Kern County Bicycle Master Plan and Complete Streets Recommendations

Volume II: Complete Streets Recommendations

FINAL REPORT

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7. Introduction to Complete Streets and Best Practices

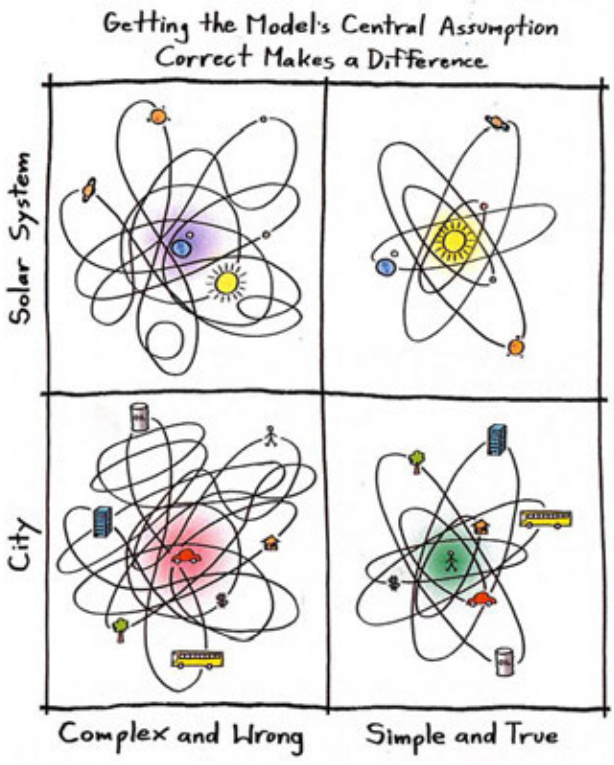
7.1 Definition and Overview

The concept of a Complete Street is about developing a route for all transportation modes. It is less about the street itself, and more about a designated route for transportation. Complete Streets are streets for everyone. They are designed for access, mobility, and safety for all users, regardless of travel mode. Complete Streets are not about hindering the automobile, but enabling transit, pedestrians, and bicyclists to travel with automobiles.

Complete streets do not have a cookie-cutter design. Most vary widely in design and appearance. However, all complete streets are comfortable and safe for any user that travels along one. When designing a complete street, the planner or engineer must consider the entire roadway right-of-way. This may mean that the physical roadway only consumes half of the overall right-of-way. An off-street multi-use trail may encompass a large portion of the right-of-way or extra wide sidewalks may be needed in a high pedestrian corridor (e.g. central business districts).

Creating Complete Streets requires a change in thinking for many public agencies as well as the general public. Public agencies must revise the age-old concept that streets are all about the automobile. In many cases this requires minor modifications to adopted standards. A bicycle lane, or sidewalk, or bus turnout can sometimes be accommodated within existing roadways or planned for in areas of new development. However, larger projects may require significant planning and engineering efforts to provide the best transportation system for all users. In well developed areas, retrofitting existing infrastructure may meet barriers that seem difficult to overcome.

The general public must also learn to navigate



Source: Ian Lockwood

Complete Streets. For the most part, the general motoring public has become used to the concept that cars rule the road. Although this is not the case (legally), most motorists believe that the vehicle has control of all that happens between the curb lines. As planners and engineers seek to incorporate Complete Streets projects, they must bear in mind that the motoring public must sometimes be reminded that each transportation mode has its place and they must all share the space.

7.2 Legislation

Complete Streets legislation has been enacted from the federal level down to community levels throughout the United States. A current Federal statute, United States Code, Title 23, Chapter 2, Section 217 (23 USC 217), mandates that:

"Bicycle transportation facilities and pedestrian walkways shall be considered, where appropriate, in conjunction with all new construction and reconstruction of transportation facilities, except where bicycle and pedestrian use are not permitted."

The Complete Streets Act (Assembly Bill 1358) passed in the State of California and requires the following:

"This bill would require, commencing January 1, 2011, that the legislative body of a city or county, upon any substantive revision of the circulation element of the general plan, modify the circulation element to plan for a balanced, multimodal transportation network that meets the needs of all users of streets, roads, and highways, defined to include motorists, pedestrians, bicyclists, children, persons with disabilities, seniors, movers of commercial goods, and users of public transportation, in a manner that is suitable to the rural, suburban, or urban context of the general plan. By requiring new duties of local officials, this bill would impose a state-mandated local program." [24]

The California Department of Transportation has also issued Deputy Directive 64 (DD-64-R1), which states:

"The Department views all transportation improvements as opportunities to improve safety, access, and mobility for all travelers in California and recognizes bicycle, pedestrian, and transit modes as integral elements of the transportation system." [25]

Together, these mandates serve as the overarching guidance for the development of Complete Streets in Kern County.

7.3 Related Planning and Design Concepts

There are several sources of planning and design guidance for Complete Streets. A variety of public and private entities research and provide guidance through manuals and recommended practices:

- Federal Highway Administration (FHWA)
- United State Department of Transportation (Caltrans)
- American Association of State Highway and Transportation Officials (AASHTO)
- Transportation Research Board (TRB)
- Institute of Transportation Engineers (ITE)
- National Complete Streets Coalition
- California Transportation Commission (CTC)
- California Department of Transportation (Caltrans)

Several of the above entities provide direction in the planning, analysis, and design of Complete Streets through the following publications:

- **FHWA Guidance – Bicycle and Pedestrian Provisions of Federal Transportation Legislation (2008)**
  - This publication provides guidance on the planning and funding sources for non-motorized transportation projects.
- **AASHTO – A Policy on Geometric Design of Highways and Streets (2011)**
  - This publication provides guidance on the design of roadways, including non-motorized transportation modes.
- **AASHTO – Guide for the Planning, Design, and Operation of Pedestrian Facilities (2004)**
  - This Publication provides guidance on pedestrian facilities.
- **Transportation Research Board (TRB) – 2010 Highway Capacity Manual**
  - This publication provides guidance on analysis of operations for all modes of travel.
- **Caltrans – California MUTCD (2012)**
  - This publication provides signing, striping, and design criteria for all transportation modes.
- **Caltrans – Highway Design Manual (Sixth Edition)**
  - The Highway Design Manual provides guidance on all design features for state highways.
  - Caltrans has recently revised the

24 *Assembly Bill No. 1358, State of California, April 2007.*

25 *Deputy Directive 64-R1, California Department of Transportation, October 2008.*

Highway Design Manual pursuant to their Complete Streets Directive (DD 64).

- **ITE – Numerous publications**
  - Urban Street Geometric Design
  - Traffic Engineering Handbook
  - Designing Walkable Urban Thoroughfares
  - Neighborhood Street Design Guidelines
  - Promoting Sustainable Transportation Through Site Design

Additionally, there are numerous other public and private organizations that have conducted research and prepared guidance for the planning, design, and implementation of Complete Streets projects throughout the world.

7.4 Best Practices

A roadway network that is dominated by automobile traffic deters commuters from using alternative forms of transportation including bicycling, walking, and public transportation. These streets often lack bicycle and pedestrian facilities and make it challenging for persons with disabilities and those without access to private automobiles to commute. Complete Streets is a concept that envisions roadways that can concurrently support multiple users, modes, and abilities.

Depending on the urban or rural context, Complete Streets designs can look very different among jurisdictions and can be implemented in various ways. Some of the common elements of Complete Street designs include:

- Pedestrian infrastructure: Sidewalks or crosswalks
- Bicycle infrastructure: Lanes and parking
- Coordinated transit facilities: Bus pull-outs or transit right of way
- Aesthetic and safety improvements: Landscaping, contrasting pavement colors and signage

7.5 Plans and Policies

The adoption of plans and policies is a key implementation strategy for creating complete streets in Kern County. In 2010 the National Complete Streets Coalition produced a Complete Streets Policy Analysis, which provides 10 elements that make an ideal complete streets policy to assist jurisdictions in producing strong, effective ordinances. The elements are:

- Includes a vision for how and why the community wants to integrate Complete Streets concepts and principles
- Specifies that 'all users' includes pedestrians, bicyclists, and transit passengers of all ages and abilities, as well as trucks, buses and automobiles
- Encourages street connectivity and aims to create a comprehensive, integrated, connected network for all modes
- Is understood by all agencies to cover all roads
- Applies to both new and retrofit projects, including design, planning, maintenance, and operations, for the entire right of way
- Makes any exceptions specific and sets a clear procedure that requires high-level approval
- Directs the use of the latest and best design

criteria and guidelines while recognizing the need for flexibility in balancing user needs
- Directs that complete streets solutions will complement the context of the community
- Establishes performance standards with measurable outcomes
- Includes specific next steps for implementation of the policy

The following are examples of best practices in plans and legislation adopted by jurisdictions throughout the country to implement Complete Streets in their city or community:

New Jersey Department of Transportation– Complete Streets Policy

The New Jersey Department of Transportation defines its Complete Streets vision as providing safe access for all users using comprehensive, integrated, and multi-modal transportation options. This policy provides a 15 step implementation process that identifies the current best available standards and practices, and recognizes the evolving, growing, and future needs of pedestrians, cyclists and other road users. Using funding as an incentive, the New Jersey Department of Transportation strongly encourages local jurisdictions to adopt similar policies.

Seattle, Washington – Complete Streets Ordinance

The City of Seattle is using a multifaceted approach to the development of a complete multimodal transportation network. The Complete Streets ordinance directs the Department of Transportation to ensure that all roadway projects provide for multiple modes. The resulting implementation of the ordinance prioritizes projects that have the most impact on network completion for all modes. An internal complete streets steering committee clarifies the daily operational practices that the Department of Transportation takes to implement the policy.

Bloomington/Monroe County, IN Metropolitan Planning Organization – Complete Streets Policy

This Complete Streets Policy acts as a catalyst for implementation specifying that its purpose is to empower citizens, local governmental agencies, planners, engineers, architects and others to incorporate Complete Street designs in all projects funded by the Bloomington and Monroe County Metropolitan Planning Organization. It requires that all new and reconstruction projects accommodate all modes of transportation and be accessible by all levels of users. Its flexibility allows communities to incorporate designs fitting for its residents and character.

Louisville, Kentucky Metro – Complete Streets Resolution and Manual

The Louisville, Kentucky Complete Streets Manual combines land use character and street types to develop preferred roadway designs for rural, suburban, traditional and downtown districts. Developers select cross sections appropriate for their project area, all of which include accommodations for multiple modes. For example, rural roadways are now required to have paved shoulders at a minimum to accommodate pedestrians and bicyclists. In addition, the complete streets manual has helped Louisville Metro to articulate regional complete streets goals for design of roads to the state DOT and incorporated cities. This means that there is greater consistency in the network for all road users.

San Francisco, California – Transit First Policy

The city's charter explicitly states that transit, bicyclists, and pedestrians should be prioritized when allocating limited right of way within the city. The policy directly ties the provision of complete streets to economic, environmental, and personal vitality. In addition, the policy provides explicit direction to prioritize transit movement, and bicycle and pedestrian safety and mobility over automobile mobility when necessary.

7.6 Infrastructure Treatments

Treatments to existing roadways can provide better safety and connectivity for multiple modes of transportation and provide support for road users with different levels of ability. This section provides best practices to improve current infrastructure and help create fully functional complete streets in Kern County. The infrastructure treatments include enhanced pedestrian, bicycle, transit, and road conditions.

7.6.1 Pedestrian Treatments

Pedestrian treatments enhance the walking environment and improve access for persons with disabilities. The design of a sidewalk and streetscape varies by the street context, functionality, classification, and demand of the pedestrians or community, so it is important to assess the current pedestrian activity before implementing treatments. On main corridors, it is beneficial to have streetscapes with amenities that promote safety, accessibility, and civic engagement, such as street trees, furniture, lighting, and other green features. These amenities provide an enjoyable experience for all types of users including seniors, children, and persons with disabilities.

Sidewalks

Sidewalks are the most fundamental element of a pedestrian network as they provide a separate, well established path for people to walk. Well-designed sidewalks are adequate in width so that at least two people can pass each other; provide access for all users, including people with disabilities; have landscaping and pedestrian amenities (trees, lighting, proper drainage); and provide safety and comfort to their users.

