Clemson University Bikeway Design Guidelines

University Planning & Design
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Bikeway Design Guidelines

The Clemson University Bikeway Plan recommends implementing a series of bike lanes, shared roadways and other bikeway facilities on campus and within the Clemson Experimental Forest. The Bikeway Design Guidelines are meant to be used in guiding bikeway facility and related development at Clemson University in a consistent manner. The University is committed to creating a bicycle system that promotes safety and provides a robust network of commuting and recreational pathways that connect the extended campus.

The design specifics and recommendations are in accordance with the American Association of State Highway and Transportation Officials (AASHTO), the Manual on Uniform Traffic Control Design (MUTCD) and other state and national standard publications. References to these guiding documents can be found in the References section. Some of the images used were created by the firm Alta Planning + Design, and come from the City of Greenville Bicycle Master Plan Design Guidelines. Used with permission by Alta Planning + Design.

Section I

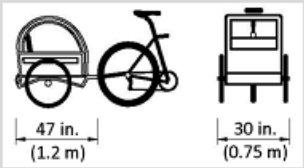
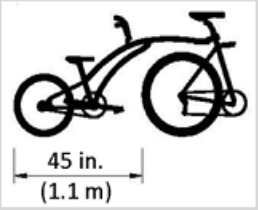
Bicycle Design Characteristics

Bicycles are:

- Built in a variety of sizes and styles and have unique physical characteristics.
- Designed to provide a variety of comfort levels for different riding behaviors.
- Have different operation and safety envelopes that depend on the bicycle types (adult upright, recumbent, tandem) and the attachment of any accessories like trailers.

Bicycle Design Characteristics

Table 1 Different Bicycle Types and Operating Features

Bicycle Type	Physical Width	Operating Envelope	Physical Length	Eye Height	Example
Conventional Bicycle	2' 6"	4' min. 5' prefer	5' 10'	5'	
Recumbent Bicycle	2' 6"	4' min. 5' prefer	8'	3' 10"	
Tandem Bicycle	2' 6"	4' min. 5' prefer	8'	5'	
Bike Trailer	2' 6"	4' min. 5' prefer	10'	5'	 or 

Bikeway design should consider the physical, safety and performance demands of bicycles and the expected behavior of bicyclists.

Section II

Bicycle Operation and Safety Envelopes

I. Typical Bicycle Speeds:

- Conventional bicycles may travel at slower speeds when pulling a trailer.
- Recumbent bicyclists typically travel at faster speeds than conventional bicyclists.

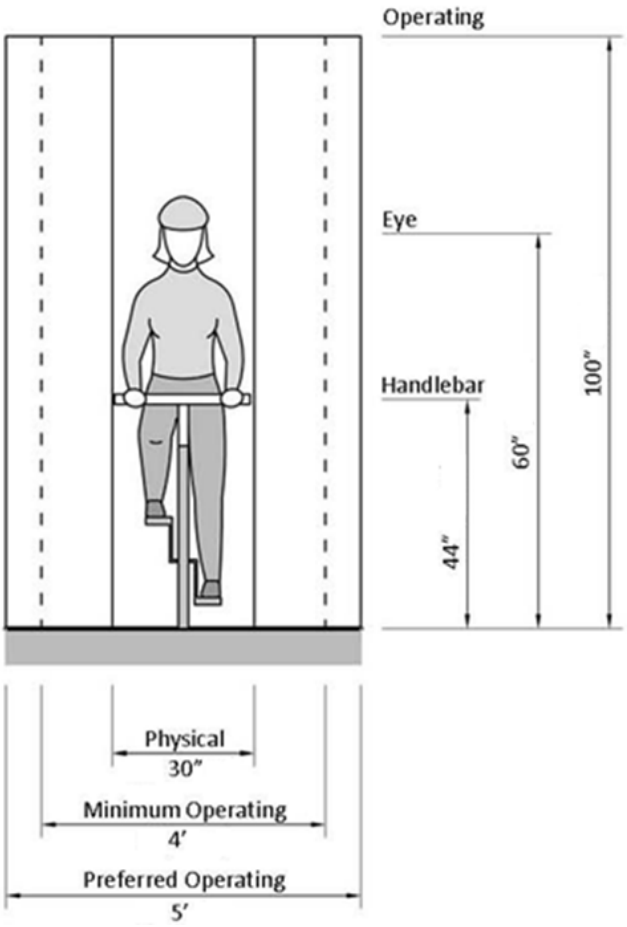
Table 2 Design Speed Expectations

Bicycle	Travel	Typical Speed
Conventional Bicycle	Paved level surface	15 mph
	Intersection	10 mph
	Downhill	30 mph
	Uphill	5-12 mph
Recumbent	Paved Level Surface	18 mph

II. Safety Operating Envelope

Recommended guidelines:

- Preferred operating envelope: 5 feet
- Minimum operating envelope: 4 feet
- Due to the operational demands of bicycles, the minimum operating space is wider than a bicycle's physical operating space.



Operating envelope for a typical bicycle.

Section III

Bikeways

1.1 Bike Lanes

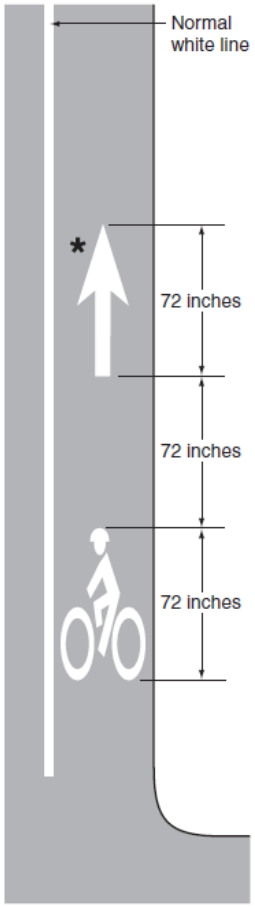
A bike lane is a defined travel lane in the roadway that is free of vehicular traffic where bicyclists are encouraged to ride. It is important that the pavement surface be smooth and free of structures. Drain inlets and utilities covers that are in the bike lane effectively reduce usable width. Where these structures exist, the bike lane width may need to be adjusted.

