



# appendix c:

## bicycle facility design guidance



Bike Plan 2011 lays out a network of functional, safe and accessible bicycle connections throughout San Antonio. It is critical that facilities and design solutions are appropriate for the type of user and existing space. This chapter provides detail and general guidance on design solutions to accompany the location-specific facility recommendations for improving bicycling conditions in San Antonio.

All pedestrian and bicycle facilities should be designed to meet current State and Federal design guidance and standards, as defined by the Texas Department of Transportation, the American Association of State Highway Transportation Officials (AASHTO), the Americans with Disabilities Act, the Texas Accessibility Standards, and the Manual on Uniform Traffic Control Devices (MUTCD). If the national standards are revised in the future, the updated standards should be followed.

The following publications should be referenced for greater detail on the design of bicycle facilities in San Antonio:

- TXDOT Bicycle-Compatible Roadways and Bikeways. Published by TXDOT and available at [http://www.dot.state.tx.us/txdot\\_library/publications/tmutcd.htm](http://www.dot.state.tx.us/txdot_library/publications/tmutcd.htm)
- Guide to the Development of Bicycle Facilities. The American Association of State Highway Transportation Officials (AASHTO), Updated in 1999. Available from AASHTO at [www.aashto.org/bookstore/abs.html](http://www.aashto.org/bookstore/abs.html).
- Manual on Uniform Traffic Control Devices (MUTCD). Published by the U. S. Department of Transportation, Washington, DC, 2009. The manual is available at <http://mutcd.fhwa.dot.gov>.
- Americans with Disabilities Act Accessibility Guidelines (ADAAG). U.S. Department of Justice, United States Access Board. Guidelines are available at <http://www.access-board.gov/adaag/html/adaag.htm>
- Designing Sidewalks and Trails for Access: Part Two - Best Practices Design Guide. Published by U.S. Department of Transportation, Washington, DC, 2001
- A Policy on Geometric Design of Highways and Streets. (Green Book) , AASHTO, 2004
- Texas Accessibility Standards. Issued by the Texas Department of Licensing and Regulation, under the Architectural Barriers Act. 1994. The standards are available at <http://www.license.state.tx.us/ab/AB.HTM>

While the goal of this document is to help engineers and designers develop roadway designs that meet all of the requirements set forth by city, state, and federal guidance, it is understood that there is a need to allow flexibility to develop safe and efficient roadway designs that serve the widest range of users. Since geometric and land use conditions vary frequently from location to location, this guidance provides key design considerations for each type of bicycle facility to help identify opportunities to alter elements of the roadway cross section to develop safe and efficient roadway designs that serve the widest range of users. **The following guidance is not a design standard, and should not be used as such. Application of this guidance requires the use of engineering judgment when retrofitting San Antonio streets to provide optimal bicycle facilities.**

Bicycle Facility Categories & Types	
<b>On-Street Bicycle Facilities</b>	Bicycle Lanes Buffered Bicycle Lanes Wide Shoulders Bicycle Boulevards Signed Routes Shared Lane Markings (“Sharrows”)
<b>Off-Street Bicycle Facilities</b>	Multi-Use Paths Cycle Track
<b>Spot Improvement Considerations</b>	Intersection Improvements Road Diets On-Street Parking Climbing Lanes Neighborhood Connections Bridges
<i>The Master Network List in Appendix D identifies recommended bicycle facility types for each street in the bicycle network.</i>	

The table to the right illustrates the bicycle facility types required for typical roadway classifications in the City of San Antonio, based on the current Unified Development Code

**SAN ANTONIO UNIFIED DEVELOPMENT CODE  
ROADWAY RIGHT-OF-WAY REQUIREMENTS**

Function	Facility Type	Facility Width	Current ROW Requirement
SUPER ARTERIAL A	Shared Path [Both Sides]	8' – 10'	200' – 250'
	Shared Path [One Side]	10' – 12'	200' – 250'
	Bike Path [Both Sides]	5' – 6'	200' – 250'
	Bike Lane [Both Sides]	5' – 6'	200' – 250'
SUPER ARTERIAL B	Shared Path [Both Sides]	8' – 10'	200' – 250'
	Shared Path [One Side]	10' – 12'	200' – 250'
	Bike Path [Both Sides]	5' – 6'	200' – 250'
	Bike Lane [Both Sides]	5' – 6'	200' – 250'
ENHANCED PRIMARY ARTERIAL	Shared Path [Both Sides]	8' – 10'	144' – 166'
	Shared Path [One Side]	10' – 12'	144' – 166'
	Bike Path [Both Sides]	5' – 6'	144' – 166'
	Bike Lane [Both Sides]	5' – 6'	144' – 166'
PRIMARY ARTERIAL A	Shared Path [Both Sides]	8' – 10'	120'
	Shared Path [One Side]	10' – 12'	120'
	Bike Path [Both Sides]	5' – 6'	120'
	Bike Lane [Both Sides]	5' – 6'	120'
PRIMARY ARTERIAL B	Bike Route / Shared Lane	Wide outside lane	70' – 120'
ENHANCED SECONDARY ARTERIAL	Shared Path [Both Sides]	8' – 10'	120' – 142'
	Shared Path [One Side]	10' – 12'	120' – 142'
	Bike Path [Both Sides]	5' – 6'	120' – 142'
	Bike Lane [Both Sides]	5' – 6'	120' – 142'
SECONDARY ARTERIAL A	Shared Path [Both Sides]	8' – 10'	86'
	Shared Path [One Side]	10' – 12'	86'
	Bike Path [Both Sides]	5' – 6'	86'
	Bike Lane [Both Sides]	5' – 6'	86'
SECONDARY ARTERIAL B	Bike Route / Shared Lane	Wide outside lane	70' – 86'
COLLECTOR STREET	Bike Lane (Both Sides)	5' – 6'	70'
	Bike Route / Shared Lane	Wide outside lane	70'

*Note: The facility types, widths, and right-of-way requirements shown are illustrated to guide implementation of bicycle facilities in areas governed by City of San Antonio standards. Refer to the City of San Antonio Uniform development Code requirements and guidance provided by the most recent American Association of State and Highway Officials (AASHTO) guidance manuals. The City's UDC, if different, shall supersede any standards shown in the table above.*



## ON-STREET BICYCLE FACILITIES

On-street bicycle facilities can include a range of design treatments such as bike lanes, striped shoulders, shared lane markings and signed routes. The goal of on-street facilities is to improve bicycling conditions on roadways while providing a visible reminder for motorists to share the road with bicyclists. On busy streets, an important purpose of these facilities is to provide lateral separation between bicyclists and motor vehicles and to encourage proper behavior among bicyclists and motorists. Another purpose and use of on-street bicycle facilities is to establish an interconnected bicycle network. It is important to note that many of San Antonio's roads with relatively low speeds and volumes do not require any new treatments.