High Visibility Crosswalks

High visibility crosswalks, which are typically ladder or continental style, should be used for all marked crossings at which pedestrians and automobiles may intersect. These crosswalk styles increase visibility of pedestrians to drivers since the markings are in the same direction as the motorist path of travel. The appropriate location to mark crosswalks usually depends on the amount of pedestrian activity the intersection has. In areas near schools, shopping centers, or other nodes of pedestrian activity, crosswalks should be placed no further than 200-300 feet apart and no closer than 150 feet.

Pedestrian Signals

Signalized or controlled crossings can be used to provide further protection for pedestrians. Pedestrian-only signals help people cross the street by requiring motorists to yield to them. Pedestrian Hybrid Beacons (also known as "HAWKs"), for example, may be installed if roadway speed and/or volumes are excessive for pedestrian travel. These signals face vehicle traffic and use a unique 'wig-wag' signal to alert oncoming traffic that pedestrians are crossing. After stopping, traffic is allowed to continue if there are no pedestrians in the crosswalk, unlike with conventional traffic signals.

Full traffic signal installations must meet MUTCD pedestrian, school, or modified warrants. Conditions for hybrid beacon placements or other signalized crossings are:

- Located more than 300 feet from an existing signalized intersection
- Roadway travel speeds of 40 mph and above
- Roadway ADT exceeds 15,000 vehicles

Street Furniture

Pedestrian facilities should be accompanied with amenities to enhance the users' experience. Providing street furniture on sidewalks acts as a buffer between pedestrians and vehicular traffic. Benches and water fountains, for example, are recommended types of street furniture because they address needs that a pedestrian may have, such as a place to rest. Street furniture should be placed outside of the walking zone so that it does not create a hazard or barrier to pedestrians.

Landscaping

Installing sidewalk landscaping also creates a buffer between pedestrians and vehicular traffic. Landscaping can make a streetscape more visually appealing and street trees can provide shade for people walking and gathering. Sidewalk landscaping requires additional water and maintenance, which can be a challenge for implementation. Drought tolerant plants can reduce maintenance costs since they require less water.

Street Lighting

Street lighting improves streetscapes by increasing security for pedestrians and increasing visibility for both bicyclists and pedestrians. Street lights should be installed on both sides of the street and the level of lighting should be consistent throughout the segment. Providing pedestrian scale lighting creates a more aesthetically pleasing and comfortable environment to walk in. Intersections often require additional lighting to allow motorists to see pedestrians crossing.

Driveways

Improving the design and minimizing the frequency of driveways can reduce conflicts between vehicles and pedestrians. Reducing driveway width and tightening curb radii causes motorists to drive more slowly. Converting driveways to a "right-in right-out" design reduces the number of conflict points between automobiles and pedestrians. Providing a level sidewalk across driveways improves access for persons with disabilities.

Curb Extensions

A curb extension is a portion of the sidewalk that is extended into the parking lane at intersections. This reduces the distance that pedestrians need to walk to cross the street, makes pedestrians more visible to motor vehicles, and causes drivers to reduce speeds by narrowing the roadway. Curb extensions must be installed with curb ramps (see below) that comply with ADA standards. Curb extensions are typically constructed with concrete, but can have decorative pavers and landscaping, as well.

Curb Ramps

Curb ramps allow persons in wheelchairs, with walkers, with strollers, and with disabilities convenient access to the sidewalk from the street. The Americans with Disabilities Act (ADA) requires curb ramps to be installed at all locations where pedestrians cross. Curb ramps for each crossing approach are recommended, rather than one curb cut per corner, so that visually and range of motion impaired people have better orientation. Warning strips should be installed on all ramps.

Pedestrian Refuge Islands

Medians are elevated barricades that divide the roadway down the center. Pedestrian refuge islands can provide a protected space for pedestrians crossing the street and allow pedestrians to focus on crossing one direction of traffic at a time. They are especially recommended for wide streets and arterials that pedestrians may have trouble crossing before the end of the signal phase.

Triangular Median Islands

Installing triangular or "porkchop" median islands provides increased safety and convenience for pedestrians crossing right turn slip lanes. Pedestrians can cross the slip lane and wait in the median until they have the right-of-way to cross the street. Striping crosswalks in combination with triangular median islands increases the visibility of pedestrians to motorists. Triangular median islands should only be used when right-turn slip lanes cannot be removed and when curb radii cannot be reduced, such as when there are high volumes of trucks.

Pedestrian Push Button

Installing pedestrian push buttons at signalized intersections allows pedestrians to trigger the signal when motor vehicles are not present. Push buttons are appropriate for arterial and congested streets because they can allot more time to pedestrians only when they are present and thus reduce vehicular delay. Push buttons can be enhanced with audible messages for visually impaired persons.

Pedestrian Countdown Signal

Pedestrian countdown signals display to pedestrians crossing the street when they have enough time to enter the crosswalk and how much time they have left to cross the street. Countdown signals improve pedestrian safety by helping pedestrians to finish crossing before the end of the signal phase.

7.6.2 Bicycle Treatments

Integrating bicycle facilities onto roadways can create a safer and more comfortable bicycling environment. Separated bikeways, such as bike lanes, buffered bike lanes, and cycle tracks, are most appropriate on arterial and collector streets where higher traffic volumes and speed warrant greater separation between modes. Separated bikeways can increase safety and therefore interest in bicycling in the County by:

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

Adding support facilities like signage and pavement stencils to existing bicycle infrastructure is a good way to enhance bike travel in the region.

Striped and Buffered Bike Lanes

Bike lanes are one-way striped travel lanes for exclusive use by bicyclists on a street or highway. Bike lanes should be at least five feet wide and can be located adjacent to a curb or on-street parking. Bike lanes should be kept clear of debris and well-maintained to increase safety of bicyclists.

Buffered bike lanes are a type of bike lane with a striped or paver delineated buffer either between the bicycle path of travel and the motor vehicle path of travel or a parking lane. A buffered bike lane can encourage bicyclists with less confidence by providing an increased level of safety that standard bike lanes do not offer. Buffers between the bicycle and motor vehicle path of travel are useful for high-speed, high-volume arterials or collectors, while buffers between the bicycle path of travel and a parking lane are appropriate for areas with high parking turnover that put bicyclists at risk of riding in the door zone.

Cycle Tracks

A cycle track is a bike facility that functions as a separated bicycle path located within the roadway right-of-way. It is physically separated from vehicular traffic by bollards, medians, on-street

parking or other treatments, and is different from sidewalks. Where there is on-street parking, cycle tracks are typically placed adjacent to the curb, in contrast to bike lanes, which are located between the on-street parking and the vehicle travel lane. Cycle tracks can be one-way or two-way, and can be at street level or raised.

Shared Roadways

A shared roadway is typically used where the existing street does not have available roadway right-of-way to support a dedicated striped bike lane. Shared roadways are recommended to be accompanied by shared lane markings, also known as sharrows, that indicates the lane is shared between automobiles and bicycles. Shared lane markings should be placed on the outside lane (furthest right lane) approximately 14 feet from the curb to properly accommodate both modes.

As shared lane markings are a relatively new bikeway marking in American cities, guidance on application will continue to evolve over time. Shared lane markings should not be considered a substitute for bike lanes, cycle tracks, or other separation treatments where these types of facilities are otherwise warranted or space permits. Desirable shared lane marking applications include:

- To indicate a shared lane situation where the speed differential between bicyclist and motorist travel speeds is very low (designed speed of < 35 mph)
- On downhill segments, preferably paired with an uphill bike lane
- On streets where the traffic signals are timed for a bicycling travel speed of 12 to 15 miles per hour
- Along front-in angled parking, where a bike lane is undesirable
- To fill a gap in an otherwise continuous bike path or bike lane, generally for a short distance
- To transition bicyclists from across traffic lanes or from conventional bike lanes or cycle tracks to a shared lane environment

Shoulder Bikeways

Shoulder bikeways are appropriate for roads that do not have curbs or gutters and are typically found in less dense, suburban, or rural areas. Shoulder bikeways include striped four feet (or more) lanes for bicycle travel and are often used as holding places or temporary bike lanes until roads can be widened and full bike lanes can be constructed. These lanes most often, but do not always, include signage. For further safety treatments, some cities have placed rumble strips to alert motorists when they have crossed into the shoulder where cyclists could be riding. The design of the rumble strips have recently been altered so that it is safe for cyclists to cross if needed.[26]

26 *Federal Highway Administration (FHWA) Technical Advisory: Shoulder and Edge Line Rumble Strips (T5040.39, Revision 1, 2011)*

Bicycle Detection

Bicycle detection at signalized intersections allows bicyclists to trigger the signal when motor vehicles are not present. Detection can be in the form of bicycle loop detectors, microwave detection, or video detection with higher sensitivity.

Intersection Crossing Markings

Pavement markings through intersections help bicyclists with proper lane positioning and alert motorists to the presence and path of bicyclists. Since intersection crossing markings make bicyclist movements more predictable, they also have the potential to reduce collisions between bicyclists and motorists.

Bike Boxes

Bike boxes allow bicyclists to position themselves in front of the traffic queue while waiting for the light to turn green. When the signal changes to green, bicyclists can move first into the intersection and thus reduce conflicts with vehicles going straight through the intersection or turning right.

Bicycle Signals

Bicycle signals can be installed where bicycle facilities with high volumes of bicyclists intersect other roadways, such as at the terminus of a bicycle path. Bicycle signals provide a bicycle only signal phase so that bicyclists can enter and exit the bicycle facility without conflicts with motorized vehicles and provide adequate timing for bicyclists to cross an intersection.

7.6.3 Transit Facilities

Shelter

Providing a shelter at high activity transit stops and stations allows commuters protection from the sun and from inclement weather. Shelters should be established outside of the pedestrian walking zone and with sufficient room for bus wheelchair lifts to load and unload passengers. If there is not adequate space to install a dedicated shelter, there should be awnings or overhangings on the surrounding buildings for commuters to stand beneath.

Seating

Benches or seats should be provided at high activity transit stops and stations for commuters to rest while waiting for the bus or train. Elderly and disabled passengers often have difficulty standing for long periods. Seating should be installed within close proximity of transit stops and stations and under the provided shelter if feasible.

Bicycle Storage

Providing bicycle storage at transit stops and stations allows commuters to combine their trips with greater convenience. Short-term bicycle racks are appropriate for bus stops where storage space in the public right-of-way is limited. Long-term storage facilities, such as lockers or enclosed storage rooms, should be provided at train stations in addition to bicycle racks for commuters that require all-day storage. Both short- and long-term parking facilities should be located near loading zones and, when possible, in view of station attendants.

Trip Information

At a minimum, all transit stops and stations should provide signage displaying the route number. Providing timetables and maps are recommended to increase convenience for commuters with transfers and those that are less familiar with the network, such as a bicyclist with a flat tire in an unfamiliar location. For major transit stations and terminals, providing passengers with real time information on arriving transit vehicles is a valuable customer service improvement.

7.6.4 Roadway Treatments

Advance Stop Bar / Yield Line

Advance stop bars or yield lines are installed up to 50 feet prior to marked crosswalks. Striping advance stop bars and yield lines helps show motorists where they should stop in relation to the crosswalk to provide pedestrians with increased safety while crossing the street. They also make pedestrians crossing more visible to drivers. Both treatments should be installed in combination with signage to make motorists more aware of crosswalks.

Curb Radii Reduction

Wide curb radii can often result in motorists traveling at high speeds when initiating turns. Reducing the curb radius at intersections causes motorists to slow down, minimizes the distance pedestrians must cross, increases the visibility of pedestrians to drivers, and reduces the risk of right hook collisions between bicyclists and vehicles.

Speed Humps / Speed Tables

Speed humps and speed tables are raised, paved portions of the street that extend from curb to curb and are intended to slow vehicle speeds. Speed tables have flat tops and can be used as raised crosswalks, which both slow traffic speeds, make pedestrians more visible to drivers, and remove the need to install curb ramps. Speed humps and speed tables can be constructed with asphalt, concrete, or decorative pavers. The cost to install speed humps and speed tables varies by size and material.

