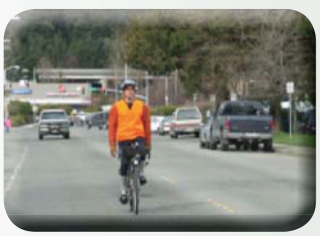
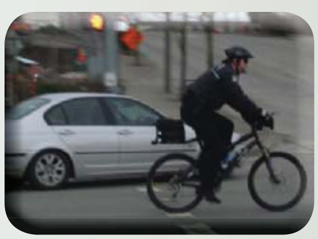
Bicycle Facilities Design Manual Guidelines for the City of Redmond





Fehr & Peers
Mirai

August 2009
Updated March 2012
by City of Redmond

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INTRODUCTION

The appropriate design of bicycle facilities is an integral component of encouraging the public to bicycle for utilitarian and recreational purposes. Good design also affects the experience, enjoyment, safety, and comfort for bicyclists.

Bikeway planning and design in Washington typically relies on guidelines and design standards established by three sources. The Washington Department of Transportation (WSDOT) *Design Manual* includes a chapter on bicycle facilities. Chapter 1020 follows guidelines developed by the American Association of State Highway and Transportation Officials (AASHTO) and the Federal Highway Administration (FHWA), and identifies specific design guidelines for various conditions and bikeway-to-roadway relationships. The AASHTO *Guide for the Development of Bicycle Facilities* includes direction on the design of all bicycle facilities. Finally, the *Manual on Uniform Traffic Control Devices* includes guidance on bikeway signing and striping. These recommendations provide a good framework for future implementation but may not always be feasible given specific constraints. For instance, along NE 85th Street, the City of Redmond wanted a design to accommodate both bicyclists and buses within a limited right-of-way. The City arrived at a shared bus/bike lane design exercising engineering judgment and reviewing designs from other cities. The City follows the WSDOT or AASHTO guidelines as a minimum. Where feasible, the City of Redmond has chosen to expand these to provide a resource for typical design challenges and to guide design decisions.

All new transportation projects will "…provide appropriate accommodation for bicyclists, pedestrians, transit users, and persons of all abilities in comprehensive and connected networks."

City of Redmond Complete Streets Ordinance

Combined Bicycle and Bus Lane on NE 85th Street

Bicycle parking rack, Downtown Redmond

The City's *Transportation Master Plan* notes that different facilities serve different types of cyclists, and that the needs of frequent and casual riders vary. The City's policy is to "routinely accommodate bicyclists as part of roadway improvement projects."[1] This is consistent with the AASHTO *Guide to the Development of Bicycle Facilities,* which states that: "All roads, streets and highways, except those where cyclists are legally prohibited, should be designed and constructed under the assumption that they will be used by bicyclists." For experienced riders, this means making every street bicycle-friendly, while for casual and intermediate riders, this means including separate bicycle lanes and providing trails where possible. In a City like Redmond, which includes a wide variety of streets, from congested urban blocks to quiet residential streets, this policy of routine accommodation will require designers to be creative and flexible. The guidelines in this document are intended as a resource for designers as the City endeavors to meet its goals and they are in harmony with other documents, which generally establish design minimums. They are meant as a <u>supplement</u> to existing local and national guidelines. They are not intended to replace engineering judgment or to become a constraint, particularly as it is difficult to capture the full spectrum of design challenges in a single document.

Design Principles

This document is based on the following design principles, which reflect the policies in the City's *Transportation Master Plan* and the requirements of the Complete Streets ordinance:

1. Routinely accommodate bicyclists as part of roadway improvement projects.

2. Endeavor to make every street bicycle-friendly by removing hazards and maintaining a smooth riding surface.

3. Provide as much space as is reasonable for on-street bicycle lanes, with a preferred width of 5.5 feet.

4. For on-street facilities, use signs primarily for wayfinding and pavement markings for channelization.

5. Strive for Citywide consistency in signs and markings.

6. Consider all levels of cyclists when making design decisions. Experienced, confident riders are most likely the design cyclist on arterials, while casual, less confident riders are more likely to use paths or low-volume collectors and residential streets.

[1] City of Redmond *Transportation Master Plan,* Chapter 5B, Policy 1a

BICYCLE LANES

This chapter includes guidelines for bicycle lanes along roadways and at intersections. Generally, bicycle lanes are “a portion of a highway or street identified by signs and pavement markings as reserved for bicycle use.”[2] Most riders benefit by having a lane that is separate from motor vehicle traffic, and bicycle lanes are typically used on streets with higher traffic volumes or greater speeds.

Guidance for Retrofitting Streets

In mostly built-out cities where there is little construction of new roads, a key challenge for designers is retrofitting existing streets with bicycle lanes. The *Transportation Master Plan* recommends a continuous, interconnected bicycle system of primary and secondary bicycling corridors. Constructing some of these corridors will require a change to the existing roadway configuration. This guidance addresses Redmond’s arterial streets and is meant as a tool to guide decisions in the following steps where the TMP recommends bicycle lanes:

1. Evaluate how well the existing cross section serves bicyclists.
2. Develop an optimum cross section to balance the needs of all users without significantly compromising safety.

The decision-making process to retrofit arterial roadways in Redmond has two steps. The results are driven by specific roadway characteristics.

First, the designer analyzes the existing space and considers modifications to provide space for bicycle lanes. Each of the figures in this document includes a preferred width. There is also discussion of a minimum that is acceptable under retrofit conditions only when a determination is made that the cost of rebuilding to attain the preferred width far exceeds the benefits of the re-build. The following questions are appropriate:

1. Can any existing lanes be narrowed?
2. Can any existing lanes be removed (consider travel lanes, turn lanes, and parking lanes)?
3. Can medians or planting strips (buffers) be narrowed?
4. Can the existing pavement be widened, or can the curbs be moved?

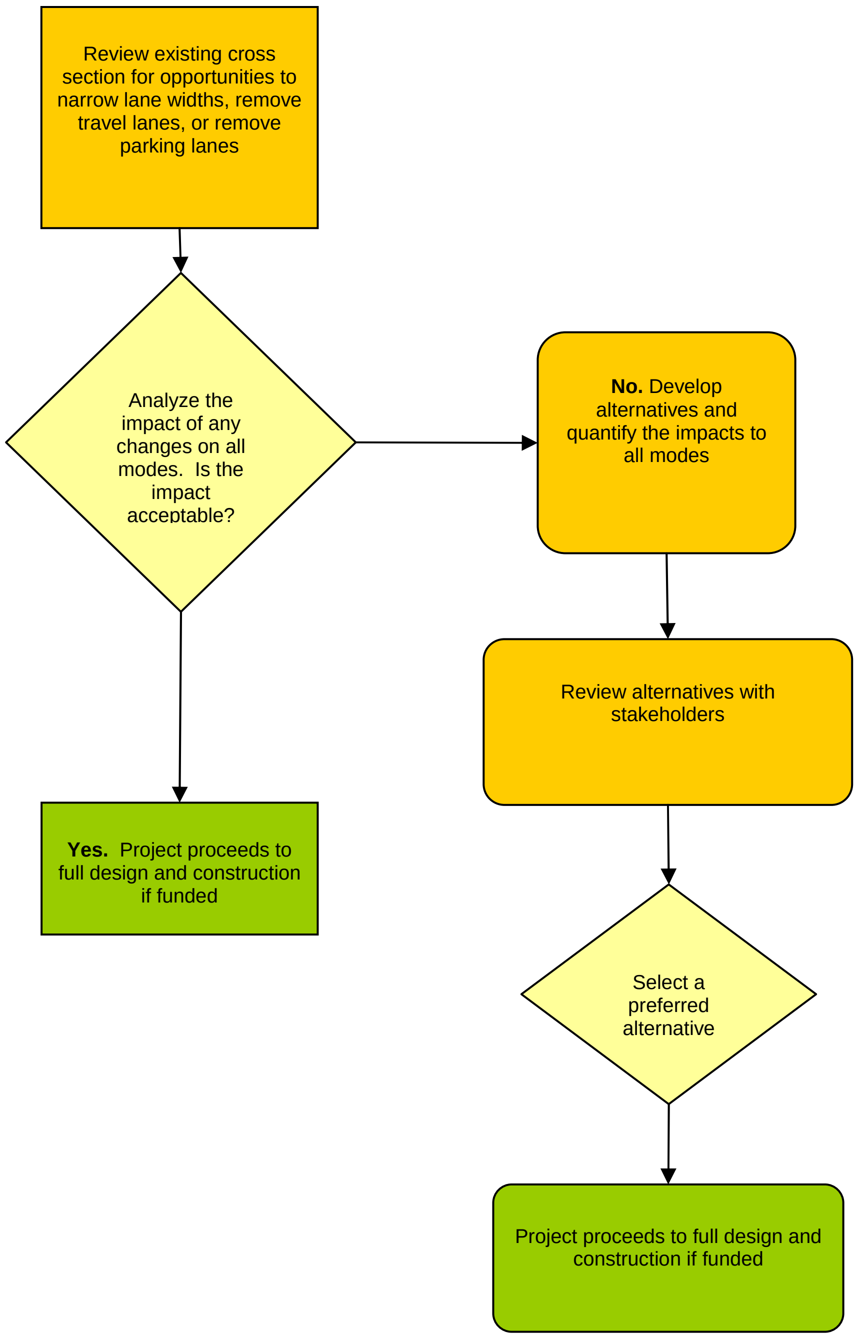
Second, the designer should consider the effect of changes in the existing cross section on:

1. Pedestrian needs (buffers, sidewalk and crossing widths, and medians).
2. Roadway capacity, including traffic volume.
3. On-street parking demand and turnover.
4. Large traffic (trucks and buses).
5. Horizontal alignment (curved roadway sections).
6. The 85^{th} percentile speed.

[2] WSDOT *Design Manual,* Chapter 1020.03

If analysis finds that bicycle lanes are feasible, the project can move to implementation. If there are constraints, designers should develop alternatives with the goal of improving bicycle safety and access to the highest degree possible. The recommendations in the TMP should guide alternative development. The following flowchart summarizes the necessary steps.

Flowchart for Street Retrofits



Bicycle Lane Dimensions

The figures on the following pages illustrate the preferred widths for bicycle lanes in the following situations:

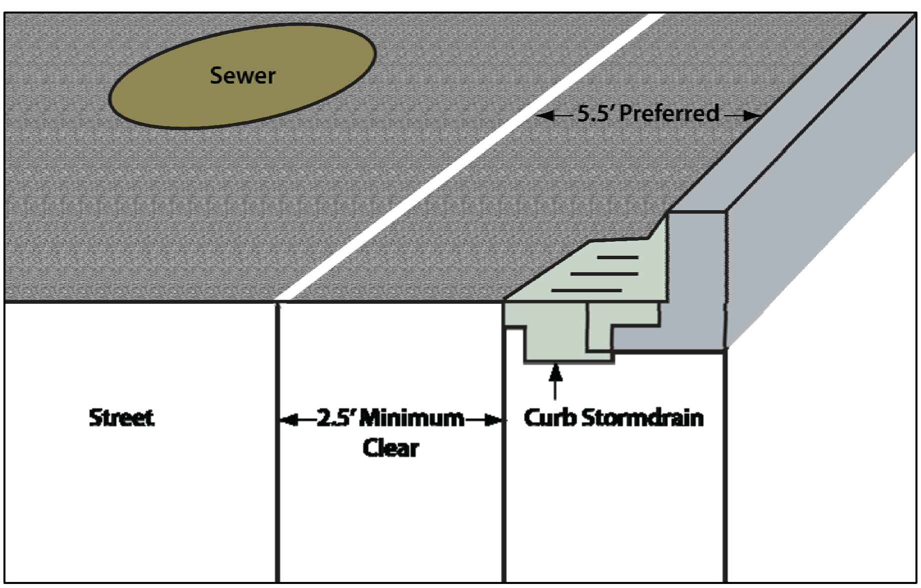
- Next to Parallel Parking
- Next to Back In Angled Parking
- Without Parking
- Along a steep grade

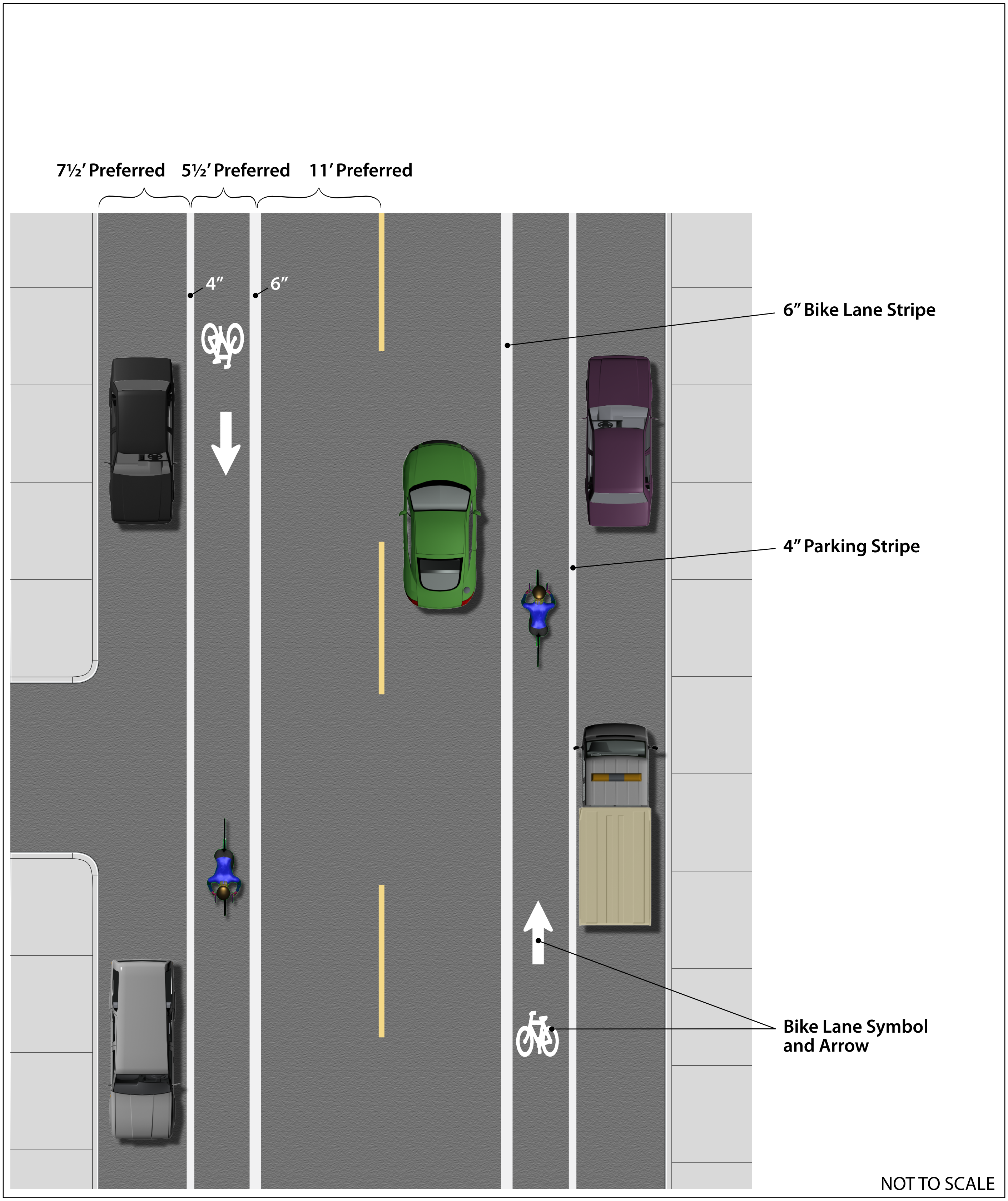
The City's standard width for bike lanes is 5.5 feet. A combined curb parking/bike lane should be a minimum width of 12.5 feet, with 13 feet desirable. This minimum combined lane should be striped with a 5.5 foot bicycle lane and seven-foot parking lane. The optimum combined lane should be a six-foot bike lane and a seven-foot parking lane. In places where there is no on-street parking, the 5.5 foot preferred width applies. In exceptional circumstances where no other reasonable options exist or retrofit situations, a 4 foot minimum is allowed as long as there is no on-street parking. However, designers should take care to maintain a 2.5 foot clear longitudinal surface, free from drainage grates and other obstructions in order to give the cyclist adequate width to ride. This means it is preferable not to consider the gutter pan as clear surface.

