users and motorists. Consideration must be given to adequate warning distance based on vehicle speeds and sight distance.

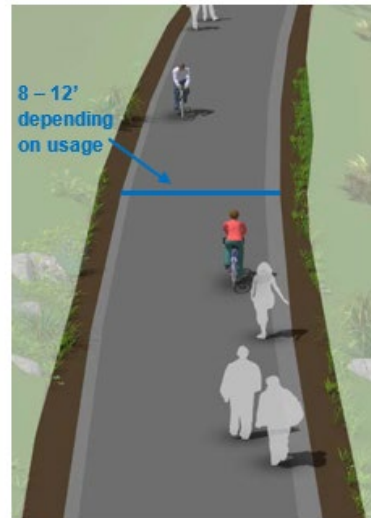
Directing the active attention of motorists to roadway signs may require additional alerting devices, such as roadway striping or changes in pavement texture. Signing for path users may include a standard STOP or YIELD sign and pavement markings, possibly combined with other features, such as bollards or a bend in the pathway to slow bicyclists. Care must be taken not to place too many signs at crossings, lest they begin to lose their visual impact.

Trail design guidance is provided in the Pennsylvania Department of Conservation and Natural Resources' (DCNR) *Pennsylvania Trail Design & Development Principles: Guidelines for Sustainable, Non-motorized Trails* and *Pennsylvania Trail Design Manual for Off-Highway Recreational Vehicles* as well as the AASHTO's *Guide for the Development of Bicycle Facilities*. Guidance for roadway considerations is provided in the MUTCD.

14.6.1 – General Design Practices

Shared-use paths can provide a desirable facility, particularly for recreation and users of all skill levels preferring separation from traffic. Bicycle paths can provide directional travel opportunities not provided by existing roadways.

The design should terminate the path where it is easily accessible to and from the street system, preferably at a controlled intersection or at the beginning of a dead-end street.



Guidance

Access Points

- Any access point to the path should be well-defined with appropriate signage designating the pathway as a bicycle facility and prohibiting motor vehicles.
- Access points should provide sight distance based on the speed of the roadway.

Width

- 8-feet is the minimum allowed for a two-way shared-use path, and only allowed if low-volume bicycle use with occasional pedestrian use, or for short lengths due to other significant constraints.
- 10-feet is recommended in most situations and will be adequate for moderate to heavy use.
- 12-feet is recommended for heavy use situations with high concentrations of multiple users. A separate track (5-foot minimum) can be provided for pedestrian use.

Lateral Clearance

- A 2-foot or greater shoulder on both sides of the path should be provided. An additional foot of lateral clearance (total of 3-feet) is required by the MUTCD for the installation of signage or other furnishings.
- If bollards are used at intersections and access points, they should be colored brightly and/or supplemented with reflective materials to be visible at night.

Overhead Clearance

- Clearance to overhead obstructions should be 8-feet minimum with 10-feet recommended.

Pavement Marking

- When pavement markings are required, use a 4-inch dashed yellow centerline stripe with 4-inch solid white edge lines.
- Solid centerlines can be provided on tight or blind corners, and on the approaches to roadway crossings.

14.6.2 – Shared-Use Paths Along Roadways

Shared-use paths along roadways, also called side paths, run adjacent to a street.

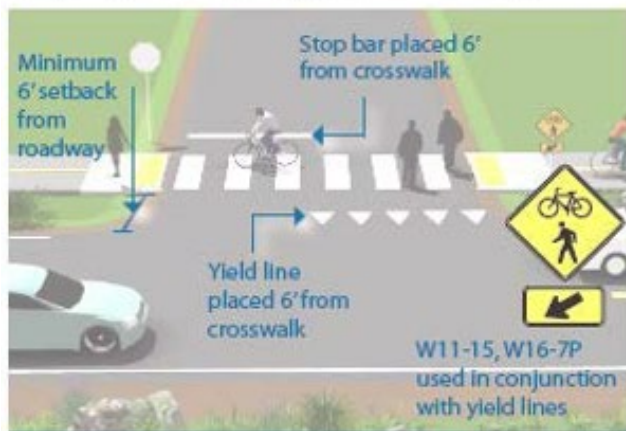
AASHTO's *Guide for the Development of Bicycle Facilities* also cautions practitioners about the use of two-way side paths on urban or suburban streets with many driveways and street crossings.