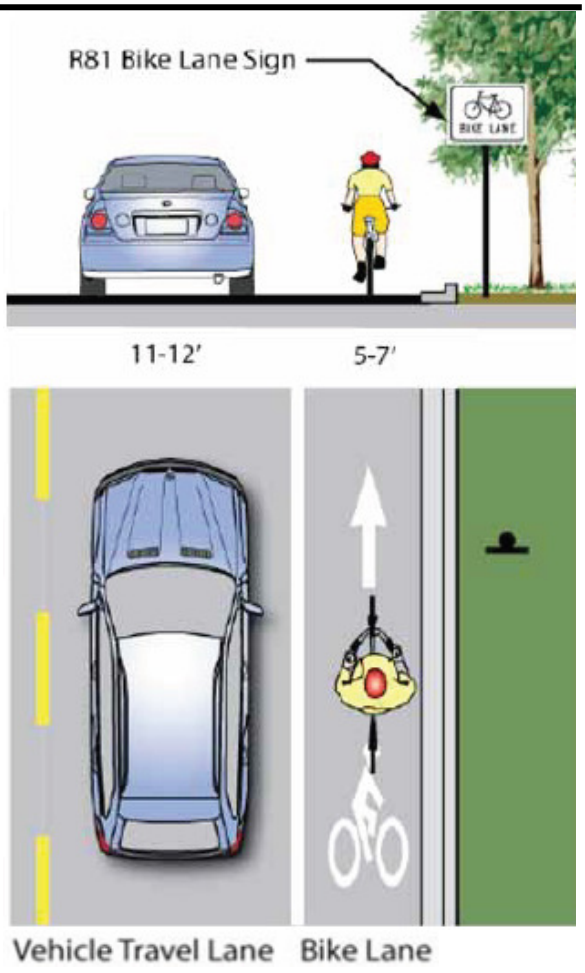
Recommended guidelines

- Preferred minimum width: 5 feet + 1 foot gutter pan
- Allowable minimum width: 4 feet + 1 foot gutter pan
- Striping line: 6 inches wide
- Pavement marking: MUTCD Figure 9C-3
  At the beginning & end of a bicycle lane at approach to intersection.

Bike Lane Example

The image to the right is a preferred pavement marking for a bike lane. MUTCD Figure 9C-3. The image on the far right is an example of a bike lane.





Section III

Bikeways

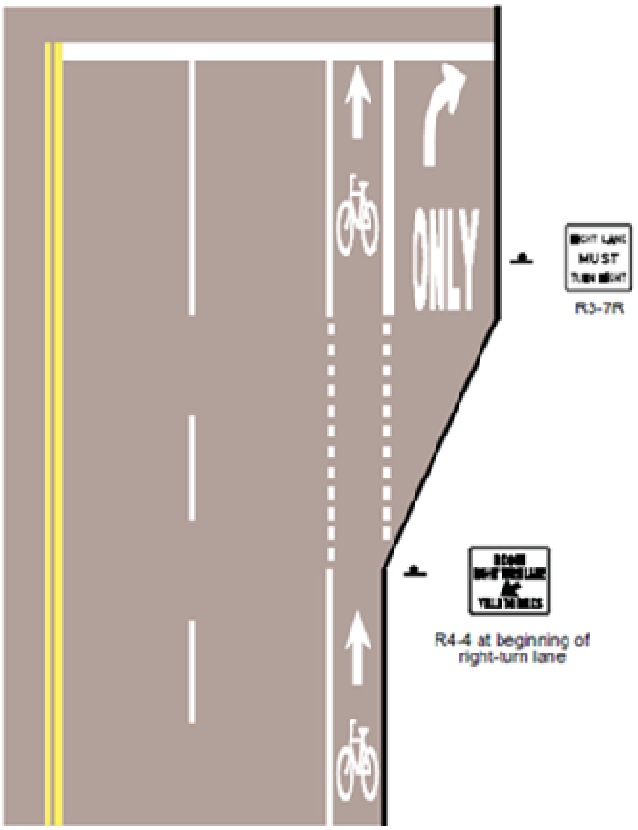
1.2 Bike Lanes next to Vehicular Turning Lanes