Analysis is critical for implementing an optimal bicycle facility. Analyze the roadway to determine feasible cross sections for bicycle facilities given existing roadway and traffic characteristics. There are two main steps in the analysis phase.

First, the designer should consider which elements of the existing roadway could potentially be modified to provide space for the target bicycle facility. The following questions should be asked:

- Can any existing lanes be narrowed?
- Can any existing lanes be removed (consider travel lanes, center-turn lanes, and parking lanes)?
- Can the existing pavement be widened, or can the curbs be moved?

Second, the designer should consider factors that affect the potential to modify the roadway in any of the three ways listed above. These factors include:

- Existing and planned land uses
- Pedestrian traffic and streetscape uses
- On-street parking demand and turnover rates
- Vehicle capacity, volume and speed (including heavy vehicle traffic such as trucks and buses)
- Roadway grade and horizontal alignment (hilly or curved roadway sections)
- Pavement surface condition

### Bicycle Lanes

Bicycle lanes are portions of the roadway that have been designated for the preferential or exclusive use of bicyclists through striping, signage and other pavement markings. On two-way streets, bike lanes shall be provided on both sides of the road so that bicyclists can ride in the same direction as adjacent motor vehicle traffic. Bike lanes should be at least 4 feet wide on roadways with open shoulders and 5 feet wide on roadways with curb and gutter. Five foot bicycle lanes are typical, but wider lanes (i.e. 6 feet) are often used on roadways with high motor vehicle traffic volumes. Bicyclists still have the right to use the travel lanes on streets with bicycle lanes to avoid obstacles, such as open car doors. It is important to note that many cars can park in lanes that are striped at 7 feet or wider, which can raise unintended enforcement issues.

Bicycle lanes can provide the following benefits:

- Increase the comfort of bicyclists on roadways
- Increase the amount of lateral separation between motor vehicles and bicycles
- Indicate the appropriate location to ride on the roadway with respect to moving traffic and parked cars, both at mid-block locations and approaching intersections
- Increase the capacity of roadways that carry mixed bicycle and motor vehicle traffic
- Increase predictability of bicyclist and motorist movements
- Increase driver awareness of bicyclists while driving or opening doors from an on-street parking space
- Provide a traffic calming effect by visually narrowing motor vehicle travel lanes.

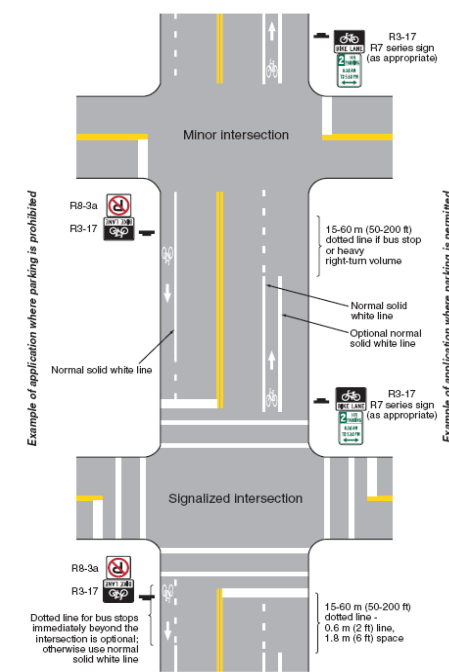
The MUTCD offers the following guidance on making and signing bike lanes:

- If used, the bicycle lane symbol marking shall be placed immediately after an intersection and at other locations as needed.
- The bicycle lane symbol marking shall be white.
- If the bicycle lane symbol marking is used in conjunction with other word or symbol messages, it shall precede them.
- If the word or symbol pavement markings are used, Bicycle Lane signs shall also be used, but the signs need not be adjacent to every symbol to avoid overuse of the signs.

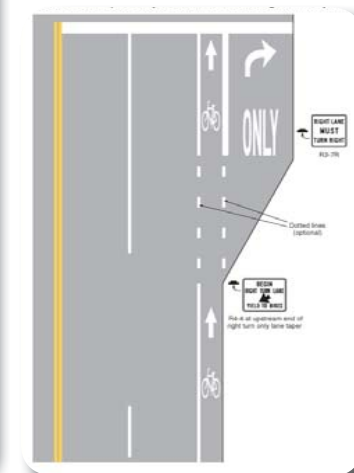
- A through bicycle lane shall not be positioned to the right of a right turn only lane.
- When the right-through lane is dropped to become a right-turn only lane, the bicycle lane markings should stop at least 100 feet before the beginning of the right-turn lane. Through bicycle lane markings should resume to the left of the right-turn only lane.
- An optional through-right turn lane next to a right-turn only lane should not be used where there is a through bicycle lane. If a capacity analysis indicates the need for an optional through-right turn lane, the bicycle lane should be discontinued at the intersection approach.
- Posts or raised pavement markers should not be used to separate bicycle lanes from adjacent travel lanes.



Figure 9C-5. Example of Pavement Markings for Bicycle Lanes on a Two-Way Street



Example of Pavement Markings for Bicycle Lanes on a Two-Way Street  
Source: Manual of Uniform Traffic Control Devices for Street and Highways, 2009 Edition



Bike lanes on multi-lane arterials



### Buffered Bicycle Lanes

In some locations, buffers may be added to bicycle lanes to provide horizontal separation from either moving or parked cars. Buffers can have positive impacts on bicyclist safety and comfort. Ideal candidates for buffered bicycle lanes are roadways with high vehicle speeds, excess capacity, and few curb cuts or turning movements.

