


Washington County
Bicycle Facility
Design Toolkit



December 2012





Washington County, in conjunction with local jurisdictions and the Tualatin Hills Parks and Recreation District, is committed to providing a quality bikeway network that facilitates bicycling for transportation in rural, suburban, and urban portions of the County. This network will provide a valuable amenity for County residents and businesses, as well as help the County make progress towards local and regional policy goals such as increasing transportation options, improving accessibility, and encouraging healthy, active lifestyles. The Washington County Bicycle Facility Design Toolkit supports development of this network by providing a menu of facility options to improve conditions for bicyclists. These facilities have been applied nationwide and provide a range of separation and protection from vehicle traffic to increase user comfort and make bicycle transportation attractive to a wider range of residents.

This document supplements the *Washington County Road Design Standards* (County ORD. 738) by offering design guidance on innovative bikeway facilities that are not currently addressed in the road standards. All information is based on current best practices in bicycle transportation planning - tailored to the Washington County context - and research compiled by Alta Planning + Design and Kittelson & Associates, Inc.. The guidance is consistent with national standards and references the following materials, where appropriate:

- Association of State Highway and Transportation Officials (AASHTO) Guide for the Development of Bicycle Facilities (Adopted 1999 Edition and Draft 2010 Update)
- Federal Highway Administration (FHWA) 2009 Manual of Uniform Traffic Control Devices (MUTCD)
- US Access Board 2011 Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way
- National Association of City Transportation Officials (NACTO) Urban Bikeway Design Guide

The Toolkit is divided into three parts:

- **Introduction** – provides an overview of the intended audience and use of the Toolkit, and guidance on special considerations related to bicycle facility design.
- **Facility Selection Process (page 7)** – outlines a three-step process for identifying appropriate bicycle facility treatments of roadways within Washington County.
- **Facility and Treatment Design Guide (page 16)** – contains one-page summaries of bicycle facility types and design treatments, including a description, dimensions, typical application, local examples, and references for additional guidance.
- **Appendices (page 37)** - provides additional information about facility cost and maintenance requirements, intersection treatments, and a generic facility selection case study.



Washington County Bicycle Facility Design Toolkit

This Toolkit supplements the Washington County Road Design Standards by offering design guidance on innovative bikeway facilities that are not currently addressed in the standards.¹ The Toolkit provides guidance to planners, designers, and engineers during the planning and design of new roads and roadway improvements throughout Washington County. The Toolkit also supports implementation of the Washington County Transportation System Plan (TSP) by providing facility design flexibility to accommodate a variety of potential future user types and volumes.

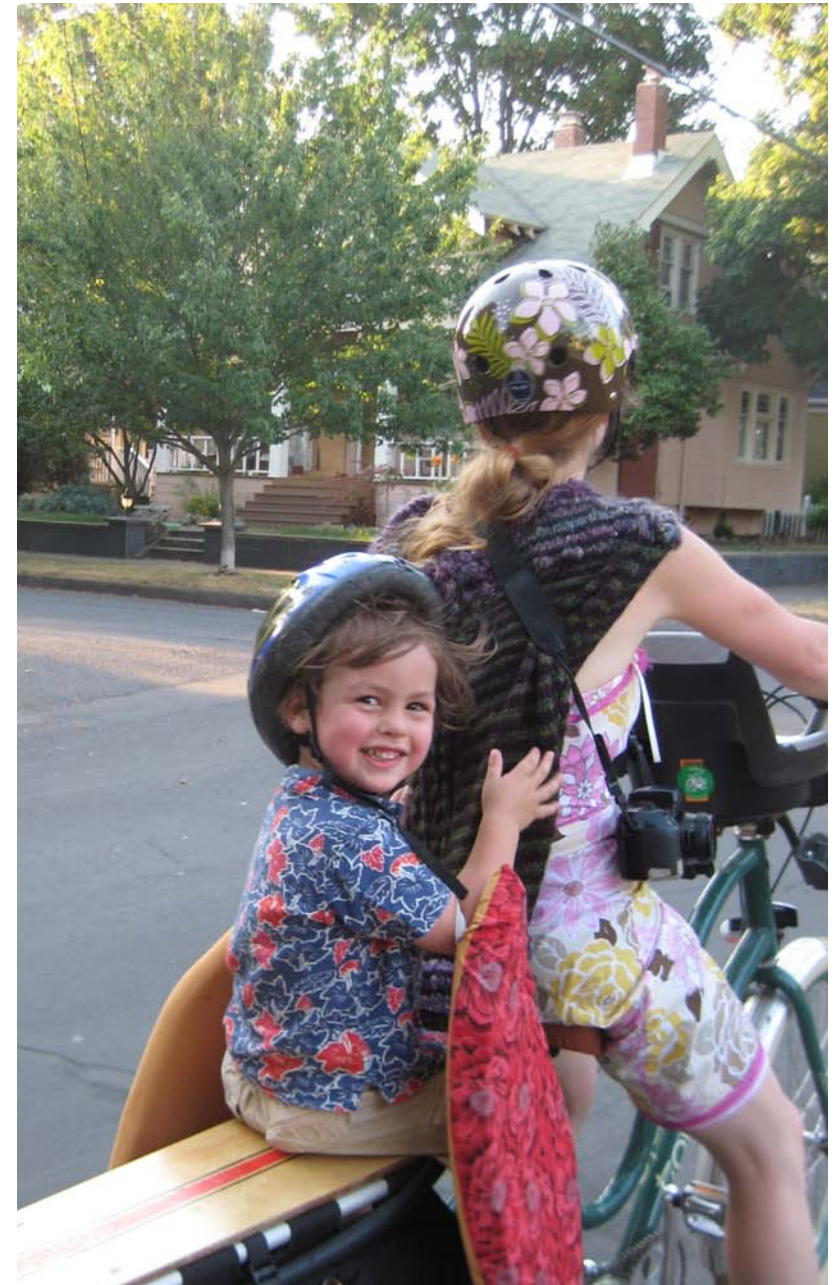
Although the Toolkit targets improvements to bicycle facilities on County-owned roads, the guidance is also applicable to roads owned by local jurisdictions. Local agencies within Washington County and neighboring counties are encouraged to use the Toolkit to support consistent bicycle facility design along routes that travel between jurisdictions. Where County bicycle facilities intersect with ODOT and city facilities, the Toolkit will provide guidance to develop appropriate transitions between their respective standards. If physical constraints require design exceptions to the current standards, then the Toolkit, as well as local and national guidance, should be used to document the decision process.

HOW TO USE THE TOOLKIT

This Toolkit is designed to help Washington County staff make well-informed decisions about bikeway design. To use this document to arrive at a preferred bicycle facility design, follow these steps:

Given the complexities of many roadways, the County encourages use of engineering judgment in all applications of the Toolkit to confirm that facilities and treatments are appropriate for the specific context and application.

- Gather data on existing and/or forecast roadway characteristics (e.g., vehicle speeds and volumes, functional classification, right-of-way width), surrounding land uses (e.g., bicycle attractors and generators), and demand (e.g., bicycle volumes, user types)
- Review special considerations and fundamentals. Decision making for off-street facilities is separately undertaken, and the provision of a separated facility does not preclude on street facilities.
- Identify potential appropriate facility types and design treatments for the street type and context
- Refine facility selection using the three-step facility selection process
- Apply engineering judgment to confirm preferred facility selection and design treatments.



¹ Until the Toolkit is adopted into the Road Design Standards, innovative bicycle facility designs may be incorporated into County projects or private developments as part of the design exception process.



SPECIAL CONSIDERATIONS

Washington County is a diverse area composed of urban, suburban, and rural roadways. This diversity makes bicycle facility design complex and requires treatments tailored to individual situations. Engineering judgment based on thorough knowledge of the roadway context and multimodal transportation is an important component of bikeway design and decisions should be documented. To assist with this, the Toolkit provides links to reference materials and studies relevant to each facility or treatment. This section also provides additional discussion of special considerations that should be incorporated into the facility selection and design process.

Types of Bicycle Facility Users

The anticipated end user should be considered when selecting appropriate bicycle facilities and design treatments. Bicycle facility users are typically grouped into three categories based on comfort and skill level:

- **Strong and Fearless or Type A (Advanced)** – This group includes bicyclists that are comfortable riding on busy roads with a low level of separation from traffic and navigating in traffic when necessary to reach destinations. This group makes up a small percentage of cyclists and the population.
- **Enthusied and Confident or Type B (Basic)** – This group includes utilitarian and recreational riders who will ride on busy streets if bike lanes or other facilities are provided, but may deviate from the most direct route to ride on low-traffic streets or shared-use paths.
- **Interested, but Concerned or Type C (Concerned)** – This group includes a wide range of people of all ages who enjoy bicycling occasionally, but may only ride on shared use paths, protected on-street facilities, or low traffic local streets. The majority of the population falls into this category.
- **No Way, No How** - a group of individuals that will not choose to bicycle for transportation or recreation no matter the infrastructure that is provided.

Surrounding land uses and destinations play an important role in determining the type of end users that want to travel on a given roadway. While surrounding land uses and destinations are important to consider, it is not possible to pre-suppose where people may want to travel. For this reason, roads within urban areas should be designed with bicycle facilities that accommodate Type C users. Bicycle facilities on rural roads, which primarily serve long-distance commuter and recreational trips, should be designed with the Type A and Type B user in mind. The Washington County TSP and County Planners will provide guidance on anticipated user types on roadways.

Minimum Bicycle Operating Dimensions

The physical dimensions and operating characteristics of bicyclists vary considerably due to different types of bicycles and differing physical abilities of bicyclists. Bicycle facilities should maintain minimum critical operating dimensions to accommodate a typical adult bicyclist, as shown in Figure 1. Minimum operating width is 4', but additional width is desirable to account for the natural side-to-side motion of cycling and shy distance from railings, curbs, or other parallel objects. Road maintenance and frequency of sweeping also impact the horizontal width needed for comfortable operation. An operating height of approximately 8' is necessary to accommodate an adult bicyclist standing upright on pedals. Typical adult bicycles are approximately 6' long, but additional length should be considered when designing median refuges or other bicycle facilities for tandems or bicycles pulling trailers. Adult bicyclists typically ride at 8 to 15 miles per hour on level terrain, but speeds vary based on age and ability.

Freight, Transit and Emergency Services Routes

Special design consideration is needed for bicycle facilities on designated freight, transit, and/or emergency services routes because large vehicles have unique operating and design needs that can conflict with the needs of bicyclists. The presence of many large vehicles can decrease safety and level of comfort for bicyclists, requiring use of more protected/separated facilities or alternate, parallel bicycle routes. Traffic calming measures to reduce vehicle speeds and increase comfort for cyclists are typically not appropriate on large vehicle routes because of the large corner radii needed for trucks to operate and disturbances caused by speed bumps.

On large vehicle routes, a 12' outside vehicle lane should be maintained, where possible, to reduce vehicle encroachment into bicycle facilities. Additional buffering should also be considered on road segments with curves where the rear wheels of large vehicles may off track into adjacent bicycle facilities. On transit routes where buses must merge over bicycle facilities to serve stops, left-side bike lanes, buffered bike lanes or other design treatments should be considered to reduce "leapfrogging" and conflicts between bicycles and boarding/alighting transit passengers.

Conflict Points: Intersections, Alleys and Driveways

A conflict point exists where motorists, bicyclists and pedestrians cross travel paths. Conflict points include, but are not limited to, intersections, driveways and alleyways. Higher concentrations of conflict points along a roadway increases the potential for crashes to occur between modes. The density of conflict points also affects the type of facility that is most appropriate. A high density of conflict points occurs when intersections are spaced <200', medium density is in the range of 200' to 600' and low density is when access points are spaced >600' apart. To improve safety and comfort, bikeway facilities should be designed to reduce conflicts wherever possible, by maximizing visibility, delineating a clear right-of-way, facilitating eye contact and awareness between competing modes, and setting behavioral expectations. For example, parking or other buffers that reduce visibility between the travel lane and bicycle facility should be removed in advance of intersections as shown in Figure 2.

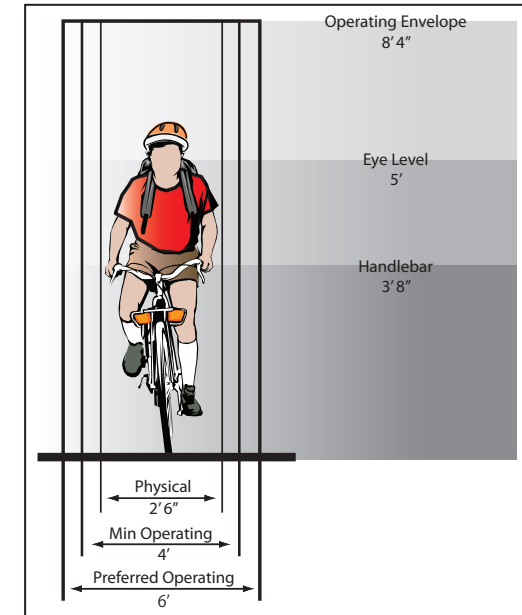


FIGURE 1. Typical Bicycle Operating Dimensions (Source: 2010 Draft AASHTO Guide for the Development of Bicycle Facilities)



FIGURE 2. Example Cycle Track Intersection Approach Treatment (Source: NACTO)



FIGURE 3. MUTCD (R3-17) and (R3-17bP) and ODOT (OBW1-9) Bike Lane Ends Signs

Specifically, design treatments at intersections can facilitate merging and turning maneuvers that help all roadway users move more safely through the intersection. Intersection design should consider existing and anticipated bicycle, pedestrian and motorist volumes and movements. The degree of mixing or separation between bicyclists and other modes should be designed to facilitate these movements, reduce the risk of crashes, and increase bicyclist comfort.

Treatments such as color, signs, medians, signal detection and timing, bicycle signals, and pavement markings may be used alone or in combination to increase safety at access points. The level of treatment required at an intersection will depend on the bicycle facility type used, whether bicycle facilities are intersecting, the adjacent street function and land- use. The 'Treatments' section, beginning on page 27, highlights potential solutions such as bike boxes and intersection markings. The *NACTO Urban Bikeway Design Guide* provides more detailed, frequently updated, guidance on a variety of intersection design treatments.

Transitions

Bicycle facilities should be designed to maximize consistency for bicyclists and minimize conflicts with other roadway users. Whenever possible, bicycle facilities should be constructed that connect bicyclists to destinations or connect the larger bicycle network. Isolated, short bicycle facilities that begin and end abruptly without connecting to a destination should be avoided unless they are part of a planned, phased approach to bikeway development (e.g., as development occurs on a designated corridor).

Bicycle facilities should transition as smoothly as possible from one facility type to another (e.g., tapering from protected cycle track, to buffered bike lane, to conventional bike lane). Abrupt facility transitions that make it difficult for cyclists to navigate along the bicycle network and/or increase vehicle conflicts (e.g., changes from right to left side bike lanes or from two-way to one-way cycle tracks) should be minimized. ODOT and MUTCD compliant signing and striping should be used wherever bike lanes or other facilities are terminated. Bicycle facilities should not be terminated in areas that abruptly force bicyclists to merge with high speed or high volume traffic.

Roadway Geometry, Vertical and Horizontal curves and Sight Distance

Roadway geometry can affect the visibility and operating characteristics of both motorists and bicyclists. Roadway segments with horizontal and vertical curves can be particularly challenging because they limit visibility and can cause off-tracking. Motorists who do not slow down in anticipation of this possibility significantly decrease the comfort of bicyclists. Furthermore, the speed differential between motorists and bicyclists increases on uphill roadway segments. Corridors with challenging roadway geometry require further analysis to identify an appropriate bikeway facility.

Maintenance

The feasibility and cost of facility maintenance should be considered when selecting appropriate design treatments and placement. Bicycle facilities must be kept clear of debris to provide a viable route for bicycle travel. Special street sweeping or plowing equipment and schedules may be needed to keep cycle tracks and raised bike lanes clear of snow and debris. Similarly, drainage must be considered during the design of these facilities to prevent water from pooling.

Facilities must also remain clearly visible to be effective. Colored pavement used to increase visibility of bike boxes and conflict zones must typically be reapplied every several years, depending on the material used and seasonal weather severity. Similarly, conventional and buffered bike lanes must typically be restriped every several years, depending on the material used. In both cases, design that reduces the frequency of vehicles driving over the painted areas can decrease the frequency with which maintenance is needed.

Cost

Available funding, initial capital cost, and life cycle costs are additional important considerations when selecting appropriate bicycle facilities. Research has shown that the return on investment for bicycle facilities can be very high, by increasing the number of bicycle trips and, over time, reducing the need for more costly road expansion projects. For example, the City of Minneapolis performed a comprehensive evaluation of two new bikeways that demonstrated a 70-percent increase in bicycle trips, a reduction in crashes across all modes and the maintenance of operational efficiency along the corridors.²

Unfortunately, due to the fact that many facilities addressed in the Toolkit are relatively new designs and that many bikeway improvements are constructed as a portion of larger roadway projects, there are few resources for establishing reliable cost estimates and comparisons for innovative bicycle facilities. Metro and the City of Portland are currently conducting a review of bicycle facility costs, which will serve as a valuable resource for County staff once completed.

Roadway Modification Strategies

Many arterials and collectors in Washington County provide adequate right-of-way to accommodate conventional bike lanes or shoulder bikeways per the Washington County Road Design Standards. However, additional right-of-way or roadway modifications may be needed in order to accommodate more protected bicycle facilities such as buffered bike lanes or cycle tracks. The bicycle facility selection

process presented in the next section identifies potential roadway modifications to create adequate pavement width for bicycle treatments on different Washington County road classifications.