Vehicle Lanes

This manual does not include a minimum width for vehicle lanes. Recent research indicates that the use of lanes narrower than 12 feet on urban and suburban arterials does not increase crash frequency (National Cooperative Highway Research Program project 17-26). The researchers recommend that geometric design policies should provide "substantial flexibility" for use of narrower lanes, particularly in retrofit situations where narrow lanes would result in added width for bicycle lanes.

Location of Utilities Adjacent to Bicycle Lanes





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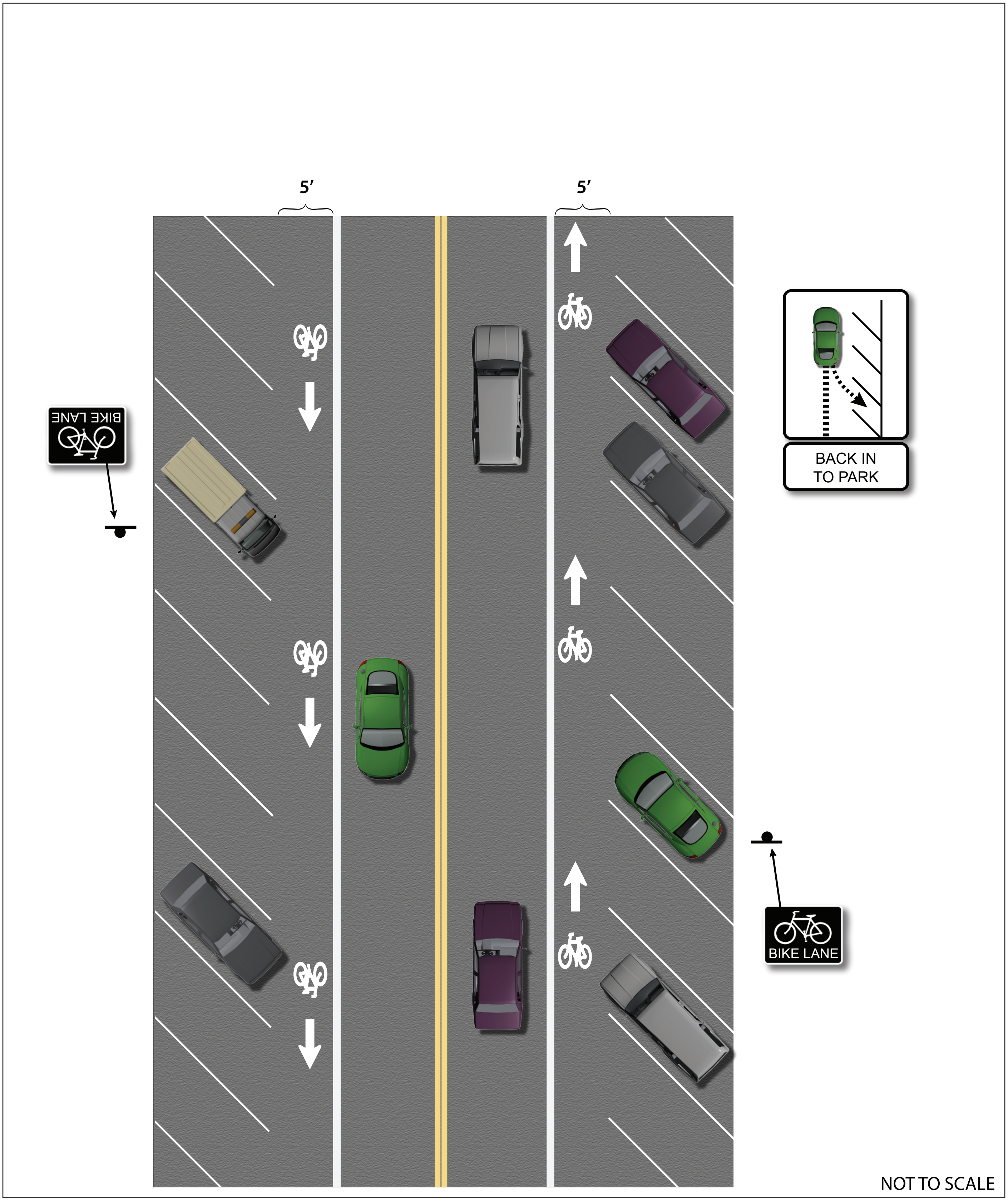
BIKE LANE ON WIDE STREET WITH PARKING ON BOTH SIDES



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BIKE LANES ADJACENT TO BACK-IN DIAGONAL PARKING

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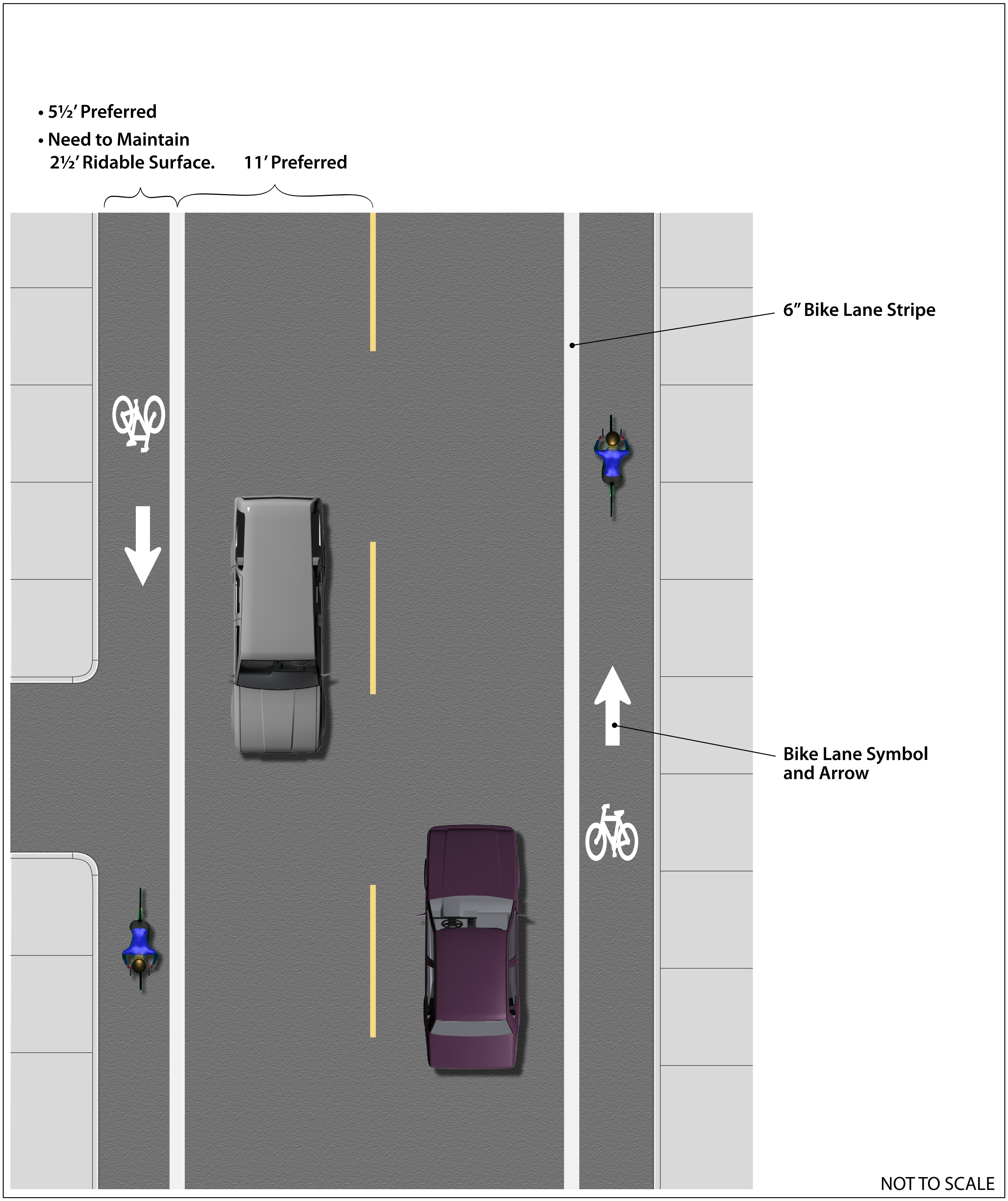

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BIKE LANE ON 2-WAY STREET WITH NO PARKING ON BOTH SIDES

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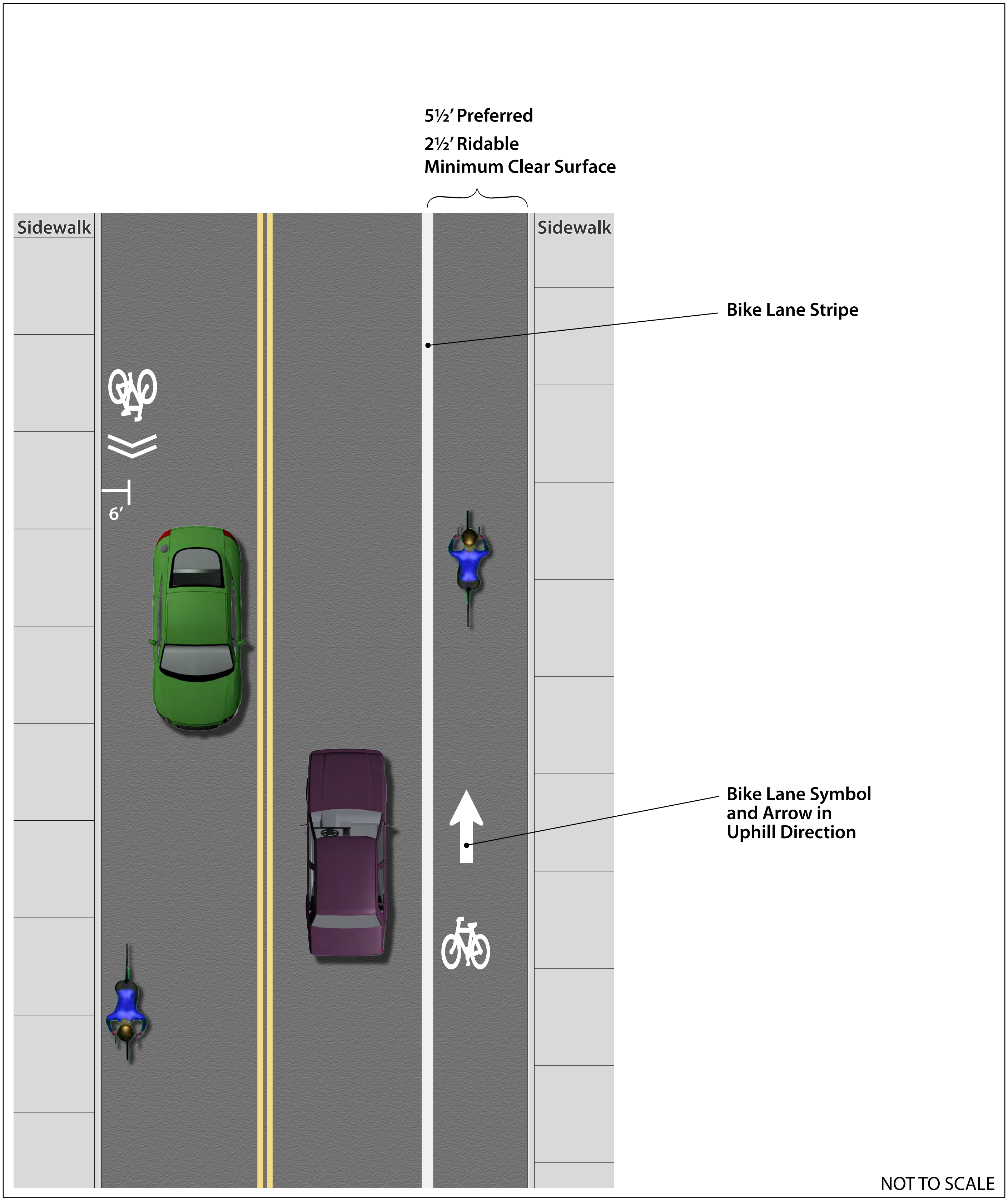

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CLIMBING LANE

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Bicycle Lane Markings

For longitudinal lines, the City uses paint, which should be reapplied at least every 12 months if possible. Pavement stencils should be reflectorized and be capable of maintaining an appropriate skid resistance under rainy or wet conditions to maximize safety for bicyclists. Thermoplastic can meet all of these requirements. It is optimized when the composition has been modified with crushed glass to increase the coefficient of friction and the maximum thickness is no larger than 100 mils (2.5 mm). The City of Seattle has noted success with pre-formed bicycle lane markings, rather than a template applied in the field.