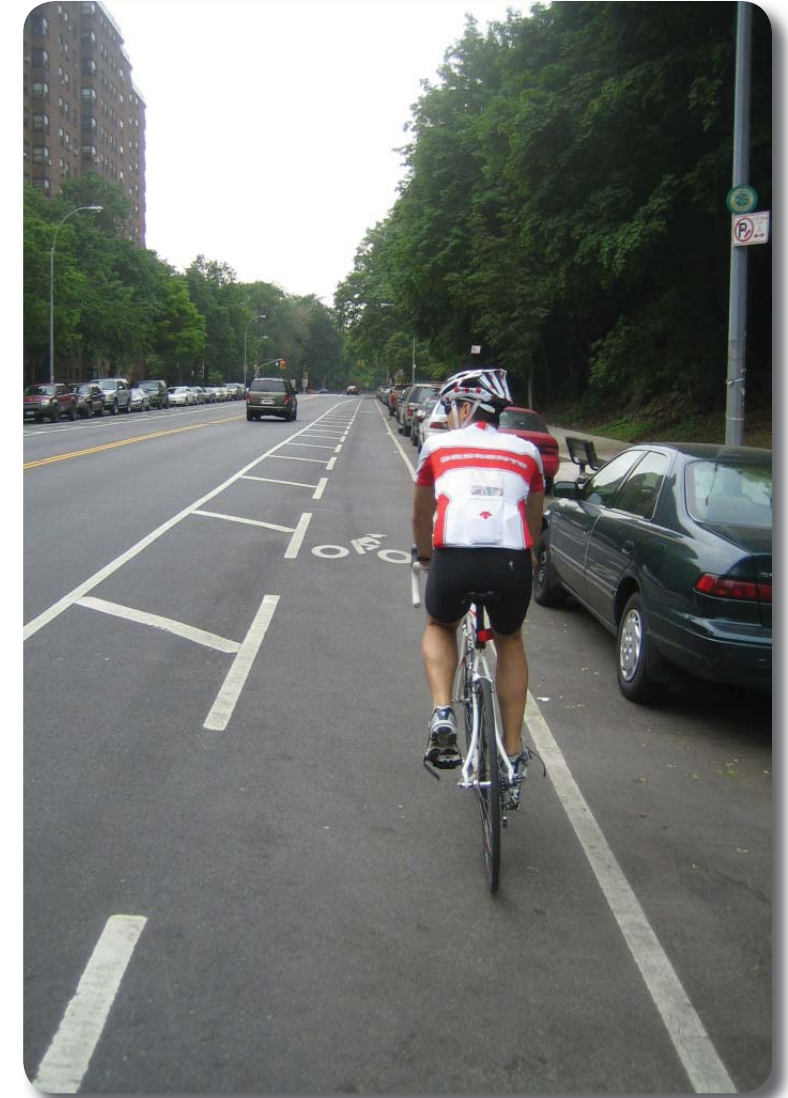
On the side of parked cars, adding a buffer to the bicycle lane can encourage bicyclists to ride away from the opening doors of parked vehicles by adding pavement markings to the bicycle lane. This treatment could be particularly useful to delineate the “dooring area” where:

- Bicycle lanes are adjacent to a seven- or eight-foot-wide on-street parking area
- Bicycle lanes are adjacent to high-turnover parking
- There are a high number of locations of dooring complaints or crashes in a particular location

Buffered bicycle lanes may also be considered on steep roadways where higher bicycle speeds can be expected and where more severe dooring crashes can be expected. Buffered and un-buffered bicycle lanes may be accompanied by signs reminding drivers to “look for bikes” when opening their doors.



Buffered bicycle lanes on Henderson Pass in north San Antonio





### Wide Shoulders

Wide, striped, and bikable shoulders are another treatment that can be considered for roads in San Antonio with higher traffic volumes and speeds. The provision of shoulders on roadways has benefits to all roadway users. These facilities increase the comfort of bicyclists by providing greater lateral separation between automobiles and bicycles, provide additional clear zone and recovery areas for vehicles, and provide additional buffer or space for pedestrians in rural areas where sidewalks may not exist. Maintenance to keep shoulder areas free of debris to maintain bicycle compatibility.

To be considered bikable, shoulders should be at least 4 feet wide on roadways with open drainage and 5 feet wide on roadways with curb and gutter. Additional shoulder width is desirable on roadways with high motor vehicle traffic volumes, high vehicular speeds, or a high percentage of trucks, buses, and recreational vehicles. It is important to note that at intersections, additional symbols, signage, arrows, or short sections of bike lanes may be needed to provide direction to bicyclists and reduce potential conflicts between bicyclists and turning cars.

There are two types of bikeable shoulders identified for San Antonio, with the difference being whether parking is allowed on the shoulder. In rural areas, no parking is allowed and shoulders should be provided as discussed above. The existing shoulders in residential areas of San Antonio, however, often function as a parking lane as well. Low occupancy rates of parking have been observed on most of these roads, which renders the shoulder as functional and bikeable space the majority of the time. In these instances, there is no need to provide an additional dedicated bicycle facility, and bicyclists should proceed with caution when overtaking parked vehicles. It should be noted that this situation should be regularly re-evaluated if on-street parking occupancy rates increase, with the addition of sharrows as location-specific guidance to bicyclists and motorists.



*A shoulder along 1604*





**Bicycle Boulevard**

Bicycle boulevards are local street routes that have been enhanced to favor through bicycle movements while also restricting through motorized vehicle movements. Bicycle through movements are facilitated by orienting stop signs to cross traffic, application of signage and pavement markings, and diversion of through vehicle traffic every couple blocks while retaining local access. Bicycle boulevards are characterized by low vehicular speeds and traffic volumes, which encourages use of the full roadway by bicycles. They are most applicable in locations with an established roadway grid where the bicycle boulevard may be located parallel to a busy vehicular or commercial strip. Bicycle boulevards are also often paired with enhanced crossings of arterial roads, railroads, or other significant barriers.

A bicycle boulevard in San Luis Obispo, CA  
 Image Source: [www.pedbikeimages.org/](http://www.pedbikeimages.org/)  
 Adam Fukushima



The Bicycle Transportation Alliance, a non-profit bicycling advocacy organization, worked with cyclists around the Portland region to create a toolbox of innovative treatments to create bicycle boulevards. They've identified 4 general categories of treatments: 1) auto speed reduction; 2) auto traffic reduction; 3) crossing busy streets; and 4) signs and markings. Within these categories are different treatments that can be used together to create a bicycle boulevard.