In general, the two approaches to side-path crossings are adjacent and setback, as illustrated below.

Guidance

- Guidance for side paths should follow that for general design practices of shared-use paths.
- To minimize potential conflicts, alternatives to side paths should be considered on streets with a high frequency of intersections or heavily used driveways.
- Where a side path terminates, special consideration should be given to transitions that discourage bicyclists from unsafely riding the wrong way.
- Crossing design should emphasize visibility of users and clarify expected yielding behavior. Crossings may be stop or yield-controlled, depending on sight lines and bicycle and motor vehicle volumes and speeds.

Adjacent Crossing - A separation of 6 feet emphasizes the conspicuity of riders at the approach to the crossing.



Setback Crossing - A set back of 25 feet separates the path crossing from merging/turning movements that may be competing for a driver's attention.



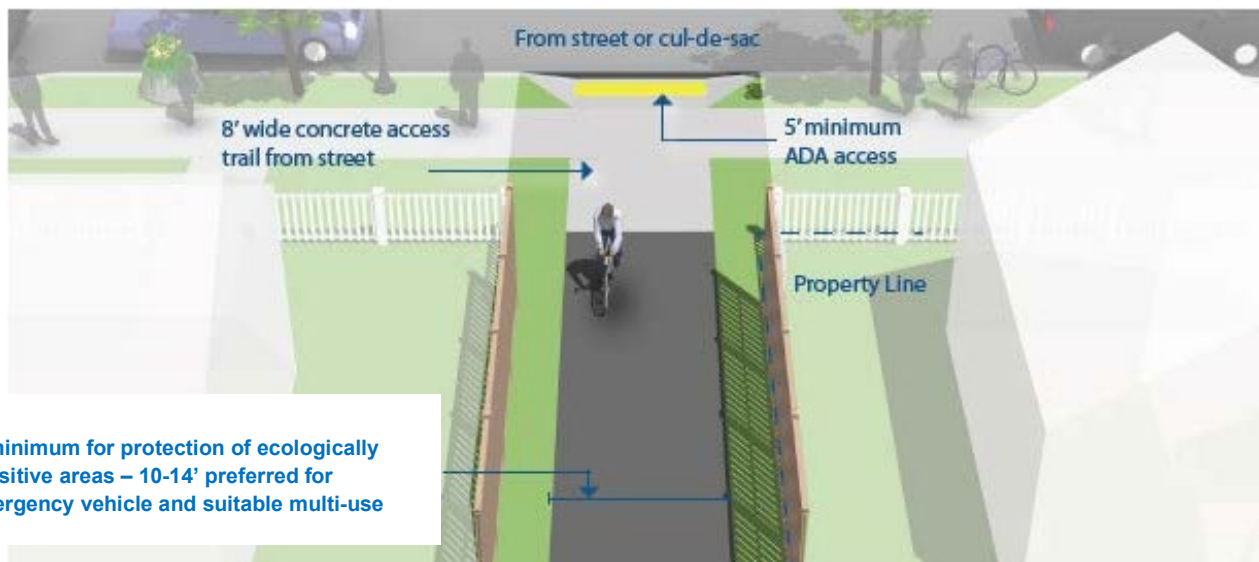
14.6.3 – Local Neighborhood Accessways

Neighborhood accessways provide residential areas with direct bicycle and pedestrian access to parks, trails, greenspaces, and other recreational areas. They most often serve as small trail connections to and from the larger trail network, typically having their own rights-of-way and easements.