- **Narrow Travel Lanes** – Restriping to reduce travel lane widths (e.g., from 12' to 11') can help free pavement width to accommodate bicycle facilities without widening the roadway or acquiring additional right-of-way. On freight, transit, and emergency response routes, inside travel lanes may be narrowed, but 12' outside lanes should be maintained, where possible, to prevent larger vehicles from encroaching upon bicycle facilities. The 2010 Highway Capacity Manual (HCM) provides analysis of the operational impacts of narrowing travel lanes. At signalized intersections, there is no difference in saturation flows between lane groups with an average width of 10 to 12.9 feet (HCM Exhibit 18-13). On multilane highway segments with speeds of 45-60 miles per hour, free flow speeds decrease by an average 1.9 and 6.6 miles per hour on 11' and 10' lanes, respectively, compared to 12' lanes (HCM Exhibit 14-8). For additional information see existing County policy.
- **Remove Travel Lane** – On roadways with excess vehicle capacity, a travel lane may be removed and the roadway restriped to accommodate bicycle facilities using existing pavement width. Lane removal may be combined with operational improvements such as signal progression to maintain acceptable vehicle operations. Seattle and other cities throughout the region have successfully removed travel lanes to accommodate bicycle facilities and complete streets features while maintaining operations and minimizing diverted traffic.
- **Remove On-Street Parking Lane** – On-street parking may be removed to accommodate bicycle facilities on roadways where promoting non-single-occupancy-vehicle travel is a priority, on-street parking utilization is low, and/or nearby alternative on- or off-street parking facilities are available. Parking lane removal should be coordinated with adjacent property owners that may be impacted.
- **Narrow or Remove Center Turn Lane** – On roadways with low left-turn volumes or excess turn lane capacity, the center turn lane may be narrowed or removed and the roadway restriped to accommodate bicycle facilities. Intersection geometry and potential safety implications (e.g., increases in rear end crashes) should be considered when assessing potential turn lane changes.
- **Add Pavement Width** – In areas where other roadway modifications are not feasible and adequate right-of-way is available, additional pavement width may be constructed to accommodate bicycle facilities. Additional pavement width for bicycle facilities should not detract from adjacent sidewalk width or pedestrian

² City of Minneapolis "Hennepin and 1st Avenue Conversion Leads to Fewer Crashes and Better Access." Accessed online 02.22.2012 at http://www.ci.minneapolis.mn.us/news/news_20100727hennepinfirstreport.

quality of service. Added pavement width at intersections and midblock pedestrian crossings should be kept to a minimum to reduce pedestrian crossing distances. The stormwater drainage impacts and costs of adding pavement width should also be considered when evaluating the feasibility of this option.

With the exception of “add pavement width”, these roadway modifications involve restriping and reallocation of existing pavement width, which can be implemented at a much lower cost than roadway widening or right-of-way acquisition. The impacts of potential roadway modifications on all modes should be evaluated on a case-by-case basis. Appropriate modifications should be selected based on an engineering traffic study and/or engineering judgment.

Sources for More Information

Oregon Bicycle and Pedestrian Design Guide (2011)
web: <http://www.oregon.gov/ODOT/HWY/BIKEPED>

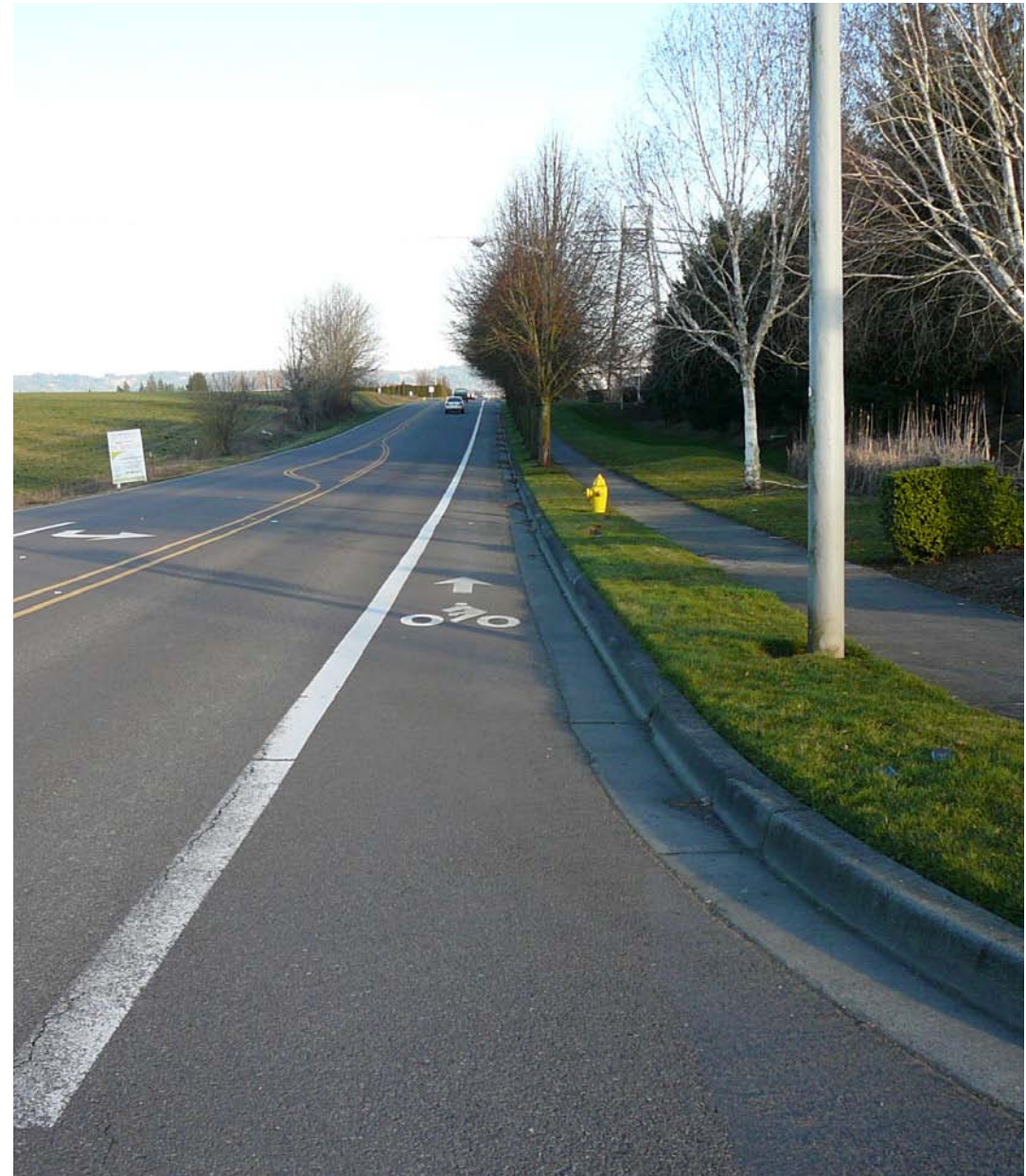
NACTO Urban Bikeway Design Guide (2011)
web: <http://nacto.org/cities-for-cycling/design-guide/>

London Cycling Design Standards
web: <http://www.tfl.gov.uk/businessandpartners/publications/2766.aspx>

Portland Bicycle Master Plan for 2030, Appendix D (2011)
web: <http://www.portlandonline.com/transportation/index.cfm?c=44597&a=289122>

FHWA, Bicycle Facilities and the Manual on Uniform Traffic Control Devices (2011)
web: http://www.fhwa.dot.gov/environment/bikeped/mutcd_bike.htm

New York City Street Design Manual (2009)
web: <http://www.nyc.gov/html/dot/html/about/streetsdesignmanual.shtml>



FACILITY SELECTION >>>

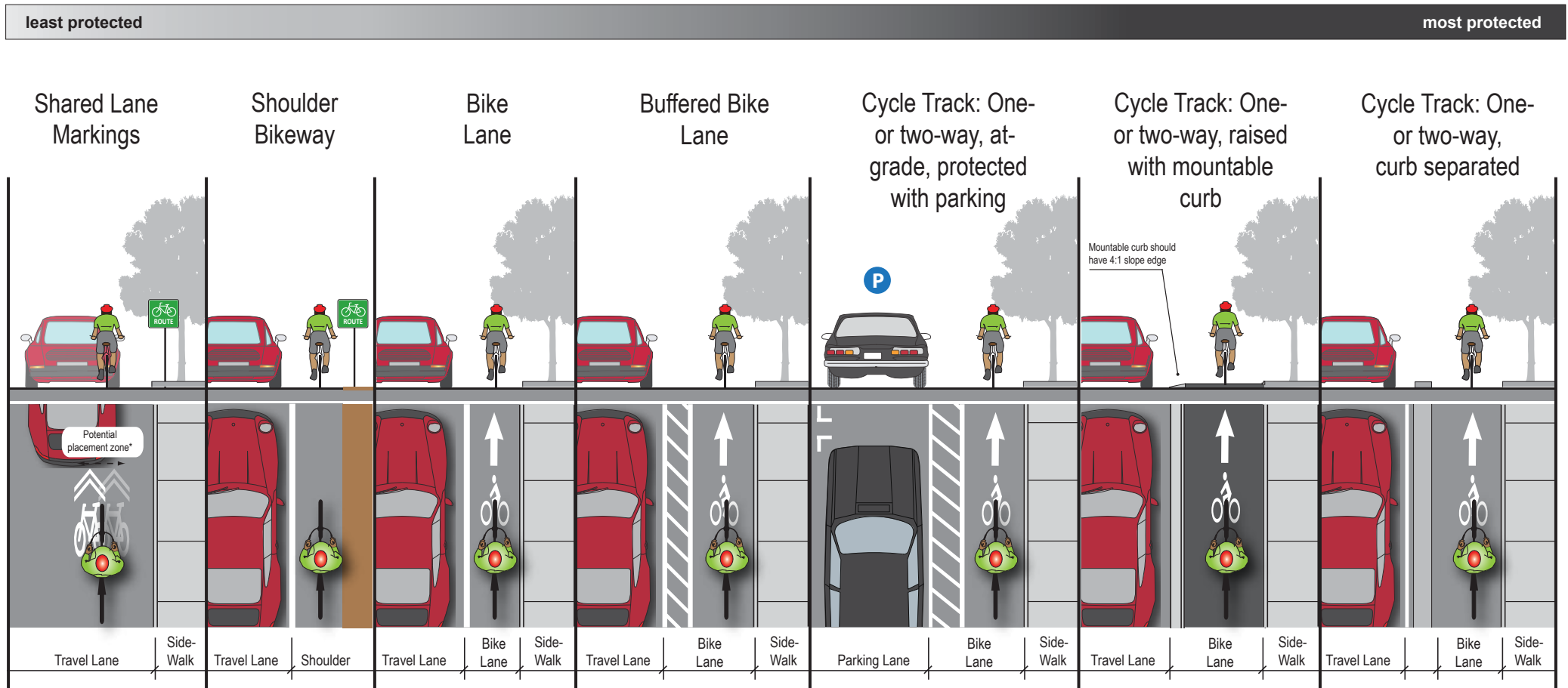
Washington County Bicycle Facility Design Toolkit

Selecting the best bikeway facility type for a given roadway can be challenging, due to the range of factors that influence bicycle users' comfort and safety. The following multi-step process assists Washington County planners, designers and engineers in determining the best bikeway solution for an existing or proposed roadway to accommodate bicyclists of varying skills and comfort levels. Specific design requirements for each of the facilities illustrated below can be found in the 'FACILITIES' section on page 18.

One of the most important factors to consider when designing for bicyclists is determining the type of bicycle user the facility is meant to attract. User preference varies with bicyclist's skill level, trip purpose, and individual characteristics, and no simple rule exists for determining what users prefer. However, as the level of separation increases, a facility becomes more attractive to a wider range of bicycle users—making bicycling a more viable and preferred transportation mode.

The County establishes a preferred bikeway network as part of its Transportation System Plan process. During this planning phase, the expected user group for individual bikeway corridors should also be determined based on factors such as whether the corridor is within an urban area. The following Bikeway Facility Selection process assumes that bikeway routes have been identified as suitable for Advanced (Class A), Basic (Class B), or Concerned (Class C) bicyclists, as defined in the County's TSP.

The continuum below illustrates the range of on-street bikeway facilities from least protected to most protected. The design details for each facility shown in the continuum can be found in the 'Facilities' section beginning on page 18. **The transportation planner or designer's primary goal is to select the the facility that will provide the greatest amount of protection within the existing roadway context for the expected user group.** The following steps demonstrate how this is accomplished.



» **BEGIN** by printing out a blank Project Worksheet (following page) to document decisions and data as you move through the Facility Selection Process.

STEP
1

Identify preferred bikeway facility using daily traffic volume and travel speed

+

STEP
2

Examine potential modifications to standard cross-sections required to accommodate the preferred facility

+

STEP
3

Run the preferred facility through a series of checks to confirm compatibility with existing roadway context

=

**RECOMMENDED
BIKEWAY FACILITY**

PROJECT WORKSHEET

Washington County Bicycle Facility Design Toolkit

PROJECT NUMBER _____ PROJECT NAME _____ EXTENTS (FROM/TO) _____

IRIS ROAD OR ASSET NUMBER _____ FUNCTIONAL CLASSIFICATION _____ LAND USE DISTRICT _____

DAILY TRAFFIC _____ 85TH-PERCENTILE SPEED _____ PERCENT HEAVY TRAFFIC _____ EXISTING ROW _____ PAVEMENT WIDTH _____

FACILITY CHECKS

- Bicycle system of county-wide significance on TSP: YES NO
- Expected Bicycle User Group (check all that apply): Advanced Basic Concerned
- Designated Freight or Transit Route: YES NO
- Emergency Services Route: YES NO
- Density of Conflict Points (Driveways/Intersections): HIGH (<200') MED (200'-600') LOW (>600')
- On-Street Parking Presence: YES NO
- Challenging Road Geometry: YES NO
- Adjacent School(s): _____
- Adjacent Park(s): _____
- Transit Route(s): _____
- Adjacent Commercial Area(s): _____
- Adjacent Neighborhood(s): _____
- Nearby Point(s) of Interest: _____

Please describe any special ROW constraints that may be present (e.g., bridges, buildings, wetlands, etc):

Department(s) that populated this worksheet:

CROSS-SECTIONS

Please sketch the existing cross-section

Please sketch the proposed cross-section

Recommended Facility Type:

Recommended Cross-Section Modification(s):

Washington County Bicycle Facility Design Toolkit

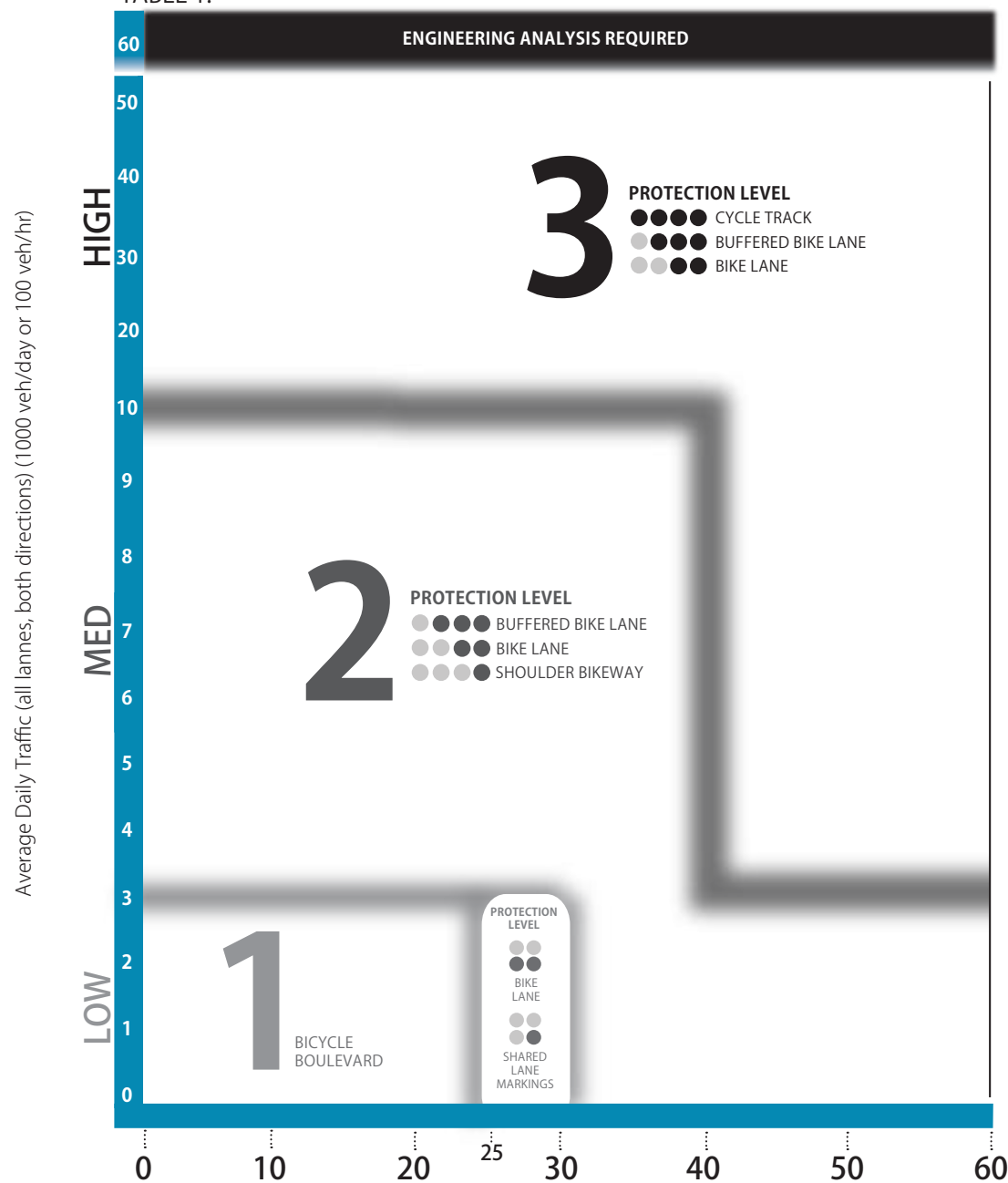
There is a significant impact on cycling comfort when the speed differential between bicyclists and motor vehicle traffic is high and motor vehicle traffic volumes are high. To narrow the range of facilities appropriate for a given roadway use Table 1. Applicable to both the rural and urban setting, Table 1 illustrates the appropriate facilities that may be considered at various speed/volume thresholds. To use this table, identify the daily traffic volume on the *y*-axis and travel speed on the *x*-axis for the existing or proposed roadway. Depending on the inputs, the roadway context will fit into one of three categories, 1, 2, or 3. Within each category the available facility types have been ranked in order of their level of protection. Select the facility with the highest protection level and proceed to **STEP 2** where potential roadway modifications are identified to accommodate this type of bikeway.