Image Source: Bicycle Transportation Alliance, [http://www.bta4bikes.org/at\\_work/bikeboulevards.php](http://www.bta4bikes.org/at_work/bikeboulevards.php)



**Signed Route**

Signed routes form essential links in a connected bicycle network for San Antonio and can be identified as preferred routes for bicycle use. These signed routes are identified as streets and roads where bicyclists can be served by sharing the travel lanes with motor vehicles. Usually, these are local streets with relatively low traffic volumes and/or low speeds, which do not need special bicycle accommodations in order to be bicycle-friendly. There are many low-volume local streets in San Antonio that are excellent for bicycling in their current condition and need no further street improvements to be bicycle compatible.

It is anticipated that these streets identified for signed routes be included in a comprehensive wayfinding system based on connecting regional and local destinations in San Antonio. The signed routes can be identified on bicycle maps that are produced to educate the community about these preferred routes. Bike route wayfinding signs and pavement markings can also be posted on local routes to indicate the particular advantages of using these routes instead of others.

An optional treatment for signed bicycle routes is custom pavement markings to enhance wayfinding. The “bike dot” used in Seattle is a good example.



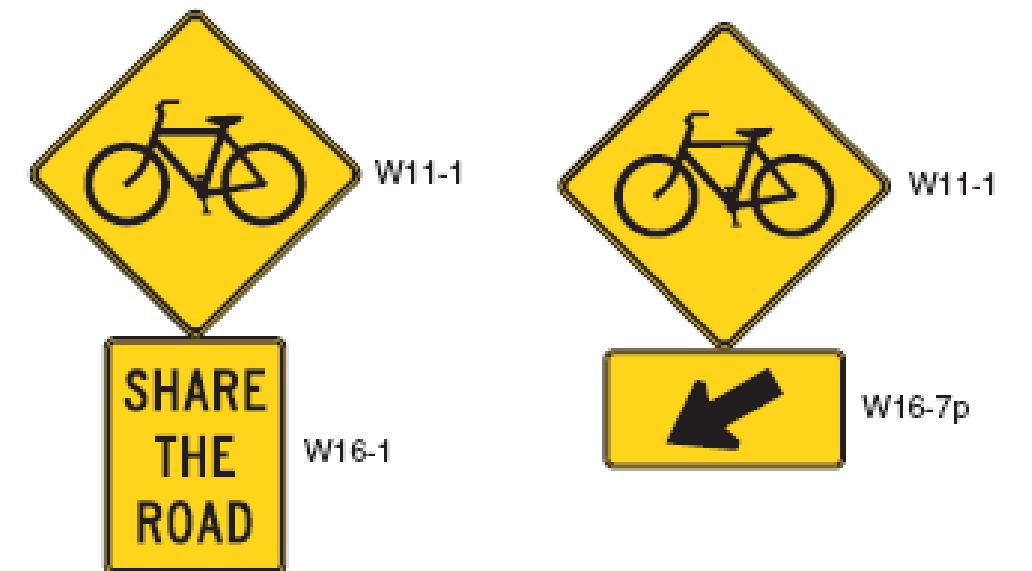
In relation to signed routes, “Share the Road” signs can be used to remind motorists to share the road with bicyclists. These signs can increase awareness of bicyclists, especially in areas where bicyclists may not be expected or where many drivers are not local. A new fluorescent yellow/green color has been approved in the Manual on Uniform Traffic Control Devices and can be used on these signs. Signs should be used judiciously, as too many signs can cause visual clutter and lead to non-compliance. Note that the “Share the Road” sign is a warning and should not be used for directional signing of a bicycle route.



The “Bikes May Use Full Lane” signs were installed in downtown San Antonio in the summer 2010.  
 Image Source: City of San Antonio, Office of Environmental Policy



In 2011, the City of San Antonio began installing destination information to their bicycle route signs.  
 Image Source: City of San Antonio, Office of Environmental Policy



Example of MUTCD Signs for Designating Shared Roadways



**Shared Lane Markings (Sharrows)**

Shared lane markings (“sharrows”) placed on the pavement provide guidance to bicyclists on the safest location to ride. Sharrows alert automobile drivers to the presence of bicyclists and encourage bicyclists to ride outside of the “door zone” of parked cars. They can reduce wrong-way bicycling and tend to increase the distance between bicyclists and passing cars. Shared lane markings are generally used where there is not enough space for separate bicycle lanes and cyclists should be encouraged to use the full traffic lane.

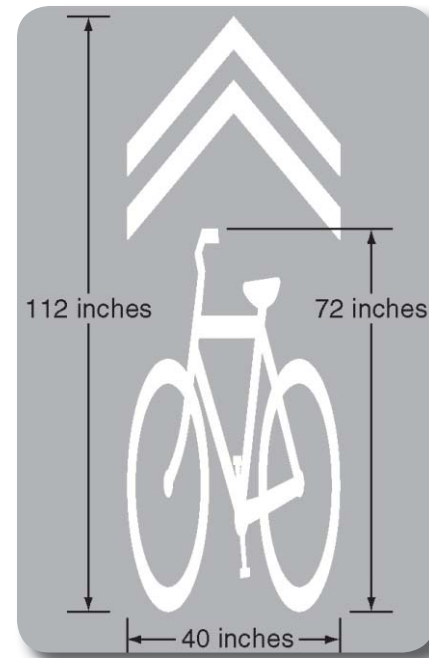
Shared lane markings have the following benefits:

- Provide a visible cue to bicyclists and motorists that bicycles are expected and welcomed on the roadway
- Indicate the most appropriate location to ride on the roadway with respect to moving traffic and parked cars
- Can be used on roadways where there is not enough space for standard width bicycle lanes
- Connect gaps between other bicycle facilities, such as a narrow section of roadway between road segments with bicycle lanes
- Complement wayfinding and point out difficult sections on signed routes

The shared lane pavement marking should be placed:

- A minimum of 11 feet from the face of the curb when used adjacent to a parking lane;
- A minimum of 4 feet from the face of curb or roadway edge when not used adjacent to a parking lane; and
- Immediately following intersections and spaced at intervals up to 250 feet thereafter;

The shared lane pavement marking should not be placed in bicycle lanes, on paved shoulders or trails, or roadways with speed limits posted above 35 mph. Sharrows should also not be used as the primary means of wayfinding or identifying routes if guidance on appropriate lane position is not warranted.