Chicanes / Chokers

Chicanes and chokers are curb extensions that alternate from one side of the street to the other. These treatments can reduce vehicle speeds by visually narrowing the roadway and requiring vehicles to shift their positions horizontally. If supplemented with landscaping, chicanes and chokers can also create a more pleasant walking environment and a buffer between the sidewalk and the street.

Speed Feedback Signs

Speed feedback signs display a driver's speed as compared to the posted speed limit on a particular segment. By showing when motorists are exceeding the posted speed limit, speed feedback signs can cause drivers to slow their speeds.

Traffic Circles

Traffic circles are circular islands in the center of intersections that control the flow of traffic. Drivers that enter the traffic circle must travel in a counter clockwise direction around the island to get to the other side. Intersections with traffic circles can be signalized, stop-controlled, or yield-controlled. Traffic circles slow the flow of vehicular traffic into intersections, which creates a more safe and comfortable environment for bicyclists and pedestrians.

On-Street Parking

Streets with bicycle facilities should be designed to enhance the comfort and safety of bicyclists. On-street parking should be in the form of parallel parking or back-in angled parking to reduce conflicts between bicyclists and motor vehicles. Typical head-in diagonal parking creates potential conflicts as it is challenging for drivers to see bicyclists when backing out of spaces. Back-in diagonal parking, as pictured below, is safer for bicyclists as motorists have a better line of sight when pulling out of this type of parking. Removing on-street parking can also enhance streets for bicyclists, though can be challenging to implement in high-demand areas.

Wayfinding Signage

Wayfinding signage can help guide bicyclists, pedestrians, and other road users to key destinations, such as transit stops and stations, and can orient

bicyclists with the bicycle network. Wayfinding signage should be placed at decision points and intersecting facilities, and should be highly visible and consistent throughout the jurisdiction. To ease navigation at night, wayfinding signage should also be appropriately reflective.

Road Diet

On streets that lack the available width to install bikeways and/or pedestrian facilities, it may be appropriate to implement a road diet, which is a reduction in the number of travel lanes to better accommodate bicycle and pedestrian treatments. Road diets are typically implemented on roadways with volumes of 20,000 vehicles per day or less, though volumes can be higher if there is a parallel street that can accommodate the displaced vehicles.

Roadway Widening

If reducing the number of travel lanes is not an option due to heavy vehicle volumes, roadways can be widened to accommodate bicycle and pedestrian facilities. This may be challenging to implement in urban areas where much of the built environment has been constructed, but may be possible on rural or suburban roads.

7.7 Safety Considerations

Conventional roadway cross-sections often prioritize vehicular travel and lack accommodations for bicyclists, pedestrians, and transit riders. Many streets have multiple wide travel lanes in each direction without frequent signals or stop signs, which create challenges for pedestrians crossing, especially those with disabilities. Sidewalks can be narrow and placed adjacent to vehicular travel lanes, not only creating a safety concern of pedestrian exposure to motor vehicle traffic, but reducing the attractiveness of walking as a mode of transportation. High numbers of driveways increase potential conflict points between vehicles and pedestrians and wide curb radii allow motorists to drive fast while reducing the visibility of pedestrians.

Streets that prioritize motor vehicles also generally lack bikeways. Roads that have bicycle facilities may still create barriers to bicycling as there are often high volumes of vehicles traveling at high speeds with minimal separation between the two modes. Transit riders begin their trips as pedestrians and/or bicyclists and thus are also affected by a lack of accommodations.

Complete streets allow for the safe transportation of all road users regardless of age or ability. Through the infrastructure treatments presented in section 7-6, complete streets encourage travel by walking, biking, and riding transit without compromising the safety and efficiency of travel by motorized vehicles. Complete streets treatments complement each other to improve safety for all road users. For example, installing bicycle facilities, such as bike lanes, can creates a separated space for bicyclists while also creating a buffer from the street for pedestrians.

Planners and designers should be mindful when implementing complete streets to not jeopardize the safety of road users by trying to "squeeze in" facilities. For example, installing bike lanes that are too narrow so as to maintain the number of travel lanes may create a false sense of security and put the bicyclist at greater risk than he/she would be without a designated bikeway.

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8. Complete Streets Opportunities and Constraints

8.1 Review of Existing Local Policies

Local policies on transportation come from a variety of sources within Kern County. The following adopted plans were considered for Policy Review:

- 2009 Kern County Circulation Element
- 2011 Federal Transportation Improvements Program (FTIP)
- 2011 Final Regional Transportation Plan (RTP)

These adopted plans largely control the placement, design, and funding of the transportation system within Kern County. Numbering and naming conventions from each plan are continued in this report for clarification. The goals, policies, objectives, and measures referenced in this report include those that enhance or detract directly to the potential implementation of Complete Streets principles in Kern County.

8.1.1 Kern County Circulation Element

The Kern County Circulation Element is a state mandated element of the County's General Plan. According to the Circulation Element,

"The purpose of a circulation element is to set up local Goals and guiding Policies about building transportation improvements. A circulation element introduces planning tools essential for achieving the local transportation Goals and Policies.

A circulation element consists of the general location and extent of existing and proposed major thoroughfares, transportation routes, terminals, and other local public utilities and facilities, all correlated with the land use element of the plan."[28]

The Kern County Circulation Element provides the broadest plan for improvements and policies for the County's transportation system. **Table 8-1** presents the Goals, Policies, and Implementation Measures from the Circulation Element that pertain to the implementation of Complete Streets in Kern County. Not all Goals, Policies, and Implementation Measures from the Circulation Element are included in this review, as many pertain to individual areas or types of circulation not relevant.

8.1.2 Federal Transportation Improvement Program`

The FTIP is included based on the reference included in the Circulation Element (Section 2.5 Other Modes). However, the FTIP includes project identification and funding based on the policies and improvements identified in the RTP.

"The FTIP establishes a systematic, realistic approach to programming capital improvement projects over a five-year term. Projects listed in the FTIP are designed to be consistent with, and implement, the Regional Transportation Plan (RTP). The RTP is a long-range plan for transportation in the region, and includes the Capital Improvement Program (CIP) within the financial element. The FTIP is subject to continual review and modifications to assure timely delivery of programs and projects identified in the RTP and Congestion Management Program."[29]

8.1.3 Regional Transportation Plan

"The 2011 Regional Transportation Plan (RTP) is a 24-year blueprint that establishes a set of regional transportation goals, policies and actions intended to guide development of the planned multimodal transportation systems in Kern County."[30]

The RTP includes a number of Elements, encompassing all modes of transportation (highways, aviation, bicycle, etc.) as well congestion management, sustainable land use, and intelligent

28 *Kern County Circulation Element, Kern County Planning Department, September 2009, Page 79.*

29 *2011Federal Transportation Improvement Program, Kern COG, July 2010, page 1.*

30 *2011 Regional Transportation Plan, Kern COG, July 2010, Page 1-1.*

Table 8-1: Kern County Circulation Element Goals, Policies, and Objectives

2.1 Introduction	
Objectives	
3) To plan for transportation modes available to all segments of the population, including people with restricted mobility.	Comment: Alternative modes of travel are encompassed within this objective
4) Kern County will plan for a reduction of environmental effects without accepting a lower quality of life in the process.	Comment: Cycling and walking are chief amongst the quality of life transportation options. Many cyclists and pedestrians choose their mode of travel solely for recreational purposes and the enjoyment it brings.
5) Maintain a minimum Level of Service (LOS) D for all roads throughout the County.	Comment: Often minimum vehicular LOS requirements can prohibit the incorporation infrastructure for alternative modes of travel due the requirements of space or lower delay for vehicular traffic. Minimum LOS standards should expand to include other modes (bicycle, pedestrian, transit) within corridors or areas where these modes are utilized and/or needed for daily travel.
2.3.3 Highway Plan	
Goals	
2) This plan proposes to improve access to Kern County using all available methods of transportation.	Comment: All roadway design should include at a minimum an assessment of the overall needs of each roadway. Not every mode of travel is needed or desired for every roadway. The needs of the user shall dictate the design of the roadways.
3) This plan sets up a simple way for protecting road right-of-way. Protecting corridors for future transportation facilities is the most important transportation planning activity in any high growth area.	Comment: The simple method for protecting roadway right-of-way does not always include alternative modes of travel.
Policies	
3) This plan's road width standards are listed below. These standards do not include State highway widths that would require additional right-of-way for rail transit, bike lanes and other modes of transportation. Kern County shall consider these modifications on a case-by-case basis. • Expressway [Four Travel Lanes] Minimum 110 foot right-of-way • Arterial [Major Highway] Minimum 110 foot right-of-way; County Standard 110 feet • Collector [Secondary Highway] Minimum 90 foot right-of-way; County Standard 90 feet • Commercial-Industrial Street Minimum 60 foot right-of-way; County Standard 60 feet • Local Street [Select Local Road] Minimum 60 foot right-of-way; County Standard 60 feet	Comment: As specifically stated, alternative modes of travel are not expressly included in the standard right-of-way designations. The standard roadway right-of-way and cross sections is discussed in Section 6.2.

2.3.10 Congestion Management Programs	
Implementation Measures	
B) The elements within the Kern Congestion Management Program are to be implemented by each incorporated city and the County of Kern. Specifically, the land use analysis program, including the preparation and adoption of deficiency plans is required. Additionally, the adoption of trip reduction and travel demand strategies are required in the Congestion Management Program.	Comment: The Congestion Management Program is included as an Element within the RTP, with further discussion of alternative modes of travel to reduce vehicle congestion.
2.5 Other Modes	
The Kern County Federal Transportation Improvement Plan (FTIP) prepared by The Kern Council of Governments, provides an examination of long-range transportation issues, opportunities, and needs for Kern County. The FTIP provides enough focus on "Other Modes" of transportation in Kern County. To provide uniformity and consistent information, the FTIP is hereby incorporated into this Plan. This incorporation specifically addresses mass transit, materials movement, traffic congestion management, pedestrian, bicycle, airports, and rail.	Comment: The Circulation Element makes no specific recommendations for policies on transit, bicycle, or pedestrian travel. The FTIP further defers policies for these modes of travel to the RTP.

transportation systems (ITS), among others. For each Element, the RTP discussed policies, planning, investments (actions), financing, and monitoring.

Table 8-2 presents a review of the relevant policies from the RTP which pertain to the development of Complete Streets within Kern County.

8.2 Review of Existing Cross Sections

The County of Kern's Engineering Department develops and maintains Development Standards which provide a base for the planning and construction of all public facilities. The Design Standards dictate the minimum design standards for streets, water supply, sewer, landscaping, and other public infrastructure. Division One of the Design Standards includes the required street typical sections based on the roadway designation and the adjacent land use. **Figure 8-1** thru **Figure 8-8** show several of the County's standard roadway cross sections. Each of the figures includes comments on the potential for Complete Streets incorporation.

8.2.1 Pedestrian Infrastructure

Each of the standard roadway designations for Type "A" roadways (Arterial Highways through Local Roads) includes a cross-section with and without sidewalk, curb, and gutter. All Type "B" roadways are shown without sidewalks. All cross-sections which call for sidewalks require a minimum of 5′ width (excluding the curb). This provides a larger area than required by ADA standards and increases the level of comfort and capacity for pedestrians.

All sidewalks are shown within a 10-12 foot area between the edge of right-of-way and the face of curb for roadways larger than the 60′ Type "A" Commercial Street. However, each of these cross-sections calls for the deletion of the sidewalk, curb, and gutter when fronting lots are larger than 2.5 acres (tract maps).

The 60′ Type "A" Commercial Street provides an 8′ sidewalk area between the edge of right-of-way and the curb face. This provides additional pedestrian comfort within areas most likely to see heavy pedestrian activity. However, this sidewalk may be reduced to a minimum of 5′ where landscaping is present and maintained by others.