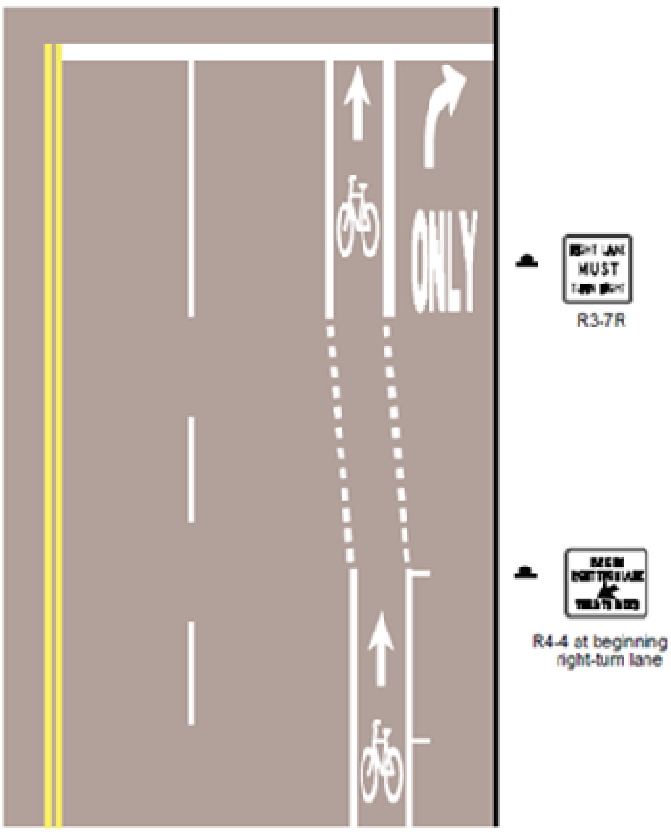
A bike lane next to a vehicular turning lane makes bicyclists more visible near intersections and encourage merging through the bike lane before the intersection. Left-turning bicyclists should be allowed to merge and use the left turn vehicle traffic lane or exit the road and use the pedestrian crosswalk.

Recommended guidelines

- The bike lane should be located to the left of the Right Turn lane.
- The lane should be marking with dotted lines to demonstrate the merging bicycle and vehicle traffic area.
- The bike lane should be marked up to the intersection stop line.
- MUTCD signs R10-6a, R10-6, R10-15, R1-5, R1-5a may be used near the intersection to communicate desired vehicular traffic behaviors.

Bike Lane next to Vehicular Turning Lane Examples





Section III

Bikeways

1.3 Uphill Bike Lanes (Climbing Bike Lanes)

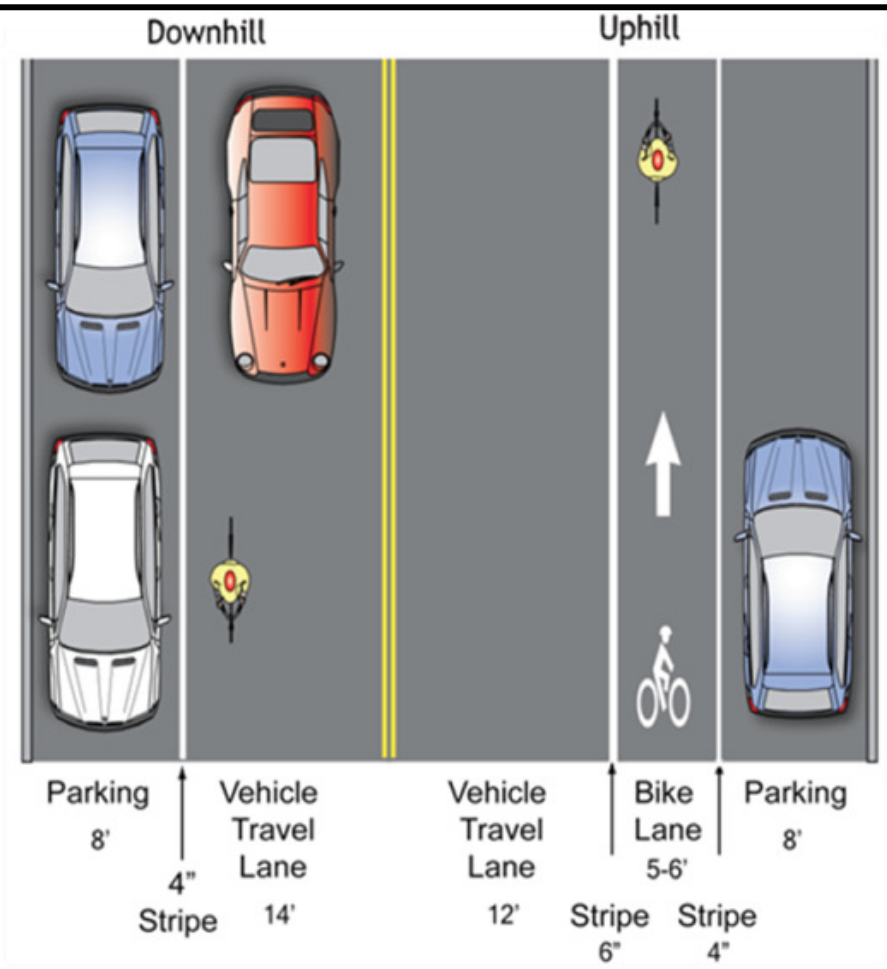
Descending bicyclists are often able to maintain vehicular traffic speeds, while bicyclists riding uphill tend to lose momentum. The speed reduction creates greater speed differentials and uncomfortable riding conditions between bicyclists and motorists. Providing a separated bike lane enables motorists to pass cyclists in a safer manner.

Recommended guidelines

- Minimum width: 5 feet + 1 foot gutter pan
- Shared lane markings should be used on the downhill part of the roadway.

Uphill Bike Lane Example

A shared lane marking may be present in the downhill lane.