Additionally, these smaller trails can provide bicycle and pedestrian connections between dead-end streets and cul-de-sacs as well as access to nearby destinations not provided by the street network.

Guidance

- Neighborhood accessways should remain open to the public.
- Trail pavement should be 10 to 14-feet wide to accommodate emergency and maintenance vehicles, meet ADA requirements, and be considered suitable for multi-use.
- Trail widths should be designed as less than 8-feet wide only when necessary to protect large, mature native trees over 18 inches in caliper, wetlands, or other ecologically sensitive areas.



14.7 – Bicycle Support Facilities

For cycling to serve as an attractive form of transportation, a system of support facilities is essential to complement the bikeway network. Useful complementary facilities include such items as convenient bicycle parking, transit access, wayfinding signage with clearly marked bike routes and destination information, and roadway features that consider the characteristics of a bicycle.

- **Bicycle Parking** – Bicyclists expect a safe, convenient place to secure their bicycle when they reach their destination. This may be for the short term (i.e., parking of two hours or less) or the long-term (e.g., parking for employees, students, residents, and commuters).
- **Access to Transit** – Safe and easy access to bicycle parking facilities encourages commuters to access transit via bicycle.

Providing bicycle access to transit and space for bicycles on buses and rail vehicles can increase the feasibility of transit in lower-density areas where transit stops are beyond the walking distance of residences. People are often willing to walk only a quarter- to half-mile to a bus stop, while they might bike as much as two or more miles to reach a transit station.

Chapter 15 of this manual provides additional transit information.

- **Roadway Considerations** – The safety of all roadway users should be considered during road construction and repair. Wherever bicycles are allowed, measures should be taken to provide for the continuity of a bicyclist’s trip through a work zone.

Work-zone maintenance and protection of traffic considerations are provided in Chapter 9 of this manual; rumble strip and other roadway considerations are provided in Chapter 12.



14.7.1 – Bicycle Parking

Short-term bicycle parking is meant to accommodate visitors, customers, and others expected to depart within two hours. The facility should have a locally-approved standard rack, appropriate location and placement, and weather protection. A maintenance agreement may be required for these facilities.

The Association for Pedestrian and Bicycle Professionals (APBP) recommends selecting a bicycle rack that:

- Supports the bicycle in at least two places, preventing it from falling over.
- Allows locking of the frame and one or both wheels with a U-lock.
- Is securely anchored to the ground.
- Resists cutting, rusting, and bending or deformation.

Guidance

- Parking should be placed at a 2-foot minimum from the curb face to avoid dooring.
- Parking should be close to destinations, with a 50-foot maximum distance from main building entrances.
- A minimum clear distance of 6 feet should be provided between the bicycle rack and the property line.
- Parking should be highly visible from adjacent bicycle routes and pedestrian traffic. Pavement markings may be added to enhance visibility.
- Racks should be located in areas that bicyclists are most likely to travel.

Where it is not possible to place racks on sidewalks (due to narrow sidewalk width, sidewalk obstructions, trees, or other barriers), bicycle parking can be provided in the street through on-street bicycle corrals in locations where on-street vehicle parking is allowed.