Generally, bicycle lane markings should be provided at transition points, particularly where the bicycle lane disappears and reappears, as it transitions from curb side to the left side of the right-turn lane. Otherwise, place them at least every 500 feet or once per block. Symbols shown in the figures are for illustration purposes and should not be used as spacing or placement guidelines.

Utility Covers and Construction Plates

Utility covers and construction plates present obstacles to bicyclists due to their slipperiness and change in surface elevation with the surrounding pavement. While covers and plates can be replaced with less slippery designs, as discussed below, to minimize their adverse impacts on bicyclists, it is best to design the roadway so that they are not located within the typical path of bicyclists riding on the roadway. Therefore, new construction should endeavor not place manhole and other utility plates and covers where bicyclists typically ride (i.e. within the six feet adjacent to the curb (or between 7 and 12.5 feet from curb if parking is permitted)). These guidelines require a minimum of 2.5 feet straight and clear.

Wet utility covers and construction plate materials can be slippery. Plain steel plates are slippery and should not be used for permanent installation on the roadway. Temporary installations of construction plates on the roadway should endeavor to avoid using plain steel plates if possible. The placement of construction plates should consider bicycles and if possible, be located to provide a clear zone for cyclists to avoid the plates. An example of an effective method for covers and plates (both steel or concrete) to have acceptable skid resistance is for the manufacturer to imprint waffle shaped patterns or right-angle undulations on the surface. The maximum vertical deviation within the pattern should be 0.25 inch (6 mm).[3]

[3] *Santa Clara Valley Transportation Authority Bicycle Technical Guidelines*

Pavement Markers

Pavement markers, whether raised reflective markers or non-reflective ceramic pavement markers (Bott's dots), present a vertical obstruction to bicyclists. When necessary as a fog line or adjacent to the edge line, reflective markers should be placed to the left of the line outside the shoulder area, and ideally the shoulder should be at least 4 feet wide. Where raised markers cross a bike lane or extensions thereof through intersections, a gap of 4 feet should be provided as a clear zone for bicyclists. At gore areas and other locations with channelizing lines, if raised reflective markers are used to supplement the striping, extra lane width shall be provided in the areas where bicycles travel to provide bicyclists with more latitude to avoid the markers.

Storm Water Drainage Design[4]

This section describes ways to reconcile storm water drainage design, typically a curb and gutter and drainage grates, with bicycling safety, both of which occur on the right edge of the road. First, alternatives to curb and gutter design are presented that would provide the same function as standard gutters and grates while not posing an impediment to bicyclists. Where grates are used, the following practices will reduce their impact on bicycling safety.

The Oregon Department of Transportation's (ODOT) Bicycle Design Guidelines state that the most effective way to avoid drainage grate problems is to eliminate them entirely with the use of inlets in the curb face.

Design Considerations

The function of drainage grates is to drain storm water quickly from the roadway and also to provide access to the maintenance worker to clean out the inlet. Gutters are sloped to direct water flow into the inlet. This keeps water from ponding at the longitudinal joint and undermining the pavement. Gutters also protect the curb from being damaged by the contractor during maintenance and resurfacing. However, grates become clogged in areas with many deciduous trees and can be rendered useless. (For example, design manuals recommend that a clogging factor of at least 50 percent be assumed for city streets, in the absence of local data.) While the gutter and inlet design must be hydraulically effective, other designs are just as effective in removing water from the roadway.

Grateless Roadway Designs

Optimally, roadways would be free of drainage grates within the traveled way by the use of curb opening inlets, particularly on grades of less than three percent. The depression in the vicinity of the curb-face inlet (approximately one inch or 30 mm) that is needed for hydraulic efficiency should take place gradually so that it does not pose an obstacle to bicyclists. Curb-face opening inlet designs can be just as effective as grates. Access for maintenance workers is placed in back (sidewalk-side) of the curb. Alternatively, slotted linear drain inlets can be used in the shoulder area in lieu of grate inlets.

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[4] *Ibid*

Design and Placement of Drainage Grates

While attempts have been made to retrofit bicycle-unsafe grates by welding crossbars onto the parallel bars, this is an unsatisfactory solution. Funds are better spent installing correct design grates.

Optimally the roadway should be designed so that the bicyclist does not have to traverse the grate, consistent with Redmond's current standard specification. On roadways with curb and gutter, the grate should not be wider than the gutter pan. If the gutter pan needs to be widened to accommodate a large drainage grate, the taper should be on the outside edge into the planter strip.

On roads with bike lanes, the roadway should be designed such that the minimum bicycle lane width of four feet is maintained between the bike lane stripe and the face of curb. If four feet cannot be maintained, then a curb face inlet design for the drainage grate should be considered.

On roadways with shoulders, the grate should be placed outside the travel path of the bicyclist, i.e. four feet of clear pavement should be maintained between the shoulder stripe and the left edge of the drainage grate. If four feet cannot be provided within the existing shoulder width, the shoulder can be widened to accommodate the grate, with the taper on the outside edge, or a narrower grate should be selected. Optimally a 12-inch maximum gutter pan should be used on new construction projects.

Bicycle Lanes at Intersections

Nationally, the majority of collisions between motorists and bicyclists occur at intersections. There are several engineering treatments to significantly reduce conflicts at intersections.

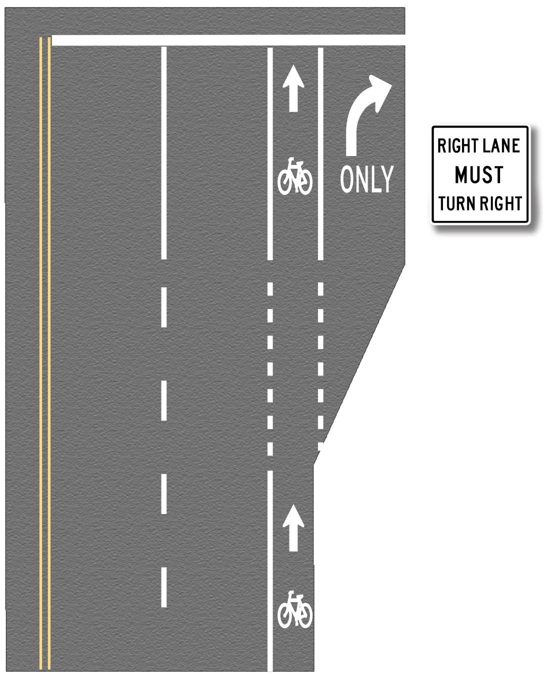
Bicycles and Right-Turn Lanes

WSDOT provides recommended intersection treatments in Chapter 1020 including bike lane “pockets.” Bike lane pockets between right-turn lanes and through lanes should be provided where available lane width allows. Where there is inadequate space for a separate bicycle lane and right-turn lane, the designer should consider the use of a combined lane, shown in the figure on the following page. The City of Eugene, OR evaluated this design and concluded that it was easy for cyclists to use. A majority of the cyclists using the facility felt that it was no different than a standard right-turn lane and bicycle lane.[5] An alternate treatment is a sharrow in the through lane adjacent to the right-turn lane.

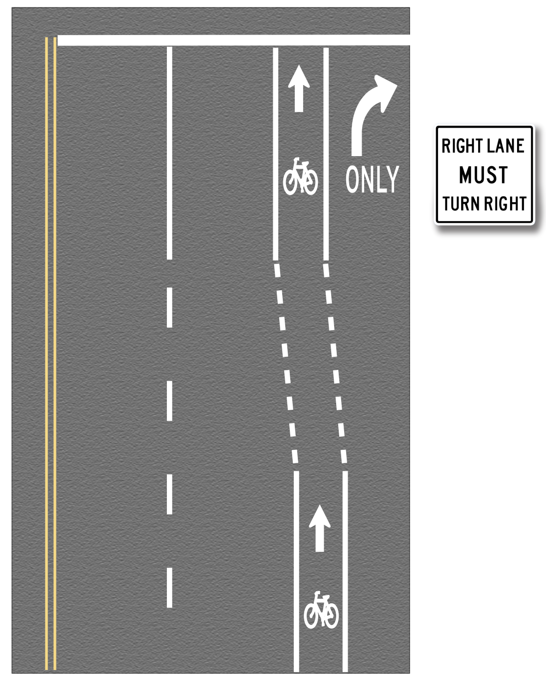
On the Horizon: Bike Boxes

Bicycle boxes are used at signalized intersections to create a dedicated space for cyclists while waiting for a green light. They offer the cyclist a “head start” and allow cyclists to position themselves for various movements (left turns, for instance). They also allow cyclists to avoid conflicts with right-turning vehicles. Bike boxes have been used in New York, Tuscon (AZ), Portland, and Eugene. Bike boxes work best at locations where they are self-enforced, that is, where there is a cyclist in the bike box during the red phase for a majority of the time. Therefore, a good baseline for a bike box would be a location with 90-120 bicycles or more per hour.

[5] *Evaluation of a Combined Bicycle Lane/Right Turn Lane in Eugene, Oregon,* Federal Highway Administration, 2000



a. Right-turn-only lane



b. Parking lane into right-turn-only lane

Note: The dotted lines in cases "a" and "b" are the preferred approach as opposed to the approach shown in case "c".

NOT TO SCALE

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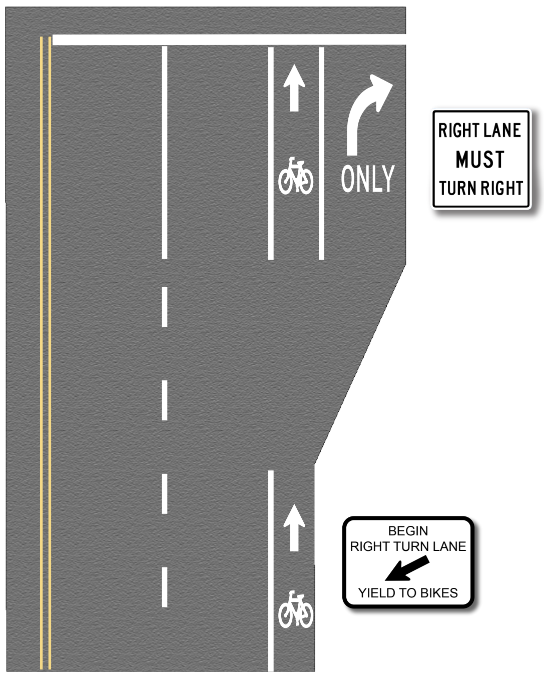
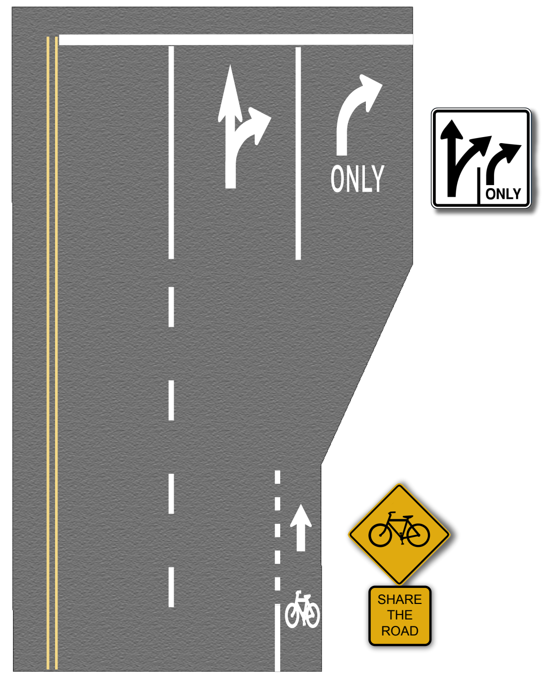
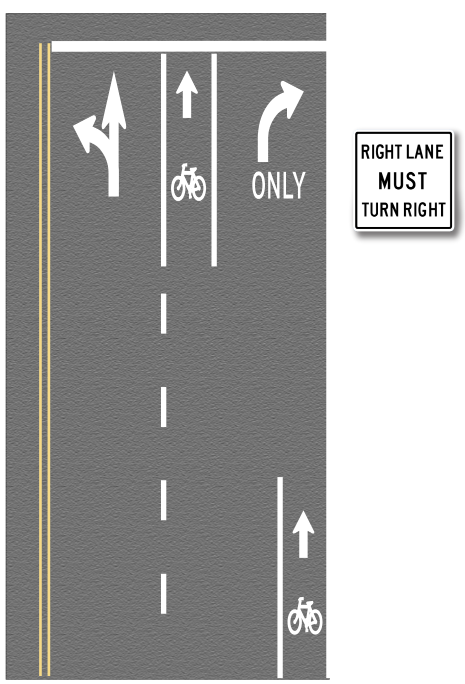
BIKE LANES
APPROACHING RIGHT-TURN-ONLY LANES