Example of Sharrows adjacent to Parking



Typical Sharrow Marking

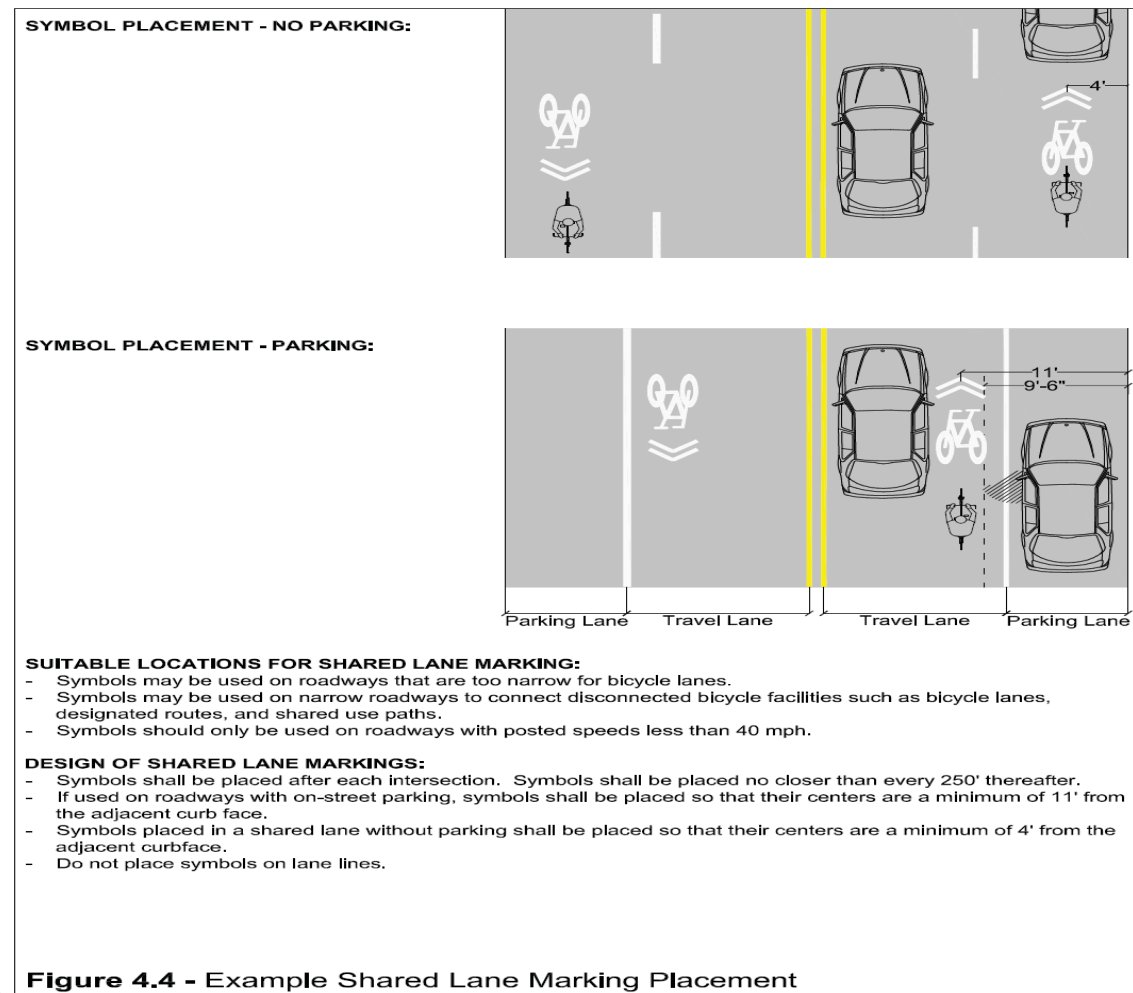


Figure 4.4 - Example Shared Lane Marking Placement



## OFF-STREET BICYCLE FACILITIES

### Multi-Use Path

Multi-use paths provide a high-quality walking and bicycling experience that is separated from vehicle traffic. These paths should be a minimum of 10 feet wide for bi-directional traffic and should be paved. Wider multi-use paths may be desirable if relatively high volumes of travelers are anticipated. Multi-use paths can be constructed along a roadway corridor, in their own corridor (such as a greenway trail or rail-trail), or a combination of both.

On high-speed roadways, there may be a need for multi-use paths in addition to bicycle lanes or shoulders. Multi-use paths should not be used to preclude on-road bicycling, but rather to supplement a system of on-road bicycle facilities for less experienced bicyclists. Multi-use paths also provide essential facilities and connections for pedestrians where they may not already exist.

Considerations for pathways parallel to roadways: Ideally, multi-use paths are provided on both sides of the roadway and bicyclists use the paths as one-way facilities (traveling in the same direction as adjacent motor vehicle traffic). Due to right-of-way and budget constraints, though, they are often provided only on one side of the roadway. Multi-use paths should be designed to reduce conflicts between pedestrians and bicyclists. They can function well if the following key design features are achieved:

- A minimum 5 foot buffer between the outside travel lane and edge of pathway can be built (a 42-inch vertical barrier is also acceptable).
- Conflicts with intersecting roadways and driveways (which may or may not be signalized) should be minimized. Paths work particularly well where they are parallel to expressways and railroad rights-of-way because they are limited access in nature. However, paths parallel to divided highways must be designed carefully, especially near crossings of high speed ramps.
- Visibility of cyclists at all crossings
- Street trees are recommended where possible (30-60' on center)