Section III

Bikeways

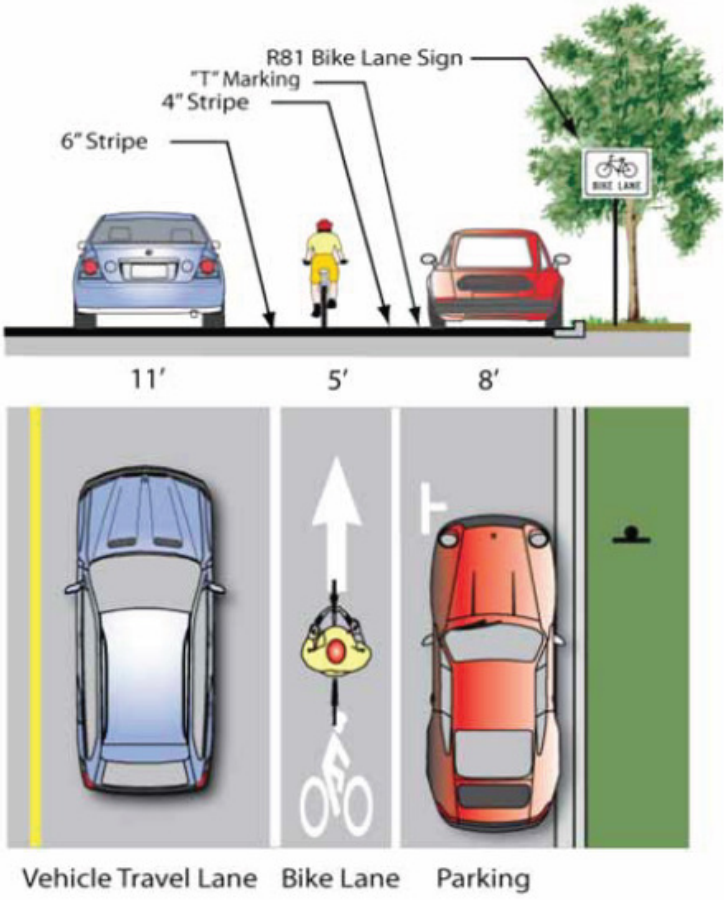
1.4 Bike Lanes and Parallel Parking

The bike lane should be located between the parking area and the travel lane. Consideration for the bicycle path location and the "door zone" should be given. See Section 2.1 for more information.

Recommended guidelines

- Minimum width: 5 feet
- Striping line width: 4 inches next to parking
  6 inches next to travel lane
- Curb face to outer edge of bike lane: 14.5 feet optimal
  12.0 feet minimum

Bike Lanes and Parallel Parking Example



Section III

Bikeways

1.5 Bike Lanes and Diagonal Parking

When diagonal on-street parking is present near a bike lane, signage should indicate that back-in parking is preferred.

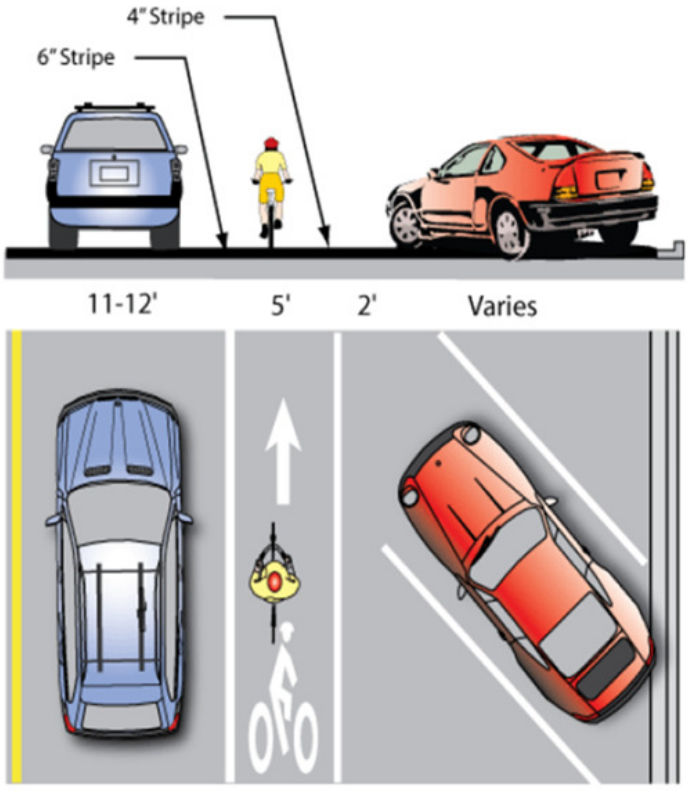
Back in diagonal parking:

- Provides better visibility for bicyclist than typical on street parallel parking.
- Minimizes open door conflicts between vehicles, pedestrians and bicyclists.
- Improves the ease of loading and unloading vehicle trunks via the sidewalk as opposed to loading and unloading from the road.

Recommended guidelines

- See guidelines for Parallel Parking
- Parking stalls should be long enough so most vehicles do not protude into the bike lane.

Bike Lanes and Diagonal Parking



Section III

Shared Roadways

2.1 Shared Roadways & Shared Lane Markings

Shared roadways are areas where bicyclists and motorists share the road. State law does not prohibit bicycle operation on most roadways, with the exception of highways and interstates. They can also be used on streets with angled parking if a bike lane is undesirable. Treatments on roads with on-street parking should place the path of the bicyclist outside of the "door zone." Signs and pavement markings should also be present.

Recommended guidelines

- Maximum speed limit: 35 mph

2.2 Shared Lane Markings

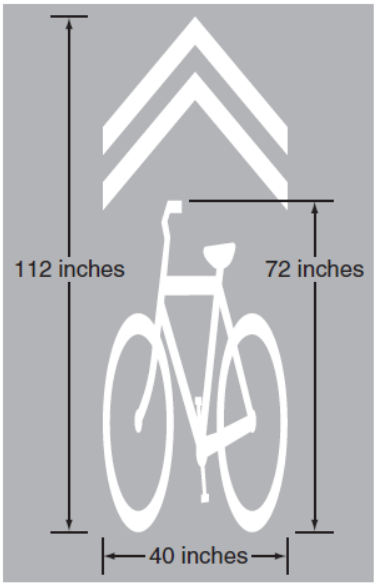
Shared lane markings are used to demonstrate a shared lane environment on the roadway.