INCREASING PROTECTION



*Speed and volume thresholds based on the London Cycling Design Standards, ODOT Bicycle and Pedestrian Design Guide (2011) and the NACTO Urban Bikeway Design Guide

TABLE 1.*



85th-percentile speed (preferred), design speed, or posted speed (mph)

Washington County Bicycle Facility Design Toolkit

This step in the process will help the designer, planner, or engineer determine if the preferred (most protected) facility type fits within the existing curb-to-curb pavement width. It also identifies potential strategies for accommodating the facility, pending a constrained right-of-way (ROW). For this step, Washington County's existing Road Design Standards are used. The County's road standards provides information on existing lane configuration and available pavement width for each road classification. This process examines Arterial, Collector, Neighborhood and Local roadways.

The table below provides information regarding the additional pavement width necessary for each treatment and how that treatment might be applied in each roadway class. If the preferred facility type does not fit within the existing pavement width, or if the potential modifications are unacceptable, repeat the process using the second most protected facility type from the identified speed/volume category on the previous page. Proceed to **STEP 3** only when a bikeway facility and roadway modification strategy have been identified.

ROADWAY MODIFICATION*

Narrow travel lanes: bikeways may be added by adjusting wide travel lanes or parking lanes within the established minimums. No reduction to the number of travel lanes required (requires a design exception)

Remove travel lane: where motor vehicle volume is below roadway capacity, the removal of a travel lane can provide the necessary pavement width to accommodate on-street bikeways. May require a traffic impact assessment or TSP amendment prior to lane removal.

Parking removal: underused on-street parking on one side of the street is removed to create space for bike lanes. For example, an acceptable situation for this scenario includes areas that have large surface parking lots adjacent to existing on-street parking. A parking utilization study should be conducted prior to removal of on-street parking.

Narrow/remove center turn lane: roadways with an underused, or extra-wide, center turn lane provide an opportunity for reallocating pavement width to develop new bikeway facilities. May require a traffic impact assessment or TSP amendment prior to lane removal or width reduction.

Add pavement width: If additional right-of-way is available along the corridor it may be possible to pave a new roadway shoulder to develop a bikeway facility.

*see page 5, 'Roadway Modification Strategies' for more detailed information

ARTERIAL					POTENTIAL MODIFICATIONS TO STANDARD CROSS-SECTION				
APPLICABLE FACILITIES	PROTECTION LEVEL	ADDITIONAL PAVEMENT WIDTH NEEDED PER DIRECTION	ROAD CLASS	FITS IN STANDARD CROSS-SECTION	NARROW TRAVEL LANES	REMOVE TRAVEL LANE	PARKING REMOVAL	NARROW/REMOVE CENTER TURN LANE	ADD PAVEMENT WIDTH
SHOULDER BIKEWAY	●	0'	A1 - A4	X			N/A		
CONVENTIONAL BIKE LANE	●●	0'	A1 - A4	X			N/A		
BUFFERED BIKE LANE	●●●	2' - 3'	A1 - A2		X	X	N/A	X	X
		2' - 3'	A3		X	X	N/A		X
		2' - 3'	A4		X		N/A	X	X
CYCLE TRACK*	●●●●	1.5' - 3'	A1 - A2		X	X	N/A	X	X
		1.5' - 3'	A3		X	X	N/A		X
		1.5' - 3'	A4		X		N/A	X	X

Washington County Road Classification	Available ROW	Available Pavement Width	Number Lanes
A1	122	98	7
A2	98	74	5
A3	90	60	4
A4	90	50	3

*For detailed information regarding the dimensions and applications of different types of cycle track facilities refer to pages 21 - 23 of the Toolkit

COLLECTOR					POTENTIAL MODIFICATIONS TO STANDARD CROSS-SECTION				
APPLICABLE FACILITIES	PROTECTION LEVEL	ADDITIONAL PAVEMENT WIDTH NEEDED PER DIRECTION	ROAD CLASS	FITS IN STANDARD CROSS-SECTION	NARROW TRAVEL LANES	REMOVE TRAVEL LANE	PARKING REMOVAL	NARROW/REMOVE CENTER TURN LANE	ADD PAVEMENT WIDTH
SHOULDER BIKEWAY	●	0'	C1 - C2	X			N/A		
CONVENTIONAL BIKE LANE	●●	0'	C1 - C2	X			N/A		
BUFFERED BIKE LANE	●●●	2' - 3'	C1		X		N/A	X	X
		2' - 3'	C2				N/A	N/A	X
CYCLE TRACK*	●●●●	1.5' - 3'	C1		X		N/A	X	X
		1.5' - 3'	C2		X		N/A	N/A	X

Washington County Road Classification	Available ROW	Available Pavement Width	Number Lanes
C1	74	50	3
C2	varies	36	2

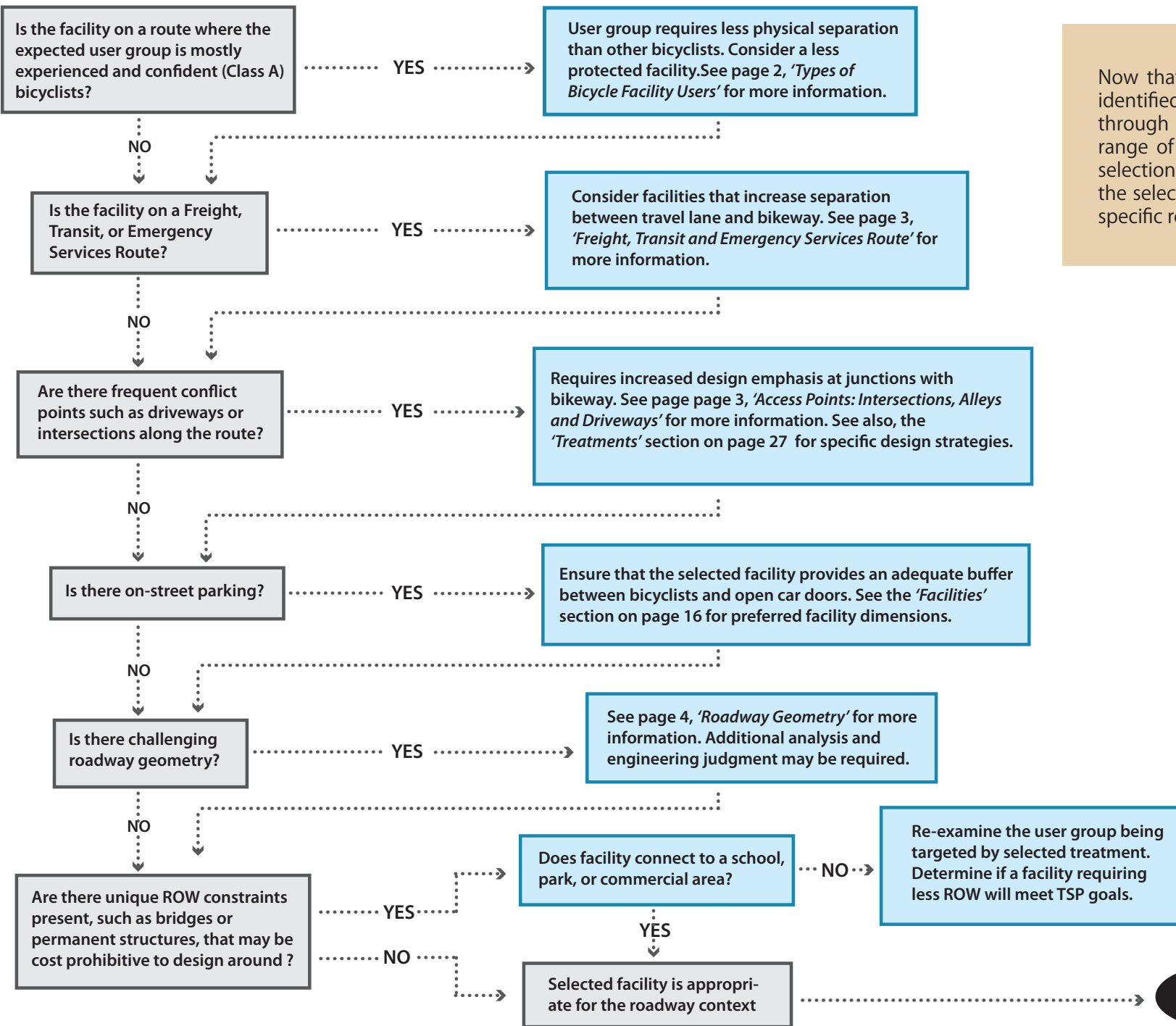
NEIGHBORHOOD					POTENTIAL MODIFICATIONS TO STANDARD CROSS-SECTION					
APPLICABLE FACILITIES	PROTECTION LEVEL	ADDITIONAL PAVEMENT WIDTH NEEDED PER DIRECTION	ROAD CLASS	FITS IN STANDARD CROSS-SECTION	NARROW TRAVEL LANES	REMOVE TRAVEL LANE	PARKING REMOVAL	NARROW/REMOVE CENTER TURN LANE	ADD PAVEMENT WIDTH	
CONVENTIONAL BIKE LANE	●●	6'	NR1						X	
		6'	NR2		X		X		X	
		6'	NR3				X		X	
		0'	NR4	X						
		6'	NR5							X
		6'	NR6				X		X	X
SHARED LANE MARKINGS	●	N/A	NR1 - NR6	X					N/A	

Washington County Road Classification	Available ROW	Available Pavement Width	Number Lanes
NR1	60	28	2
NR2	60	32	2
NR3	60	36	2
NR4	60	36	2
NR5	50	28	2
NR6	50	32	2

*For detailed information regarding the dimensions and applications of different types of cycle track facilities refer to pages 21 - 23 of the Toolkit

LOCAL					POTENTIAL MODIFICATIONS TO STANDARD CROSS-SECTION				
APPLICABLE FACILITIES	PROTECTION LEVEL	ADDITIONAL PAVEMENT WIDTH NEEDED PER DIRECTION	ROAD CLASS	FITS IN STANDARD CROSS-SECTION	NARROW TRAVEL LANES	REMOVE TRAVEL LANE	PARKING REMOVAL	NARROW/REMOVE CENTER TURN LANE	ADD PAVEMENT WIDTH
CONVENTIONAL BIKE LANE	●●	6'	L1						X
		6'	L2		X		X		X
		6'	L3		X		X		X
		6'	L4		X		X		X
		6'	L5						
SHARED LANE MARKINGS	●	N/A	L1 - L5	X					N/A

Washington County Road Classification	Available ROW	Available Pavement Width
L1	50	24
L2	38	32
L3	34	28
L4	30	24
L5	26	20



Now that a preferred facility type has been identified, it is time to run this selection through a set of "checks". Due to the wide range of factors influencing bikeway facility selection these checks will help confirm that the selected facility is the best choice for the specific roadway context.



FACILITIES >>>

- 17 SHARED LANE MARKINGS**
- 18 SHOULDER BIKEWAY**
- 19 CONVENTIONAL BIKE LANE**
- 20 BUFFERED BIKE LANE**
- 21 PROTECTED CYCLE TRACK**
- 22 RAISED CYCLE TRACK**
- 23 TWO-WAY CYCLE TRACK**
- 24 MULTI-USE OFF-STREET PATH**
- 25 BICYCLE BOULEVARD**

DESIGN SUMMARY >>

Shared lane markings (SLMs), also known as “sharrows”, are often used on streets where bicycle facilities are desirable but motor vehicle speeds and volumes do not necessitate a separated bikeway. Such markings delineate specifically where bicyclists should operate within a shared vehicle/bicycle travel lane. They must never be used as a replacement for bike lanes on high-speed or high-volume roadways.

- Where on-street parking exists, SLMs encourage bicyclists to ride outside the door zone
- Encourages bicyclists to ride in a straight line so that their movement is predictable for motorists
- Alerts motorists to expect the presence of bicyclists
- Can be used as bicycle wayfinding to direct bicyclists along designated routes (chevron can be angled to provide route turning guidance)

DIMENSIONS:

- See MUTCD Section 9C.07
- SLM marking must be positioned 4' min. from curb or the edge of the parking lane if on-street parking is present

TYPICAL APPLICATION:

- Streets with traffic volumes $\leq 3,000$ AADT
- Streets with posted travel speeds ≤ 30 mph

LAND USE CONTEXT:

- Urban and suburban

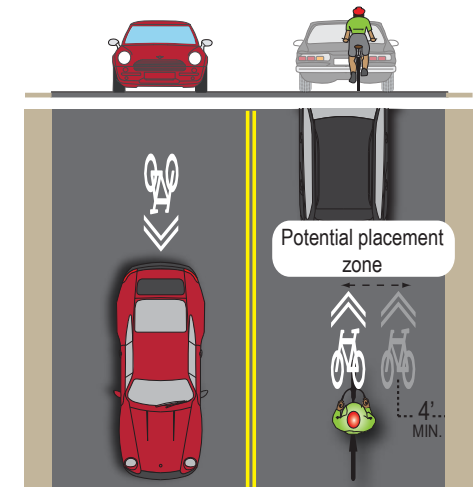
PEER COMMUNITIES/LOCAL EXAMPLES:

- Portland, OR (NE Tillamook St); Tigard, OR (Burnham St)

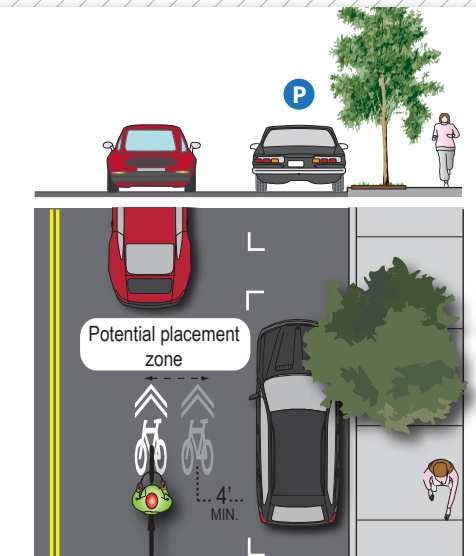
ADDITIONAL GUIDANCE:

- Manual on Uniform Traffic Control Devices (MUTCD) Chapter 9: Traffic Control for Bicycle Facilities, National Association of City Transportation Officials (NACTO) Urban Bikeway Design Guide

SUBURBAN ROADWAY WITH SLMs



URBAN ROADWAY WITH SLMs



DESIGN SUMMARY >>

On rural roads with a large shoulder, shoulder bikeways can accommodate bicycle travel. Shoulder bikeways are generally used by commuter and long-distance recreational riders, rather than families with children or more inexperienced riders. This treatment is allowed under Washington County's existing roadway design standards.

- Provides a space for bicyclists to ride that is separate from motor vehicle traffic

DIMENSIONS:

- 6' minimum; wider shoulder optional (Washington County Road Design Standards)

TYPICAL APPLICATION:

- Rural highways, arterials and some collectors

LAND USE CONTEXT:

- Rural

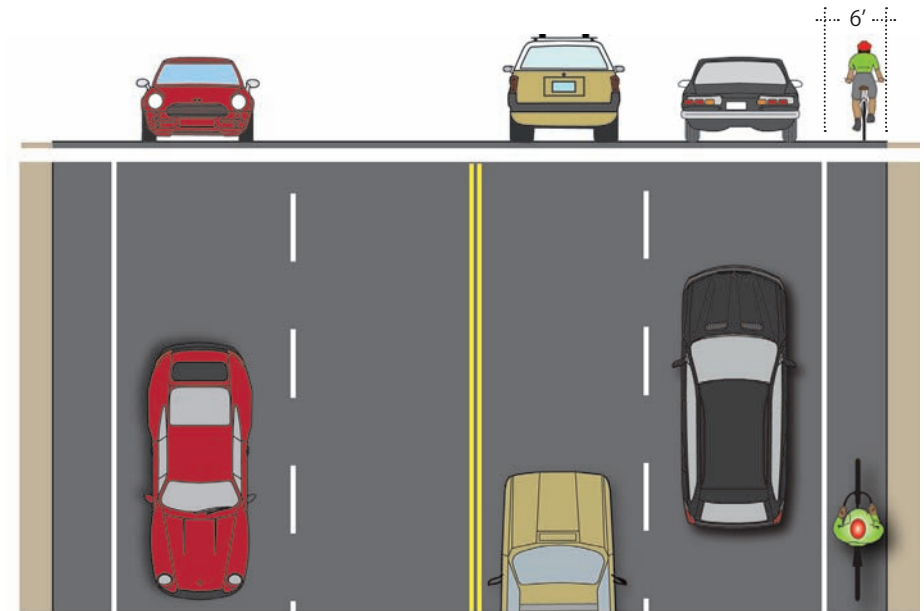
PEER COMMUNITIES/LOCAL EXAMPLES:

- Troutdale, OR (Historic Columbia River Hwy)

ADDITIONAL GUIDANCE:

- AASHTO Guide for the Development of Bicycle Facilities, Oregon Bicycle and Pedestrian Plan (2007 Update)

ROADWAY WITH PAVED SHOULDER



A paved shoulder on a rural arterial appeals most to recreational bicyclists traveling long distances

DESIGN SUMMARY >>

Designated exclusively for bicycle travel, bike lanes are separated from vehicle travel lanes with striping and pavement stencils. Bike lanes are most appropriate on arterial and collector streets where higher traffic volumes and speeds warrant greater separation. Bike lanes also increase safety and reduce wrong-way riding. This treatment is required on arterials and collectors when roads are newly constructed or reconstructed, per Washington County's existing Road Design Standards.