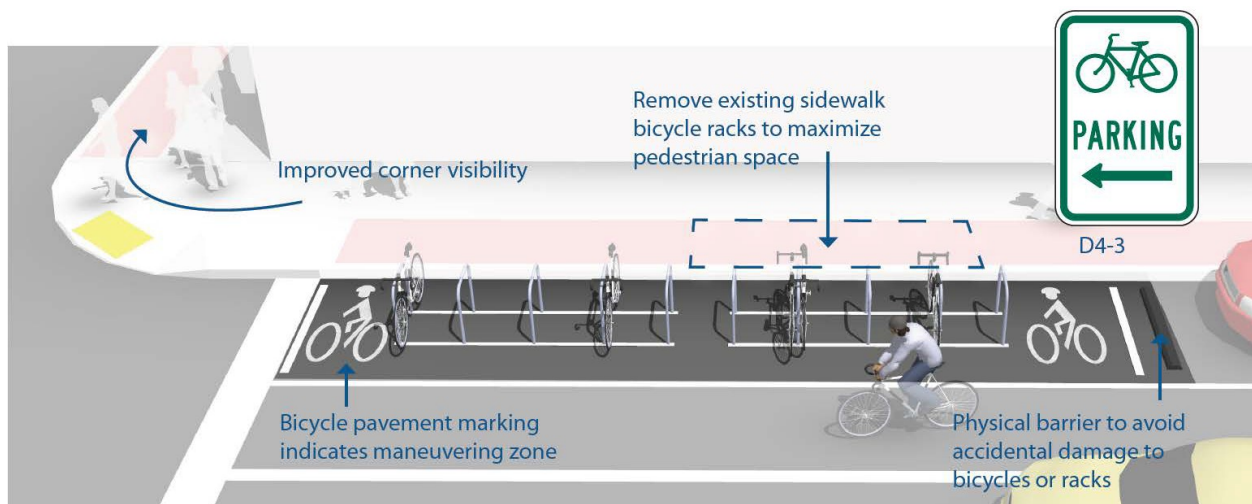
14.7.2 – On-Street Bicycle Corrals

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

Bicycle corrals (which require a Highway Occupancy Permit and possible maintenance agreement) move bicycles off the sidewalks, leaving more space for pedestrian and sidewalk activities. Because bicycle parking does not block sight lines (as large motor vehicles do), it may be possible to locate bicycle parking in no-parking zones near intersections and crosswalks.

Guidance

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



14.7.3 – Bicycle Access to Transit

Safe and easy access to transit stations and secure bicycle parking facilities is necessary to encourage commuters to access transit via bicycle. Bicycling to transit reduces the need to provide expensive and space-consuming vehicle parking spaces.

Many people who ride to a transit stop will also want to bring their bicycles with them on public transportation. Buses and other transit vehicles should be equipped accordingly.



Guidance

Access

- The design should provide direct and convenient access from the bicycle and pedestrian networks to transit stations and stops.
- The design should provide maps at major stops and stations showing nearby bicycle routes.
- The design should provide wayfinding signage and pavement markings from the bicycle network to transit stations.
- The design should ensure that connecting bikeways offer proper bicycle actuation and detection.

Bicycle Parking

- The route from bicycle parking locations to station/stop platforms should be well-lit and visible.
- Signage should note the location of the bicycle parking, rules for use, and instructions, as needed.
- Parking should be easy to use and well maintained. Long-term parking should be safe and secure, with features such as bicycle lockers at transit hubs.

14.7.4 – Roadway Considerations

14.7.4.a – Drainage Grates

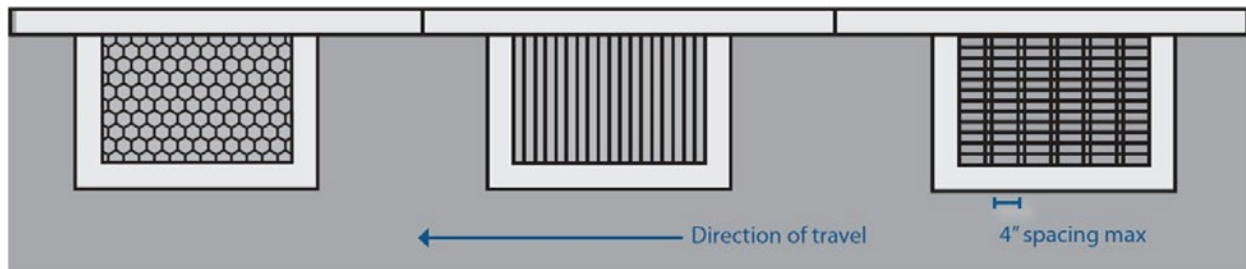
Drainage grates are typically located in the gutter area near the curb of a roadway. They contain slots through which water drains into the municipal storm sewer system.