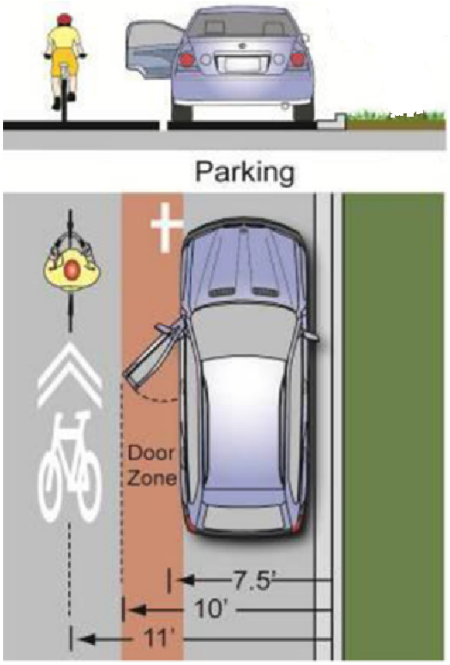
Recommended guidelines

- Placement: 4 feet from curb face minimum
  Immediately after an intersection
  250 feet intervals
- Placement on street with parking: 11 feet from curb face or
  1 foot outside "door zone"

Shared Roadway and Shared Lane Marking Examples

To the right, a shared lane marking, also called a "sharrow." To the far right, an example of how on-street parking can affect the path of a bicyclist.





Section III

Shared Use Paths

3.1 Shared Use Paths

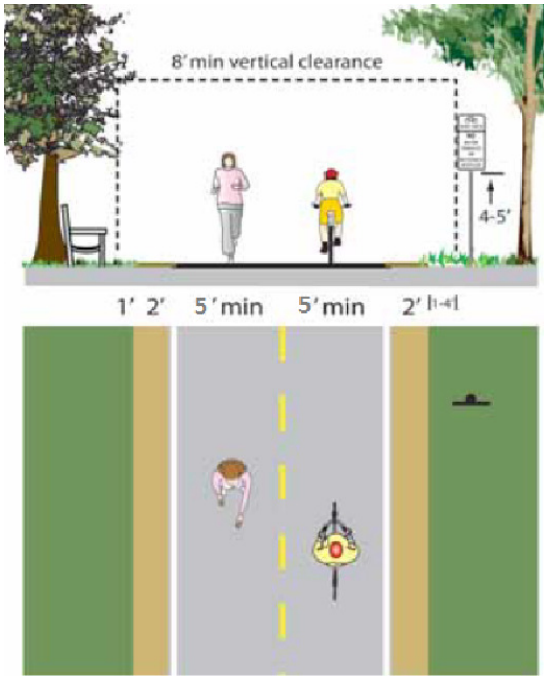
Off-road bicycle paths provide recreational riding opportunities that can be pleasant and have minimal interaction with vehicular traffic. These paths can also provide bicycle routes for less skilled riders and children. Paths should be designed to accommodate shared uses like bicycle riding, walking, running and other activities. Fencing or shrubs may be considered on paths with steep slopes or embankments. Design and placement for lighting, drainage signage and pavement type should be considered. For more information on grading, superelevation and stopping distance, please see AASHTO.

Recommended guidelines

- Minimum width: 10 feet
- Minimum grade: 2 feet
- Maximum grade slope adjacent to path: 1:6 ratio maximum
  1:3 ratio near steep slopes
- Minimum clearance to obstructions: 3 feet lateral clearance
  8 feet vertical clearance
- Maximum design speed: 20 mph paved path
  15 mph unpaved path

Shared Use Path Examples

The 3 foot lateral clearance to obstructions can be 3 feet of the same treatment or broken up to give the path a bit of a shoulder, as seen in the image to the right.



Section III

Traffic Control Facilities at Intersections

4.1 Bike Lanes through a Major Intersection

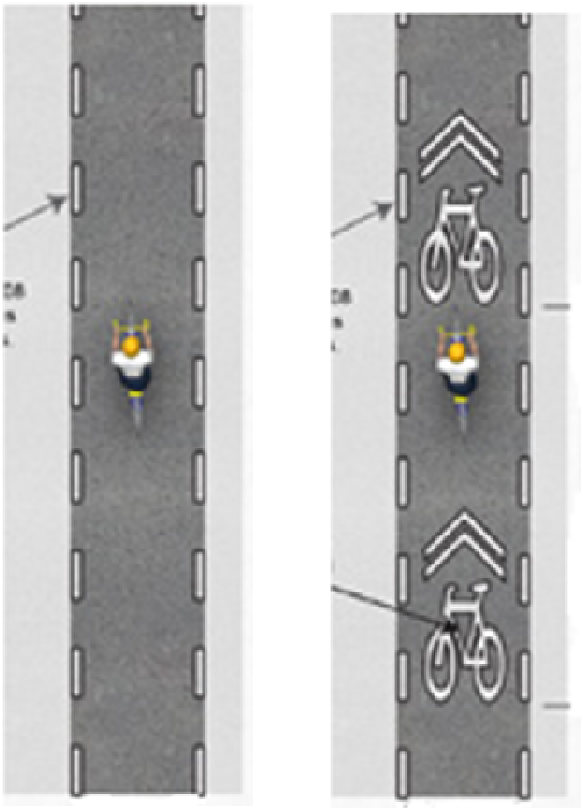
Marking a bike lane through an intersection can reduce conflicts between bicyclists and motorists, guide a straight or directional bicycle path and promote the multi-modal nature of the corridor. It should not be installed over a pedestrian crosswalk.