- Defines road space for bicyclists and motorists, reducing the possibility that motorists will stray into cyclists' path
- Discourages bicyclists from riding on the sidewalk
- Reminds motorists that bicyclists have a right to the road

DIMENSIONS:

- 6' recommended; required if on-street parking is present
- 5' acceptable if no parking or parking not marked
- 4' minimum in constrained locations
- 7' maximum if buffer or barrier is not provided (greater widths may encourage vehicle loading or driving in bike lane)

TYPICAL APPLICATION:

- Streets with traffic volumes $\geq 3,000$ AADT
- Streets with posted travel speeds ≥ 25 mph

LAND USE CONTEXT:

- Urban, suburban, rural

PEER COMMUNITIES/LOCAL EXAMPLES:

- Washington County (Baseline Rd and Murray Blvd)

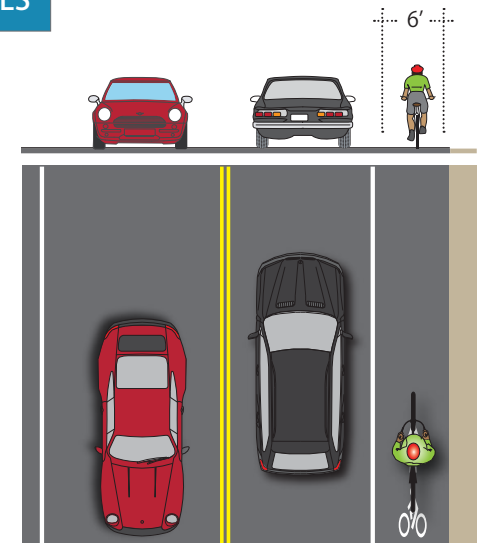
ADDITIONAL GUIDANCE:

- AASHTO, MUTCD, NACTO

RURAL ROADWAY WITH BIKE LANES



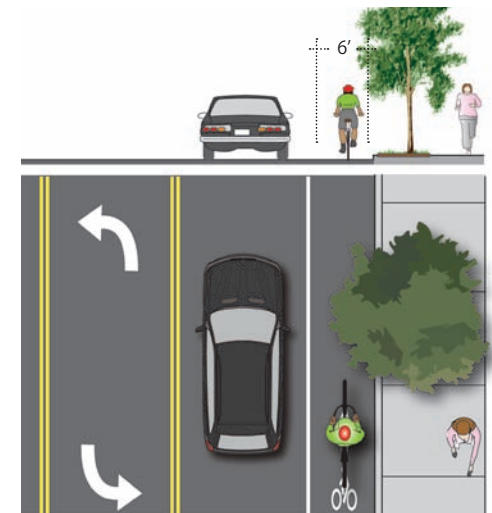
Bike lanes on rural roadways help to separate bicyclists from large vehicles such as transit, freight, and emergency vehicles



URBAN ROADWAY WITH BIKE LANES



On-street parking was removed on this suburban street to accommodate bike lanes



DESIGN SUMMARY >>

Bike lanes on high-volume or high-speed roadways can be dangerous or uncomfortable for cyclists, as automobiles pass or are parked too close to bicyclists. Buffered bike lanes are designed to increase the space between the bike lanes and the travel lane or parked cars. Buffered bike lanes are not currently addressed in the Washington County Road Design Standards.

- Allows motorists greater separation from bicyclists in the bike lane (as travel speeds increase greater separation is needed)
- Provides space for cyclists to pass one another without encroaching into the travel lane

DIMENSIONS:

- Same as a Conventional Bike Lane (5' to 6') with the addition of a 2' to 3' painted buffer
- Buffer is typically diagonally hatched to increase visibility

TYPICAL APPLICATION:

- Any location where a bike lane may be considered and sufficient right-of-way exists
- Streets with posted travel speeds ≥ 25 mph
- Where motor vehicle traffic volumes $\geq 10,000$ AADT

LAND USE CONTEXT:

- Urban, suburban, rural

PEER COMMUNITIES/LOCAL EXAMPLES:

- Washington County (Tualatin-Sherwood Rd and Evergreen Rd); Portland, OR (SE 101st Ave)

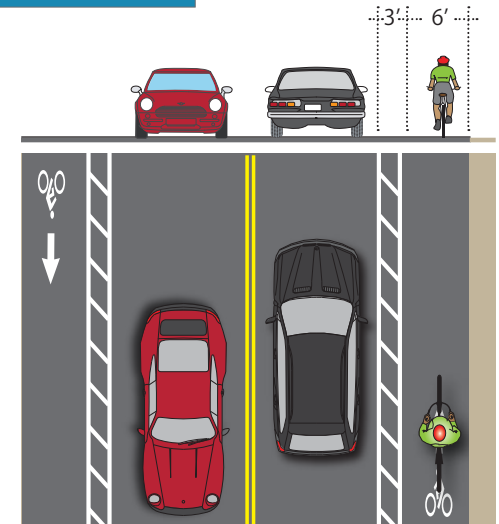
ADDITIONAL GUIDANCE:

- NACTO, CROW Design Manual, London Bicycle Design Standards

RURAL ROADWAY WITH BUFFERED BIKE LANES



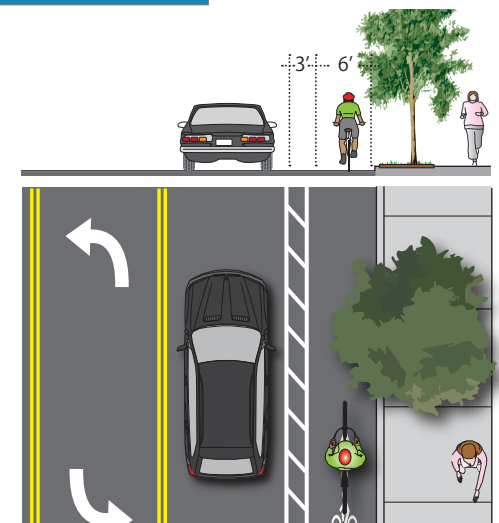
Buffered bike lanes increase the shy distance between passing motorists and bicyclists



URBAN ROADWAY WITH BUFFERED BIKE LANES



A bike commuter in an urban setting rides comfortably in the buffered bike lane



DESIGN SUMMARY >>

Protected cycle tracks are on-street bikeway facilities that provide the safety and comfort of multi-use paths within the road right-of-way. This is accomplished by combining a painted buffer with a physical barrier such as flexible bollards, a landscaped buffer, or a parking lane. The added protection further separates motor vehicles and bicyclists where travel speeds and/or motor vehicle traffic volumes are high. This type of facility appeals to a wider range of bicycle users than a conventional bike lane. Protected cycle tracks are not currently addressed in the Washington County Road Design Standards.

- Dedicates and protects space for bicyclists and improves perceived comfort and safety
- Reduces risk of 'dooring' compared to a bike lane, and eliminates the risk of a doored cyclist being run over by a motor vehicle (if adjacent to a parking lane)

DIMENSIONS:

- 5' to 7' bike throughway
- 2' to 3' painted buffer (can be combined with planted median, flexible bollards, standard curb and gutter, or other barrier)
- Greater design emphasis is required to provide sufficient sight lines at intersections and for the treatment of pedestrian crossings of the cycle track

TYPICAL APPLICATION:

- Streets with multiple lanes and high traffic volumes ($\geq 10,000$ AADT)
- Streets with high travel speeds (≥ 40 mph)
- Streets with few intersections and driveway access points (requires innovative design treatment at intersections)
- One-way or two-way streets

LAND USE CONTEXT:

- Urban and suburban

PEER COMMUNITIES/LOCAL EXAMPLES:

- Portland, OR (SW Broadway); Missoula, MT (Higgins Ave)

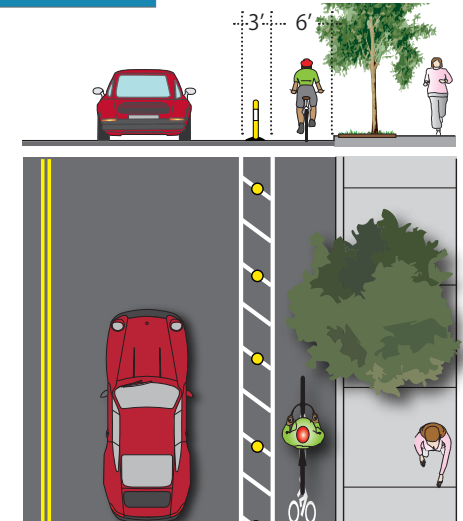
ADDITIONAL GUIDANCE:

- NACTO, Portland Bicycle Plan for 2030 (Appendix D)

SUBURBAN ROADWAY WITH CYCLE TRACK



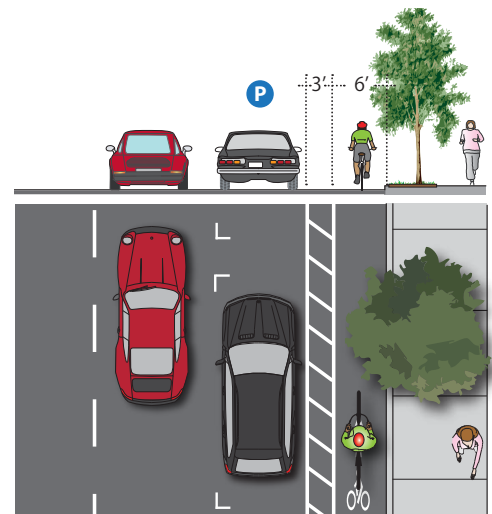
A cycle track in Tucson, AZ uses a textured buffer and bollards to provide a separated bikeway facility



URBAN ROADWAY WITH CYCLE TRACK AND PARKING LANE



The 9th Street cycle track in NYC is on the left side of the street to avoid conflict with transit stops



DESIGN SUMMARY >>

A raised cycle track is a grade separated cycle track. Commonly located above the adjacent travel lane and below the sidewalk, they can also be found at sidewalk grade. They provide many of the same benefits as a protected cycle track, but with the added bonus of allowing bicyclists to more easily move between the travel lane and bikeway facility. Steps must be taken to ensure that no lip is present at the juncture of the bikeway and roadway surface and that the slope is gentle (4:1). Raised cycle tracks are not currently addressed in the Washington County Road Design Standards.

- Dedicates space for bicyclists and improves perceived comfort and safety
- Allows bicyclists to easily exit the bike lane to ready for turns or when overtaking other cyclists

DIMENSIONS:

- 5' to 7'
- Mountable curb should be 1.5' and have a 4:1 slope edge
- Special attention needed for drainage to prevent pooling

TYPICAL APPLICATION:

- Streets with multiple lanes and high traffic volumes ($\geq 10,000$ AADT)
- Streets with high travel speeds (≥ 40 mph)
- Streets with few intersections and driveway access points
- One-way or two-way streets

LAND USE CONTEXT:

- Urban and suburban

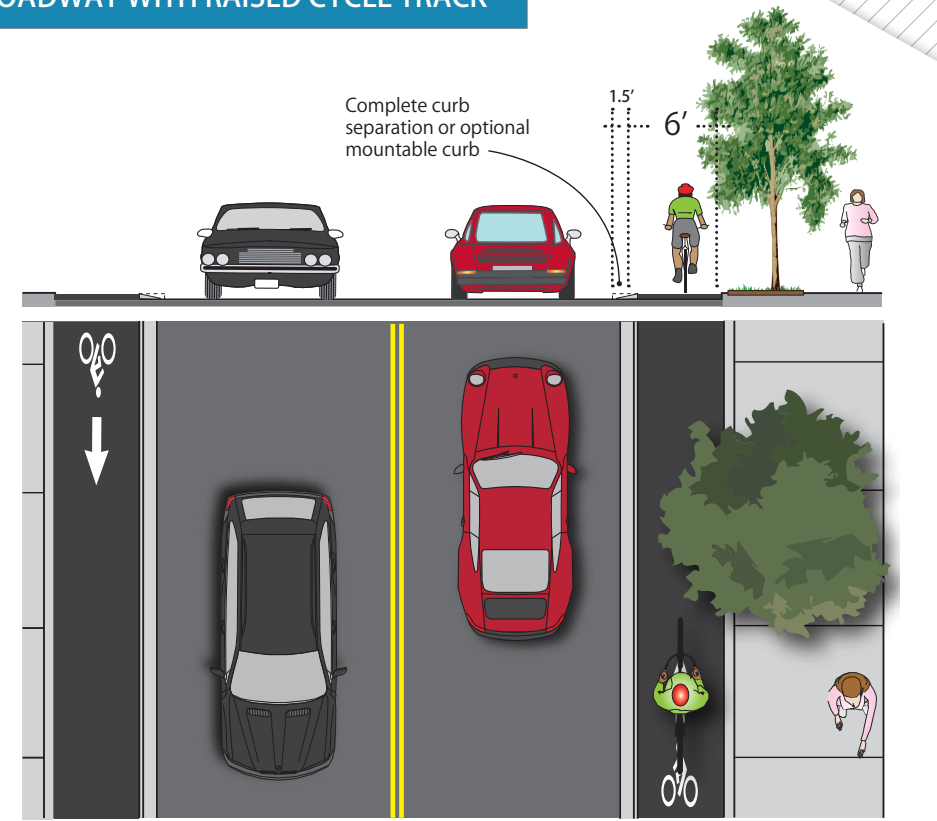
PEER COMMUNITIES/LOCAL EXAMPLES:

- Bend, OR (Alderwood Circle); Portland, Oregon (Cully Blvd)

ADDITIONAL GUIDANCE:

- NACTO, Oregon Bicycle and Pedestrian Plan (2007 Update)

ROADWAY WITH RAISED CYCLE TRACK



This raised and colored cycle track in Bend, Oregon vertically separates bicyclists and motorists



A raised cycle track in Corvallis, Oregon allows bicyclists to transition seamlessly into the travel lane when necessary

DESIGN SUMMARY >>

Two-way cycle tracks allow for bicycle travel in two directions on the same side of the road. They share many of the same benefits and characteristics of one-way cycle tracks, but require additional design treatments at intersections due to the limited visibility of bicyclists riding behind parked cars or barriers. This is due to some bicyclists traveling in the opposite direction of travel, which may be confusing for motorists entering/exiting the roadway. Two-way cycle tracks are not currently addressed in the Washington County Road Design Standards.

- Dedicates and protects space for bicyclists and improves perceived comfort and safety
- May reduce bicyclist out of direction travel
- Can improve bicycle connectivity by allowing contra-flow travel

DIMENSIONS:

- 10' min. and 12' preferred width
- Can be combined with parking buffer, mountable curb, or physical barrier (width varies)

TYPICAL APPLICATION:

- Streets with multiple lanes and high traffic volumes ($\geq 10,000$ AADT)
- Streets with high travel speeds (≥ 40 mph)
- Streets with few intersections and driveway access points (requires innovative design treatment at intersections)
- One-way or two-way streets
- On streets where contraflow bike travel is desirable

LAND USE CONTEXT:

- Urban and suburban

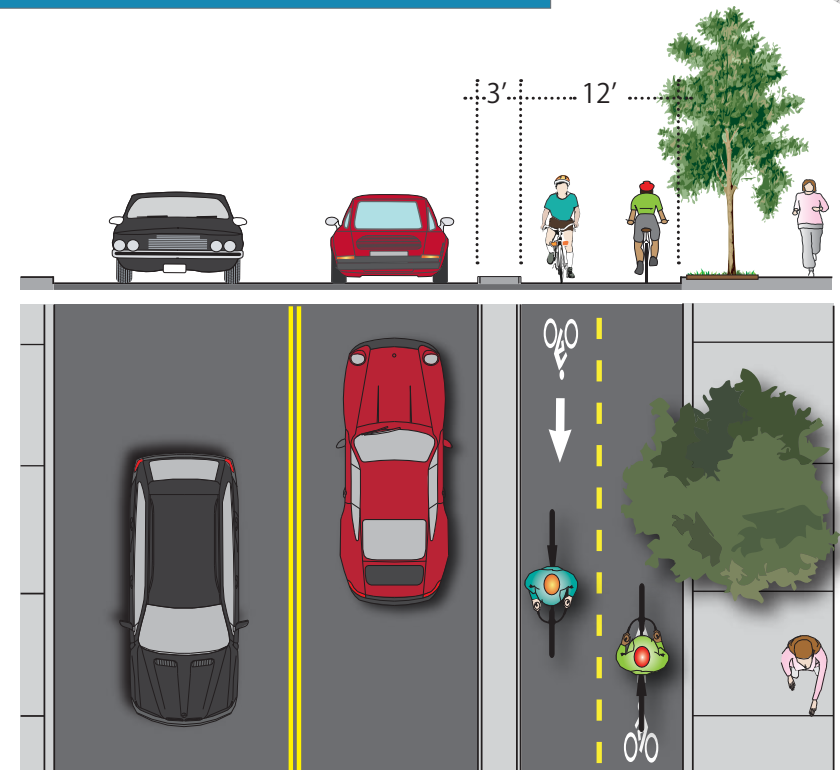
PEER COMMUNITIES/LOCAL EXAMPLES:

- Washington DC; Portland, Oregon; New York City, New York

ADDITIONAL GUIDANCE:

- NACTO, CROW, London Bicycle Design Standards

ROADWAY WITH TWO-WAY CYCLE TRACK



A new two-way cycle track facility in Washington DC is protected by a painted buffer and a parking lane



This two-way cycle track in Montreal, Quebec provides access to an adjacent park and is separated by a vegetated buffer

DESIGN SUMMARY >>

Multi-use paths serve bicyclists and pedestrians and provide additional width over a standard sidewalk. Public Works only constructs paths within the existing ROW (eg., adjacent to roads). Paths constructed in other locations may provide transportation benefits, but would be constructed by the Parks Department. Paths constructed next to roads must have some type of vertical (e.g., curb or barrier) or horizontal (e.g., landscaped strip) buffer separating the path area from adjacent vehicle travel lanes. This treatment is allowed in the right-of-way under Washington County's existing Road Design Standards.

DIMENSIONS:

- 10' is the minimum allowed for a two-way shared-use path and is only recommended for low traffic situations
- 12' or greater is recommended for high-use areas, or in situations with high concentrations of multiple users such as joggers, bicyclists, rollerbladers and pedestrians. In some cases pavement markings/signage may be used to separate trail users

TYPICAL APPLICATION:

- Where there are few at-grade crossings such as driveways and alleyways
- Where the existing roadway context makes a completely separated bikeway the preferred alternative (i.e. high traffic speeds and volumes in a constrained right-of-way).