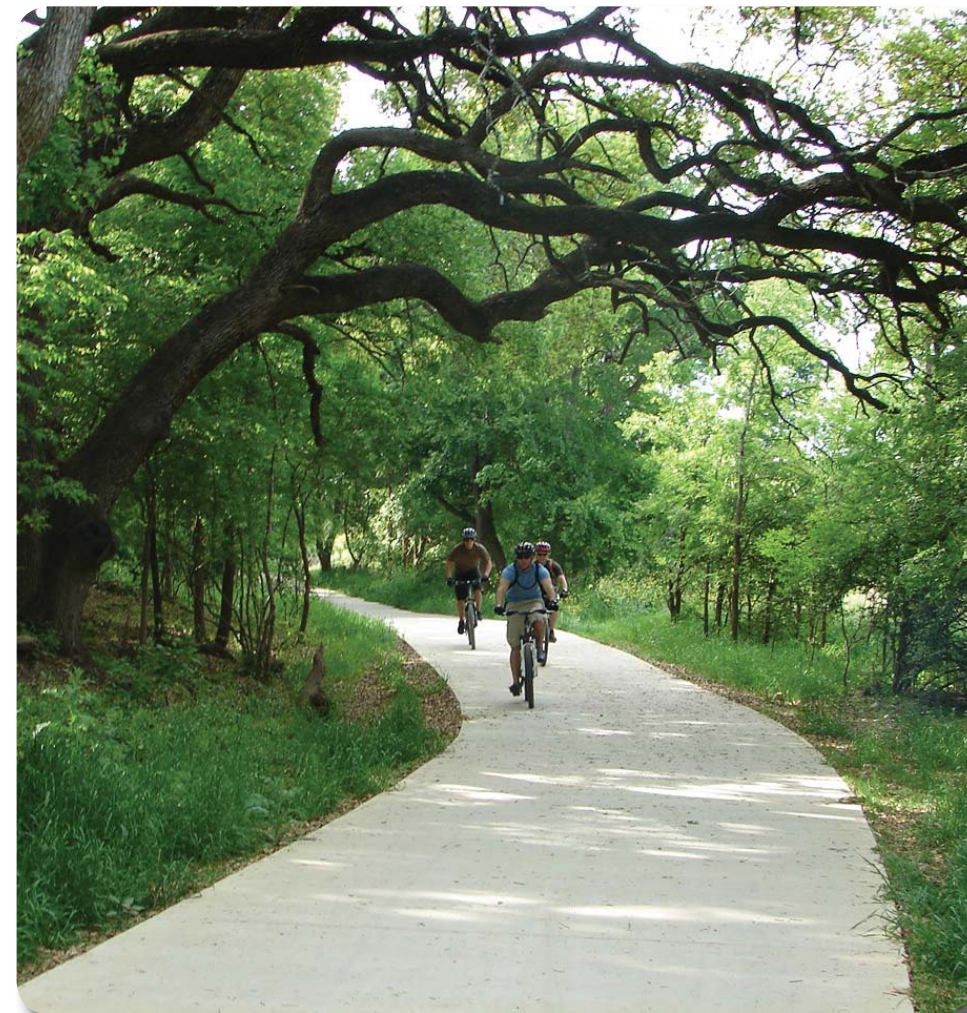
- Crossings of free flow ramps should be avoided, or minimized and made sufficiently safe
- Conflicts between pedestrians and bicyclists are minimized by having adequate width, clear space at the side of the path, and sight distance at locations where pedestrians cross or enter the facility.
- Berms and/or vegetation can be used to separate paths from adjacent areas; however, it is not desirable to place the pathway in a narrow corridor between two barriers (such as fences, bollards, or a knee-wall) for long distances. This prevents path users from leaving the path in the event of an emergency, and creates an uncomfortable experience for the user.

**Considerations for trails and greenways:** The clear zone of trees, signs and other objects near trails is an important issue to consider in trail design. Information on clear zone requirements from the 1999 AASHTO Guide for the Development of Bicycle Facilities is included below.

A minimum 2-foot wide graded area with a maximum 1:6 slope should be maintained adjacent to both sides of the path; however, 3 feet or more is desirable to provide clearance from trees, poles, walls, fences, guardrails or other lateral obstructions. Where the path is adjacent to canals, ditches or slopes down steeper than 1:3, a wider separation should be considered. A minimum 5-foot separation from the edge of the path pavement to the top of the slope is desirable. Depending on the height of embankment and condition at the bottom, a physical barrier, such as dense shrubbery, railing or chain link fence, may need to be provided.



Photo Credit: Cleo McCall







### Cycle Track

Cycle tracks create a physically separated and buffered space for directional bicycle travel. Cycle tracks are currently more popular in European countries, but have been selectively implemented in the United States. They are distinct from Multi-Use Paths in that they are for the exclusive use of bicyclists and are operationally related to the overall roadway, whereas multi-use paths operate on their own alignments unrelated to roadways that may be adjacent for sections. The physical separation from other vehicles on the roadway can consist of curbs, striping, bollards, flexible posts, landscaping strips, or parked vehicles. The Cycle track can be at the same grade as the adjacent roadway or raised to the level of an adjacent landscaping buffer or sidewalk.

Cycle tracks are intended to connect urban destinations with large volumes of pedestrians and bicyclists of various experience levels. Experienced cyclists may prefer to continue to use the roadway and operate in mixed vehicle traffic.



Avenue B cycle track in San Antonio  
Image Source: City of San Antonio, Office of Environmental Policy



Landscaping between a cycle track and vehicular travel lane  
Image Source: Toole Design Group



A cycle track in Lower Manhattan, NY  
Image Source: Nate Baird, <http://thecityfix.com/nycs-bike-route-network-bridging-the-gaps/>



## SPOT IMPROVEMENT BICYCLE FACILITY DESIGN CONSIDERATIONS

### Intersection Improvements

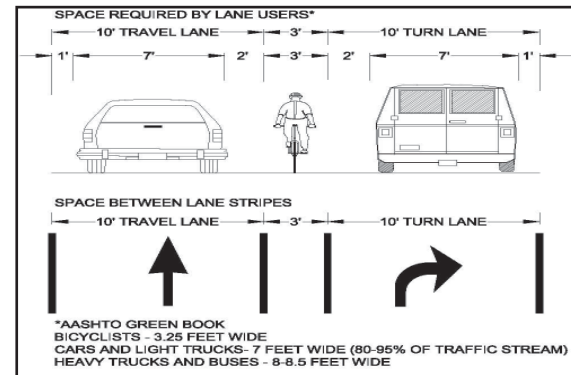
Intersections can present major barriers to bicyclists when dedicated bicycle facilities are sacrificed for vehicle turning lanes. Therefore, it is essential to continue bicycle facilities through intersections and provide the transitions between facilities as they change. Detailed design is needed so that proper facility transitions are included in each intersection. Pedestrian crossing features such as crosswalks, countdown pedestrian signal heads, and push buttons are also recommended, as they can be especially useful for bicyclists that are more comfortable navigating the intersection as a pedestrian.