c. Right-turn-only lane



d. Optional right/straight and right-turn-only



e. Drop lane

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BIKE LANES
APPROACHING RIGHT-TURN-ONLY LANES

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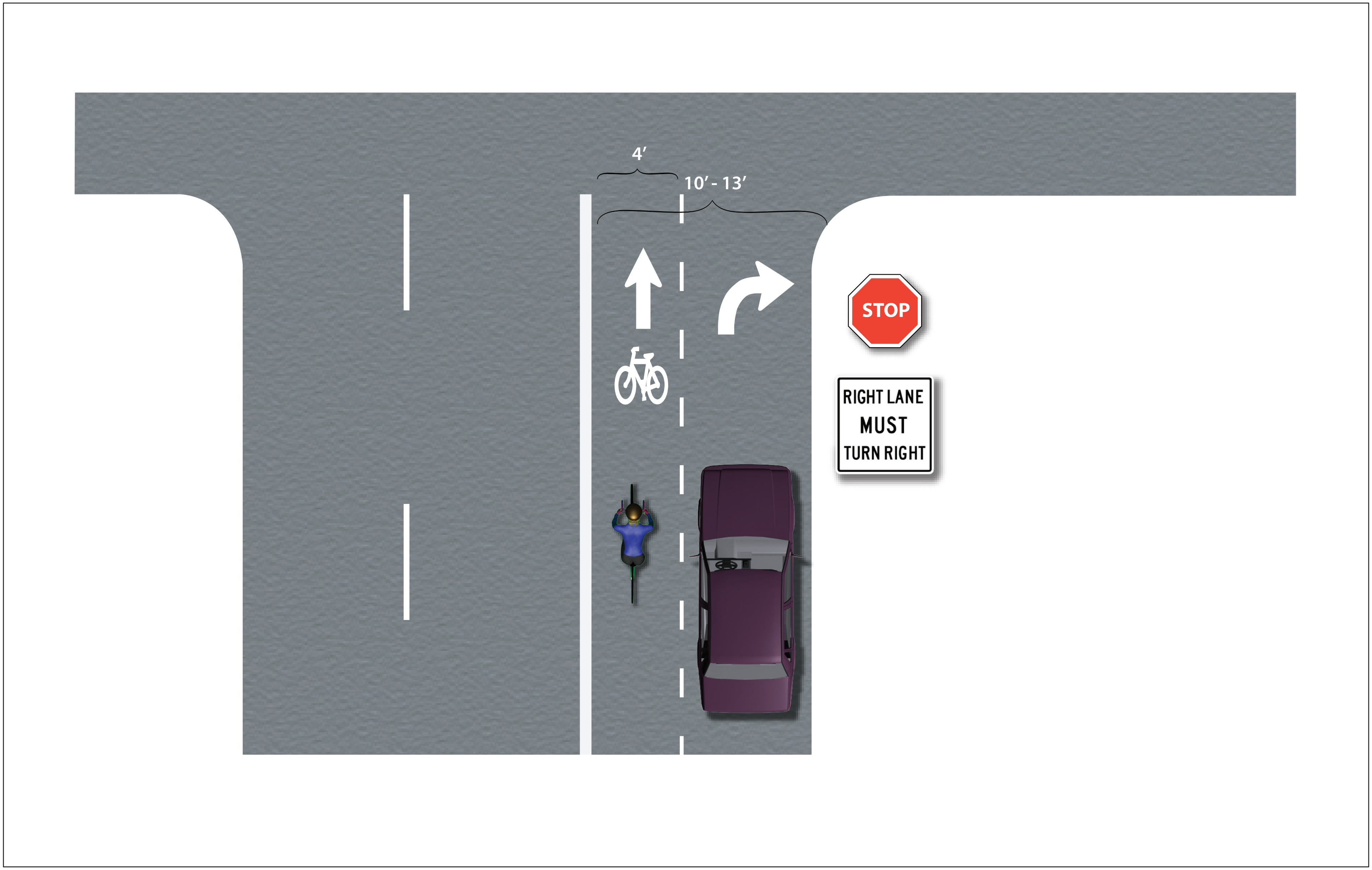

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SHARED BICYCLE / RIGHT-TURN POCKET

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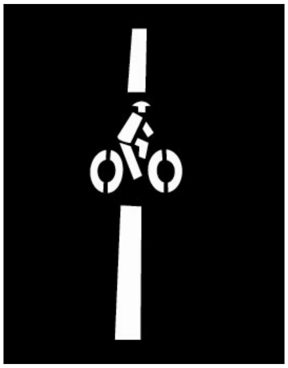
Bicycle Loop Detectors and Push Buttons

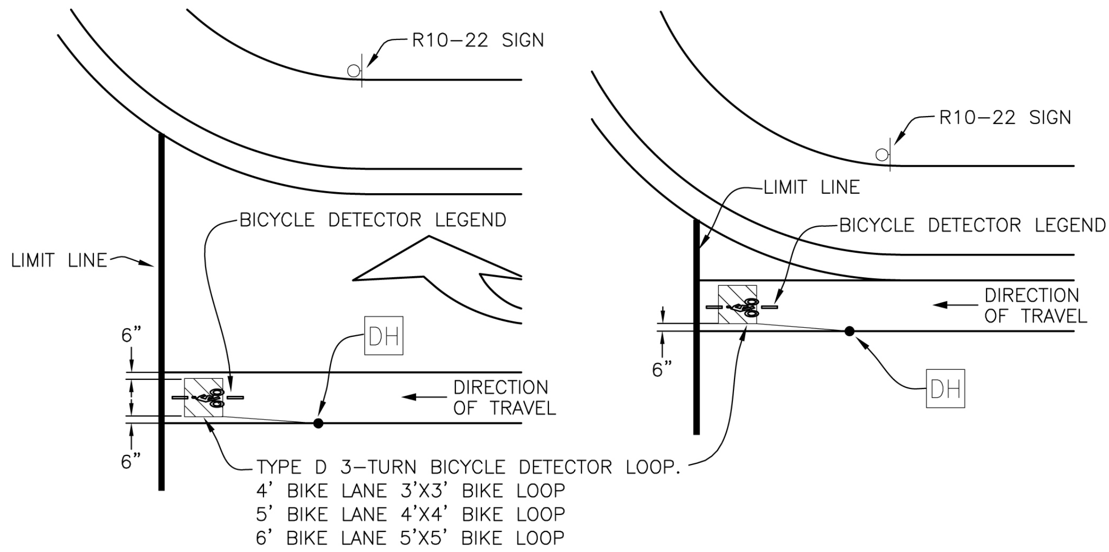


As new signals are installed or major updates happen to existing signalized locations, bicycle loop detectors should be installed on the bikeway system for all movements that do not recall to an automatic green light. It is suggested that loop detectors be installed in the approach bike lane 100 feet in advance of the intersection as well as at the intersection itself. The upstream loop should not be used when it would be triggered by right-turning vehicles. When the upstream loop is triggered, the green time should be extended for the cyclist to reach the loop at the stop bar, at which point the signal should allow the cyclist to clear the intersection. The time that a bicycle needs to cross an intersection is longer than the time needed for vehicles, but shorter than the time needed for pedestrians. The AASHTO *Guide for the Development of Bicycle Facilities* includes detailed equations for bicycle signal timing. In general, while the normal yellow interval is usually adequate for bikes, an adjustment to the minimum green should be considered.

Stencils indicating the loop detector should be marked on the roadway at the intersection where a bicyclist may not be positioned correctly over a loop. The figure on the following page shows the appropriate location and use of loop detector stencils at intersections.

Bicycle pushbutton in Menlo Park, CA

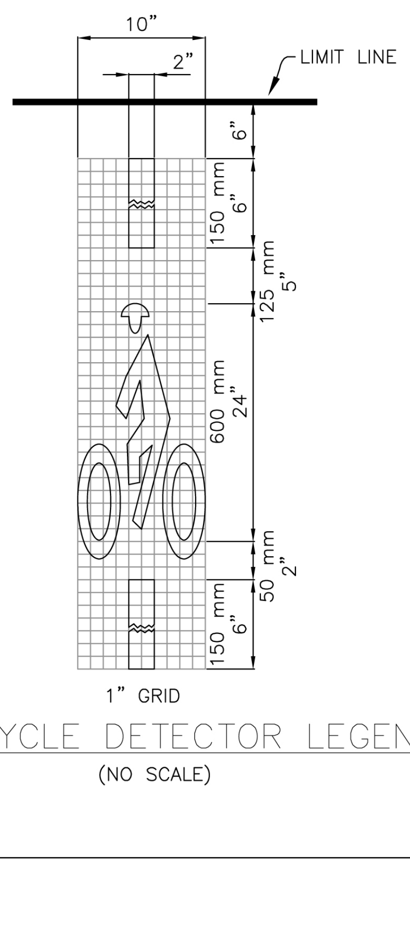
Push buttons are appropriate when other methods of detection are not feasible, particularly at narrow tunnels or where multi-use paths cross signalized intersections. A bicycle push button/pad/bar is similar to those used for pedestrians, but installed in a location most convenient for bicycles and actuates a signal timing most appropriate for bicyclists. The sign plate located above the push button/pad/bar indicates that it is for use by bicyclists. The larger the surface of the button, the easier it is for cyclists to use, thus a push pad is preferential to a push button, and a push bar is preferential to a push pad, as it can be actuated without removing one's hands from the handlebars. Advantages of the push button are that it is typically less expensive than other means of detection, and it allows for different signal timing for different user needs. The disadvantages of the pushbutton are that the location of the pushbutton usually does not allow the cyclist to prepare for through or left-turning movements at the intersection, and that it forces the bicyclist to stop completely in order to actuate the signal.



NOTE: CENTER OF BICYCLE DETECTOR LOOP SHALL BE 3' BACK FROM THE LIMIT LINE.

TYPICAL BICYCLE DETECTOR LOOP AND LEGEND PLACEMENTS

(NO SCALE)



BICYCLE DETECTOR LEGEND

(NO SCALE)

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BICYCLE DETECTION DETAILS

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BICYCLE ROUTES

Bicycle routes are intended to provide continuity throughout a bikeway network and are primarily identified with signs. Bike routes can be used to connect discontinuous segments of a bicycle lane or bicycle path. Bike routes are shared facilities with either motorists on roadways or with pedestrians on sidewalks (not desirable).

Minimum widths for bike routes are not presented in the Design Manual, as the acceptable width is dependent on many factors. The following table presents recommended average daily traffic (ADT) and speed thresholds for bike routes.

RECOMMENDED GUIDELINES FOR BIKE ROUTES

Shared Lane Width (ft)	ADT	Travel Speed	Notes
12 (arterial); 11 (collector); no minimum on local street	under 12,000	under 30 mph	
14	12,000 – 20,000	30 - 35 mph	Use of sharrow strongly recommended at volumes higher than 7,000 vehicles per day, lane widths narrower than 14 feet, or locations with on-street parking.
15	Over 12,000	over 35 mph	Bike routes are strongly discouraged under these conditions, special considerations for short stretches connecting bicycle lanes, where sharrows are strongly recommended.
Source: Fehr & Peers			

Bicycle Boulevards

An additional type of bicycle route facility is the Bicycle Boulevard. Typically, bike boulevards are on low-volume streets adjacent to higher volume arterials where bicycles have priority and have a relatively stop-free, low conflict route to their destinations. Traffic calming treatments, such as traffic circles, chokers and medians, are often used on bicycle boulevards to calm traffic.

Bicycle Boulevard, Berkeley, CA

There are five general issues to address during bike boulevard implementation:[7]

1. Create the look and feel of a bicycle boulevard
2. Slow traffic and discourage diversion of traffic to the bike boulevard when unwarranted STOP signs are removed. Unwarranted STOP signs cause excessive stopping and delay for cyclists. They also increase noise and air pollution, increase fuel consumption, and non compliance compromises safety for all. They often increase speeds mid-block as well.
3. Address school or pedestrian related safety issues.
4. Help bicyclists cross major streets
5. Reduce motor vehicle traffic speeds
6. Prevent diversion of motor vehicle traffic onto adjacent neighborhood streets.

[7] *Berkeley Bicycle Boulevard Tools and Design Guidelines*

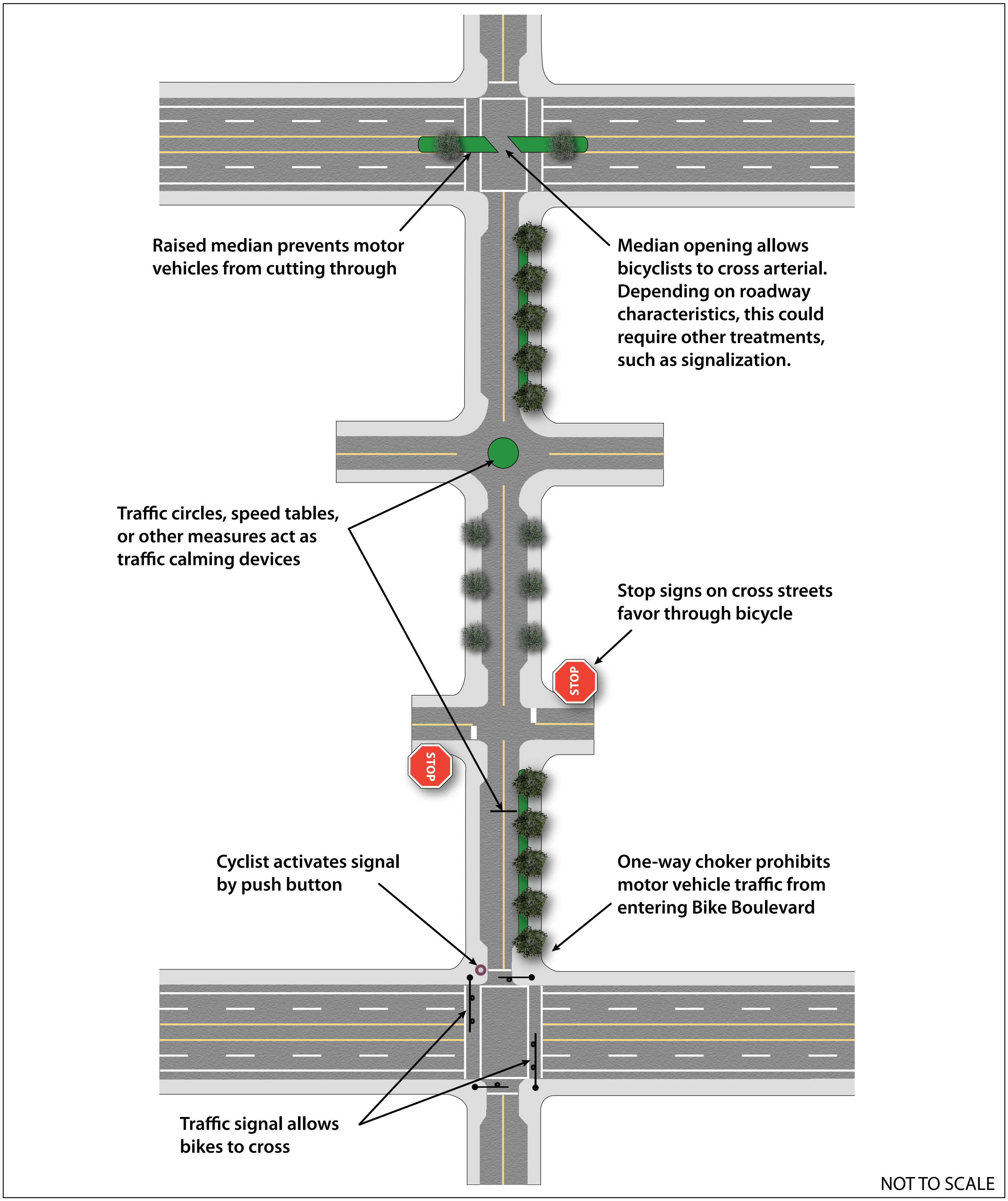
There are two categories of tools that can help address these issues. The first category is called Basic Tools. These strategies are appropriate for all bicycle boulevards. They include:

- ❖ Signs
- ❖ Unique pavement stencils
- ❖ Pavement legends
- ❖ Landscaping and street trees

The second category is called Site Specific Tools. These are used to varying degrees on a bicycle boulevard to respond to a specific issue, and they require more analysis and stakeholder involvement:

- ❖ Traffic circles
- ❖ Bulbouts
- ❖ Traffic signals
- ❖ High-visibility crosswalks

Redmond lacks the type of grid network that offers continuous alternative routes for cyclists. However, if opportunities arise, it is possible to connect bicycle boulevards on cul-de-sacs using separate paved bike paths. Since these opportunities will be rare, bicycle boulevards are not currently a core part of the Redmond bikeway network.