LAND USE CONTEXT:

- Urban, suburban, rural

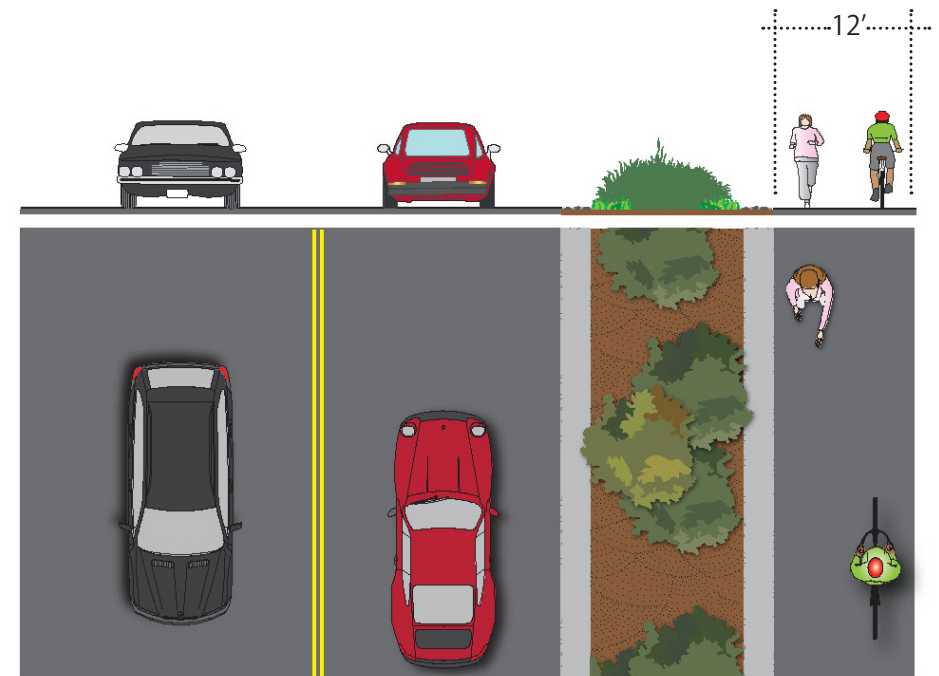
PEER COMMUNITIES/LOCAL EXAMPLES:

- Off-street multi-use paths are popular in communities both urban and rural across the country

ADDITIONAL GUIDANCE:

- AASHTO, Metro Greenway Trails

MULTI-USE PATH ADJACENT TO ROADWAY



This trail in Boulder, CO runs along the perimeter of a university and demarcates separate bicyclist and pedestrian areas



A trail adjacent to a busy thoroughfare in Minneapolis, MN improves bicyclist comfort

DESIGN SUMMARY >>

Bicycle Boulevards are low-volume streets where motorists and bicyclists share the same space. Traffic calming and other treatments along the corridor reduce vehicle speeds so that motorists and bicyclists generally travel at the same speed, creating a more comfortable environment for all users. Bicycle Boulevards incorporate treatments to facilitate convenient crossings where the route crosses a major street. Bicycle Boulevards are not currently addressed in the Washington County Road Design Standards.

- Bicycle Boulevards incorporate cost-effective and less physically-intrusive operational and capital treatments than other bikeway facilities
- Improve user comfort by serving as alternate parallel facilities that allow cyclists to avoid major streets
- Residents living on bicycle boulevards benefit from reduced vehicle speeds and thru traffic, creating a safer and more-attractive environment

TYPICAL APPLICATION:

- Streets with traffic volumes $\leq 3,000$ AADT
- Streets with posted travel speeds ≤ 25 mph
- Along network identified in planning process

LAND USE CONTEXT:

- Urban and suburban

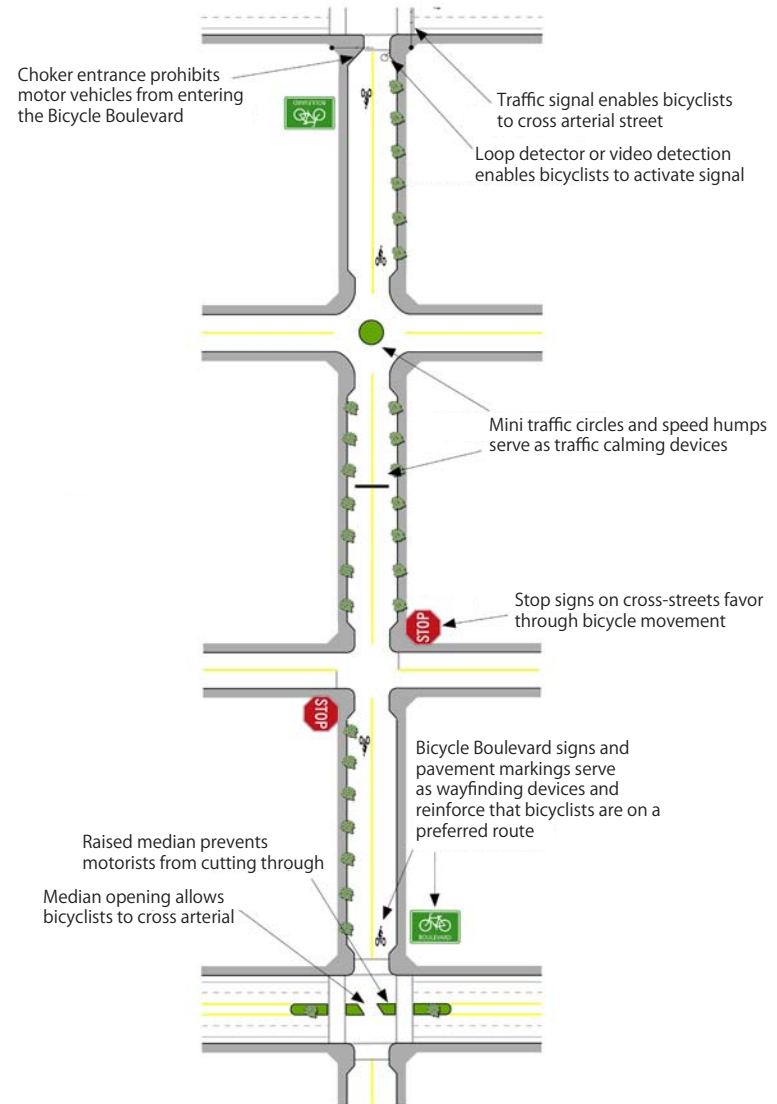
PEER COMMUNITIES/LOCAL EXAMPLES:

- Portland, OR (NE Going St)

ADDITIONAL GUIDANCE:

- Washington County neighborhood Streets Program, Alta Planning + Design and IBPI, Bicycle Boulevard Planning and Design Handbook, www.ibpi.usp.pdx.edu/guidebook.php

SAMPLE BICYCLE BOULEVARD CORRIDOR



TREATMENTS >>>

- 27 COLORED BIKE LANE
- 28 CONTRAFLOW BIKE LANE
- 29 UPHILL BIKE LANE; DOWNHILL SHARED LANE MARKING
- 30 BICYCLE SIGNAL
- 31 INTERSECTION CROSSING MARKINGS
- 32 BIKE BOX
- 33 TWO-STAGE LEFT TURN QUEUE BOXES
- 34 WAYFINDING
- 35 LIGHTING

DESIGN SUMMARY >>

Bicyclists are especially vulnerable at locations where the volume of conflicting vehicle traffic is high, and where the vehicle/bicycle conflict area is long. Some jurisdictions use colored pavement in the bikeway to guide cyclists through major vehicle/bicycle conflict points (FHWA requires green colored pavement). These conflict areas are locations where motorists and cyclists must cross each others' path (e.g., at intersections or merge areas). The colored pavement typically extends through the entire bicycle/vehicle conflict zone (e.g., through the entire intersection, or through the transition zone where motorists cross a bike lane to enter a dedicated right turn lane).

- Draws attention to conflict areas
- Increases motorist yielding behavior
- Emphasizes expectation of bicyclists on the road

DIMENSIONS:

- Width is the same as a conventional bike lane with addition of colored thermoplastic or colored aggregate and dashed lines
- Can be paired with 'Yield to Bikes' signs in conflict areas

TYPICAL APPLICATION:

- Where bikeway crosses motor vehicle merge lane
- Across motor vehicle slip lanes and turn pockets
- Challenging intersections

LAND USE CONTEXT:

- Urban, suburban, rural

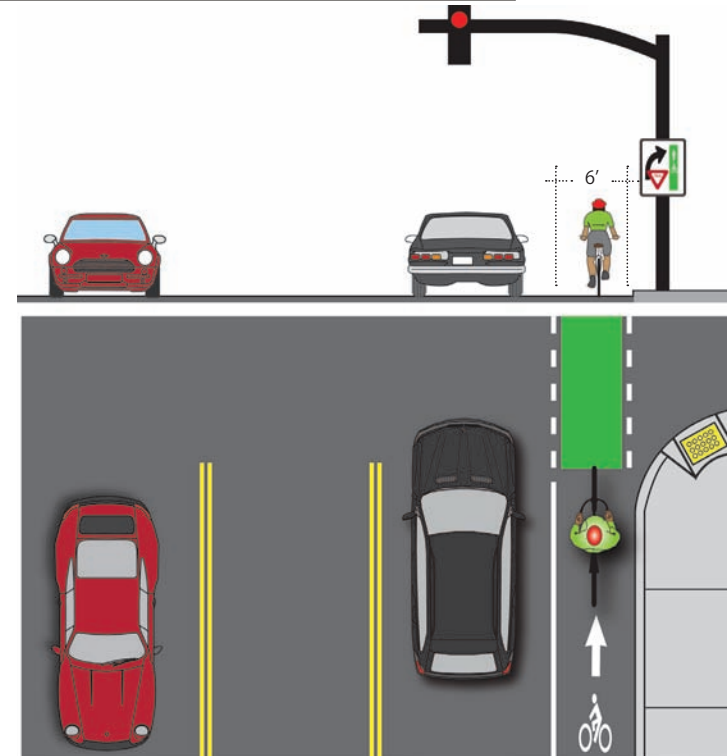
PEER COMMUNITIES/LOCAL EXAMPLES:

- Portland, OR (NE Broadway); Eugene, OR (Alder St)

ADDITIONAL GUIDANCE:

- MUTCD (interim approval; see Section 3G.01), NACTO

ROADWAY WITH COLORED BIKE LANE IN CONFLICT AREA



Colored bike lanes increase awareness of potential conflict areas

DESIGN SUMMARY >>

Contraflow bike lanes provide bi-directional bicycle access along a roadway that is one-way for automobile traffic. This treatment can provide direct access and connectivity for bicyclists, avoiding detours and reducing travel distances for cyclists. Contraflow bike lanes are not currently addressed in the Washington County Road Design Standards.

- Provides direct access and connectivity for bicycles traveling in both directions
- Allows traffic calming of motorists without limiting bicycle traffic
- Cyclists do not have to make detours as a result of one-way traffic

DIMENSIONS:

- The contraflow lane should be 5' to 6' and marked with a solid double yellow line and appropriate signage (MUTCD R5-1 with 'EXCEPT BIKES' added)
- Bike lane markings should be clearly visible to confirm that contraflow lane is exclusively for bicycles.
- Special attention is required at intersections because motorists will not expect bicyclists traveling in the opposite direction

TYPICAL APPLICATION:

- One-way streets that provide direct access to schools, parks, or commercial areas

LAND USE CONTEXT:

- Urban, suburban and rural

PEER COMMUNITIES/LOCAL EXAMPLES:

- Portland, OR (NE Weidler St); Madison, WI (University Ave)

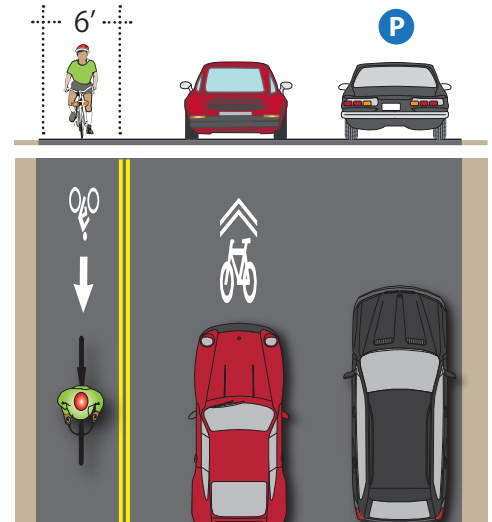
ADDITIONAL GUIDANCE:

- This treatment is a federally-recognized design standard, and present in some state DOT manuals, NACTO and the MUTCD

RURAL ROADWAY WITH CONTRAFLOW BIKE LANE



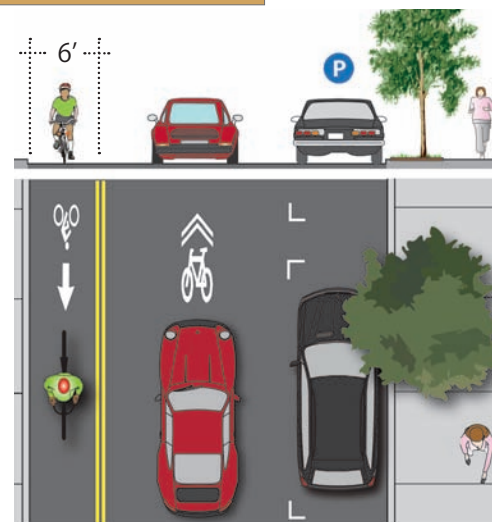
A rural contraflow facility improves bicycle access to a regional park



URBAN ROADWAY WITH CONTRAFLOW BIKE LANE



The double yellow lines and pavement lines clearly demarcate the space for exclusive bicycle use



DESIGN SUMMARY >>

Also known as a bicycle climbing lane, the uphill bike lane; downhill SLM treatment is most appropriate in topographically challenging locations. On downhill grades the speed differential between motor vehicles and bicycles is typically less, which allows shared lane markings to be used in place of a standard bike lane. Slower moving uphill bike traffic remains separate from motor vehicle traffic with a standard bike lane treatment. This treatment is not currently addressed in the Washington County Road Design Standards.

- Positions bicyclists in the travel lane away from the curb and parked cars (if parking lane present), which may be a hazard on descents
- Bicyclists traveling uphill and moving at slower speeds remain separated from faster moving motor vehicle traffic

DIMENSIONS:

- 6' min. recommended width for uphill bike lane
- SLM pavement markings must be positioned 4' min. from curb or 11' min. from curb if on-street parking is present

TYPICAL APPLICATION:

- Streets with topographical challenges
- Streets with a constrained right-of-way

LAND USE CONTEXT:

- Urban, suburban, rural

PEER COMMUNITIES/LOCAL EXAMPLES:

- Seattle, WA (Stone Way Ave)

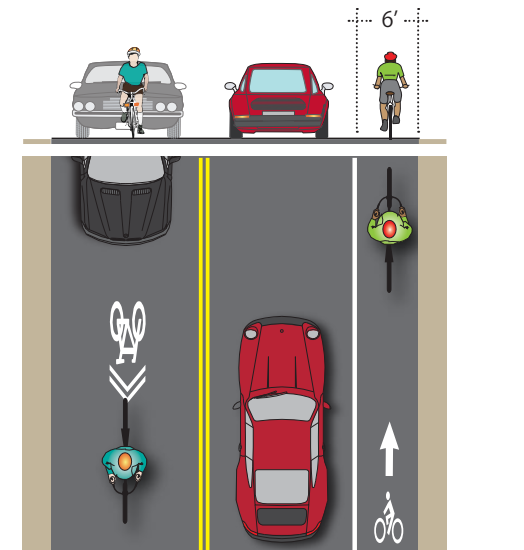
ADDITIONAL GUIDANCE:

- Seattle Bicycle Master Plan, NACTO

RURAL ROADWAY TREATMENT



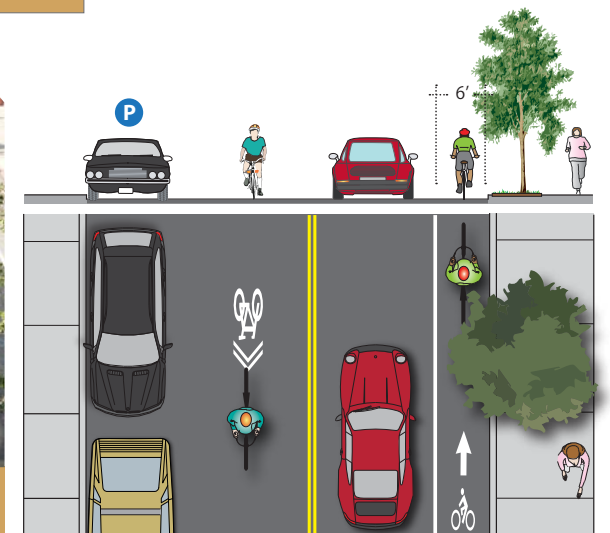
An uphill bike lane; downhill shared lane marking in a rural setting



URBAN ROADWAY TREATMENT



A bicycle climbing lane in use in the famously hilly Seattle, Washington



DESIGN SUMMARY >>

At some intersections bicyclists have different needs than other roadway users (e.g. bicycle only movements; conflicts with motorists, transit, or pedestrians). In these areas, bicycle signal heads can be used to provide additional guidance to bicyclists and other roadway users. Bicycle signals are used in combination with conventional traffic signals and use the standard green, yellow, red lenses with the addition of a bicycle stencil. Bicycle signals are not currently addressed in the Washington County Road Design Standards.

- Prioritizes bicycle movements and separates them from conflicting movements
- May improve safety and comfort of cyclists and overall intersection operations
- Preferable to instructing bicyclists to use pedestrian signals

DIMENSIONS:

- Signal head should be clearly visible to oncoming bicycles
- Bicycle phase should provide adequate clearance time and actuation/detection (if not pretimed)

TYPICAL APPLICATION:

- Intersections with bicycle only movements, (e.g., a transition from a trail to an on-street facility on the opposite side of the intersection), or where there are conflicts with other roadway users
- Multi-use path crossings

LAND USE CONTEXT:

- Urban, suburban, rural

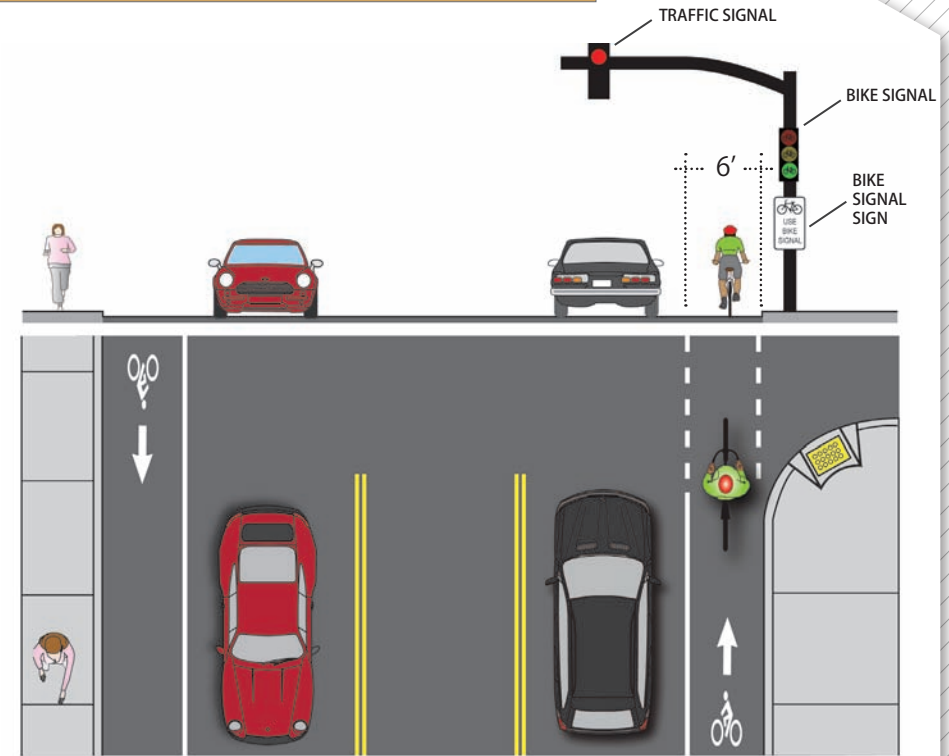
PEER COMMUNITIES/LOCAL EXAMPLES:

- Portland, OR (NE Broadway/Williams)

ADDITIONAL GUIDANCE:

- Currently there are no standards for determining bicycle clearance times. Design and operation should consider general MUTCD guidance, local conditions, and engineering judgment

ROADWAY WITH BIKE SIGNAL



A bicycle signal in use in San Luis Obispo separates motor vehicle and bicycle movements



A bicycle signal with accompanying signage alerting bicyclists to obey the signal

DESIGN SUMMARY >>

Intersection crossing markings are pavement markings through intersections that delineate the path that bicyclists should take through an intersection or across a driveway or ramp. Different marking strategies, including colored bike lanes or chevrons are used throughout the country. Crossing markings are not currently addressed in the Washington County Road Design Standards.