Continuity of bicycle facilities at intersections takes into consideration the cross section elements and design factors mentioned above. Intersection treatments may vary depending on the approaching cross section. Conversely, bicycle treatments at closely spaced intersections may determine the cross section between nodes. Under ideal circumstances a standard bicycle lane would be accommodated at the approach to an intersection. However, with the frequent need for dedicated turn lanes at intersections, the roadway cross section can become constrained. The following designs offer options for accommodating bicycles in these constrained locations. These designs are considered experimental and it is recommended that San Antonio conduct additional experimental studies before widespread implementation.

#### Pocket Lane

Pocket lanes are used when there isn't sufficient space to install a bicycle lane at the approach to an intersection. Pocket lanes provide for a continuous bicycle facility through an intersection. They can encourage motorists to drive more slowly, and maintain a consistent traveling path. The striped pocket lane encourages through bicyclists to stay to the left of right-turning vehicles, and the lane enables bicyclists to bypass stopped vehicles. Pocket lanes should be a minimum of three-feet wide<sup>3'</sup> in width and should not be marked as bicycle lanes (e.g., should not include the bicycle symbol pavement marking). Pocket lanes are not recommended on roadways with

high speeds or high heavy vehicle volumes (10% of ADT or greater).



#### Shared Bicycle/Bus/Right Turn Lane

Shared bicycle/right turn lanes are used when there isn't sufficient space to install a bicycle lane at the approach to an intersection. The shared bicycle/right turn lane encourages bicyclists to remain to the left of right turning traffic by striping a dashed bicycle lane on the left side of the right turn lane. This maintains the visual continuity of the bicycle lane while still allowing adequate shared space for bicycles and turning vehicles. As an alternative to a dashed bike lane, a shared lane marking may be placed on the left side of a right turn lane to indicate that this space is shared between through bicyclists and right-turning vehicles.

#### Un-Signalized Crossings

Un-signalized intersections and mid-block crossings can also be intimidating for both pedestrians and bicyclists. Factors that influence the crossing's real or perceived safety include width of the road, speed of traffic, and tendency for vehicles to yield. Crossings on Hartford, Westfield, Borton Landing, and several other roads exhibit characteristics that can be uncomfortable for those looking to cross.

Several measures can be used to improve safety at un-signalized crossings, ranging from high-visibility crosswalk striping and signage to higher-level treatments such as textured crosswalks, curb extensions ("bumpouts"), median refuge islands (curbed or uncurbed), in-road lighting, overhead lighting, High Intensity Activated Crosswalks (HAWKs) and Rectangular Rapid Flashing Beacons (RRFBs).

In-road lighting, HAWKS and RRFBs are typically pedestrian-actuated, and help to increase the visibility of bicyclists and pedestrians to oncoming motorists. Curb extensions and median refuge islands improve crossing conditions by shortening the crossing length, increasing visibility, and acting as a traffic calming feature. Median refuge islands should be sized to accommodate a full bicycle length waiting in the median.

#### Road Diet Considerations

Roadway capacity is considered when examining the number and type of vehicular travel lanes. If a reduction in the number of travel lanes is desired, a traffic analysis should be performed to determine if that "road diet" option is feasible.

Roadways with higher vehicular speed and volumes are less comfortable for cyclists, and are therefore in more need of dedicated bicycle facilities. Excess capacity can also result in higher traffic speeds. Some roads may benefit from the fewer travel lanes or conversion of travel lanes to turning lanes. Reducing traffic volume and/or speed can also allow for the installation of narrower travel lanes and turn lanes.

Heavy vehicles (trucks and buses) may require additional operating space on roadways. Additionally, frequent passing of bicyclists by heavy vehicles in a narrow cross section may create conflicts. The AASHTO Guide cites "if substantial truck traffic is anticipated, additional lane width may be desirable." The use of travel lanes below 11'-feet wide is not recommended on streets with a high percentage of heavy vehicles. This guidance recommends a threshold of 10% of the ADT or greater. Locations of high intensity heavy vehicle use may see overall roadway safety improvements with a reduction in the total number of lanes to allow provision of wider lanes.



### On-Street Parking

Providing ample on-street parking is often considered an important need by the general public, and efforts to reduce or eliminate it can be met with strong opposition. However, the reduction or elimination of parking should be considered in areas where bicyclists are constrained to riding too close to parked vehicles or where enhanced bicycle facilities are desirable. In locations where there is excess parking capacity, consideration should be given to the following options:

- consolidate parking to one side of road
- remove parking completely where there is no demand or sufficient off street capacity
- remove parking temporarily where there is a need for additional throughput capacity (i.e. - peak hour bike lane, bus lane, and/or travel lane)

High parking turnover can affect the safety of all roadway users. Bicyclists are vulnerable roadway users in part because they often ride adjacent to parked vehicles. When riding within the area of an opening door, the bicyclists is in danger of being struck and injured. Existing law requires a motorist to not open a door into moving traffic; nonetheless, the designer should consider this potential hazard in the design process. To reduce the incidence of “dooring” the designer may consider reducing or eliminating parking, providing a buffered bicycle lane or adding dooring warning signs (See Buffered Bicycle Lane discussion).

### Climbing Lanes

Road grade has the largest affect on bicyclist operating speed. On steep ascents, bicyclists may be slowed to the speeds of pedestrians. On steep descents, bicyclists may exceed motor vehicle speeds. On hilly streets the designer can accommodate bicyclists by utilizing a climbing bicycle lane in the uphill side of the road. On downhill sections bicyclists can be directed to share the lane with motorist. This technique can be used on constrained rights-of-way to reduce the total width required to accommodate bicyclists in the roadway cross section. Careful consideration should be given to placing bicycle lanes adjacent to parking on portions of roadways with steep descents (See Buffered Bicycle Lane discussion).

Generally steep is defined as being a roadway segment that is at least 300 feet in length with a minimum grade of four percent (4%).

### Neighborhood Connections

Neighborhood connections expand the network for non-motorized users by creating short connecting trail segments between sections of the roadway grid that are currently closed to all traffic. These connections provide the key benefit of shortening travel distances and times, which greatly increases the possibility of choosing to walk or bike for short trips. These short connections can also help bicyclists bypass high volume or difficult roadway sections.

Many such connections have already been established throughout San Antonio, including paths off, along, and across streams and arroyos. These connections have become valued community and neighborhood amenities, and provide important links in the connected bicycle network for San Antonio. While many existing connections have been implemented through the development process, retrofitting existing areas often requires the establishment of access easements or the purchase of right of way. These connections should be viewed as potential longer-term improvements to address any concerns that may arise from current property owners.