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BICYCLE BOULEVARD

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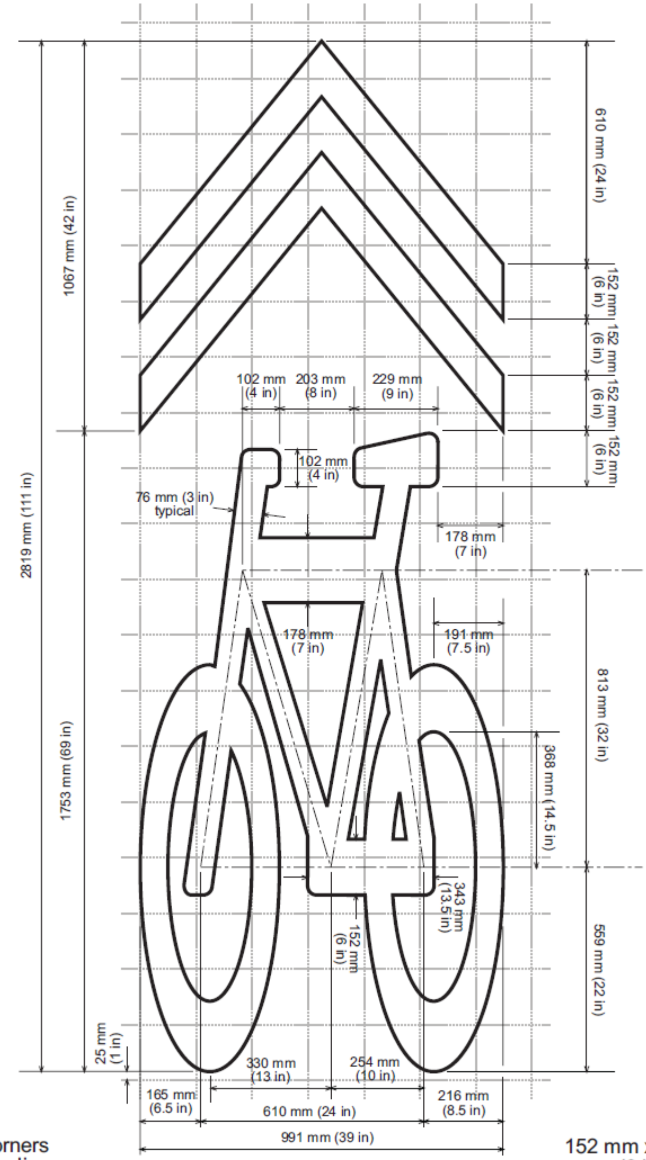
Shared Lane Markings

Shared Lane Markings, or “Sharrows” are a recent design application that have been tentatively approved for the 2009 update to the *MUTCD* Standards. Sharrows are on-street stencils that reinforce that bicyclists are legitimate road users, and sharrows are helpful connectors between multi-use paths or bike lanes when roadway widths are too narrow for a bike lane. Sharrows are suitable for streets with posted speeds below 35 mph, preferably with on-street parking.

Another potential application for sharrows is in high-conflict zones. Some cities are experimenting with colored bicycle lanes for this purpose; however, Sharrows are more immediately understood by motorists and cyclists as a bicycle facility. New York is the latest American city to use Sharrows this way, although they have long been used in Paris to raise the visibility of cyclists through complex intersections and to clearly indicate the best path of travel for cyclists.



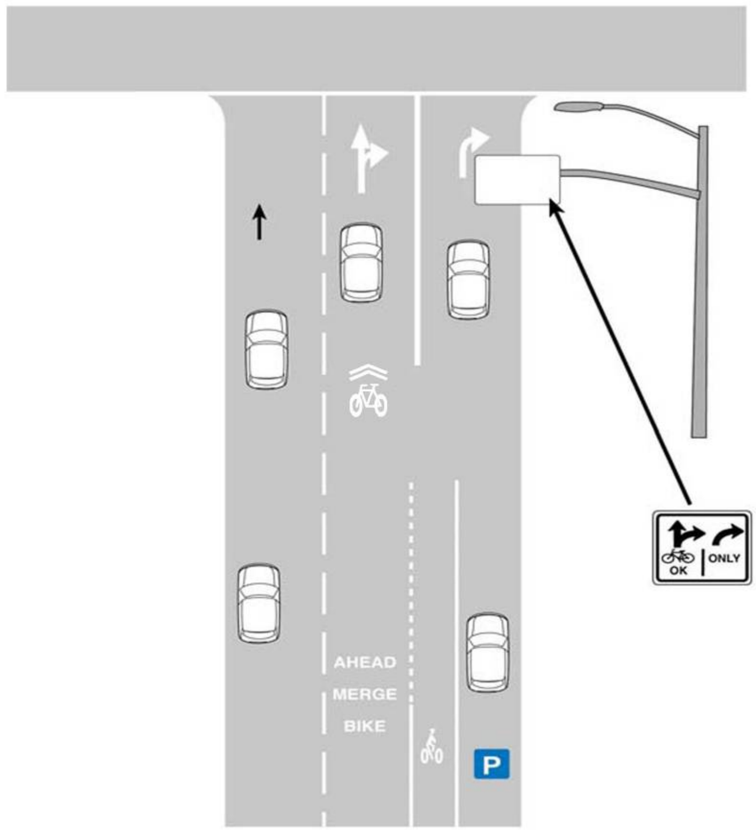
All rounded corners
25 mm (1 in) radius

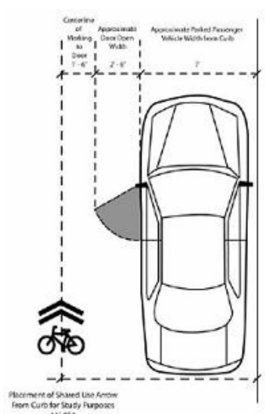
152 mm x 152 mm grid
(6 in x 6 in)

NO SCALE

Sharrow Pavement Stencil

Shared Roadway Marking Guidance for Installation





SHARED USE PATHS

Shared-use paths are completely separated from roads by distance or barriers. At-grade crossings of roadways should be minimized if possible along shared-use paths to avoid conflicts. Bike paths can offer opportunities not provided by the road system as they can serve as both recreational areas and/or desirable transportation corridors.

According to the WSDOT standards, two-way paths should be 12 feet wide under most conditions, with a minimum two-foot wide graded area on both sides. These path "shoulders" should be flush with the trail. In some cases, a wider path may be appropriate to accommodate a high volume of users, multiple closely-placed access points, limited sight distance, attractions adjacent to the trail, and busy trail or street intersections. Where desirable, paths should have an adjacent four-foot wide unpaved area to accommodate pedestrians. This pedestrian path should be placed on the side with the best view, such as adjacent to a river or other vista. Where equestrians are expected, a separate facility should be provided.

Asphaltic concrete or Portland cement concrete should be used for the shared-use path. Decomposed granite, which is a better running surface for preventing injuries, is the preferred surface type for side areas and jogging paths.

A yellow centerline stripe may be used to separate opposite directions of travel. A centerline stripe is particularly beneficial to riders who may use unlighted paths after dark. They are mainly recommended on curves with poor sight distance.

Sidewalks and meandering paths are usually not appropriate to serve as bike paths because they are primarily intended to serve pedestrians, have too many motor vehicle crossings, and generally do not meet WSDOT's design standards.

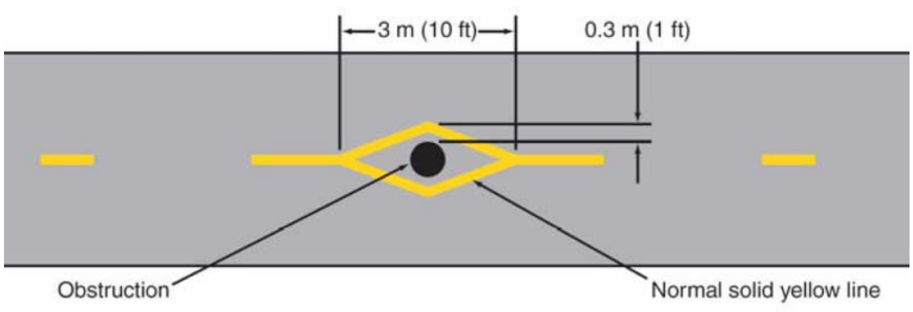
MULTI-USE PATHWAY WIDTHS		
	AASHTO Standards	Preferred Standards
Minimum width	8.0'	12.0'
Vertical clearance	8'	8'
Horizontal clearance	2.0'	3.0'
Maximum cross slope	2.0%	2.0%

Bollards

Bollards can be placed at bike path access points to separate the path from motor vehicles and to warn and slow bicyclists as they approach street crossings. Only one bollard in the center is recommended; two bollards force cyclists to use the single opening in the middle. The diagonal layout of bollards will make the space between the bollards appear narrower, slowing bicyclists and deterring motorcyclists from entering the trail. The bollards are spaced to provide access by people using wheelchairs.

New 2009 MUTCD standards discourage the use of bollards if other options such as signage are practical. The image below shows the recommended striping and placement for bollards on shared use paths. In all cases, an odd number of bollards is better than an even number.

Bollard Placement



Bridges

Bridges will be required wherever paths cross creeks and drainages. Bridges can be pre-fabricated, made from self-weathering steel with wood decks. The preferred width of a path on a bridge is 14 feet. Openings between railings should be 4" maximum. Railing height should be a minimum of 42" high. There are some locations where a 48" high railing should be considered. This includes bridges or bridge approaches where high-speed, steep-angle (25 degrees or greater) impacts between a bicyclist and the railing are more likely to occur, such as where the radius of a curve is below the minimum recommended curvature at the end of a long descending grade.

Fences

Fencing may be necessary on some paths to prevent path users from trespassing on adjacent lands. In areas where private residences are passed, privacy may be a concern. While fencing can isolate path users and contribute to a sense of insecurity, screen fences could be used for this purpose. Screen fences can be made of wood, concrete block or chain link if combined with vine planting. However, if fencing is used, it is important to consider that cyclists will maintain at least two feet of lateral clearance from fixed objects along the trail, such as fences and bollards. This effectively narros the usable width of the path and can cause conflicts between trail users if the remaining effective trail width is too narrow.

At-Grade Trail Crossings

The following guidance is taken from the AASHTO *Guide to the Development of Bicycle Facilities,* the City of Seattle's *Bicycle Master Plan,* and the City of San Francisco's *Supplemental Bicycle Design Guidelines.*

Shared use path crossings come in many configurations, with many variables: the number of roadway lanes to be crossed, divided or undivided roadways, number of approach legs, the speeds and volumes of traffic, and traffic controls that range from uncontrolled to yield, stop or signal controlled. Each intersection is unique and requires engineering judgment to determine the appropriate intersection treatment. The safe and convenient passage of all modes through the intersection is the primary design objective.

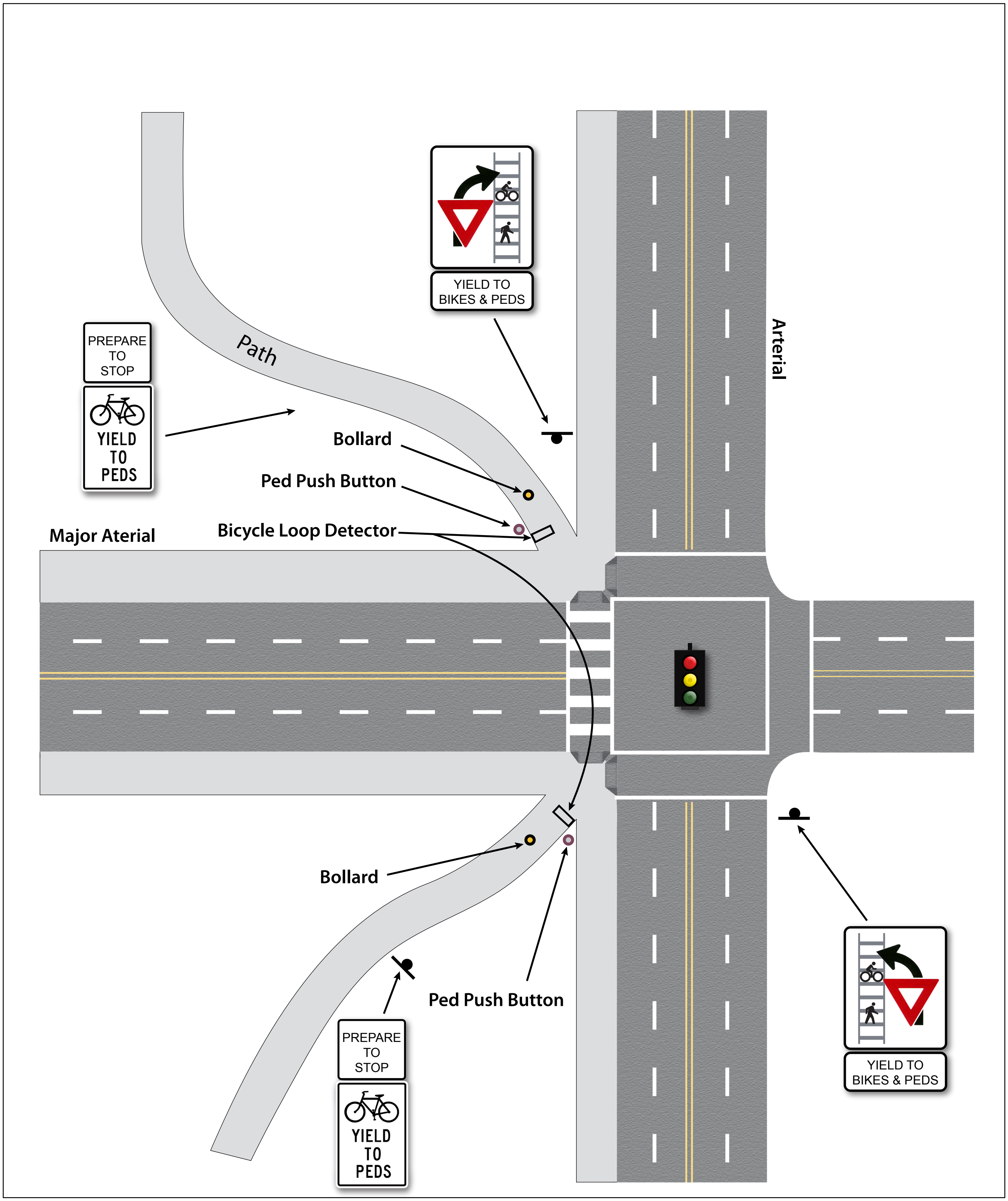
Regardless of whether a pathway crosses a roadway at an existing roadway intersection, or at a new midblock location, the principles that apply to general pedestrian safety at crossings (controlled and uncontrolled) are transferable to pathway intersection design.