Table 8-2: Regional Transportation Plan Relevant Policies

Goals	
1. Mobility	Improve the mobility of people and freight
2. Accessibility	Improve accessibility to, and the economic well being of, major employment and other regional activity centers
3. Reliability	Improve the reliability and safety of the transportation system
4. Efficiency	Maximize the efficiency and cost effectiveness of the existing and future transportation system
5. Livability	Promote livable communities and satisfaction of consumers with the transportation system
6. Sustainability	Provide for preservation and expansion of the system while minimizing effects on the environment
7. Equity	Ensure an equitable distribution of the benefits among various demographic and user groups
Comment: Each of the above goals presents an opportunity to provide not only for motorists, but all transportation users.	
Policies	
5. Seek additional funding to help maintain existing bikeways.	Comment: Maintaining existing bicycle facilities should receive the level of attention as roadway maintenance.
6. Seek funding for new bicycle projects from local, state and federal sources.	Comment: By actively seeking bicycle improvement funds, rather than incorporating them in to typical roadway projects, Complete Streets projects may be advanced through funding unavailable to typical roadway improvements.
9. Encourage Kern COG member jurisdictions to implement their adopted local bicycle plans and to incorporate bicycle facilities into local transportation projects.	Comment: Implementation of projects by individual agencies provides a ground level approach to providing bicycle facilities where they are needed most within each community.
10. Periodically update the Kern Regional Bicycle Plan.	Comment: The regional bicycle plan is needed to deliver large projects within and between communities, specifically unincorporated areas without typical transportation funding sources. The bicycle network will also benefit from long-range planning of facilities to ensure that projects are delivered with the same level of planning as typical roadway projects.
43. Expand the accident reduction campaigns on Kern's rural highways.	Comment: Safety improvements to all roadways will enhance the viability and attractiveness of alternative modes of travel, especially those areas without dedicated facilities.
52. Promote sustainable community design that supports transit use and increases nonmotorized transportation while still meeting the mobility needs of residents and employees.	Comment: As with all transportation planning, proper land use planning will provide increased opportunities, enhanced viability and attractiveness, and increased demand for the use of alternative and non-motorized modes of travel.

Figure 8-1: Kern County Roadway Standards, Arterial Highway

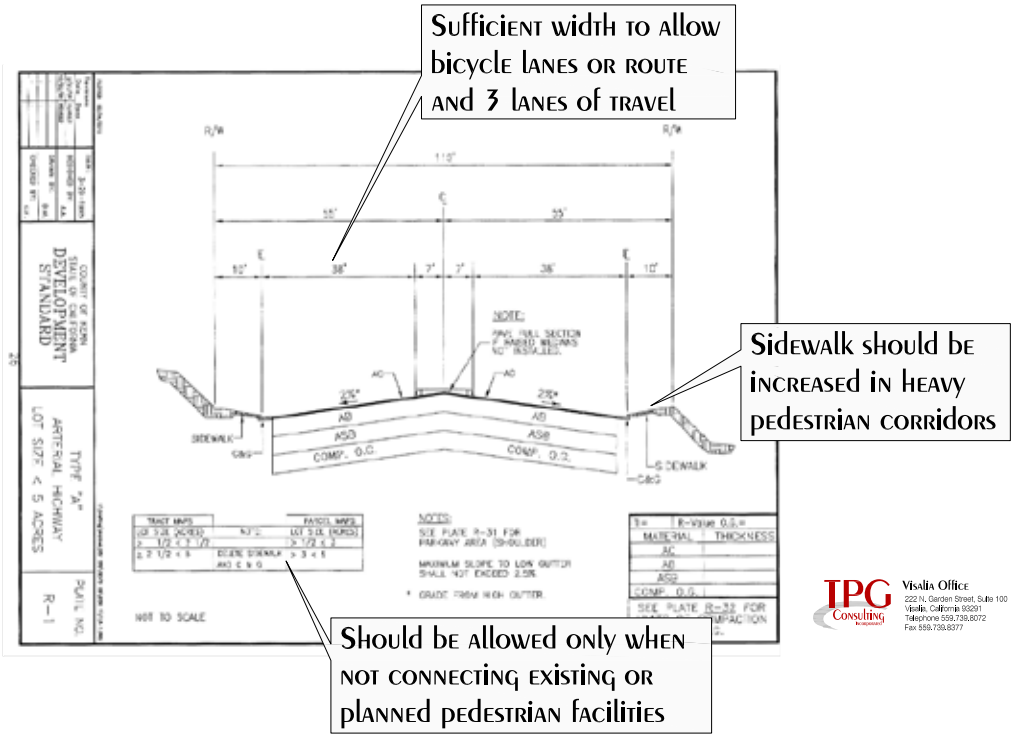


Figure 8-2: Kern County Roadway Standards, Collector Highway

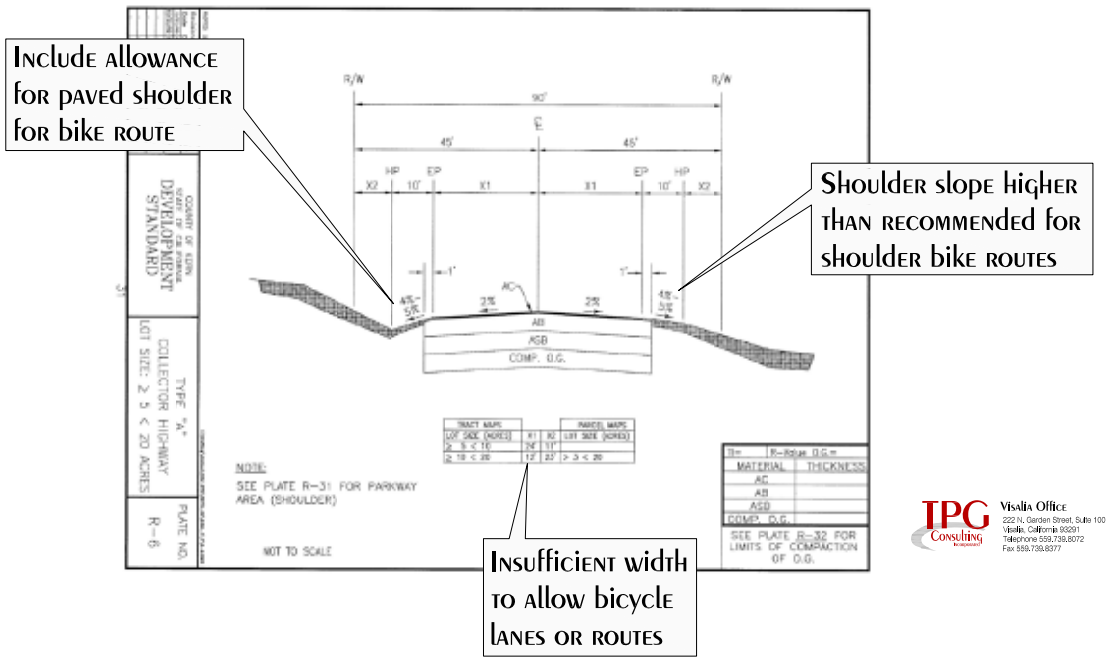


Figure 8-3: Kern County Roadway Standards, Local Street (<5 acres)

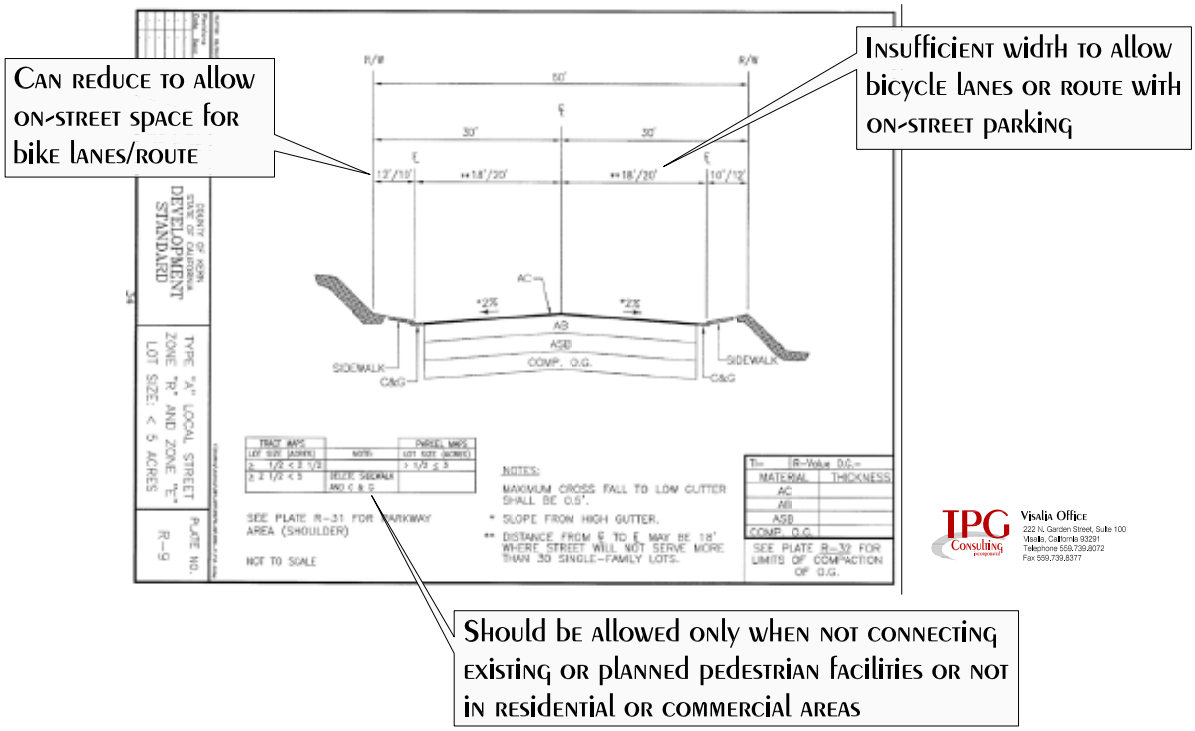


Figure 8-4: Kern County Roadway Standards, Local Street (>3 <20 acres)