Many older grates were designed with linear parallel bars spread wide apart, which can catch a bicyclist's front tire. This may cause the bicyclist to tumble over the handlebars and sustain potentially serious injuries.

Beyond grates, potential cyclist safety issues also include those presented by gutters (and their joints if a pavement differential exists), bus pads, historical pavements (such as cobblestones or bricks), and flush curbs.

Guidance

- Where bikes are allowed, all new drainage grates must be bicycle-friendly, incorporating horizontal slats when necessary, so that bicycle tires and assistive devices do not fall through the vertical slats.
- See RC-45M for approved inlet grates



14.7.4.b – Landscaping

Bikeways can become inaccessible due to overgrown vegetation. All landscaping design should ensure compatibility with the use of the bikeways. Publication 461, *Roadside Planting Guide*, and Publication 461A, *Roadside Beautification Overview and Application*, provide landscaping design details.



14.7.4.c – Signing and Pavement Markings

Bike lanes, shared shoulders, bicycle boulevards, and paths require different wayfinding and regulations signage. The examples provided in this chapter are intended to provide general guidance only. Messages and installation of bicycle guide signs should follow the Tourist Oriented Directional Signs Policy described in Publication 46, *Traffic Engineering Manual*.



14.7.4.d - Bicycle Signals at Signalized Intersections

Bicycle signals are additional signals at signalized intersections used to clarify when to enter an intersection and by restricting conflicting vehicle movements.

Bicycle signal heads are similar to conventional traffic signals, but use red, yellow, and green lenses incorporating a stenciled bicycle icon. AASHTO's *Guide for the Development of Bicycle Facilities* adds that a standard three-lens signal head with a supplemental SIGNAL plaque (i.e., R10-10b) could be used.

Bicycle signals should only be used in combination with an existing, conventional traffic signals. Bicycle signals would not be used at a unsignalized intersection or crossing. Bicycle signal heads may be installed at signalized intersections to indicate bicycle signal phases and other bicycle-specific timing strategies.

Signage and pavement markings may be used to supplement these facilities for both bicyclists and motorists. An R10-10b sign shall be installed immediately adjacent to every bicycle signal face that is intended to control only bicyclists, including signal faces with bicycle symbol signal indications, all-arrow signal indications, and every combination thereof. The purpose of the sign is to inform motor vehicle drivers who can see the signal face that these signal indications are intended only for bicyclists.



Signals may be necessary as part of a protected bicycle facility (such as a protected bike lane with potential turning conflicts) or to decrease vehicle or pedestrian conflicts at major crossings. An intersection with bicycle signals may also reduce delays for a crossing bicyclist and discourage illegal and unsafe crossing maneuvers.

A bicycle signal should be considered in the following scenarios:

- At intersections with bicycle-specific movements, such as a contraflow bicycle lane or track, where a bicycle signal may be necessary to indicate right-of-way to the bicyclist.
- At intersections where bicycle movements need to be separated in time from a conflicting vehicular movement, such as locations with a high volume of left or right turns. Bicycle signals at these intersections can allow for a separate bicycle phase or movement.
- At locations with high vehicle turning volumes, where bicyclists could benefit from a bicycle signal with a Leading Bicycle Interval (LBI), similar to a leading pedestrian interval. An LBI gives bicyclists a head start at intersections by giving them several seconds of green time before the concurrent vehicular movement receives the green indication. This provides bicyclists an opportunity to make a lane change or left turn and reduces the risk of conflicts between bicyclists and turning traffic.
- At intersections with high bicycle volumes, such as shared-use path crossings, where bicyclists would otherwise follow the pedestrian indication. At these locations, a bicycle signal can reduce confusion.
- At intersections where bicyclists would normally follow the vehicular indication. At these locations, a bicycle signal provides a longer clearance interval more suitable to bicyclist speeds, potentially preventing them from getting caught in the path of an oncoming vehicle.