A bike lane on Woodlawn Ave connects to Woodlawn Park.  
Image Source: Halff Associates, Inc.

### Bridges

Federal law, as established in the Transportation Equity Act for the 21st Century (TEA-21), makes the following statements with respect to bridges:

*“In any case where a highway bridge deck is being replaced or rehabilitated with Federal financial participation, and bicyclists are permitted on facilities at or near each end of such bridge, and the safe accommodation of bicyclists can be provided at reasonable cost as part of such replacement or rehabilitation, then such bridge shall be so replaced or rehabilitated as to provide such safe accommodations.” (23 U.S.C. Section 217)*

For bridges that have an existing or proposed multi-use path approaching one side, the bridge should be constructed with a shared use path on that side, separated from traffic by a concrete barrier. Use of the concrete barrier requires a crash cushion, or should otherwise be designed so that it does not pose a hazard to errant vehicles. The pathway should be a minimum of 12’ wide, and should not be less than 10’ wide. The barrier between the pathway and the shoulder should be a uni-directional concrete barrier with a minimum height of 42” from the surface of the pathway. The railing on the other side of the pathway is not required to be crashworthy, but should also be a minimum height of



A shoulder disappears as it approaches a bridge, which imposes a barrier.  
Image Source: Halff Associates, Inc.



42" from the surface of the pathway (48" is recommended to provide an added measure of safety for bicyclists). Transitions at the bridge approaches should enable access to the pathway on the bridge by bicyclists who may be riding on the paved shoulder rather than on the pathway. It is important to also consider how the "shy distance" affects a bicyclist or pedestrian when walking along vertical objects. This distance is usually assumed to be 2 feet from the edge of a person's arm to the edge of the vertical object.

The provision of a pathway on one side requires that safe crossings (grade separated, if necessary) be provided on each end of the bridge so as to allow access to the other side of the road. The determination of the appropriate treatment should be based on the following factors:

- **Land Uses and Destinations:** In an urban area with destinations in close proximity to the bridge on both sides of the road, pedestrians need access on both sides of the bridge
- **Cost:** The cost of providing sidewalks on both sides of the bridge should be weighed against the cost of providing safe crossings (grade separated, if necessary) on either end of the bridge to enable bicyclists to access the other side of the road.

The following guidelines apply to bridge replacement projects on rural roadways with open sections. These bridges should be constructed with 10' wide shoulders on both sides. Roadway shoulder improvements associated with bridge replacement projects should include 4' wide (minimum) paved shoulders for bicycle use on approaches. Pedestrians who occasionally use rural bridges will share the shoulder space with bicycles – sidewalks generally are not required on rural bridges. However, on bridge replacement projects that are near points of community development such as schools, shopping centers, local businesses, tourism attractions, or other land uses that result in pedestrian concentrations along the highway, a curb and sidewalk cross section should be used in conjunction with 4' paved shoulders on each side of the road to accommodate bicyclists.

Bridges can be retrofitted to better accommodate bicyclists and pedestrians. There are a variety of ways of accomplishing this:

- Reducing the width and/or number of travel lanes to create more space for bicycles and/or pedestrians. For example, a narrow sidewalk can be widened to provide for a more comfortable pedestrian environment, while maintaining adequate shoulder width for bicycling.
- Adding a new bicycle and pedestrian structure to the existing bridge structure. In some cases, bridge footings may have been constructed in anticipation of a future roadway widening, or it may otherwise be possible to add an additional structure for pedestrians and bicyclists. Bridge retrofit solutions require detailed structural analysis to determine if the bridge can accommodate the additional weight of new facilities without compromising its structural integrity.

### Railroad Crossings

Under certain circumstances, railroad tracks crossing the road can present a dangerous condition for bicyclists. At diagonal at-grade crossings, the gap next to the rail can trap the front wheel of a bicycle causing the bicyclist to crash. To prevent this from happening, the bicycle lane or shoulder should be designed to enable the bicyclist to approach the track at an angle closer to 90 degrees (but not less than 60 degrees) without having to swerve into motor vehicle travel lanes.

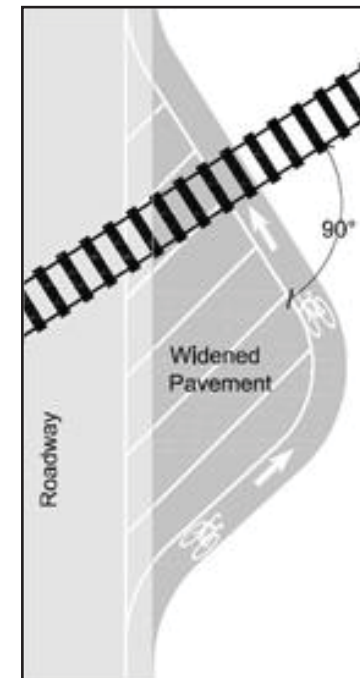
The bicycle lane or shoulder should be designed so as to enable the bicyclist to approach the track at an angle closer to 90 degrees. The width of the dimensions of the widened area will be dependent upon the skew of the railroad tracks relative to the bicyclist crossing point. It is important that the bicyclist is given sufficient space on the approach and the departure of the crossing to safely transition back to the traveled way. An example of this widening treatment is shown in the figures above.

In locations where a retrofit may not be feasible or where the retrofit may not occur for a period of time, the Manual on Uniform Traffic Control Devices (MUTCD) includes the W10-12 warning sign which should be used to warn bicyclists of skewed railroad crossings. A filled or rubberized flangeway can also help to reduce, but not eliminate the risk of a trapped wheel.

The bicycle lane or shoulder should be designed so as to

enable the bicyclist to approach the track at an angle closer to 90 degrees. The width of the dimensions of the widened area will be dependent upon the skew of the railroad tracks relative to the bicyclist crossing point. It is important that the bicyclist is given sufficient space on the approach and the departure of the crossing to safely transition back to the traveled way. An example of this widening treatment is shown in the figures above.

In locations where a retrofit may not be feasible or where the retrofit may not occur for a period of time, the Manual on Uniform Traffic Control Devices (MUTCD) includes the W10-12 warning sign which should be used to warn bicyclists of skewed railroad crossings. A filled or rubberized flangeway can also help to reduce, but not eliminate the risk of a trapped wheel.



The recommended design treatment at diagonal railroad crossings.  
Image Source: Toole Design Group