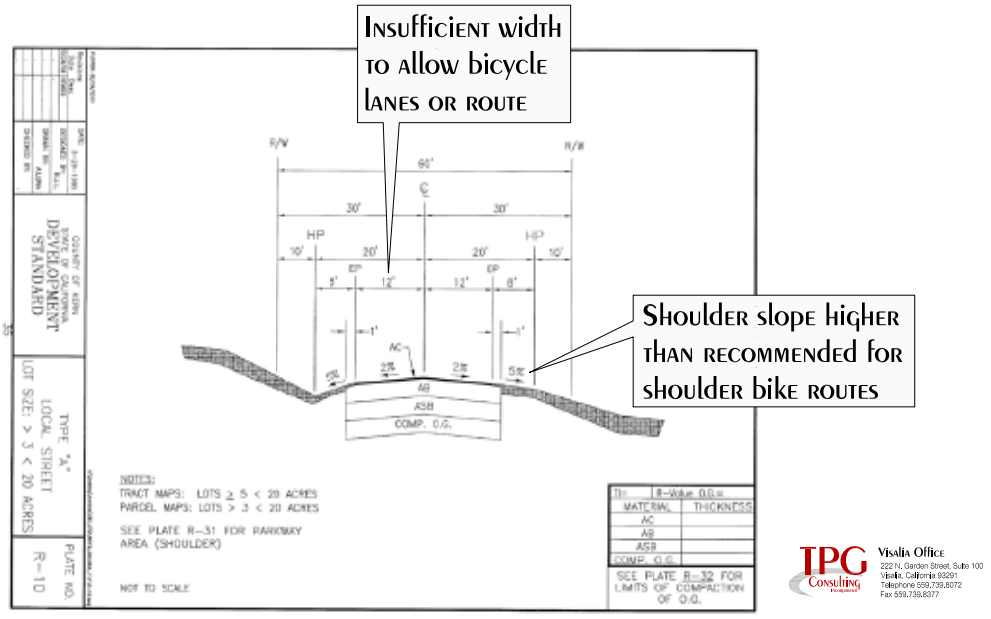


Figure 8-5: Kern County Roadway Standards, Commercial Street

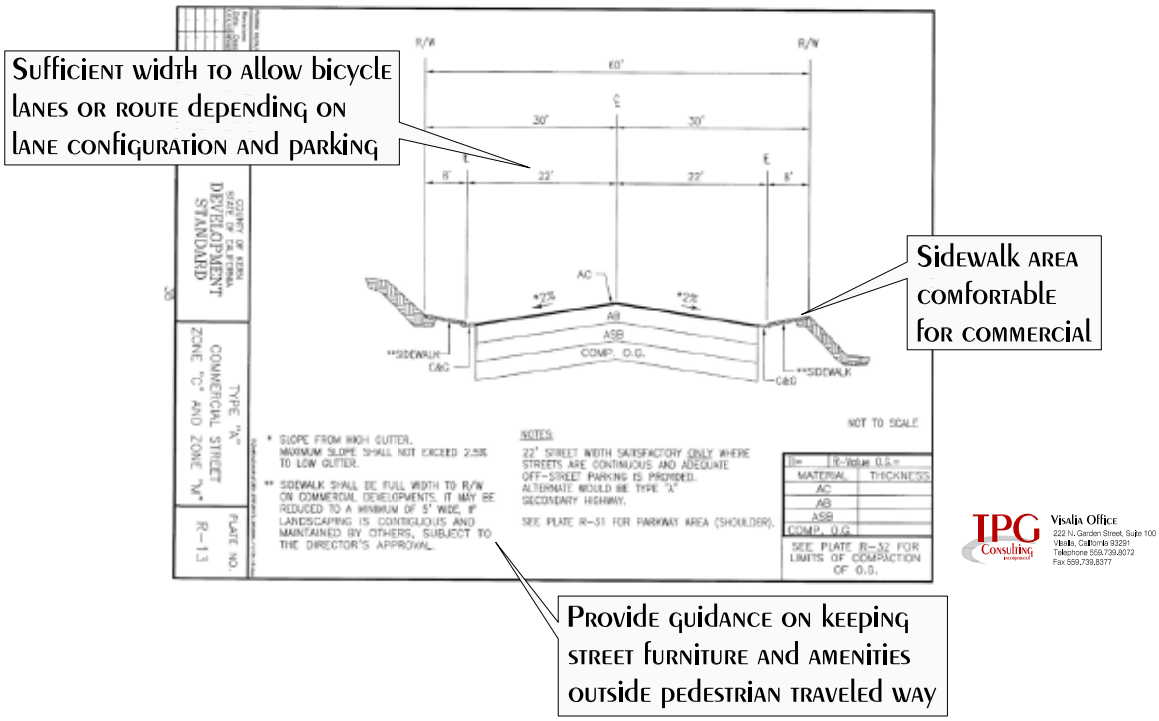


Figure 8-6: Kern County Roadway Standards, Collector Highway

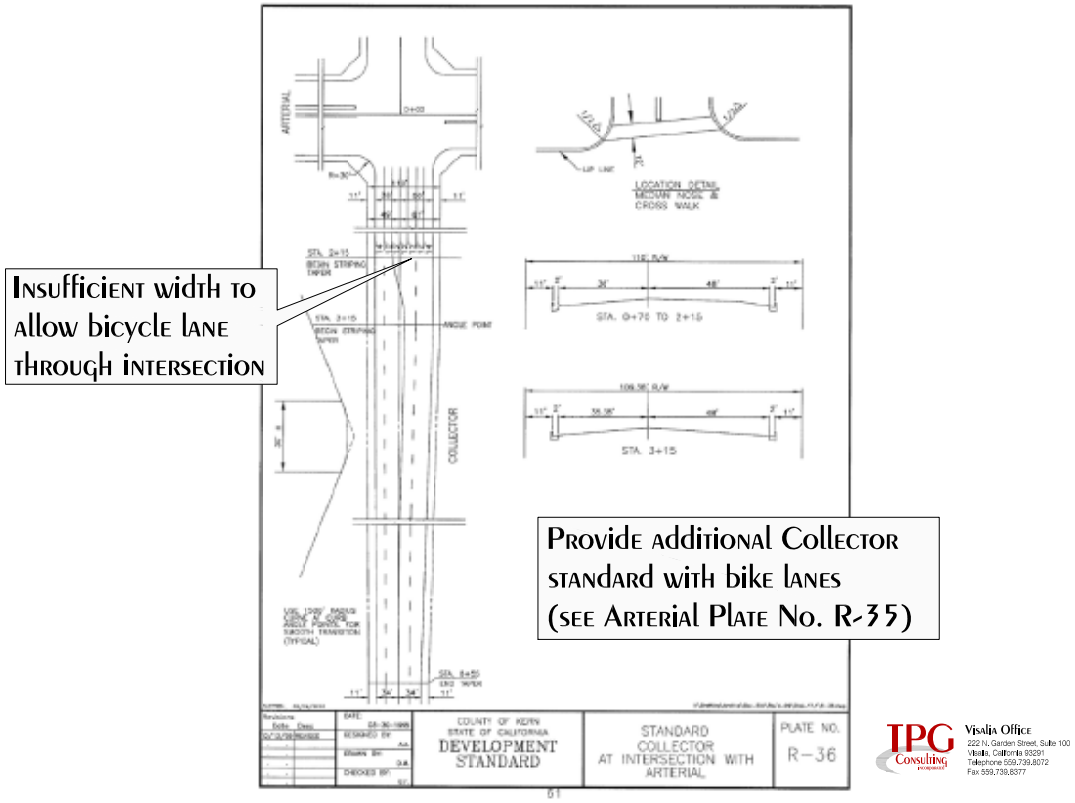


Figure 8-7: Kern County Roadway Standards, Turn Lane Transitions

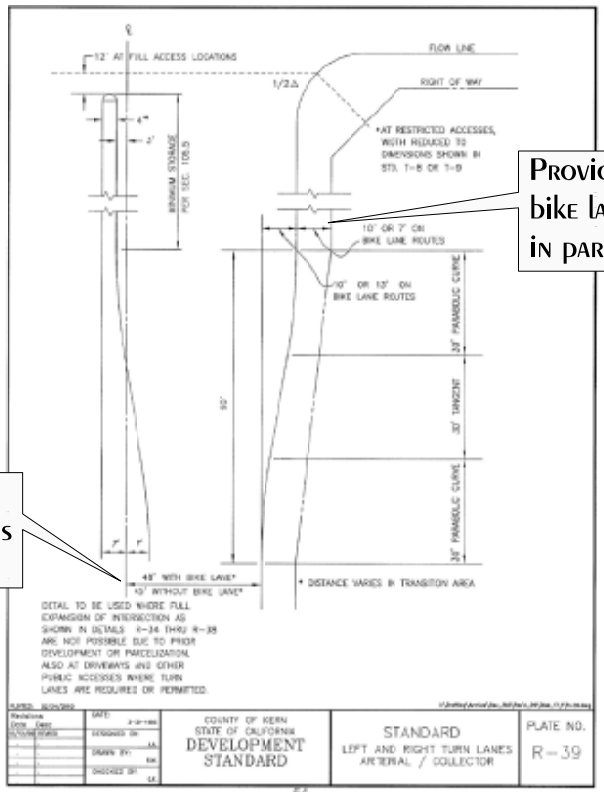
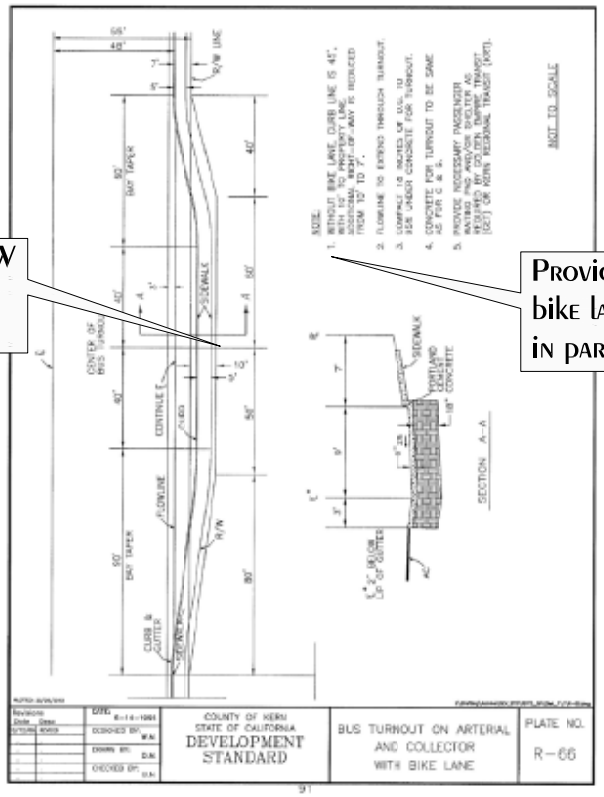


Figure 8-8: Kern County Roadway Standards, Bus Turn Out



8.2.2 Bicycle Infrastructure

Kern County's roadway cross-sections do not specifically identify bicycle facilities or designated areas within the right-of-way for their placement. The Design Standards provide the following guidance:

"When bike lanes are required along a highway, the curb line shall be extended (3) feet and the parkway area reduced three (3) feet."

This guidance allows for the installation of bicycle lanes by reducing the parkway width by three feet (which does not reduce the sidewalk area) and travel lanes within the roadway are similarly reduced (although not expressly shown). This installation is further demonstrated in the standard arterial transition at an intersection (Plate R-35). This Design Standard shows a bicycle lane's effect on the roadway and parkway. For a six-lane arterial, the middle lane is reduced from 12' to 11', the outside lane from 14' to 12' and the parkway reduced from 10' to 7'.* This Standard also details the transition of a bicycle lane through an intersection when a separate right-turn lane is present.

8.2.3 Transit Infrastructure

Bus turnouts are detailed in the Design Standards (Plate R-66). The Design Standards require bus turnouts at all Golden Empire Transit (GET) and Kern Regional Transit (KRT) bus stops as required by those entities. The bus turnouts provide a separate loading and unloading zone outside the normal roadway right-of-way to provide for uninterrupted flow of bicycles and vehicles on the roadway.

8.3 Current and Potential Barriers for Implementation

Current and future barriers to Complete Streets implementation come from several sources, including existing infrastructure, policies, and design standards.

8.3.1 Existing Infrastructure

Much of the existing roadway infrastructure within Kern County was not designed to accommodate bicycles, pedestrians, or transit. Often times, the demand for these modes of travel increase around older facilities through new development. Or the demand was always there ; however, the infrastructure was built to standards not incorporating other nodes of transportation. The retrofitting of existing infrastructure (and the funding to do so) is often more of a barrier than creating brand new facilities. Acquisition of right-of-way, relocation of structures and utilities, and reduction of automobile space all create significant hurdles to implementation of Complete Streets.

8.3.2 Policies

As previously identified in Section 8.1, Kern County's existing policy documents provide guidance and recommend goals for the implementation of Complete Streets. However, there are policies which create obstacles to the development of Complete Streets.

A minimum LOS policy, for vehicular travel, on roadways has always been an accepted and required part of any agency's transportation planning. However, this standard often leads to the over-construction of roadways to meet a peak threshold that may leave the roadway nearly deserted during a large portion of the day. The space to construct wider roads typically comes at the expense of infrastructure for alternative modes of travel since this is cheaper than acquiring additional right-of-way from adjacent property. An additional lane of travel will require approximately 12' of paved roadway. This equates to more space than is necessary for a bicycle lane and sidewalk, or as much space as a Class I bicycle path.

Further, there is no adopted LOS policy for

** Note: Sidewalk patterns below 10 feet may create sight distance problems for drivers, cyclists and pedestrians at driveways.*

pedestrian, bicycle or transit users. These transportation modes are often not analyzed quantitatively in transportation planning studies. The most current 2010 Highway Capacity Manual (HCM2010) provides detailed and accepted practices for analyzing LOS for each of these modes. Until these modes are analyzed quantitatively, they are not likely to receive the space or attention that they require to become viable transportation options.

Neither the Circulation Element nor the RTP include policies for the proper planning and development of pedestrian facilities. Often pedestrian facilities are included only where they are typically assumed to be needed, such as:

- Commercial retail areas
- Residential areas
- Schools
- Parks

However, pedestrian facilities connecting these uses can often be ignored, especially in rural areas. Pedestrian Master Plans within incorporated and unincorporated communities should be undertaken, along the lines of the Bicycle Plan, to address the planning and needs of future pedestrian facilities. In order to make walking a viable and attractive mode of transportation, the infrastructure must be in place for people to feel safe and comfortable. And in order to provide these facilities for the future, they must be planned in the present.