Guidance

Locations where bicycle signals have had a demonstrated positive effect include:

- Those with a high volume of bicyclists at peak hours.
- Those with a high number of bicycle/motor vehicle crashes, especially those caused by turning vehicle movements.
- At T-intersections with major bicycle movement along the top of the “T”.
- At the confluence of an off-street bike path and a roadway intersection.
- Where separated bike paths run parallel to arterial streets.

The designer should consider the following when installing bicycle signal heads:

- The bicycle signal shall be placed in a location clearly visible to oncoming bicyclists, who will have varying lateral positions on the bicycle facility.
- There shall be no right turn on red where bicycle signals are used to separate bicycle through movements from vehicular turning movements or to provide an LBI.
- The bicycle signal shall have an adequate clearance interval, which is generally determined by considering intersection width and bicyclist travel speed.
- If the bicycle phase is not set to recall each cycle, bicycle signals must be installed with appropriate detection and actuation, preferably passive (e.g., the bicyclist does not have to dismount and use a pushbutton).
- Use of smaller heads, programmable lenses, tunnels, and louvers can prevent confusion caused when motor-vehicle drivers misinterpret green bike face signals.

The FHWA Interim Approval MUTCD IA-16 provides guidance on the use of a bicycle signal face, including the meaning of bicycle signal indications, application parameters, design and location of bicycle signal faces, operation, and regulatory signing requirements. Additionally, the guidance outlines prohibitions to the use of a bicycle signal face without request to experiment.

Appendix 14A: Bike Facilities Maintenance and Bike Lane Requests

Operation and Maintenance of on Road Bicycle Facilities

The costs involved with the operation and maintenance of bicycle facilities should be considered and budgeted for when planning a facility, since neglected maintenance can render bicycle facilities unrideable and the facilities can become a liability.

In suburban and rural areas, on-road bike lanes generally consist of pavement markings, line striping, and signing. They are not physically separated from other traffic and utilize/share shoulder space.

Publication 23 – *Maintenance Manual* sets forth the Department’s policies and practices for roadway maintenance. It includes guidance on winter services and roadside management that relate to bicycle lane (shoulder) maintenance and operations.

As a matter of current policy, the Department will remove the snow from the state road and shoulder in anticipation of further snow events and to provide an option for safe refuge for disabled vehicles. This includes non-separated bike lanes that are part of roadway/shoulder.

The Department also removes overgrown vegetation and other debris, sweeps after winter operations, responds to issues with pavement quality, and replaces pavement markings and line striping as part of restriping or resurfacing projects on state roads.

The ‘local’ maintenance requirement for these types of bike lanes essentially involves replacing bike lane signs that are damaged or destroyed and replacing pavement markings in between Department restriping/resurfacing work. These responsibilities shall be included in a maintenance agreement that must be signed prior to the inclusion of the bicycle facility into the overall project design.

More complex designs in suburban, urban, or urban core areas involving physical separation with vertical and horizontal elements, signalization, changes to drainage or other elements will require a substantially more complex maintenance agreement that will identify and address the issues particular to the project. The project manager should coordinate with the District Planner, District Bicycle and Pedestrian Coordinator, and the Statewide Bicycle and Pedestrian Coordinator, to ensure the agreement is fully vetted. In no case should the bicycle facility proceed to construction before a fully executed agreement is in place.

Sharrows

Projects which contain sharrows must have a written request letter from the municipality on municipal letterhead prior to the project’s advertisement for construction. This letter must request the sharrows, commit to maintaining the sharrows and to follow all municipal procedures as outlined in Section 6109 of Title 67 as applicable. Subsequently, if PennDOT agrees in coordination with the District traffic unit, then an approval letter must be sent to the municipality from the District ADE-Design. Approvals are per **67 Pa. Code § 212.5**. Sample

request and approval letters for sharrows can be found in the ECMS File Cabinet under the Resources tab.