Recommended guidelines

- Minimum width: Match preceding bike lane
- Striping: 2 feet dotted lines
  6 feet intervals
- Shared lane markings may be present

Bike Lanes through a Major Intersection Example

A bike lane does not have to be marked through an intersection. Example of bike lane markings in an intersection can be found to the right.



Section III

Traffic Control Facilities at Intersections

4.2 Loop Detectors

Bicycle-activated loop detectors allow a bicycle to trigger a change in the traffic cycle. The purpose of using a bicycle loop is to detect bicycles at intersections and to give extra green light time to bicyclists before the light turns yellow to make it through a signalized intersection. Types A (6 foot square) and E (unmodified circle) are not bike-sensitive in their center and are not preferred.

Recommended guidelines

- Preferred loop detector types: Quadrapole Loop—Type C or Diagonal Quadrapole Loop – Type D
- Acceptable loop detector types: Type B - 5 feet square diamond
Type C - quadrapole
Type D - diagonal slashed
Type Q
Type E - circle with a slash
- Placement: 100 feet from the stop line and
At the stop line

4.3 Loop Detector Pavement Markings and Signage

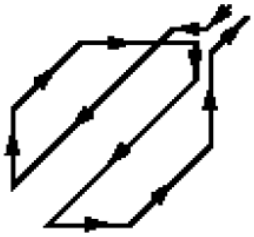
Loop detectors that are sensitive to detect bicycles should have pavements markings and signage that instructs cyclists how to trip them.

Recommended guidelines

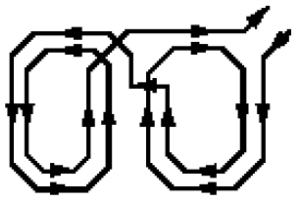
- Placement: Over bicycle-activated loop detectors

Loop Detectors, Pavement Markings and Signage Examples

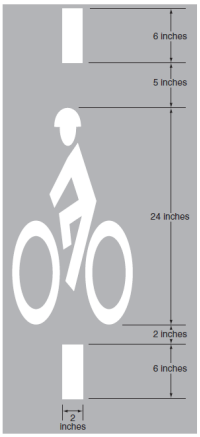
Preferred loop detectors found below. To the right, loop detector pavement markings and signage.



Diagonal Quadrupole Loop Type D



Quadrupole Loop - Type C



Section III

Traffic Control Facilities at Intersections

4.4 Bike Box

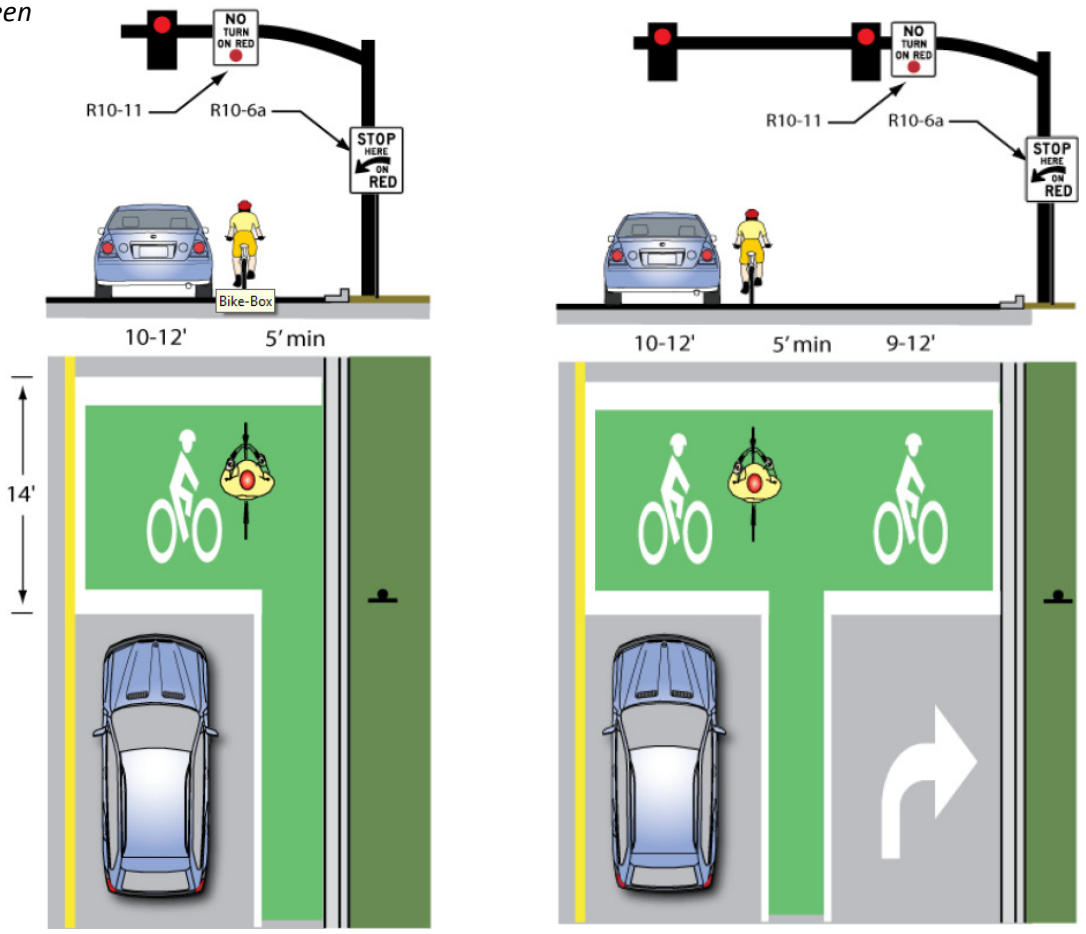
A bike box is a box just before the intersection formed by the stop line, the crosswalk and the curb. It's used to hold queuing bicyclist at an intersection. A bike lane should lead directly to the bike box. They increase bicyclist visibility and allow groups of bicyclists to clear an intersection quickly, minimizing impediment to traffic. They are typically used at an intersections with high bicycle traffic as well as where there may be a right or left turning conflicts, though other considerations may be given. Traffic signs should be present to communicate expected bicycle and vehicular traffic behaviors.