8.3.3 Design Standards

The Kern County Design Standards for bicycle and pedestrian facilities are less than comprehensive. Section 8.2 discusses the County's currently adopted standards for the construction of transportation facilities.

There is a lack of guidelines on the installation of bicycle facilities along the County's standard roadways. Only one type of roadway, Arterial, is shown with the proper location of bicycle lanes at or near an intersection. Each roadway type, from Arterial Highway to Local Street should be shown with the implementation of bicycle lanes, shared use markings, or other commonly utilized bicycle facilities. Furthermore, transitions for bicycles through various conflicts are not included (intersections, driveways, ramps, roundabouts, etc.).

There is also a lack of design standards for off-street trails and paths. Off-street facilities are not recommended in all areas and are typically reserved for large volume areas or special cases, despite being one of the best facilities for bicycle and pedestrian travel. They are used for both intra and inter-community travel and provide the highest level of safety and comfort for users.

8.4 Analysis of Opportunities for Complete Streets

Despite the above barriers to Complete Street implementation, there are abundant opportunities within Kern County. The following recommendations include several methods for achieving these opportunities both from a planning and design standpoint.

Existing facilities can most easily incorporate Complete Streets concepts through typical maintenance. As streets are resurfaced, repaired, or extended, many bicycle facilities can be incorporated for a nominal cost. Addition of bicycle lanes, "sharrows" or signage is typically a small portion of the overall cost of resurfacing a roadway.

The County must actively improve the accessibility of various land uses for alternative modes of travel. Bicycle connections between communities for commuter and recreational travel should be analyzed similarly to vehicular travel. Communities within Kern County should dedicate resources towards connecting complimentary uses via pedestrian and bicycle facilities. By providing complete connectivity, the increased viability of alternative modes of travel will gain users and acceptance.

The County should incorporate an LOS standard for all modes of travel. Incorporation of multiple modes into the Kern COG regional travel demand model is a large project, but would allow easier and better analysis of these modes. When comparing transportation improvement projects, this will allow a direct quantitative analysis of the various modes. This type of comparison will also allow the County to accept lower vehicular LOS when the LOS for alternative modes of travel is improved.

The County should incorporate clear pedestrian policies for County roadways. These policies should direct the placement of connecting facilities within communities and complimentary land uses. They should also address the usefulness of the pedestrian facilities. Sidewalks are of little use when a large portion of their functional area is occupied by poles, equipment, street furniture, landscaping, or other obstructions.

The County's roadway standards should be modified to include clear direction for the construction of bicycle facilities within County roadways. Bicycle signing and striping through intersections, ramps, driveways, etc. must all be properly designed if cyclists are to feel comfortable and know their place on the roadway.

The County should also maintain standards for the development of off-street bicycle and/or pedestrian facilities. At a minimum, these should include recommended widths, striping, offsets from buildings and roadways, and roadway crossing details. The County should also establish policies to incorporate off-street trails wherever possible along waterways, utility alignments or railroads (active or abandoned).

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9. Complete Streets Recommendations and Design Guidelines

9.1 Policy Recommendations

The following policies are recommended for the implementation of Complete Streets in Kern County:

- Develop a comprehensive bikeway and pedestrian network that is feasible, fundable over the life of the Plan, and that serves bicyclist's needs for all trip purposes.
- Prepare and maintain a Bicycle Master Plan that identifies existing and future needs, provides specific recommendations for facilities and programs, and identifies priorities and funding sources for implementation.
- Update the Bicycle Master Plan to meet requirements of Bicycle Transportation Account (BTA) funding at least every five years.
- Maintain and improve the quality, operation, and integrity of the bicycle and pedestrian network and support facilities.
- Increase public awareness of the benefits of bicycling and of available bicycle and trail facilities and programs.
- Bicycle signage and route maps should be made readily available and accessible to the public.
- As land uses within undeveloped areas of unincorporated communities are developed, bicycle, pedestrian, and transit facilities should be considered as a joint effort between the City and private development.
- These facilities should be required when connecting existing or planned facilities.
- The County should work with development to provide bicycle parking within reasonable walking distances to all destinations within Downtown. Bicycle parking should be as convenient as, or more so than, automobile parking.
- Coordinate roadway and development projects with the transit agency serving each area to provide the necessary amenities prior to construction.
- Incorporate bicycle, pedestrian, and transit improvements into Transportation Impact Fee programs when not solely used for recreation.
- Closure of gaps in pedestrian, bicycle, or transit network
- Prioritize Complete Streets projects based on the following criteria:
  - Expand existing network
  - Ease of implementation
  - Access to activity centers, neighborhoods, or regional network
  - Promote alternative travel use

9.2 Infrastructure and Facility Treatments

Chapter 7 of this report includes a number of facility treatments to incorporate pedestrian, bicycle, transit and safety enhancements to roadways. These treatments provide an added measure of comfort and safety for these modes while retaining the ability for vehicles to travel without significant encumbrance. The goal of any Complete Street should be the mobility and safety of all roadway users.

These treatments provide varied levels of effectiveness, safety, and cost. **Tables 9-1** through **9-4** provide weighting of each of these treatments and factors.

9.2.1 Pedestrian Treatments

Treatments such as landscaping, pedestrian signals, and curb extensions all provide high levels of protection for pedestrians as well as enhance the experience of pedestrian travel. Landscaping may be used only as an aesthetic treatment, or

Table 9-1: Effectiveness of Pedestrian Facility Treatments

Treatment	Reduces Vehicle Speed	Safety Increase	Level of Effectiveness*	Cost
Sidewalk	No	Moderate	Moderate	Low
High Visibility Crosswalks	Yes	Moderate-High	Moderate	Low
Pedestrian Signals	Yes	High	High	High
Street Furniture	No	Low	Low	Low
Landscaping	Maybe	Low-High	Moderate-High	Low-Moderate
Street Lighting	No	Moderate	Moderate	Moderate
Limit Driveways	Maybe	Moderate-High	High	Low-High
Curb Extensions	Yes	High	High	High
Curb Ramps	No	Moderate	Moderate-High	Low-Moderate
Pedestrian Refuge Islands	Maybe	High	High	Moderate
Triangular Median Islands	Maybe	High	High	Moderate-High
Pedestrian Push Buttons	No	Low-Moderate	Moderate	Low-Moderate
Pedestrian Countdown Signal	No	High	High	Moderate

**Note: Level of effectiveness refers to the enhancement of pedestrian experience and level of compliance (safety, comfort, reaction of other modes of travel, etc.)*

when placed between the street and sidewalk, a buffer zone for an additional level of safety. Curb extensions typically increase safety and comfort, except when designed without a grade separation from the roadway and vehicles may cut across them for tighter turns. Other treatments such as street furniture curb ramps, and push buttons (at signals) enhance the level of comfort for pedestrians, but by themselves, do not provide a significant level of safety improvement.

Costs vary for each type of implementation, and often the largest factor is the incorporation of the treatments into existing infrastructure. For instance, curb extensions may typically affect not only right-of-way, but drainage and parking as well. Reducing the number of driveways may be easily accomplished in undeveloped areas, but modifying existing access may prove difficult and costly in developed areas. Installation of pedestrian push buttons is less when installed with the traffic signal, but can increase dramatically when added to existing signals.

9.2.2 Bicycle Treatments

As with pedestrian enhancements, some treatments increase safety and are highly effective, while others may provide improvements in only one area. All treatments that result in a significant change in the roadway solely to the benefit of the cyclist, (e.g., bicycle signals and cycle tracks) should be installed with care and satisfaction of applicable criteria (warrants). Bicycle improvements installed without meeting minimum warrants may cause drivers to disregard them due to minimal use or installation in an area that significantly alters travel behavior.

Regarding costs, the largest factor in many bicycle enhancements is the availability of right-of-way. Many pavement marking enhancements (e.g. bicycle lanes, shared roadways, bike boxes) can be installed at minimal cost during a typical roadway resurfacing project. However, when additional right-of-way is needed, the cost to purchase land and install additional paved area can result in significant costs. A solution to this in many cases is the removal or reduction of on-street parking or travel lane widths.

Table 9-2: Effectiveness of Bicycle Facility Treatments

Treatment	Reduces Vehicle Speed	Safety Increase	Level of Effectiveness*	Cost
Striped Bike Lanes	Maybe	Moderate	Moderate	Low-Moderate
Buffered Bike Lanes	Yes	High	High	Moderate
Cycle Tracks	Yes	High	High	Moderate-High
Shared Roadways	Maybe	Low-Moderate	Moderate	Low-Moderate
Shoulder Bikeways	No	Low-Moderate	Low-Moderate	Low
Bicycle Detection	No	Moderate	High	Moderate
Intersection Crossing Markings	Maybe	Moderate-High	High	Moderate
Bike Boxes	Maybe	Moderate	High	Low
Bicycle Signals	Yes	High	High	High

**Note: Level of effectiveness refers to the enhancement of the cyclists' experience and level of compliance (safety, comfort, reaction of other modes of travel, etc.)*

9.2.3 Transit Treatments

The transit facility treatments shown in **Table 9-3** provide little in the way of safety by themselves. The level of safety is determined more by the separation of these enhancements from the roadway as well as the adjacent pedestrian and bicycle facilities. For instance, a shelter by itself provides a small safety increase through visibility when installed on an unimproved roadway shoulder, and little to no safety increase when installed on a sidewalk in a bus turnout.

However, all of the transit facility treatments provide improved experiences for the transit user. Shelters and seating provide comfort to the waiting passengers and may attract users; whereas, a bus stop with no amenities may cause riders to find an alternate mode of travel, especially in inclement weather conditions. Bicycle storage provides uncertain benefits, but is more effective when installed in or near destination areas where users are more likely to switch to short length trips. Trip information is also helpful to some passengers, but the majority of transit users will research or know their planned route ahead of time.

9.2.4 Roadway Treatments

As previously mentioned, curb extensions, reduced curb radii and chicanes/chokers can provide highly effective treatments, except when a grade separation or barrier (planter, etc.) is not present to prohibit wheel paths from encroaching onto the pedestrian traveled way. Speed feedback signs provide an active reminder to motorists of the speed limit which increases the likelihood of compliance. Rumble strips alert motorists when they are drifting off of the roadway and can be an effective safety measure for motorist and bicycle conflicts.

Table 9-3: Effectiveness of Transit Facility Treatments

Treatment	Reduces Vehicle Speed	Safety Increase	Level of Effectiveness*	Cost
Shelter	Maybe	Moderate	High	Moderate
Seating	No	Low	Moderate	Low
Bicycle Storage	No	Low	Low-High	Moderate
Trip Information	No	Low	Moderate	Low

**Note: Level of effectiveness refers to the enhancement of experience and level of compliance (safety, comfort, reaction of other modes of travel, etc.)*

Table 9-4: Effectiveness of Roadway Facility Treatments

Treatment	Reduces Vehicle Speed	Safety Increase	Level of Effectiveness*	Cost
Advance Stop Bar / Yield Line	Maybe	Moderate-High	High	Low-High
Curb Radii Reduction	Yes	Moderate	High	Moderate-High
Speed Humps / Speed Tables	Yes	Moderate-High	High	Moderate
Chicanes / Chokers	Yes	High	High	High
Speed Feedback Signs	Maybe	Moderate-High	Moderate-High	Low-Moderate
Traffic Circles	Yes	High	Moderate-High	Moderate-High
On-Street Parking	Yes	Negative[1]-Moderate	Moderate	Moderate-High
Wayfinding Signage	No	Low	Moderate	Low-Moderate
Road Diet	Maybe	Moderate	High	Moderate
Roadway Widening	Yes	Low-High	Low-High[2]	High

**Note: Level of effectiveness refers to the enhancement of pedestrian experience and level of compliance (safety, comfort, reaction of other modes of travel, etc.)*

[1]Negative = reduced safety to cyclists in some instances

[2] Depends upon the pedestrian/bicycle facility installed as a part of the widening, widening traffic lanes may reduce these factors.