When trails cross roadways at intersections, the trail should generally be assigned the same traffic control as the parallel roadway (i.e., if the adjacent roadway has a green signal, the trail should also have a green/walk signal or if the parallel roadway is assigned the right-of-way with a stop or yield sign for the intersecting street, the path should also be given priority). At signalized intersections, if the parallel roadway has signals that are set to recall to green every cycle, the pedestrian signal heads for the trail should generally be set to recall to walk. Countdown pedestrian signals should be installed at all signalized trail crossings as signal heads are replaced. As required by the *Manual on Uniform Traffic Control Devices*, the walk signal for any trail shall not conflict with a protected left- or right-turn interval.

Consideration should be given to providing a leading pedestrian interval at trail crossings (i.e., three seconds of green/walk signal time are given to trail users before any potentially-conflicting motor vehicle movements are given a green signal). This allows pedestrians and bicyclists to have a head start into the roadway to become more visible to turning traffic.

Where the signals for the parallel roadway are actuated, the trail crossing will also need to be actuated. For trail crossings, the minimum WALK interval may be 9-12 seconds to accommodate increased flow. The USE PED SIGNAL sign may be used at trail crossings at signalized intersections. Pedestrian pushbuttons should be located within easy reach of both pedestrians and bicyclists, who should not have to dismount to reach the pushbutton.

The figure on the following page illustrates the preferred approach for a trail at a controlled intersection. An advance loop detector within 100 feet of the intersection should be considered, so bicyclists can approach the intersection slowly but without having to stop.



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BICYCLE PATH CROSSING OF ROADWAY

If trails cross at intersections with all way stops, stop signs should be placed at each trail approach.

Consideration should be given to removing stop signs for the trail and the parallel roadway leaving the intersection two-way stop controlled for the intersecting roadway. An engineering study should be conducted before removing or adding any stop signs.

At intersections with STOP signs controlling only one of the approaches, the trail should be assigned the same right-of-way as the parallel street. Stop signs should not be placed on the trail approaches to the intersecting roadway if the parallel street has no stop signs.

If the two streets have the same roadway classification, and the stop signs face the intersecting street that is parallel to the trail, consideration should be given to reversing the stop sign placement, giving the right-of-way to the trail and the parallel street. An engineering study should be conducted before reversing the stop sign placement.

The decision of whether to use a traffic signal at a mid-block trail crossing should be primarily based on the latest version of the *MUTCD* Pedestrian Signal warrants.

At mid-block crossings, all trail users (including bicyclists) should be included in calculating the "pedestrian volume" for the warrant procedure. When a trail crossing meets the warrants, there may be other reasons why a signal is not necessary at the crossing. Where a decision has been made not to install a traffic signal at a mid-block trail crossing, STOP signs should be used to assign the right-of-way to the trail or the roadway. These signs are intended to remind cyclists and pedestrians to stop and look before crossing because although these locations are marked crosswalks, train users should exercise caution before crossing. To minimize driver confusion, these stop signs should be installed such that they are not visible by drivers on the intersecting street. If the signs are visible to drivers, it may lead them to interpret that they have the right-of-way and do not need to stop for trail users. The assignment of priority at a shared-use path/roadway intersection should be assigned with consideration of the following:

- The relative importance of the trail and the roadway.
- The relative volumes of trail and roadway traffic.
- The relative speeds of trail and roadway users.

BICYCLE PARKING

Every bicycle trip has two main components: the route selected by the bicyclist and the “end-of-trip” facilities at the destinations, such as safe and secure bicycle parking. This section provides guidance on the provision and placement of safe, secure, and convenient bicycle parking facilities.

As the Redmond bicycle network grows, so will the population that chooses to ride a bike. The availability of secure and convenient parking is critical to bicyclists. The availability of short and long-term bicycle parking at key destinations such as parks, schools, community facilities, transit stations, and Centers is a vital part of a complete bicycle network.

Parking should be highly visible, accessible and easy to use. Facilities should be located in well-lit areas and covered where possible. They should not interfere with pedestrian flows. Installation is equally important; for example a rack that is too close to a wall or other obstruction will not be effectively utilized. See the figures on the following pages for design specifications.

There are different types of parking facilities just as there are different levels of bikeway facilities. Parking facilities fall into one of three main categories:

Bicycle Racks

Bicycle Racks are low-cost devices that provide a location to secure a bicycle. Ideally, bicyclists can lock both their frame and wheels. The bicycle rack should be in a highly visible location secured to the ground, preferably within 50 feet of a main entrance to a building or facility. Whenever possible, the racks should be visible from the doorways and/or windows of buildings, and not in an out of the way location, such as an alley. Short-term bicycle parking is commonly used for short trips, when cyclists are planning to leave their bicycles for a few hours.

Covered bike racks protect bicycles from rain and other elements.

Bicycle Rack Materials

Stainless steel
Requires no coating and is attractive and virtually Maintenance-free, but it is typically the most expensive material.

Vinyl coating
Can be somewhat more expensive than other options, but is one of the best when aesthetics and durability are considered. Vinyl requires inimal maintenance.
Vinyl coatings are the most user-friendly of all the options because they will not scratch bicycles the way harder coatings will.

Powder coating
An excellent option because it allows all of the same color options as paint, but is very durable. Powder coating is usually the same cost as galvanized.

Galvanized coatings
Durable and much less expensive than stainless steel, but galvanized racks are not typically considered as attractive as other options.

Paint
Economical, but is not as durable as the other options. This is a major issue in the Puget Sound region where metal surfaces are subjected to alternating cycles of heavy rain in the winter months and heat in the summer.

Stock
Whenever possible, racks should be constructed from square metal stock, since round stock may be vulnerable to pipe cutters.

The most common mistake in installing bike racks is placing them too close to a wall or fence, or orienting them the wrong way, rendering the rack unusable; nor should they impede pedestrians. In addition, in order to accommodate a range of bicycle styles and sizes, racks must be installed to allow sufficient space between bicycles and between racks.

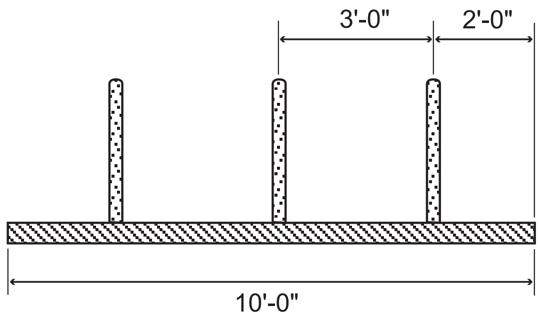
If there are two or more rack spaces (also known as “elements”) in a single rack, there must be a minimum of 30 inches center to center between bicycle tires when bicycles are locked side to side; otherwise, the handlebars of one bicycle can prevent another bicycle from parking in the adjacent space.

In addition to optimizing space by situating adjacent bicycles a sufficient distance apart, bicycle racks must be installed to allow sufficient space for bicyclists and their bicycles to move about between racks. In most cases, a standard bicycle footprint is six feet long. Aisles between rows of racks must be a minimum of four feet wide.

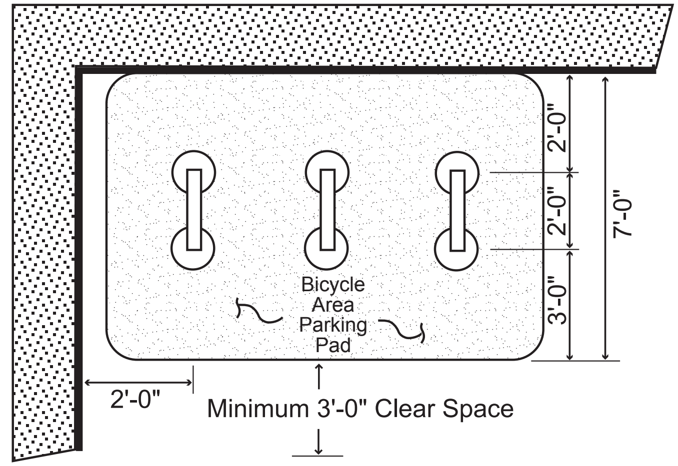
For security, bicycle racks should always be installed in concrete. If concrete is infeasible, asphalt is acceptable on rare occasions. Soil is never acceptable. There are two primary types of bicycle rack installation: surface mount and cast in place. Either is acceptable, but for certain rack models, only one installation type will work.

Surface mount is appropriate where racks are being installed onto an existing concrete slab. Anti-tampering bolts and other hardware should be used to prevent theft of the whole rack. If an asphalt substrate is all that is available, concrete footings should be poured.

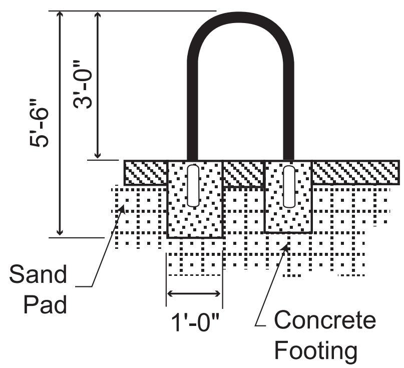
Cast-in-place is the best option for security purposes, but may be impossible if the rack installation location already has a slab poured or if the chosen rack type does not provide a cast-in-place option. Cast-in-place installation is appropriate for either asphalt or concrete.



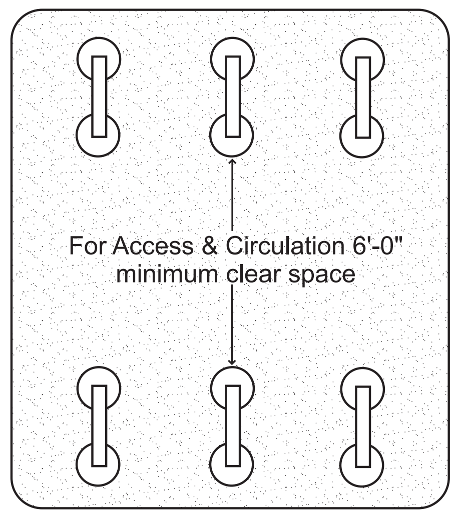
PROFILE VIEW



PLAN VIEW



SIDE VIEW



PLAN VIEW WITH MULTIPLE ROWS

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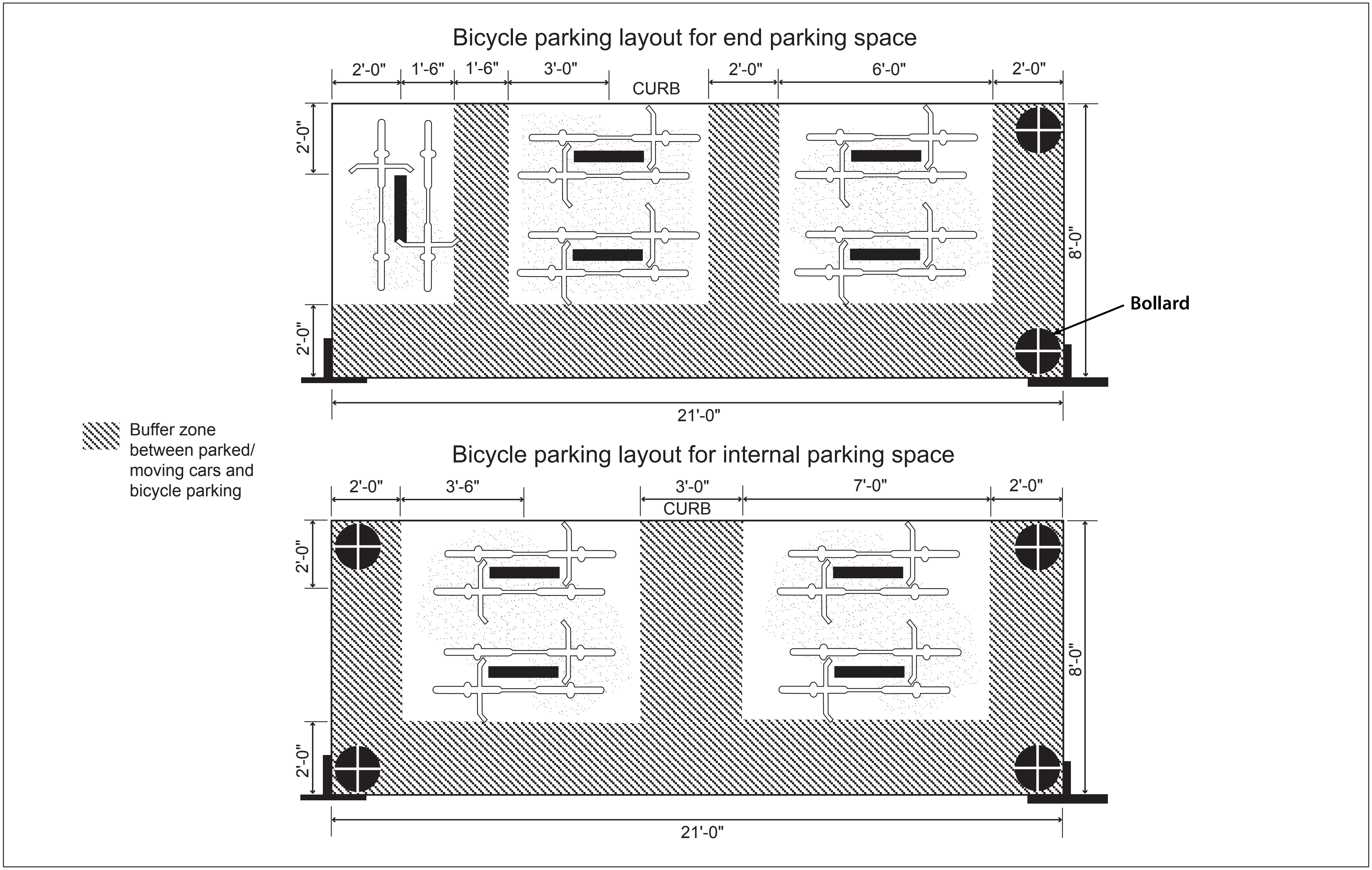
MULTIPLE RACK DIAGRAM



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GUIDELINES FOR BIKE RACK PLACEMENT IN PARALLEL ON STREET PARKING SPACE

FIGURE

Bicycle Lockers

Bicycle Lockers are covered storage units that can be locked individually, providing secure parking for one bicycle. Bicycle Cages are secure areas with limited-access doors. Occasionally, they are attended. Each of these means is designed to provide bicyclists with a high level of security so they feel comfortable leaving their bicycles for long periods of time. They are appropriate for employees of large buildings and at transit stations. Lockers provide a secure place for bicyclists to store their helmets or other riding gear. Showers are important for bicycle commuters with a rigorous commute and/or formal office attire.