Bike Lane Requests

Bike lanes designate a portion of a roadway, by striping, signing and pavement markings, for the preferential or exclusive use of bicyclists. The Bike Lane Request/Approval Letters in this section are not for use with Separated Bike Lanes, which require an executed maintenance agreement prior to construction. **67 PA Code § 212.5(b)1(v)** requires municipalities to maintain signage and pavement markings along bike lanes. PennDOT will remove snow from approved bike lanes that are part of the roadway on state roads (i.e. non-separated) and perform other routine roadway maintenance, such as sweeping and vegetation trimming, in accordance with normal operations.

Municipalities interested in creating bike lanes shall contact the PennDOT District Bicycle/Pedestrian (BP) Coordinator during the project scoping process so PennDOT can advise in the conceptual stage of the project. As the bike lane plan develops, at some point it will be necessary for the Municipality to request approval from the District. The Municipality shall request approval for the Bike Lane. The request can be submitted via mail or electronically. An example letter is provided in **Exhibit 14.A.1**. PennDOT will not install bike lanes without a municipal request.

The request for approval will include a detailed description of the proposed bike lane. If the information provided with the request letter is not adequate for the Department to make an informed decision, PennDOT will use the approval letter to notify the municipality that approval is denied pending the submission and approval of additional information. The letter will detail the additional information required.

PennDOT will evaluate the bike lane request based on AASHTO's *Guide for the Development of Bicycle Facilities*. The Department will consider, among other things, the following:

- Bike lane width (5' minimum preferred), motor vehicle lane width (minimum width is not necessarily desirable), roadway speed, and adjacent parking.
- Pavement condition and smoothness, rumble strips, inlets, flush utility covers, and adequate drainage.
- Bridge railing height and expansion joints.
- Right edge of the Bike Lane, such as curb, gutter, or guiderail.
- Conflicts at intersections, driveways, and railroad crossings.
- Signal timing and turning maneuvers.
- Transit stops and pedestrian crossings along the length of the bike lane.

The bike lane description shall include state routes and/or local roads listed in sequential order, starting from one end and progressing to the other end of the bicycle lane. In addition to the listing of the routes, the limits and identification of segments of each route in the bicycle lane

must be indicated. The design should indicate if the bicycle facility is a bike lane or a buffered bike lane. The description and location shall specify the bicycle lane width, which side or sides of the roadway are involved, whether pavement or a portion of the shoulder is utilized, and any other pertinent information necessary to properly locate the bicycle lane.

Drawings detailing the proposed bike lane shall also be included. If the bike lane is part of a PennDOT project, the municipality should coordinate with PennDOT for drawings and description details.

Bicycle signals require an approved signal permit. If bicycle signals are required, or required to be relocated, for the proper function of the bike lane, an approved signal permit will be required prior to approval. If the requested bike lane is not part of a PennDOT project, the municipality must provide an Engineering Study for the proposed bike lane, with a P.E. Seal, detailing the considerations outlined above.

The District Bicycle/Pedestrian Coordinator will review the request with appropriate PennDOT staff. A template approval letter is shown in **Exhibit 14.A.2**. PennDOT approval is required from the District ADE for Design. If the Bike Lane is not approved, a letter will be sent to the municipality explaining why.

Exhibit 14.A.1 Example Bike Lane Request Letter

DATE

District Bicycle/Pedestrian Coordinator
Street Address
City, State, Zip Code

Subject: Municipal Request for a Non-Separated Bicycle Lane

County:
Municipality Name:
SR, Section:
Project Length:
Project Name:

Dear Bicycle/Pedestrian Coordinator:

(Municipality Name's) would like to request a (Bike Lane and associated pavement markings) on SR (1234). The proposed bicycle facility is described below:

[Provide a description of the proposed bike route. Include location map and relevant drawings detailing the routing, pavement markings and signage. The State Routes and/or local roads should be listed in sequential order starting from one end and progressing to the other end of the bicycle lane routing. In addition to the listing of the routes, the limits and identification of segments of each route in the bicycle lane routing should also be indicated. The description and location should specify the bicycle lane width, which side or sides of the roadway are involved, whether pavement or a portion of the shoulder is utilized and any other pertinent information necessary to properly locate the bicycle facility.]