- Establish expected bicycle travel paths and increase the visibility of cyclists
- Define and raise awareness of potential conflict zones
- Increases bicyclist level of comfort by delineating route through intersections

DIMENSIONS:

- Width is generally the same as a conventional bike lane, with addition of dashed lines (MUTCD 3B.08), and optional colored thermoplastic, chevrons, and/or shared lane markings (MUTCD 9C-9)
- Minimum striping width of 6" adjacent to travel lane

TYPICAL APPLICATION:

- Signalized, wide, or complex intersections on streets with bike lanes or cycle tracks
- Areas where vehicle movements encroach into or cross bicycle facilities (e.g. ramps)

LAND USE CONTEXT:

- Urban and suburban

PEER COMMUNITIES/LOCAL EXAMPLES:

- Dotted line extensions are used in many cities nationwide
- Other intersection markings used in New York, NY (9th Ave); Portland, OR (Interstate Ave)

ADDITIONAL GUIDANCE:

- AASHTO, NACTO



DESIGN SUMMARY >>

Bike boxes move back the stop bar for vehicles at signalized intersections in order to create a designated area for bicyclists to wait during the red signal phase. Bike boxes create a more comfortable and safe environment for cyclists by increasing their visibility to motorists and providing them a way to get ahead of queued traffic. Bike boxes are not currently addressed in the Washington County Road Design Standards.

- Increases visibility and safety of cyclists
- Helps prevent “right-hook” conflicts between cyclists and vehicles
- Facilitates cyclist left turns and transitions from right to left side bike lanes (if box extends across entire intersection)

DIMENSIONS:

- Transverse lines shall be used to create a bike box 10’ to 16’ deep and indicate where motor vehicles are required to stop (MUTCD 3B.16)
- A Bike Symbol or Helmeted Bicyclist Symbol (MUTCD 9C-3A or 9C-3B) shall be centered between the crosswalk line and stop line
- Bike boxes may be combined with a green colored pavement background

TYPICAL APPLICATION:

- Signalized intersections on streets with bike lanes or cycle tracks
- Intersections with high volumes of motorists and bicyclists
- Intersections with frequent motorist right-turns and/or bicyclist left-turns

LAND USE CONTEXT:

- Urban and suburban

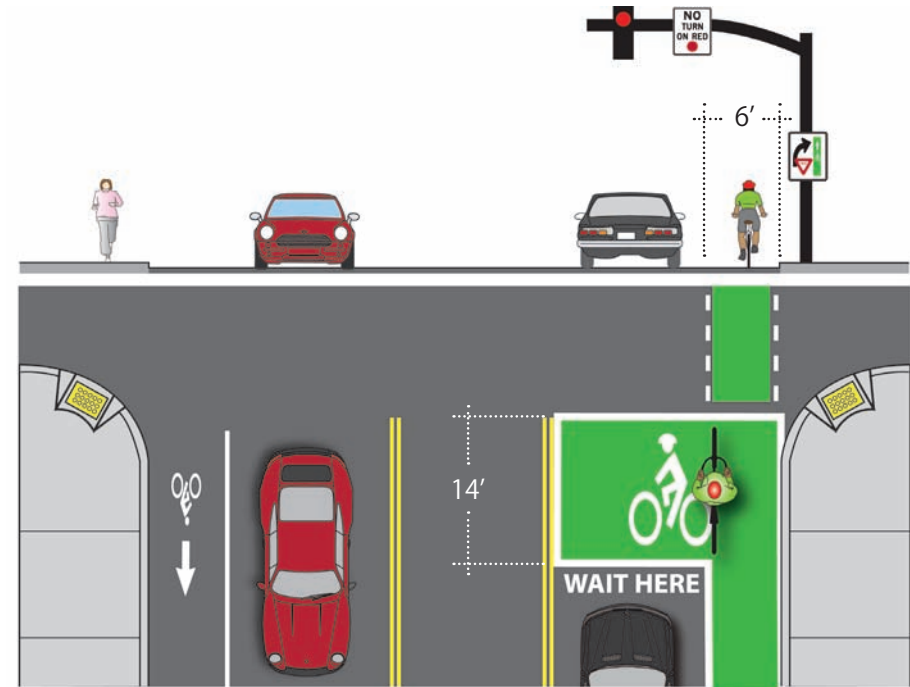
PEER COMMUNITIES/LOCAL EXAMPLES:

- Portland, OR (SE Hawthorne); Eugene, OR (Alder St)

ADDITIONAL GUIDANCE:

- NACTO, MUTCD

INTERSECTION WITH BIKE BOX



A blue bike box in Vancouver, BC alerts motorists to remain behind bicyclists waiting for a signal change



One of Portland's first green bike boxes located at SW 14th Ave and Burnside Street

DESIGN SUMMARY >>

Left-turns are often difficult for bicyclists to maneuver, especially when cyclists must merge from a bike facility into heavy vehicle traffic. Two-stage turn queue boxes (sometimes referred to as Copenhagen lefts, hook turns, or box turns) provide an option for bicyclists to safely make left turns at signalized intersections. In a two-stage left turn, cyclists proceed straight through the intersection with the green signal and wait in a queue box on the cross street to proceed through the intersection on its next green signal. Two-stage left turn queue boxes are not currently addressed in the Washington County Road Design Standards.

- Increases bicyclist comfort making some left turns
- Reduces conflicts between bicyclists, turning motorists, and pedestrians in crosswalk
- Preferable to instructing bicyclists to use pedestrian signals
- Increases bicyclist delay because it requires two signal cycles

DIMENSIONS:

- Located in a protected area between the bike lane and crosswalk (see NACTO for details on queue box placement in roadway)
- Colored texture, a bicycle stencil and turn arrow pavement markings should be used to heighten visibility of the turn box

TYPICAL APPLICATION:

- Signalized intersections
- Streets with high traffic volumes and/or speeds
- Streets with a significant number of bicyclists making left-turns

LAND USE CONTEXT:

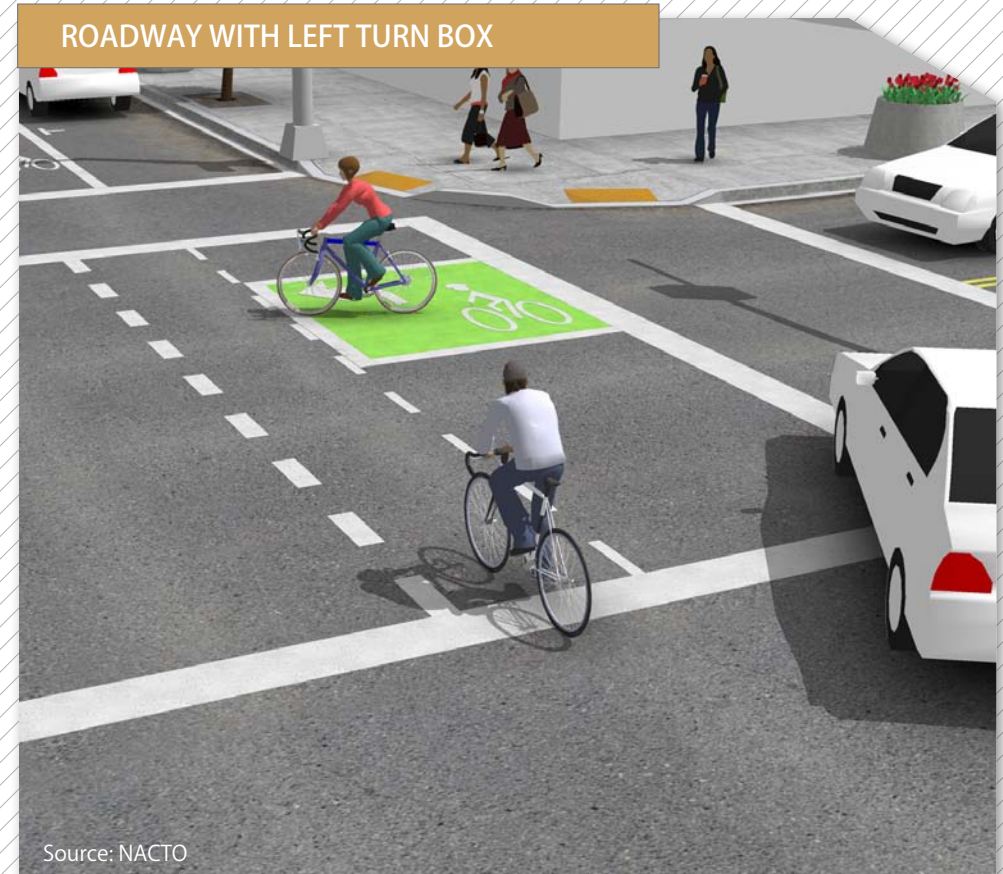
- Urban, suburban, rural

PEER COMMUNITIES/LOCAL EXAMPLES:

- Portland, OR (NW Lovejoy and 9th Ave)

ADDITIONAL GUIDANCE:

- CROW, Portland Bikeway Facility Design Guide



DESIGN SUMMARY >>

Wayfinding signs are typically placed at key locations leading to and along bicycle boulevards, including where multiple routes intersect and at key bicyclist “decision points.” Wayfinding signs displaying destinations, distances and “riding time” can dispel common misperceptions about time and distance while increasing users’ comfort and accessibility to key destinations. ‘Bike Route’ signage is currently allowed under the Washington County Road Design Standards; more detailed bikeway signage is not addressed.

- A cost-effective yet highly-visible treatment that can improve the riding environment

DIMENSIONS:

- Note that too many signs tend to clutter the right-of-way, and it is recommended that these signs be posted at a level most visible to bicyclists and pedestrians, rather than per vehicle signage standards.
- It is important that signs be consistently placed along designated bicycle routes to be highly effective

TYPICAL APPLICATION:

- Designated bicycle routes
- Bicycle Boulevards

LAND USE CONTEXT:

- Urban, suburban, rural

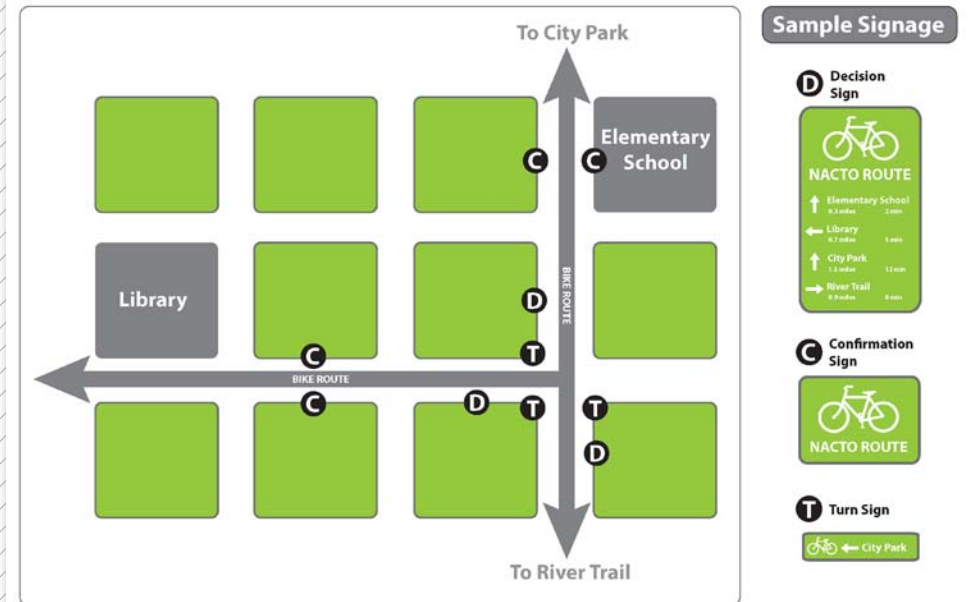
PEER COMMUNITIES/LOCAL EXAMPLES:

- Portland, OR; Eugene, OR

ADDITIONAL GUIDANCE:

- MUTCD, NACTO, Bicycle Boulevard Planning and Design Handbook, www.ibpi.usp.pdx.edu/guidebook.php

EXAMPLE WAYFINDING SIGNAGE PLACEMENT



Source: NACTO



An example of some generic bike route wayfinding signage commonly found in communities across the US



Wayfinding signage in Eugene, Oregon provides bicyclists with direction, distance and average ride time to key destinations

DESIGN SUMMARY >>

Bicycle facility lighting can help to increase user comfort and safety, is viewed as a crime deterrent, and can help increase year-round bicycle facility use. Although there are no industry accepted warrants for non-freeway lighting, design guidance is available to support engineering judgment. For example, luminaires should be placed adjacent to facilities crossing roadways as opposed to directly above the facility in order to better illuminate pedestrians and bicyclists. Washington County's existing Road Design Standards include roadway design light levels based on road classification and "pedestrian conflict" rank, which considers pedestrian night activity levels and surrounding land uses. All lighting equipment must be included in the current Portland General Electric approved street lighting equipment list. Solar and other alternative energy sources should be considered where practical.

DIMENSIONS:

- Off-street facilities typically use pedestrian-scale luminaires
- Poles and luminaires should provide adequate vertical (8') and horizontal (2') clearance. Pedestrian lighting is typically positioned $\leq 16'$ above the sidewalk or path
- Average illuminance levels for high/medium/low conflict roadways and intersections are provided in the Washington County Road Design Standards, Exhibits 11 and 12
- Illumination at midblock crossings is evaluated on a case by case basis

TYPICAL APPLICATION:

- Areas with high expected night usage (e.g. colleges, commuter routes)
- Intersections and areas with varying geometry (e.g. turns, tunnels)
- Facilities with bicycle volumes or crash rates

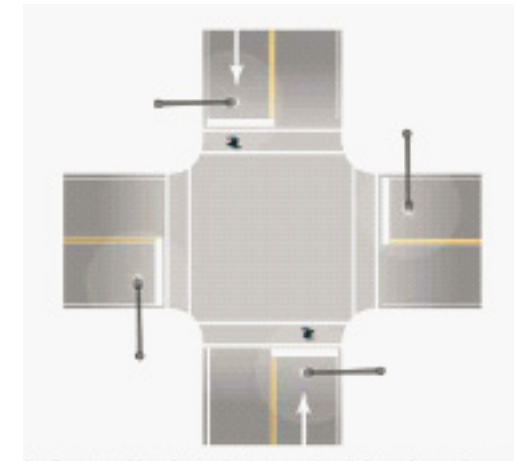
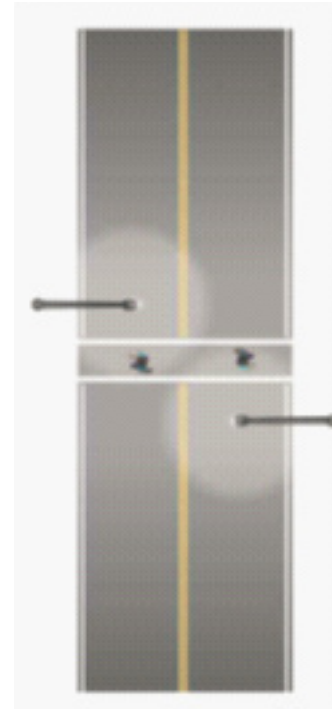
LAND USE CONTEXT:

- Urban, suburban, rural

ADDITIONAL GUIDANCE:

- Washington County Road Design Standards (Section 350), AASHTO Roadway Lighting Design Guide, IES Roadway Lighting Manual, FHWA Report on Lighting Design for Midblock Crosswalks

LIGHTING LAYOUT FOR MIDBLOCK AND INTERSECTION CROSSINGS



Source: : FHWA Report on Lighting Design for Midblock Crosswalks

APPENDICES >>>

- 37 APPENDIX A. MAINTENANCE AND CONSTRUCTION**
- 38 APPENDIX B. INTERSECTION TREATMENT ALTERNATIVES**
- 45 APPENDIX C. GENERIC FACILITY SELECTION CASE STUDY**