Electronic Bicycle Lockers

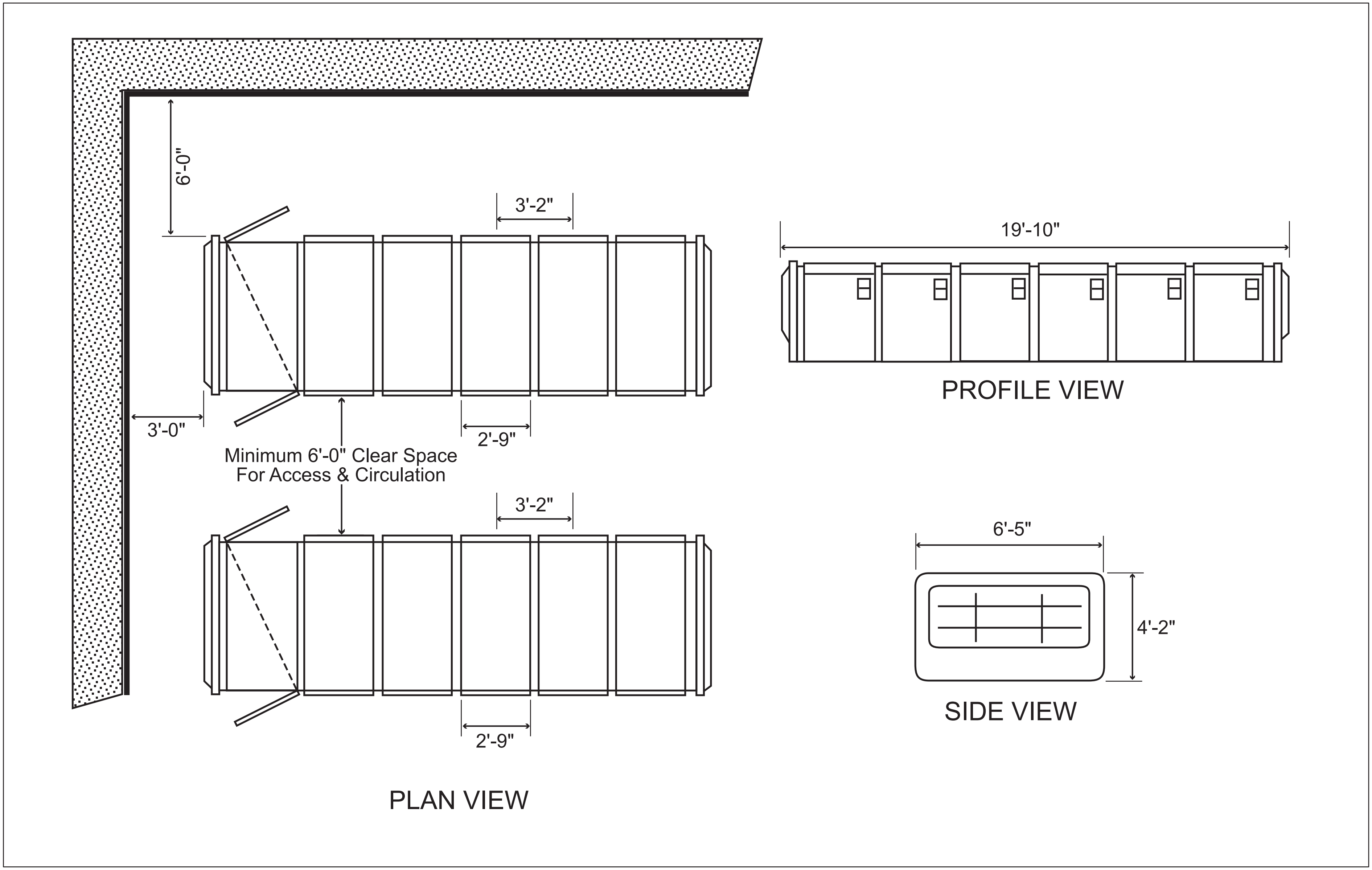
Electronic bike lockers provide secure individualized parking that can be accessed with an electronic card. Unlike standard key lockers which provide one key for one renter, a single e-locker can be rented by multiple cyclists each week by using smart card technology.

Bicycle Locker Materials

Stainless steel
The best material because it is the strongest and most durable, it reflects sunlight well, and requires the least amount of maintenance because it never needs painting.

Powder coated steel
The second best option. Although not as durable as stainless steel, powder coated steel is available in a broad range of colors (though dark colors should be avoided due to heat absorption in the summer) and will last many years.

Composite materials
Composite materials such as resin-based materials, chip-board, and particle board should be avoided. These materials photo-oxidize and break down quickly, and are not as secure as steel lockers.



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GUIDELINES FOR PLACEMENT OF BICYCLE LOCKERS

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Multimodal Centers and Bicycle Stations

Unstaffed bicycle stations are shared access storage areas in which registered cyclists lock their own bicycles. Cyclists gain access to these facilities by registering for a key or key code. Security can be bolstered with surveillance cameras, human monitoring, visual transparency (such as wrought iron fencing), and by locating them in areas with plenty of pedestrian activity. (Note: cameras are only recommended in conjunction with human monitoring and action; otherwise, they do not deter vandalism or theft.)

Also known as valet bicycle parking, staffed bicycle parking facilities offer a high level of security and often provide repair and retail services to generate revenue to offset staffing costs and to provide additional services for users. Bikes parked in staffed facilities are typically not locked if they are checked in and out by the staff person. Staffing costs make such facilities more expensive to operate than other types of parking, so hours of operation can be limited. Cyclists who need to retrieve a parked bicycle after hours must make prior arrangements with the staff operator. Arrangements may include securing the user's bike to an outdoor rack of locker at the time the staffed facility closes thereby allowing the bike user to retrieve their bicycle after-hours.

Other services or amenities sometimes offered at attended bicycle parking facilities include: bicycle repairs, bicycle and electric car sharing, bicycle rental, bicycle maintenance classes, restroom, locker room and shower, tools and repair stands for customer use, bike tours, and a café.

Staffed bicycle parking facilities that are subsidized typically offer free parking. These facilities have typically struggled to mature into self-sustainable operations

Determining the best type of bicycle parking to augment lower-security bicycle racks requires consideration of a number of factors:

1. Cyclists' usage patterns and potential demand: Considerations include how many spaces are needed and the duration and frequency of parking.

2. Available space or facilities: Is there enough space to install bicycle lockers or would a bike shed or bicycle station, which provide the same amount of parking in a smaller footprint, suffice? Is there an existing structure that could be used to house the shared bike parking?

3. Resources for parking administration: Who will manage the bicycle parking on a day-to-day basis? Who will respond to customer issues?

4. Available funding for capital/operating costs: Outside capital funding to construct bicycle parking facilities is much easier to come by than securing ongoing operations funding.

APPENDIX A: BICYCLE ROUTE SIGNS AND WAYFINDING PROTOCOL (SEATTLE, WA)

This appendix provides a bicycle route sign and wayfinding protocol which should help guide installation of bicycle wayfinding signs in Redmond. Regional consistency is important because many bicycle trips are inter-jurisdictional. The significant effort Seattle invested in the design and installation protocol for its signs make it a natural de facto standard for the region.

Bicycle Route Signage and Wayfinding Protocol

Bicycle route signs will be posted on designated roadways and trails to direct bicyclists to major destinations throughout Seattle. Pavement markings will also be used to assist with wayfinding in some locations. The general protocol for locating signs and markings is described below. Several routes will be signed during the first year after this plan is adopted, and modifications will be made to this protocol based on this experience.

General

- Use standard city and regional sign designs developed as a part of this Plan (see Figure G.1: Bicycle Wayfinding Sign Designs).
- Follow Manual on Uniform Traffic Control Devices (MUTCD) standards for sign installation, such as minimum height of signs above ground and horizontal placement from edge of the roadway or trail.
- Keep the regional route sign separate from the city route sign on all segments that are both regional and city routes (e.g., combined signs will not be used, though two different types of signs may be on the same post).
- City route signs should include a directional arrow, destination, and distance.
- When city route signs (e.g., "blades") are used, the sign listing the closest destination should be on top, and the furthest destination should be on the bottom. A maximum of three directional subplate signs should be used on any single bicycle route sign.
- Destinations on signs should be named using common neighborhood names (e.g., Urban Villages and Urban Centers), major transit hubs, and regional parks.
- While a route may extend the length of the city, it should not list all destinations on a single signpost; instead, it should show important intermediate destinations.
- Reduced-size signs can be used as route confirmation signs on regional routes. These smaller signs may be placed lower to the ground or on different types of poles than the regular-size signs.
- Regional route signs can be installed on the same or separate posts as the city route signs.
- Install signs on feeder streets between nearby destinations (e.g., schools, transit hubs, parks, Urban Village Centers, etc.) and city or regional bicycle routes. These feeder streets may have signs to indicate the distance and direction to the destination, and the distance and direction to the bicycle route. Pavement markings may be used on feeder streets in place of or in conjunction with these signs.

Bicycle Routes on Trails

- Post bicycle route signs at all major decision points along the trail (feeder trail intersections, forks in the trail, etc.).
- Provide bicycle route confirmation signs at the following locations:
  - After all roadway crossings (local streets and arterials).
  - Every one-third to one-half mile, depending on the segment length, sight distance, and need for confirmation signs.
- Install street name signs at all locations where trails intersect streets. This type of sign should have a sign blade for both the street name and the trail name.

Bicycle Routes on Streets

- Post bicycle route signs at all turns or decision points along the route.
- Use circular dot bicycle pavement markings with an arrow (or other markings) on non-arterial streets to indicate turns along an on-street route where signs may be difficult to see because of parked cars or vegetation (optional: use bike-in-arrow markings to indicate turns).
- Use the following guidelines to install route confirmation signs and communication that bicyclists are still on the correct route:
    - Provide bicycle route confirmation signs every one-third to one-half mile on straight segments of the route, depending on the locations of crossings with other bicycle routes, locations of primary arterial roadway crossings, sight distance, and the overall frequency of street crossings.
    - Locate bicycle route confirmation signs near crossings of other bicycle routes and primary arterial roadway crossings on straight segments of bicycle routes.
    - Use pavement markings to complement confirmation signs, where appropriate.
- Install spot signage to show bicyclists how to access and cross bridges, travel through complicated areas, and connect through gaps between existing sections of bicycle facilities (this signage does not need to be part of a signed route).

Sign designs for bicycle wayfinding on city streets and on Urban Trails and Bikeways System routes were developed during the Bicycle Master Plan process. These designs are shown in Figure G.1: Bicycle Wayfinding Sign Designs. The Seattle Department of Parks and Recreation is working with SDOT to develop brown signs for routes on Olmsted Boulevards.

Figure G.1. Bicycle Wayfinding Sign Designs

Examples of wayfinding signs for city routes

Examples of wayfinding signs for regional routes

APPENDIX B: ACCOMMODATION OF BICYCLE TRAFFIC DURING CONSTRUCTION, CONSTRUCTION SPECIFICATIONS (CAMBRIDGE, MA)

This appendix provides a sample construction specification that may be integrated into the City of Redmond's own construction specifications in order to improve bicycle accommodation during construction projects.

SPECIAL PROVISIONS
ACCOMMODATION OF BICYCLE TRAFFIC DURING CONSTRUCTION:

A. Bicycle traffic shall be accommodated on all public streets either within bicycle lanes where existing or in vehicular travel lanes.

B. Where bicycle lanes are not present, provide a shared vehicle lane as wide as physically feasible.

C. When travel lanes are restricted to less than 14-foot in width warning signage (W11-1/W16-1 combination - Bicycle warning symbol with SHARE THE ROAD plaque) shall be placed warning motor vehicle operators of the presence of bicycles in the roadway.

D. If the disruption occurs in a bicycle lanes over a short distance (approximately 500 feet or less), bicyclists should be routed to share a motor vehicle lane.

E. On projects where the disruption occurs over a longer distance (more than 500 feet), and on busy roadways, a temporary bicycle lane or wide outside lane (at least 14 foot wide) should be provided. If that is not feasible, provide access, including ramps if necessary, for bicyclists to have the option of using sidewalks, except within zones where sidewalk bicycle riding is prohibited by the City.

F. Steel plates:

1. When steel plates are used in the travel way warning signage (Warning Steel Plates Ahead) shall be placed at least 50 feet in advance.

2. Steel plates shall be set so there is no vertical lip over 1/4 inch between the plate and adjacent pavement. This shall be accomplished in one of the following ways:

    a. Recessing the plate so that the top of the plate matches adjacent pavement (with no lip over 1/4 inches).

    b. Providing bituminous concrete lip painted reflective orange to provide a smooth transition slope up from existing pavement to top of plate.

3. Non-slip surface steel plates are preferred for use, and must be used where plates are in an intersection or within a crosswalk.

G. Raised castings: Where raised castings are present after cold planing and/or in anticipation of final paving, provide the following:

1. Advance warning signs saying: “Caution – Raised Castings Ahead.”

2. Spray paint reflective orange the raised portions of the castings.

H. Cold planing and pavement installation: Where cold planing or the installation of pavement in lifts results in vertical joints greater than 1/4 inch, provide temporary bituminous concrete lip painted reflective orange to provide a smooth transition slope between the pavement layers.