(Municipality Name) is aware of its responsibility to install and maintain all Bike Route Signs and Pavement Markings associated with the bicycle lane per **67 PA Code § 212.5(b)1(v)**.

(Municipality Name) will coordinate with the PennDOT in advance of any work in the right-of-way. (Municipality Name) is also responsible to remove debris from the bike lane as needed. PennDOT will remove snow from Non-Separated Bike Lanes on State Roads and perform other routine roadway maintenance such as sweeping and vegetation trimming, in accordance with normal operations. This letter authorizes the Municipality to remove all Bike Lane Signs and Pavement Markings upon written notification to PennDOT. PennDOT also reserves the right to remove all Bike Lane Signs and Pavement Markings and will notify Municipality of such removal.

Please contact (Municipal Contact) to discuss the proposed bikeway:

Municipal Contact
Address
Telephone: (xxx) xxx-xxxx
E-mail:

Sincerely,

Name
Municipal Official

Exhibit 14.A.2 Example Bike Lane Approval Letter

DATE

Municipal Contact Person
Municipality Name
Street Address
City, State, Zip Code

Subject: Municipal responsibilities for Non-Separated bicycle lane facilities under 67 PA Code § 212.5

County:
Municipality Name:
SR, Section:
Project Length:
Project Name:
MPMS Number:

Dear Municipal Contact Person:

The Pennsylvania Department of Transportation (PennDOT) concurs with (Municipality Name's) plan to install a bicycle lane along SR (1234). The proposed bicycle lane is described below:

[Provide a description of the proposed bike route. Include location map and relevant drawings detailing the routing, pavement markings and signage. Approved documents submitted by the Municipality can be used to describe the bike lane.]

The purpose of this letter is to inform (Municipality Name) of its responsibility to install and maintain Bike Lane Signs and Pavement Markings for bicycles. Please see **67 PA Code § 212.5(b)1(v)**. (Municipality Name) is responsible to install and maintain all signage and pavement markings associated with the bicycle lane described above. (Municipality Name) will coordinate with the PennDOT in advance of any work in the right-of-way. (Municipality Name) is also responsible to remove debris from the bike lane as needed. PennDOT will remove snow from Non-Separated Bike Lanes on State Roads and perform other routine roadway maintenance such as sweeping and vegetation trimming, in accordance with normal operations. This letter authorizes the Municipality to remove all Bike Lane Signs and Pavement Markings upon written notification to PennDOT. PennDOT also reserves the right to remove all Bike Lane Signs and Pavement Markings and will notify Municipality of such removal.

Please direct all correspondence to the following contact:

PennDOT Engineering District X-X
Contact Person
Address
Telephone: (xxx) xxx-xxxx
Email: xxxxx@pa.gov

Sincerely,

Name
Assistant District Executive for Design

Chapter 15 – Transit Facilities (To Be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.

Chapter 16 – Freight Facilities (To Be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.

Chapter 17 – Plain People Community Considerations (To Be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.

Chapter 18 – Traffic Calming (To Be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.

Chapter 19 – Parking (To Be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.

Chapter 20 – Lighting (To Be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.

Chapter 21 – Wildlife Crossings (To Be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.

Chapter 22 – Landscape Planting (To Be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.

Chapter 23 – Emergency Escape Ramps (To Be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.

Chapter 24 – Rest Areas and Welcome Centers (To Be Added Later)

This chapter will be published in the future. Until it is published, please refer to relevant topic in Publication 13M.