Costs of roadway treatments are typically high due to demolition of existing facilities to install the planned enhancement. Installation of chicanes or traffic circles may also require significant traffic control costs during demolition and installation. Costs for speed humps can vary significantly depending on the material used. Striping and signage treatments are typically low and may be completed along with routine maintenance. Advance stop bars and yield lines may be installed at minimal expense except when they require the relocation of traffic signal detectors.

9.3 Multimodal Level of Service Recommendations

One of the biggest barriers in the implementation of Complete Streets is the current practice of using traffic level of service (LOS) standards to measure traffic congestion on the roadway network as often times the only performance measure. However, within Kern County, "jurisdictions are encouraged to incorporate multimodal level of service standards as appropriate for each community facility type, place type, and corridor type, as recommended in the latest Highway Capacity Manual update." (Kern COG Regional Transportation Plan, p 4-109.) Most are familiar with "level of service" as applied to traffic conditions as a measure of the motorist's perception of traffic operations along roadways and at intersections. Multimodal level of service (MMLOS) expands those measures to evaluate all major modes of travel: walking, biking, taking transit, and driving. MMLOS also provides a means to better understand the trade-offs among travel modes as they share the public right-of-way, while "non-motorized mode"-specific measures provide a means of measuring the performance or quality of the bicycling and walking environment. This effort provides an opportunity to expand the current performance measures of peak hour traffic congestion and frequencies and routes of transit service to include measures that address bicycling and walking conditions.

Performance measures for bikes and pedestrians have been developed, providing several options for multimodal level of service standards for consideration:

- Pedestrian Performance Measures – Several factors come into play when considering the pedestrian environment: ease at which a street can be crossed, including wait time and crossing distances; sidewalk presence and continuity; street density; vehicle volumes and speeds; percent of heavy vehicles; and topography. The 2010 Highway Capacity Manual, in addition to multimodal procedures, includes procedures to evaluate pedestrian LOS based on capacity and pedestrian density for areas of high pedestrian volumes, and on shared-use trails based on bicycle and pedestrian volumes. Pedestrian measures could apply across an entire district, be specific to a corridor, or measure the quality of a walk trip to access transit. The measures consider physical characteristics, location factors, and user factors. Others, like the Pedestrian Environmental Quality Index, measure the quality of walk trips.
- Bicycle Performance Measures – Bicycle LOS or other methods, such as the Bicycle Environmental Quality Index (BEQI), or Bicycle Compatibility Index (BCI), are based on measurable traffic and roadway factors, such as vehicle speed, volumes, and surface conditions. They provide a means for quantifying bicyclists' comfort level for specific roadway geometries and traffic conditions. "Compatibility" can be defined by factors such as bike lane presence and width, roadway width, traffic volumes, pavement surface conditions, motor vehicle's speed and type, and on-street parking.

This list touches upon some of the various measures available when considering multimodal level of service standards for Kern County. The County could adopt multimodal LOS standards using the latest 2010 Highway Capacity Manual or these other quality of service standards that have been developed for bicyclists and pedestrians.

9.3.1 2010 Highway Capacity Manual Multimodal LOS

Recently, the National Cooperative Highway Research Program (NCHRP) developed and calibrated a method for evaluating the multimodal level of service (MMLOS) provided by different urban street designs and operations. The method provides an LOS grade for each user type – motorist, transit passenger, bicyclist, and pedestrian – for a roadway corridor based on the user's perceptions of the quality of service provided by the street. The MMLOS method is designed for evaluating "complete streets," context-sensitive design alternatives, and smart growth from the perspective of all major roadway users on the urban street.

The 2010 Highway Capacity Manual adopted much of the NCHRP report for its multimodal level of service methodology. For bicyclists and pedestrians, the LOS grades correspond to numerical scores, which are calculated using a variety of inputs that cover the facility design, facility controls, and volumes. The thresholds for each LOS grade are shown in **Table 9-5** with a general description of what the scores represent for these alternative modes.

By applying the MMLOS methodology, the Bicyclist LOS is a weighted combination of the bicyclists' experience at intersections and on street segments in between the intersections. LOS A represents the best performance, with bicyclists feeling the most safe and comfortable as they travel through the intersections and along the segment, whereas LOS F represents the worst performance with bicyclists feeling the least safe and comfortable as they travel through the intersections and along the segment. The numerical score is dependent upon the width of the paving between the outside lane stripe and the edge of pavement (which includes parking lane and bike lane, if present) as well as the pavement condition. Vehicle speeds and volumes will also affect the bicycle segment LOS as well as the number

Table 9-5: Definition of Multimodal Level of Service (MMLOS)

LOS	Numerical Score	Bicycle	Pedestrian
A	≤2.00	Few driveway and cross street conflicts, good pavement condition, ample width of outside lane, including parking and bike lanes	Low traffic volumes, wide buffer separating sidewalk from traffic, numerous street trees, high parking occupancy
B	>2.00 and ≤2.75		
C	>2.75 and ≤3.50		
D	>3.50 and ≤4.25		
E	>4.25 and ≤5.00		
F	>5.00	Poor pavement condition, narrow width of outside lane, frequent driveways and cross streets	High traffic volumes, limited buffer separating sidewalk from traffic, few street trees, low parking occupancy

Source: 2010 Highway Capacity Manual

of access points (driveways and unsignalized cross streets) they encounter. For example, a Bicyclist LOS C for a roadway with a bike lane will require good pavement conditions.

Pedestrian LOS is based on the worst LOS between two methods: pedestrian density, as described in Chapter 18 of the Highway Capacity Manual, or a weighted combination of non-density factors related to pedestrians' experience on the street segment and at intersections, as well as roadway crossing difficulty. The density-based LOS thresholds are shown in **Table 9-6**.

Table 9-6: Pedestrian LOS Thresholds for Walkway Density

LOS	Walkway Density (in square feet per person)	Numerical Score
A	>60	≤2.00
B	>40	>2.00 and ≤2.75
C	>24	>2.75 and ≤3.50
D	>15	>3.50 and ≤4.25
E	>8	>4.25 and ≤5.00
F	≤8	>5.00

As a measure of the quality of the pedestrian's experience, the Pedestrian LOS methodology included in the latest 2010 Highway Capacity Manual is most sensitive to traffic volumes, buffer width between sidewalk and traffic, number of street trees, and parking occupancy. As with the Bicyclist LOS, LOS A represents the best performance with pedestrians feeling the most safe and comfortable as they travel along the segment, whereas LOS F represents the worst performance with pedestrians feeling the least safe and comfortable as they travel along the segment. Using this methodology, a pedestrian LOS C standard might be represented by a tree-lined street where the traffic lane is separated from the sidewalk by parked cars.

While detailed collision data is not specifically incorporated as part of the 2010 HCM bicycle and pedestrian LOS calculations, the perceived safety factors are accounted for by the lateral separation of the walkway from moving vehicles, buffer zone elements, and the number of potential conflicts from turning vehicles at intersections.

9.3.2 Issues with Development of Multimodal Performance Measures

Issues that arise in the development of the multimodal performance standards include:

- Consistency with current traffic LOS standards and transit performance measures.

- Prioritization of modes based on the user's need.
- Context for using bike and pedestrian LOS standards.

Each of these issues is discussed below.

Maintaining LOS standards would provide consistency with the current traffic LOS and transit measures in the RTP, but could be augmented with bicycle and pedestrian measures. The Bicyclist LOS and Pedestrian LOS standards could apply to all arterial and collector roadways, key roadways, such as designated multimodal corridors or CMP roadways, or a subset of the Congestion Management System. However, defining standards for these other modes may result in situations where a corridor meets the standard for some modes, but not all modes.

Flexible LOS standards would take into account motorist LOS but only as one of a number of context-related factors to better understand the trade-offs among travel modes inherent in street design. One approach may be to establish mode priorities. Some roadways serve as key development corridors, but also as the main through route for both motorists and bicyclists. As such, there will need to be a balance of priorities that can be measured using MMLOS to quantify the trade-offs among these competing modes. For example, for arterials serving mixed use, higher density development, the priority could be established for pedestrian LOS that would allow for a substandard motorist LOS.

In establishing multimodal LOS standards, the context needs to be considered. MMLOS may best be applied to specific corridors that serve multiple modes of travel and are constrained by development, such that roadway widening is not feasible. A Bicyclist LOS may only apply to corridors with existing or proposed bike lanes as a way to measure the effects of investment in bike lanes or Pedestrian LOS may be applied in areas with high pedestrian activity, such as downtown or near schools.

9.4 Level of Service Analysis for Bicycle Design Standards

For the purposes of this working paper, a link level analysis was performed using the 2010 Highway Capacity Manual MMLOS methodology to analyze the compatibility of the model design standards presented in the appendices. Using the cross-sections, the bicycle LOS and pedestrian LOS were determined for existing and proposed conditions. A range of directional traffic volumes from 250 to 2,000 vehicles per hour and speeds of 25 mph and 45 mph for the facilities were tested for each bike lane design standard to indicate the potential change in bicycle and pedestrian levels of service with and without the proposed bike lane. **Tables 9-7, 9-8, 9-9,** and **9-10** summarize the results of the link level analysis for each of the design standards detailed in the appendices section "Class II Bikeway: Retrofitting Existing Streets" assuming an average vehicle speed of 45 mph.

9.4.1 Class II Bikeway: Retrofitting Existing Streets, Roadway Widening

Table 9-7 shows Pedestrian and Bicyclist LOS results when the roadway is widened to accommodate the Class II bikeway and a sidewalk when compared to existing conditions without a bike lane and/or sidewalk. It also shows the results with and without on-street vehicle parking. Key findings are that this design:

- Improves the Bicyclist LOS by at least one letter grade depending upon the directional vehicle volumes.
- Improves the Pedestrian LOS dramatically by providing the sidewalk, especially with the additional separation from moving vehicles with the on-street parking.

The roadway widening benefits both the bicyclist and pedestrian, particularly on lower volume two lane roadways.

Table 9-7: Class II Bikeway: Retrofitting Existing Streets, Roadway Widening

	Cross Section		Volume							
			250	500	750	1000	1250	1500	1750	2000
Roadway Widening	Bike (EB) with parking	Existing	3.80 (D)	4.15 (D)	4.35 (E)	4.50 (E)	4.61 (E)	4.71 (E)	4.78 (E)	4.85 (E)
		Proposed	2.82 (C)	3.17 (C)	3.38 (C)	3.52 (D)	3.64 (D)	3.73 (D)	3.81 (D)	3.88 (D)
	Ped (EB) with parking	Existing	4.10 (D)	4.67 (E)	5.24 (F)	5.81 (F)	6.38 (F)	6.94 (F)	7.51 (F)	8.08 (F)
		Proposed	1.96 (A)	2.53 (B)	3.09 (C)	3.66 (D)	4.23 (D)	4.80 (E)	5.37 (F)	5.94 (F)
	Bike (WB) no parking	Existing	3.80 (D)	4.15 (D)	4.35 (E)	4.50 (E)	4.61 (E)	4.71 (E)	4.78 (E)	4.85 (E)
		Proposed	2.04 (B)	2.39 (B)	2.60 (B)	2.75 (B)	2.86 (C)	2.95 (C)	3.03 (C)	3.10 (C)
	Ped (WB) no parking	Existing	4.10 (D)	4.67 (E)	5.24 (F)	5.81 (F)	6.38 (F)	6.94 (F)	7.51 (F)	8.08 (F)
		Proposed	2.45 (B)	3.01 (C)	3.58 (D)	4.15 (D)	4.72 (E)	5.29 (F)	5.86 (F)	6.43 (F)

Table 9-8: Class II Bikeway: Retrofitting Existing Streets, Lane Narrowing

	Cross Section		Volume							
			250	500	750	1000	1250	1500	1750	2000
Lane Narrowing	Bike (EB)	Existing	4.14 (D)	4.49 (E)	4.70 (E)	4.84 (E)	4.96 (E)	5.05 (F)	5.13 (F)	5.20 (F)
		Proposed	3.21 (C)	3.56 (D)	3.77 (D)	3.91 (D)	4.03 (D)	4.12 (D)	4.20 (D)	4.27 (E)
	Ped (EB)	Existing	2.00 (B)	2.57 (B)	3.14 (C)	3.71 (D)	4.28 (E)	4.85 (E)	5.42 (F)	5.99 (F)
		Proposed	1.98 (A)	2.55 (B)	3.12 (C)	3.68 (D)	4.25 (E)	4.82 (E)	5.39 (F)	5.96 (F)
	Bike (WB)	Existing	4.14 (D)	4.49 (E)	4.70 (E)	4.84 (E)	4.96 (E)	5.05 (F)	5.13 (F)	5.20 (F)
		Proposed	3.21 (C)	3.56 (D)	3.77 (D)	3.91 (D)	4.03 (D)	4.12 (D)	4.20 (D)	4.27 (E)
	Ped (WB)	Existing	2.00 (B)	2.57 (B)	3.14 (C)	3.71 (D)	4.28 (E)	4.85 (E)	5.42 (F)	5.99 (F)
		Proposed	1.98 (A)	2.55 (B)	3.12 (C)	3.68 (D)	4.25 (E)	4.82 (E)	5.39 (F)	5.96 (F)

9.4.2 Class II Bikeway: Retrofitting Existing Streets, Lane Narrowing

Table 9-8 shows Pedestrian and Bicyclist LOS results when the vehicle lane is narrowed to accommodate the Class II bikeway when compared to existing conditions without a bike lane. Key findings are that this design:

- Improves the Bicyclist LOS by at least one letter grade depending upon the directional vehicle volumes.
- Results in minor changes to the Pedestrian LOS at low vehicle volumes and no changes to Pedestrian LOS at higher volumes.