I. When the roadway or travel lanes narrow due to construction, advance warning signs should be placed at least 20 feet in advance.

J. Narrow cuts that are parallel with the direction of travel create an extreme hazard for cyclists, whose tires could get caught. These should never be made and left in an area where bicyclists will be traveling. If necessary, they should be blocked off and cyclists routed around the hazard.
When performing advance pavement cutting for trenching or other roadway excavation, use only saw cutting (approximately 1/4 inch or narrower).

K. Debris should be swept to maintain a reasonably clear riding surface in the bicycle lanes or, where there are no bicycle lanes, the outer 5 or 6 feet of roadway. Promptly remove gravel, debris, litter, sand, stone, and other obstructions from bicycle lanes and travel lanes.

L. Advance construction signs shall not be placed in bicycle lanes and shall not otherwise obstruct bicyclists' path.

M. Temporary ramps for site access ramps. The creation of ramps in the roadway is not permitted unless being created in an area that is otherwise used by on-street parking.

N. Restore pavement markings for bike lanes within 2 weeks of paving.

APPENDIX C: CITY OF REDMOND LONG-TERM BICYCLE PARKING GUIDELINES (PREPARED BY SvR DESIGN, FEBRUARY 2012)

This appendix, prepared in 2012, provides additional detail to the guidelines included in the original 2009 document for long-term bike parking. Guidelines indicate the location and design of secure, long-term bicycle parking facilities in accordance with the City of Redmond's bicycle parking requirements as published in Section 21.40.020 of the Redmond Zoning Code.

City of Redmond

Long-Term Bicycle Parking Guidelines

February 2012

City of Redmond Long-Term Bicycle Parking Guidelines

PURPOSE

This report adds additional detail to the bicycle parking guidelines included in the Redmond Bicycle Facilities Design Manual for locating and designing secure, long-term bicycle parking facilities in accordance with the City of Redmond's bicycle parking requirements as published in Section 21.40.020 of the Redmond Zoning Code. Additional information regarding bicycle parking and other bicycle related design issues are addressed in the Redmond Bicycle Facilities Design Manual and the American Pedestrian and Bicycle Professionals Bicycle Parking Guidelines, 2nd Addition.

DESIGN CONSIDERATION

Security:
Long-term bicycle parking needs to be located in a secure location where access to the bicycles is limited and is not available to the general public. Secure access can be achieved in any of the following ways:

- Designated indoor bike room with locking system
- Bike cage with locking system in a parking garage
- Uncaged bike parking in a garage or area with 24-hour secured access (protect bike parking areas not in a cage from autos with bollards, curbs, or other means)
- Individual bicycle lockers with locking system
- Designated bike space with racks inside an office area which can be locked when it is not occupied
- If garage racks are accessible to the general public they must be directly adjacent to an attendant booth that is occupied 24-hours a day

PUBLIC AWARENESS AND ACCEPTANCE

Notifying building occupants of the availability of easily accessible and convenient to use long-term bike parking will ensure that it is well used and an important amenity for all.

- Locate bicycle parking in a well-lit, well-traveled area
- Follow guidelines for proper layout and installation of the bike racks
- Inform building users of this important amenity
- Identify bicycle parking with prominent signage
- Consider including other amenities, such as a bicycle tool station or lockers for cyclists' personal effects and bike gear

BICYCLE RACK TYPES

For a list of rack types generally acceptable to the City of Redmond, see the section entitled "Acceptable Racks" in Bicycle Parking Guidelines, 2nd Edition (2010) published by the Association of Pedestrian and Bicycle Professionals (APBP). This publication is available at www.apbp.org. Acceptable rack types include:

- Inverted U (single or fastened in series)
- Post and Ring

- Wall-Mounted Racks with fixed attachment points
- Wheel well - Secured, with arm or feature that supports frame
- Modified Coat hanger
- Two-Tier, or Double-Decker

Whichever type of rack is selected, the rack should provide users with the ability to securely lock their bicycle to the rack. Because rack dimensions, bicycle spacing, and additional features such as locking or support mechanisms vary by manufacturer, check to ensure that selected racks comply with the minimum dimensions recommended in these guidelines.

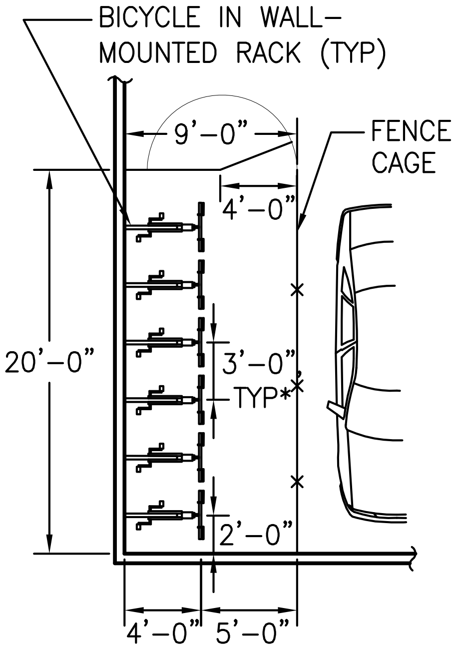
LAYOUT, ACCESS AND CLEARANCE

The layout, access and clearance of long-term bicycle parking are critical to it being a useful amenity for a development.

- See the figures on the following pages for guidance and examples of rack layout within secure, long-term bicycle parking facilities, including general rack and aisle spacing dimensions
- A minimum 3 feet parallel spacing between conventional ground-level bicycle racks (e.g. inverted-U racks) to allow access to bicycles parked adjacent to each other
- A minimum 5 feet perpendicular access aisle between rows of bicycle parking to allow users to safely move and park their bicycles
- A minimum 2 feet 6 inches perpendicular spacing between a row of conventional ground-level bicycle racks (e.g. inverted-U racks) and walls or obstructions to allow the bike to be placed correctly on the rack
- Allow 24" minimum clearance for user access between a wall or other obstruction and the side of the nearest parked bicycle (may use 18" minimum for some rack types such as wall-mount)
- Provide at least 25% ground-level bicycle parking spaces, to allow for use by those unable to lift their bicycles to higher racks and those with bicycle types that may not fit in upper-level or wall-hanging racks (e.g. recumbents, folding bicycles, cargo bicycles, or those with trailers)

SPECIAL CONSIDERATIONS

- Providing bicycle parking at the end of a parking stall intended for use also by a motorized vehicle is not acceptable
- A single-family townhome with secure garage is exempt from the bicycle parking requirement, as the garage may be used for secure bicycle parking



* DISTANCE BETWEEN WALL-HUNG BICYCLES MAY BE REDUCED TO 18" (AS RECOMMENDED BY RACK MANUFACTURER AND APPROVED BY THE CITY) IF RACKS ALTERNATE HEIGHT

FIGURE 1. ONE PARKING STALL (LEFT)

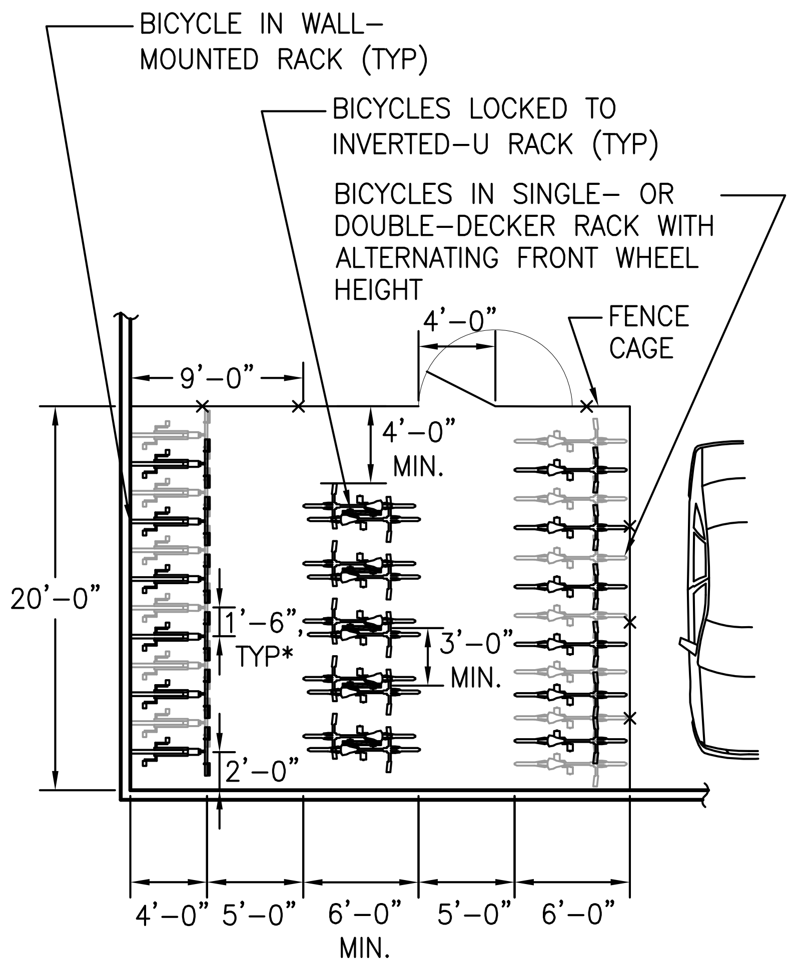
Secure, long-term bicycle parking facility example using one typical end parking stall.

- Accommodates 6 bicycles as shown
- Shown with fence cage enclosure; if there is no cage, bollards & paint, curb or other means should be used to prevent vehicle access to the area
- Parking stalls adjacent to bicycle parking must be designed with sufficient space for door opening and vehicle maneuvering (into/out of stall)
- Ground-level bicycle parking needs to be provided elsewhere on site to provide access to all users

FIGURE 2. THREE PARKING STALLS (RIGHT)

Secure, long-term bicycle parking facility example using three typical parking stalls.

- Accommodates 48 bicycles as shown (incl. double-decker racks at right)
- Shown with fence cage enclosure; if there is no cage, bollards & paint, curb or other means should be used to prevent vehicle access to area
- Middle or right "stalls" could be replicated further into lot for additional bicycle parking space.



* DISTANCE BETWEEN WALL-HUNG BICYCLES SHOWN HERE AS REDUCED TO 18" FOR RACKS THAT ALTERNATE HEIGHT

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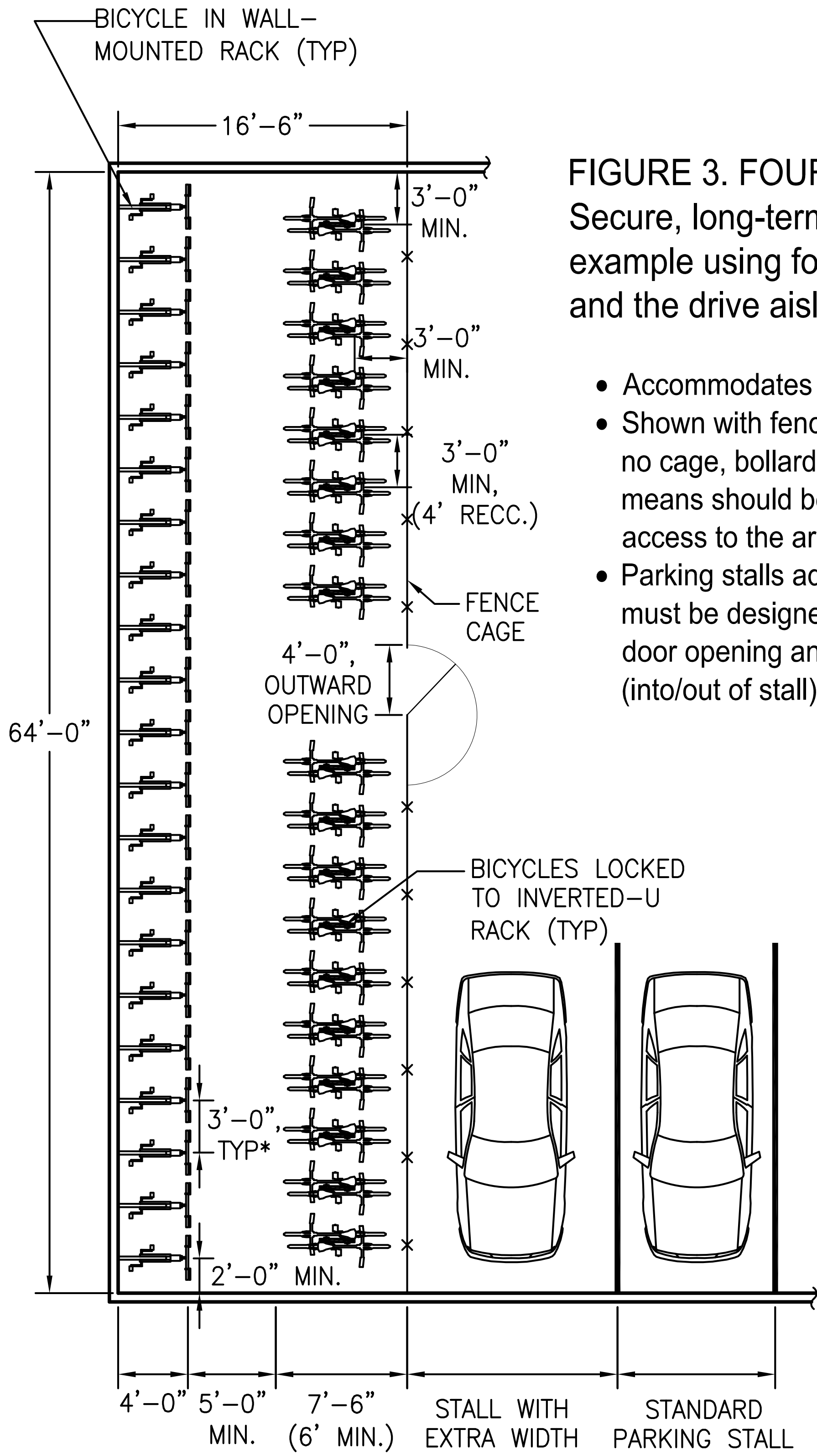
FIGURE 3. FOUR PARKING STALLS

Secure, long-term bicycle parking facility example using four typical parking stalls and the drive aisle between.

- Accommodates 53 bicycles as shown
- Shown with fence cage enclosure; if there is no cage, bollards & paint, curb or other means should be used to prevent vehicle access to the area
- Parking stalls adjacent to bicycle parking must be designed with sufficient space for door opening and vehicle maneuvering (into/out of stall)



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