Recommended guidelines

- Placement: Before intersection
  Across one or two lanes of traffic
- Width: 10 feet minimum
  16 feet maximum
- Pavement markings: Centered in the box

Bike Box Examples

Bike box examples can be seen here. The image on the far right is preferred in areas where there are wide lanes and/or where cyclists may need make left turns.



Section III

Signs

5.1 Wayfinding and Guidance Signs

The design and feel of the Clemson University bikeway wayfinding sign system should evoke a similar, yet distinct feel to the existing university image, identification and wayfinding system. It should be designed to communicate and inform bicyclists about the location of bicycle routes, destinations and mileage. The signing system should enhance the connections between the campus and the Clemson Experimental Forest.

Recommended guidelines

- Sign Placement: After turns
  Where a route changes
  At destinations
- Pavement markings can also be a part of the wayfinding system.

Wayfinding Sign Examples

Bicycle Route Sign. *Signs can include route name and/or unique symbol.*

Decision Signs. *Signs can help bicyclists find their way to a destination and include mileage and time.*

Section III

Signs

5.2 Warning Signs

Warning signs advise motorists to share the road and watch for bicyclists. Warning signs should also be placed on streets near bikeways to alert motorists of bicycle crossings. Sign placement should be consistent to help the flow of pedestrian, bicycle and vehicular traffic. It is a cost-effective, highly-visible treatment that can help the riding environment for bicyclists on designated roads within campus boundaries.

Recommended guidelines

- Sign Placement:

  Near major activity centers
  Major roadways
  Major intersections

Warning Sign Examples

Warnings signs can help communicate expected bicycle, vehicular and pedestrian behaviors and interactions. They should be used to delineate shared roadways and bike lanes. Other signs can found in the MUTCD.

Section III

Bicycle Parking

6.1 General Bicycle Parking

Bicycle parking is a support facility that provides bicycle storage at a destination. There are two different types of bicycle parking: short term and long term. Short term parking is recommended when storing a bicycle for a short period of time, quick activities or errands. Long term bicycle storage is recommended for long periods of time, overnight or all day for some commuters.

Bicycle Parking Facilities Guidance

- A bicycle rack should support a bicycle fame at two different points. Poorly designed bicycle parking can bend wheels and damage bicycles.
- Place racks in visible areas to increase security and highlight bicycling a visible travel option.
- Place racks close to buildings and outside of landscape screening area to minimize theft or vandalism.
- Provide lighting for bicycle parking areas.
- When possible, provide shelter over a bike rack to protect the bicycle from exposure to the elements, even for short periods of time.
- Racks should be mounted into the ground.
- Consider that all bicycle racks do not necessarily hold the number of bicycles advertised. Actual spacing between rack elements may be inadequate and may result in damaged bicycles. Some rack designs may encourage incorrect use and may inadvertently lower rack capacity.

Recommended guidelines for rack placement

- Distance from curb: 24 to 30 inches
- Distance from other street furniture: 3 feet minimum
- Distance from other bicycle racks: 4 feet minimum
- Distance from a crosswalk or intersection : 5 feet minimum
- Distance from building: 50 feet maximum
- Short term bicycle space requirement : 1 space per 10 students (2 space minimum)
- Long term bicycle space requirement: 1 space per 10 students + 1 space per 10 employees