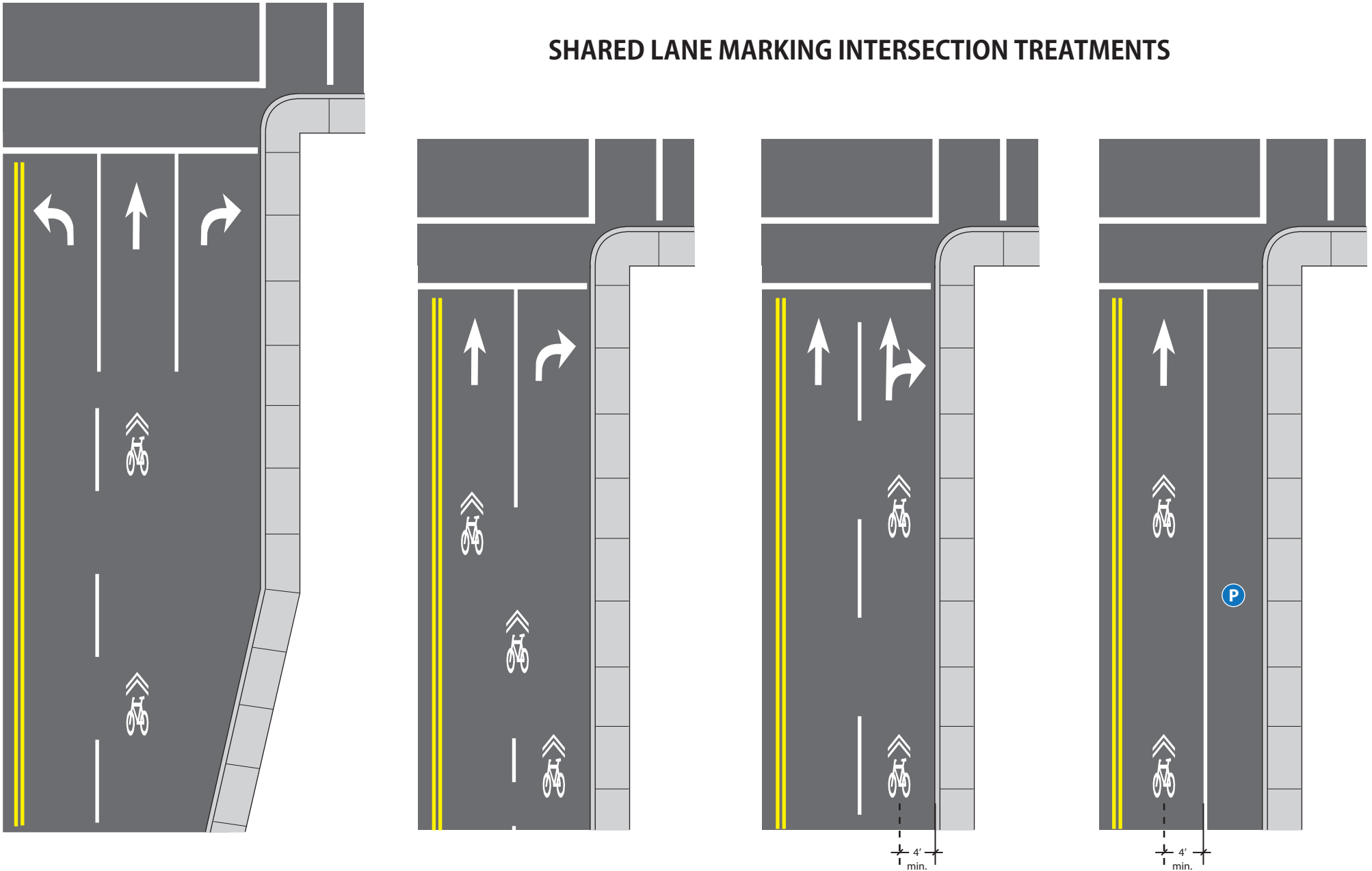
MAINTENANCE AND CONSTRUCTION MATRIX	MAINTENANCE REQUIREMENTS	CONSTRUCTION COST (Relative to other Facilities and Treatments)	NOTES
FACILITIES			
Shared Lane Markings			Depends on placement. Pavment markings that are centered in the travel lane suffer less wear because vehicle wheels will drive over the marking less.
Shoulder Bikeway			
Bike Lane			
Buffered Bike Lane			
Protected Cycle Track			Access by streetsweeping or snow clearing equipment is dependent on the specific protection strategy used.
Raised Cycle Track			Access by streetsweeping or snow clearing equipment is dependent on the specific protection strategy used.
Two-way Cycle Track			Access by streetsweeping or snow clearing equipment is dependent on the specific protection strategy used.
Multi-Use Off-Street Path			
Bicycle Boulevard			Depends on the level of treatment. Construction cost increases with the level of traffic calming required
TREATMENTS			
Colored Bike Lane			Durability of colored pavement depends on many factors
Contra-Flow Bike Lane			
Uphill Bike Lane; Downhill SLM			
Bicycle Signal			
Intersection Crossing Markings			Durability of pavement markings depends on many factors
Bike Box			
Two-Stage Left Turn Queue Boxes			
Wayfinding			Depends on level of detail and number of signs

This table provides a general review of the intensity of maintenance needs and overall construction cost of individual facilities.

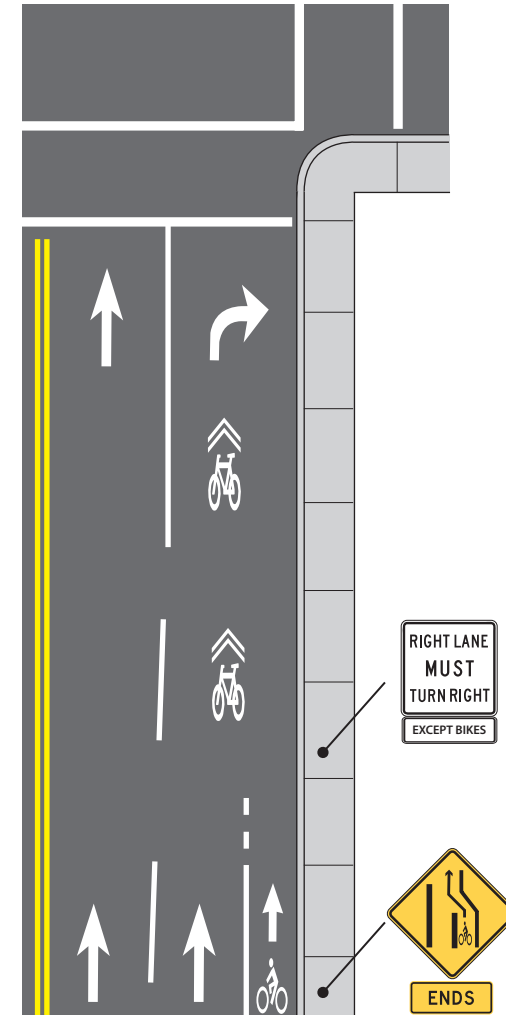
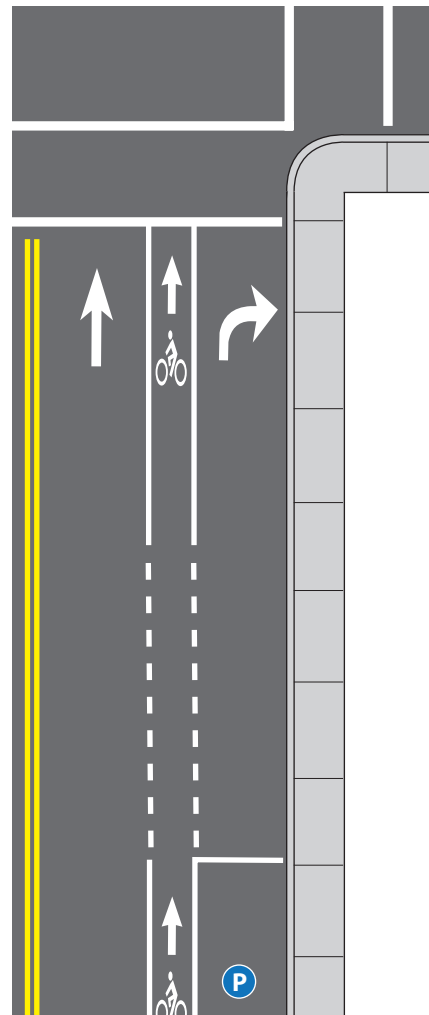
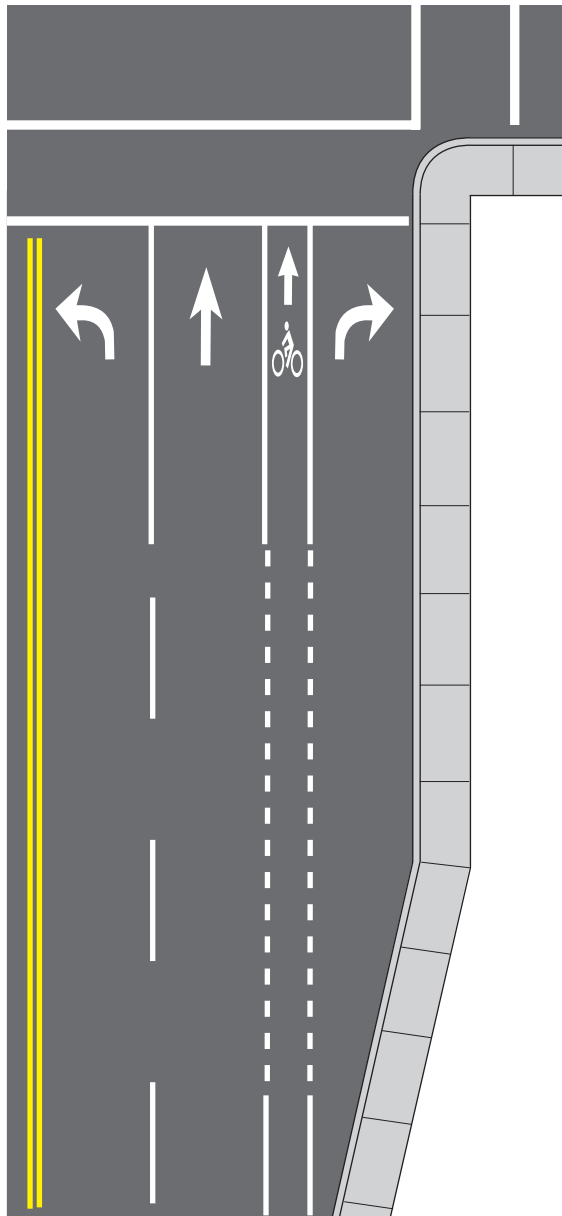
- Lowest Cost/Easiest to Maintain
-
-
- Highest Cost/Most Difficult to Maintain

Appendix B, Intersection Treatment Alternatives, offers a selection of potential bikeway intersection treatments based on lane configuration and the type of bikeway being designed for.

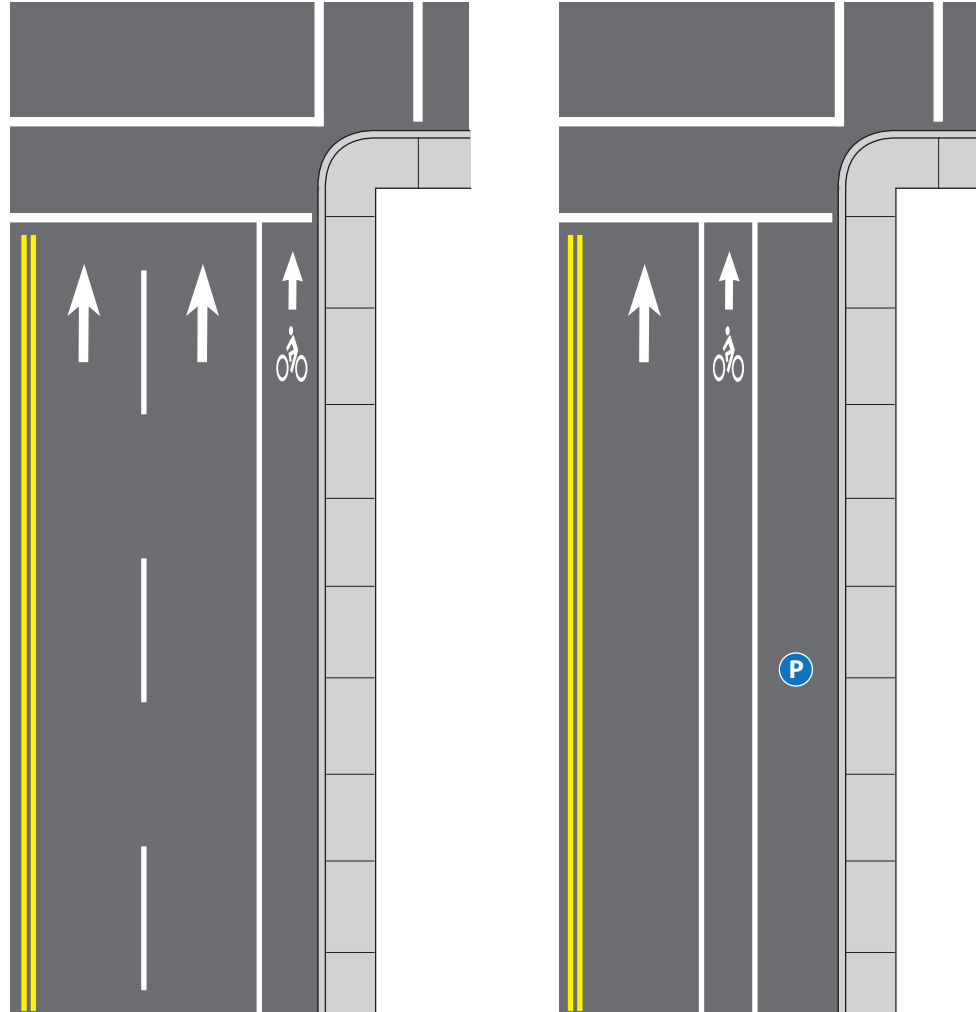
SHARED LANE MARKING INTERSECTION TREATMENTS



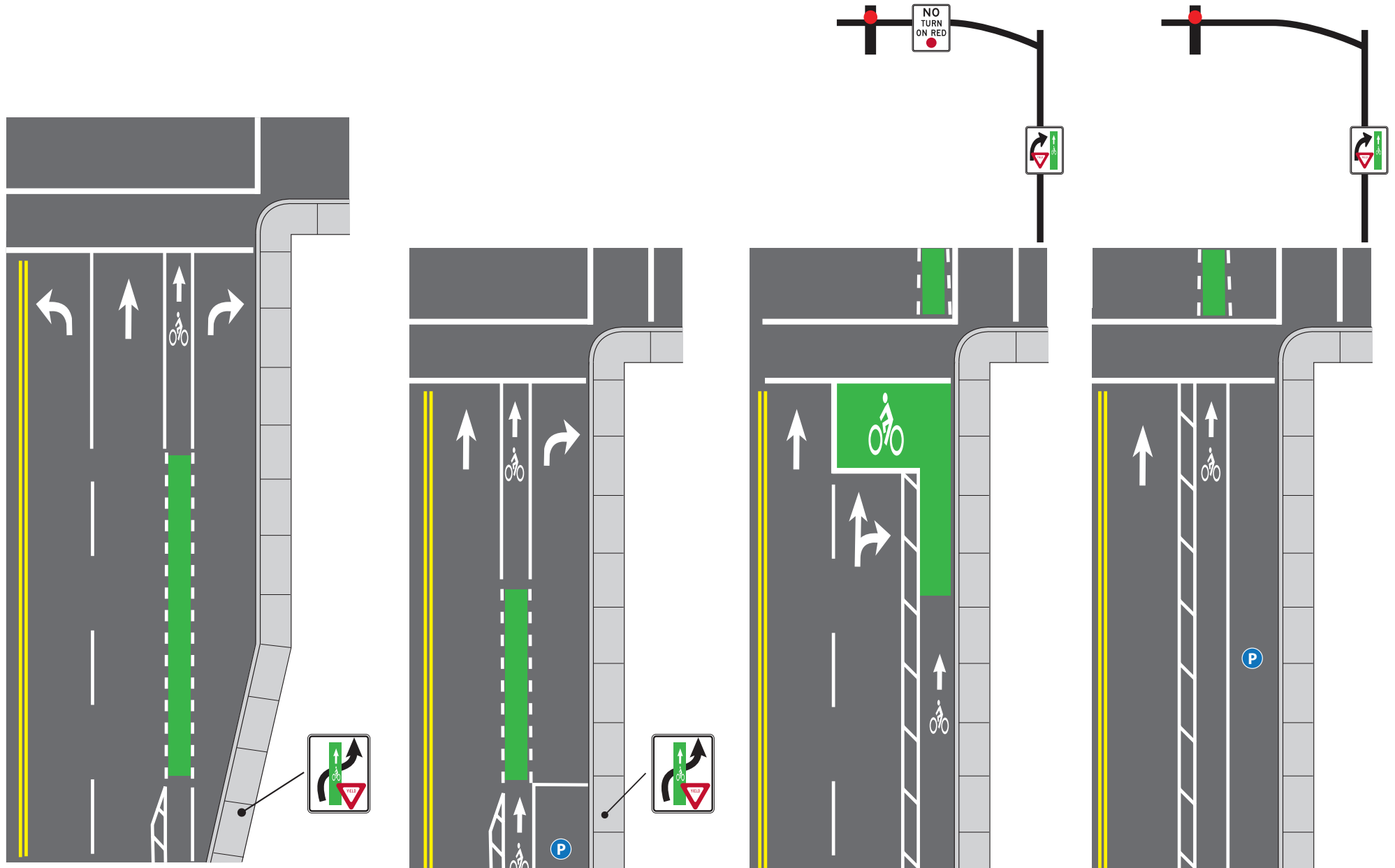
BIKE LANE INTERSECTION TREATMENTS (1 of 2)



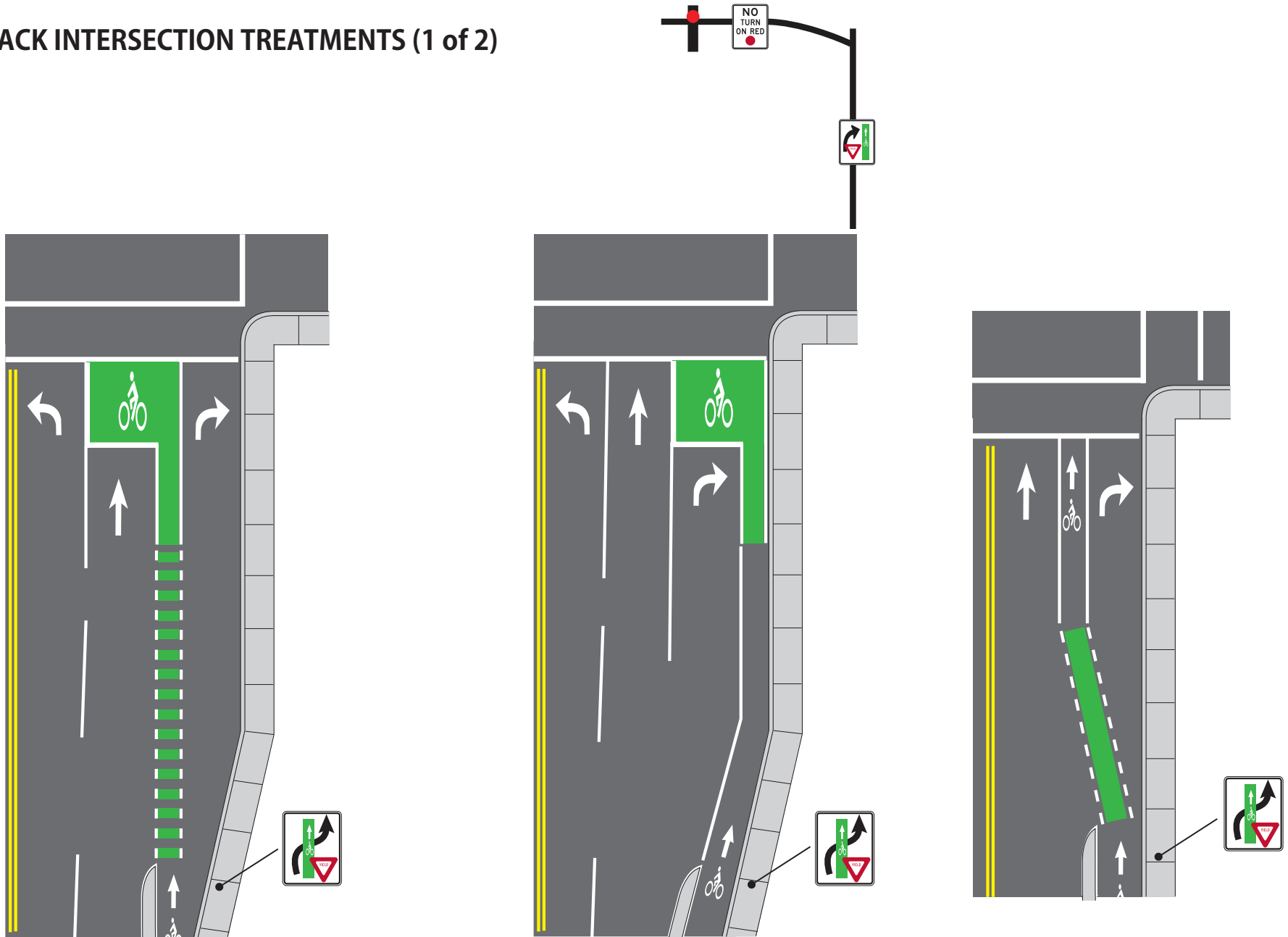
BIKE LANE INTERSECTION TREATMENTS (2 of 2)



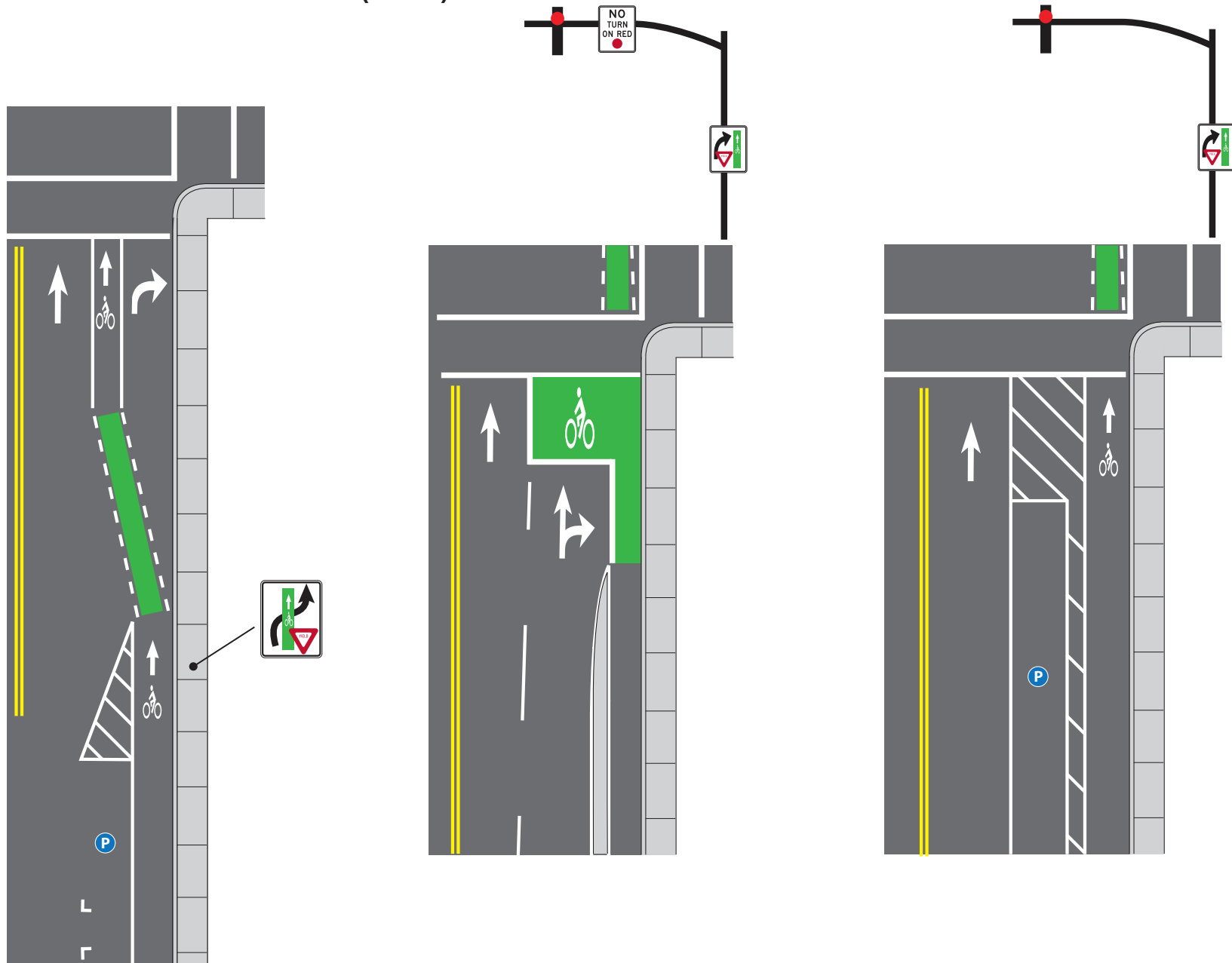
BUFFERED BIKE LANE INTERSECTION TREATMENTS



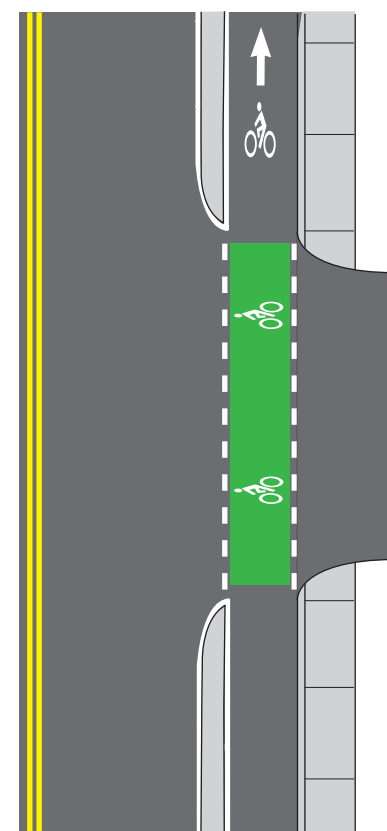
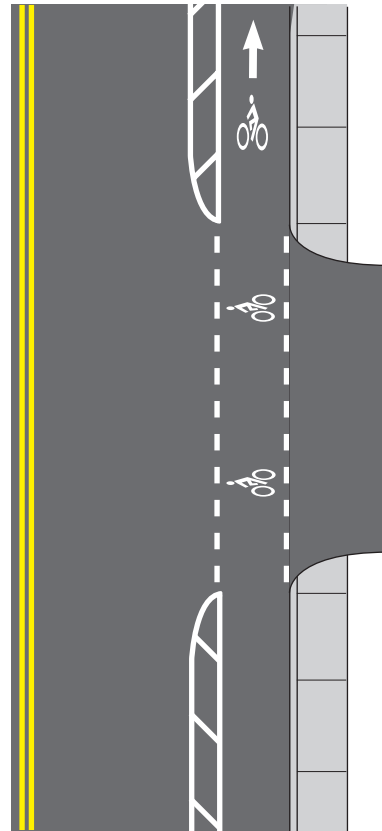
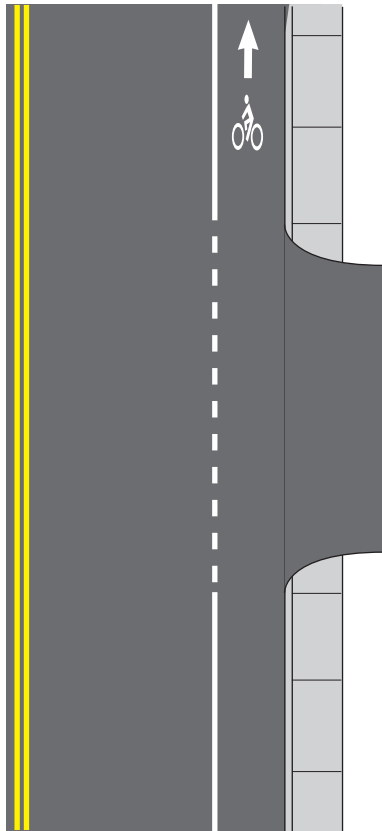
CYCLE TRACK INTERSECTION TREATMENTS (1 of 2)



CYCLE TRACK INTERSECTION TREATMENTS (2 of 2)



DRIVEWAY TREATMENTS



Washington County Bicycle Facility Design Toolkit

Appendix C, Generic Facility Selection Case Study, is a step-by-step training module that demonstrates how the facility selection process is applied to a generic roadway and land use context.

1 Begin a new project by printing out one of the blank 'Project Worksheets' found on page 10.

2 Practitioners should fill in the corresponding fields with available data. This information will be used to inform the bikeway facility selection process.

PROJECT WORKSHEET

Washington County Bicycle Facility Design Toolkit

PROJECT NUMBER 999 PROJECT NAME Generic Rd EXTENTS (FROM/TO) Alpha St / Beta St

IRIS ROAD OR ASSET NUMBER 999 FUNCTIONAL CLASSIFICATION Arterial (A2) LAND USE DISTRICT Commercial, Mixed-Use

DAILY TRAFFIC 38k 85TH-PERCENTILE SPEED 44 PERCENT HEAVY TRAFFIC 3.3% EXISTING ROW 98' PAVEMENT WIDTH 74'

FACILITY CHECKS

Bicycle system of county-wide significance on TSP: YES NO

Expected Bicycle User Group (check all that apply): Advanced Basic Concerned

Designated Freight or Transit Route: YES NO

Emergency Services Route: YES NO

Density of Conflict Points (Driveways/Intersections): HIGH (<200') MED (200'-600') LOW (>600')

On-Street Parking Presence: YES NO

Challenging Road Geometry: YES NO

Adjacent School(s): ABC Elementary, XYZ Middle School

Adjacent Park(s): Lone Tree Park

Transit Route(s): serves 3 lines

Adjacent Commercial Area(s): Plaza Business Area

Adjacent Neighborhood(s): _____

Nearby Point(s) of Interest: _____

Please describe any special ROW constraints that may be present (e.g., bridges, buildings, wetlands, etc): _____

Department(s) that populated this worksheet: _____

CROSS-SECTIONS

Please sketch the existing cross-section

Please sketch the proposed cross-section

Recommended Facility Type: _____

Recommended Cross-Section Modification(s): _____

5 STEP TWO identifies the right-of-way needs of the preferred facility, in this case a cycle track on an Arterial (class A2)

ARTERIAL					POTENTIAL MODIFICATIONS TO STANDARD CROSS-SECTION				
APPLICABLE FACILITIES	PROTECTION LEVEL	ADDITIONAL PAVEMENT WIDTH NEEDED PER DIRECTION	ROAD CLASS	FITS IN STANDARD CROSS-SECTION	NARROW TRAVEL LANES	REMOVE TRAVEL LANE	PARKING REMOVAL	NARROW/REMOVE CENTER TURN LANE	ADD PAVEMENT WIDTH
SHOULDER BIKEWAY		0'	A1 - A4	X			N/A		
CONVENTIONAL BIKE LANE		0'	A1 - A4	X			N/A		
BUFFERED BIKE LANE		2' - 3'	A1 - A2		X	X	N/A	X	X
		2' - 3'	A3		X	X	N/A		X
		2' - 3'	A4		X		N/A	X	X
CYCLE TRACK*		1.5' - 3'	A1 - A2		X	X	N/A	X	X
		1.5' - 3'	A3		X	X	N/A		X
		1.5' - 3'	A4		X		N/A	X	X

ROADWAY MODIFICATION*

Narrow travel lanes: bikeways may be added by adjusting wide travel lanes or parking lanes within the established minimums. No reduction to the number of travel lanes required (requires a design exception)

Remove travel lane: where motor vehicle volume is below roadway capacity, the removal of a travel lane can provide the necessary pavement width to accommodate on-street bikeways. May require a traffic impact assessment or TSP ammendment prior to lane removal.

Parking removal: underused on-street parking on one side of the street is removed to create space for bike lanes. For example, an acceptable situation for this scenario includes areas that have large surface parking lots adjacent to existing on-street parking. A parking utilization study should be conducted prior to removal of on-street parking.

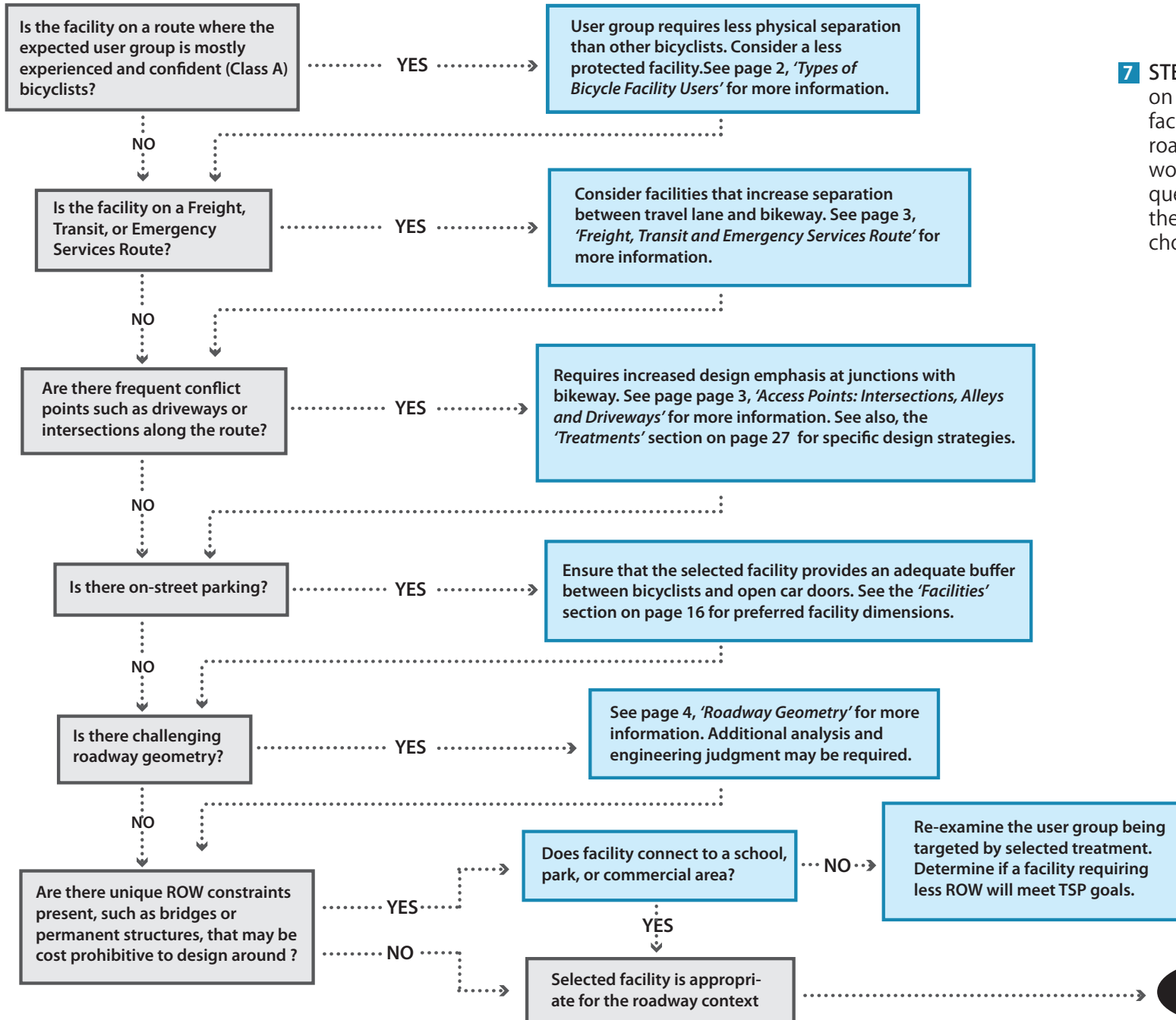
Narrow/remove center turn lane: roadways with an underused, or extra-wide, center turn lane provide an opportunity for reallocating pavement width to develop new bikeway facilities. May require a traffic impact assessment or TSP ammendment prior to lane removal or width reduction.

Add pavement width: If additional right-of-way is available along the corridor it may be possible to pave a new roadway shoulder to develop a bikeway facility.

*see page 5, 'Roadway Modification Strategies' for more detailed information

6 Identify potential roadway modifications to accommodate a cycle track facility

*For detailed information regarding the dimensions and applications of different types of cycle track facilities refer to pages 12 - 14 of the Toolkit



7 STEP THREE uses the set of “checks” found on page 15 to confirm that the selected facility is the best choice for the specific roadway context. In this example you would have answered “no” to each of these questions. This leads to the conclusion that the selected cycle track facility is the best choice for the roadway/land use context.

FINISH

8 The final step is to fill out the remainder of the project worksheet with your preferred bikeway facility. Make sure to indicate the department(s) involved in populating the worksheet.

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Nearby Point(s) of Interest: _____

Please describe any special ROW constraints that may be present (e.g., bridges, buildings, wetlands, etc): _____

Department(s) that populated this worksheet: _____

CROSS-SECTIONS

Please sketch the existing cross-section

Please sketch the proposed cross-section

Recommended Facility Type: Cycle Track

Recommended Cross-Section Modification(s): Narrow travel lane widths to 11' and CTL width as needed.