Section III

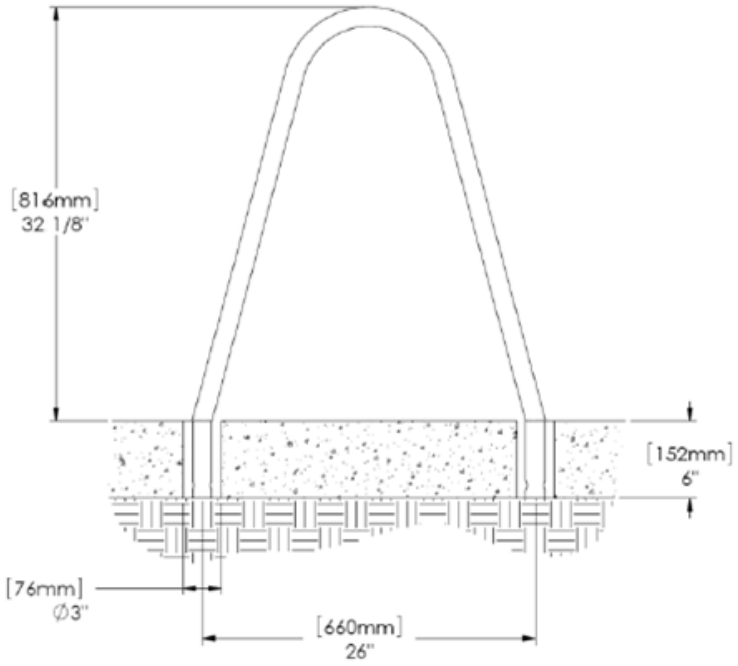
Bicycle Parking

6.1 General Bicycle Parking (continued)

Bike Rack Examples

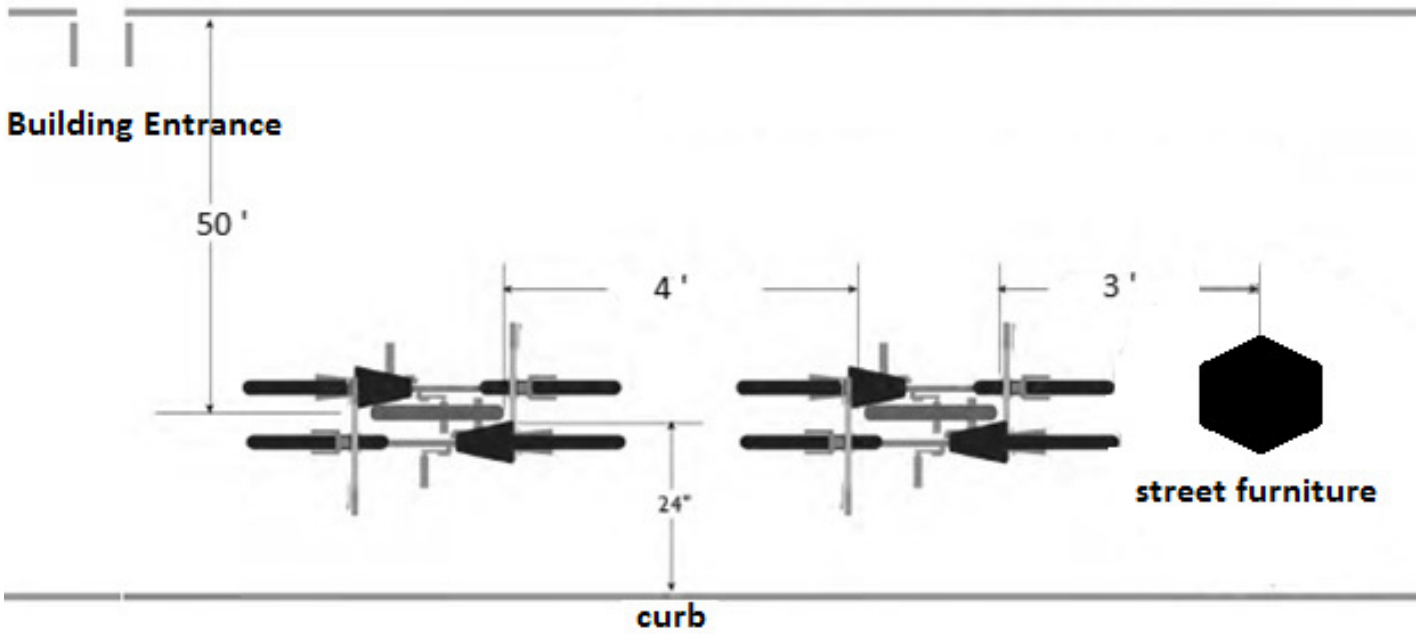
Bola Bike Rack, Landscape Form, *preferred*

This is the preferred bike rack design, but other acceptable racks may fall under the "Inverted U" or "Post and Ring" bike rack type. See the APBP Bicycle Parking Guidelines further guidance, including photos of acceptable bike racks.



Bike Rack Layout Example

The image below provides a visual for bicycle rack placement guidelines on the following. The following page. Image is not drawn to scale.



Section III

Bicycle Parking

6.2 Long Term Bicycle Parking

Specific design guidelines for long term bicycle parking will be further developed as the need arises. Long term parking should be sheltered and provide enhanced security. The location of long term storage will vary on campus. Considerations should be given to those who live on campus as well as those who live off campus. Long term parking areas should be convenient and near a bikeway.

Long Term Bicycle Parking Facilities include:

- Covered bicycle racks
- Bicycle storage rooms
- Bicycle lockers

Recommended guidelines

• Expected parking time:	More than 2 hours
• Long term space requirement: (planned capacity)	1 space per 10 students 1 space per 10 employees or 1 space per 20,000 sq ft

Long Term Bicycle Parking Examples

Covered bike racks, found below, can be used as short term or long term parking. Bike rooms, top left, can provide limited access which may be preferable in university environments where there is high turn over and traffic in buildings on a daily basis. Bike lockers, bottom left provide individual security which may be preferred for daily commuters. Bike rooms or cages provide group security.

Section IV

References

7.1 References

The bikeway design guidelines recommendations in this document were developed using national recommendations and standards to guide future local development. Innovations in bikeway facility design and standards are continually being developed. The resources should be consulted for more detailed information on recommended designs and treatments. For further reference, please refer to the most up-to-date publications of the following resources.

Reference List

- Clemson University Design Guidelines
- Clemson University Sign Guidelines
- South Carolina Department of Transportation, Engineering Directive Memorandum 22
- 1999 AASHTO Guide for the Development of Bicycle Facilities (an updated guide is expected to be released in 2012)
- 2009 Manual on Uniform Traffic Control Devices
- National Association of City Transportation Officials Cities for Cycling Urban Bikeway Design Guide
- FHWA Designing Sidewalks and Trails for Access Part II of II: Best Practices Design Guide
- 2004 Characteristics of Emerging Road and Trail Users and Their Safety
- APBP Bicycle Parking Guidelines, 2nd Edition (2010)
- City of Greenville Bicycle Master Plan Design Guidelines

Section IV

Acknowledgements

Clemson University

University Planning and Design

Staff

Gerald Vander Mey	Director
Tanya DeOliveira	Planner