The lane narrowing primarily benefits the bicyclist. In this case, pedestrians already have a sidewalk without the changes to accommodate the bike lane.

9.4.3 Class II Bikeway: Retrofitting Existing Streets, Lane Reconfiguration

Table 9-9 shows Pedestrian and Bicyclist LOS results when the travel lanes are reconfigured to accommodate the Class II bikeway when compared to existing conditions without a bike lane. Key findings are that this design:

- Improves the Bicyclist LOS by two letter grades for the range of direction vehicle volumes.
- Degrades the Pedestrian LOS, particularly at higher volumes.

The lane reconfiguration benefits only the bicyclist. The road diet, which consolidates traffic to a single travel lane, results in a degraded Pedestrian LOS due to more vehicles traveling in closer proximity to the walkway.

Table 9-9: Class II Bikeway: Retrofitting Existing Streets, Lane Reconfiguration

	Cross Section		Volume							
			250	500	750	1000	1250	1500	1750	2000
Lane Reconfiguration	Bike (EB)	Existing	3.97 (D)	4.32 (E)	4.52 (E)	4.67 (E)	4.78 (E)	4.87 (E)	4.95 (E)	5.02 (F)
		Proposed	2.50 (B)	2.85 (C)	3.06 (C)	3.21 (C)	3.32 (C)	3.41 (C)	3.49 (C)	3.56 (D)
	Ped (EB)	Existing	2.39 (B)	2.68 (B)	2.96 (C)	3.25 (C)	3.53 (D)	3.82 (D)	4.10 (D)	4.38 (E)
		Proposed	2.48 (B)	3.05 (C)	3.62 (D)	4.19 (D)	4.76 (E)	5.33 (F)	5.90 (F)	6.46 (F)
	Bike (WB)	Existing	3.97 (D)	4.32 (E)	4.52 (E)	4.67 (E)	4.78 (E)	4.87 (E)	4.95 (E)	5.02 (F)
		Proposed	2.50 (B)	2.85 (C)	3.06 (C)	3.21 (C)	3.32 (C)	3.41 (C)	3.49 (C)	3.56 (D)
	Ped (WB)	Existing	2.39 (B)	2.68 (B)	2.96 (C)	3.25 (C)	3.53 (D)	3.82 (D)	4.10 (D)	4.38 (E)
		Proposed	2.48 (B)	3.05 (C)	3.62 (D)	4.19 (D)	4.76 (E)	5.33 (F)	5.90 (F)	6.46 (F)

Table 9-10: Class II Bikeway: Retrofitting Existing Streets, Parking Reduction

	Cross Section		Volume							
			250	500	750	1000	1250	1500	1750	2000
Parking Reduction	Bike (EB) with parking	Existing	4.56 (E)	4.91 (E)	5.12 (F)	5.26 (F)	5.38 (F)	5.47 (F)	5.55 (F)	5.62 (F)
		Proposed	3.39 (C)	3.74 (D)	3.95 (D)	4.09 (D)	4.21 (D)	4.30 (E)	4.38 (E)	4.45 (E)
	Ped (EB) with parking	Existing	2.06 (B)	2.63 (B)	3.20 (C)	3.77 (D)	4.34 (E)	4.91 (E)	5.48 (F)	6.05 (F)
		Proposed	1.99 (A)	2.56 (B)	3.13 (C)	3.70 (D)	4.27 (E)	4.84 (E)	5.41 (F)	5.97 (F)
	Bike (WB) no parking	Existing	4.56 (E)	4.91 (E)	5.12 (F)	5.26 (F)	5.38 (F)	5.47 (F)	5.55 (F)	5.62 (F)
		Proposed	2.72 (B)	3.07 (C)	3.27 (C)	3.42 (C)	3.53 (D)	3.63 (D)	3.70 (D)	3.77 (D)
	Ped (WB) no parking	Existing	2.06 (B)	2.63 (B)	3.20 (C)	3.77 (D)	4.34 (E)	4.91 (E)	5.48 (F)	6.05 (F)
		Proposed	2.50 (B)	3.07 (C)	3.64 (D)	4.21 (D)	4.77 (E)	5.34 (F)	5.91 (F)	6.48 (F)

9.4.4 Class II Bikeway: Retrofitting Existing Streets, Parking Reduction

Table 9-10 shows Pedestrian and Bicyclist LOS results when on-street parking occupancies are reduced or removed to accommodate the Class II bikeway when compared to existing conditions without a bike lane. Key findings are that this design:

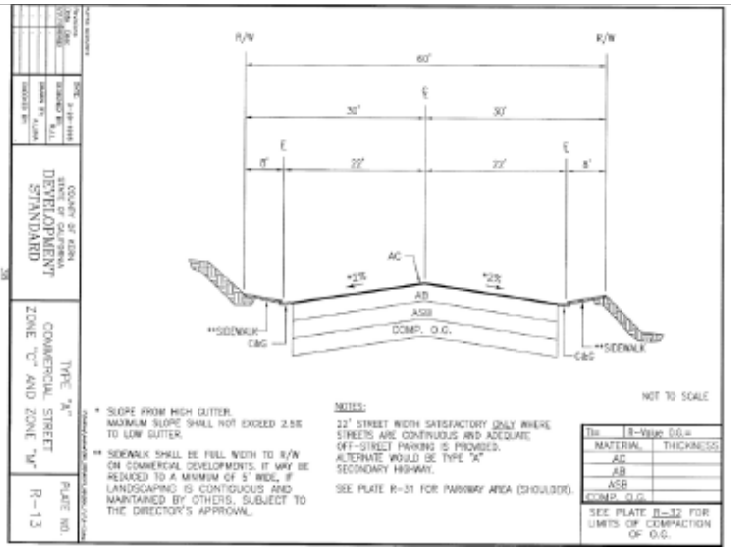
- Improves the Bicyclist LOS by one or more letter grades depending upon the vehicle volumes and parking by direction.
- Results in minor changes to the Pedestrian LOS at low vehicle volumes, no changes to Pedestrian LOS at higher volumes for the side with on-street parking.
- Results in no change to or degrades the Pedestrian LOS, depending upon the vehicle volume for the side without on-street parking.

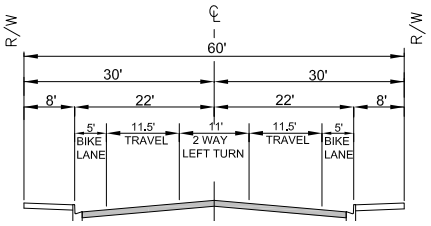
The parking reduction benefits the bicyclist. The reduction of parking on one side shifts the center line which affects the separation of pedestrian from moving traffic resulting in a degraded Pedestrian LOS.

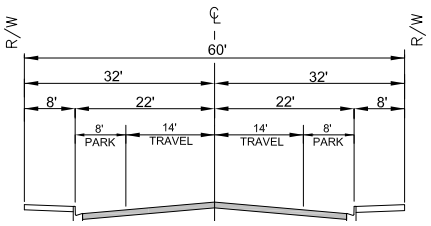
9.5 County Design Standards

As noted in Chapter 6, the Kern County Design Standards provide information including cross sectional details for each roadway type and more information on incorporating bicycle facilities than many adjacent city and county documents. Following on from the recommendation made in previous sections and to address the few gaps in bicycle facility design, new and modified designs shown in **Figures 9-1** through **9-6** are proposed for incorporation into the standards.

Figure 9-1: Kern County Roadway Standards, Commercial Street Alternatives

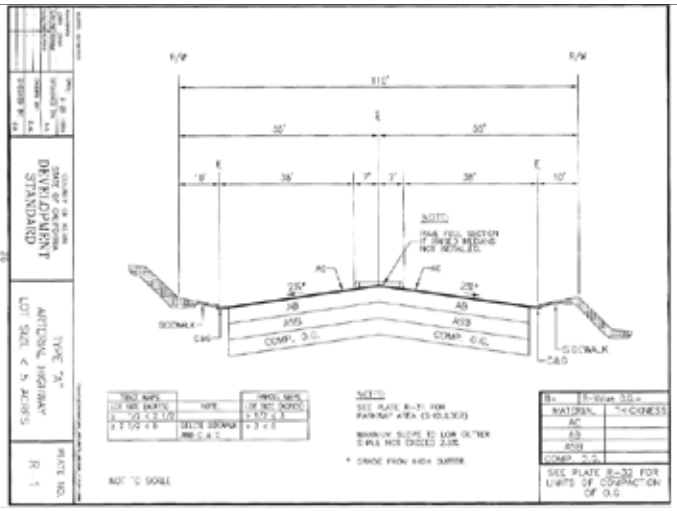






Note: Sidewalk patterns below 10 feet may create sight distance problems for drivers, cyclists and pedestrians at driveways.

Figure 9-2: Kern County Roadway Standards, Arterial Highway Bike Route



COMPLETE STREETS ARTERIAL HIGHWAY
BIKE PATH

Figure 9-3: Kern County Roadway Standards, Arterial Highway Bike Trail

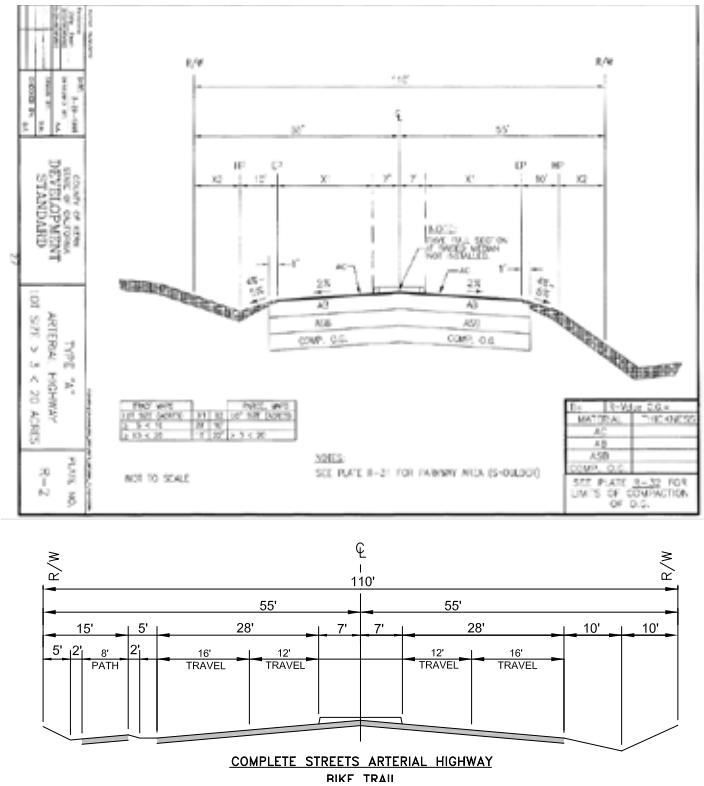
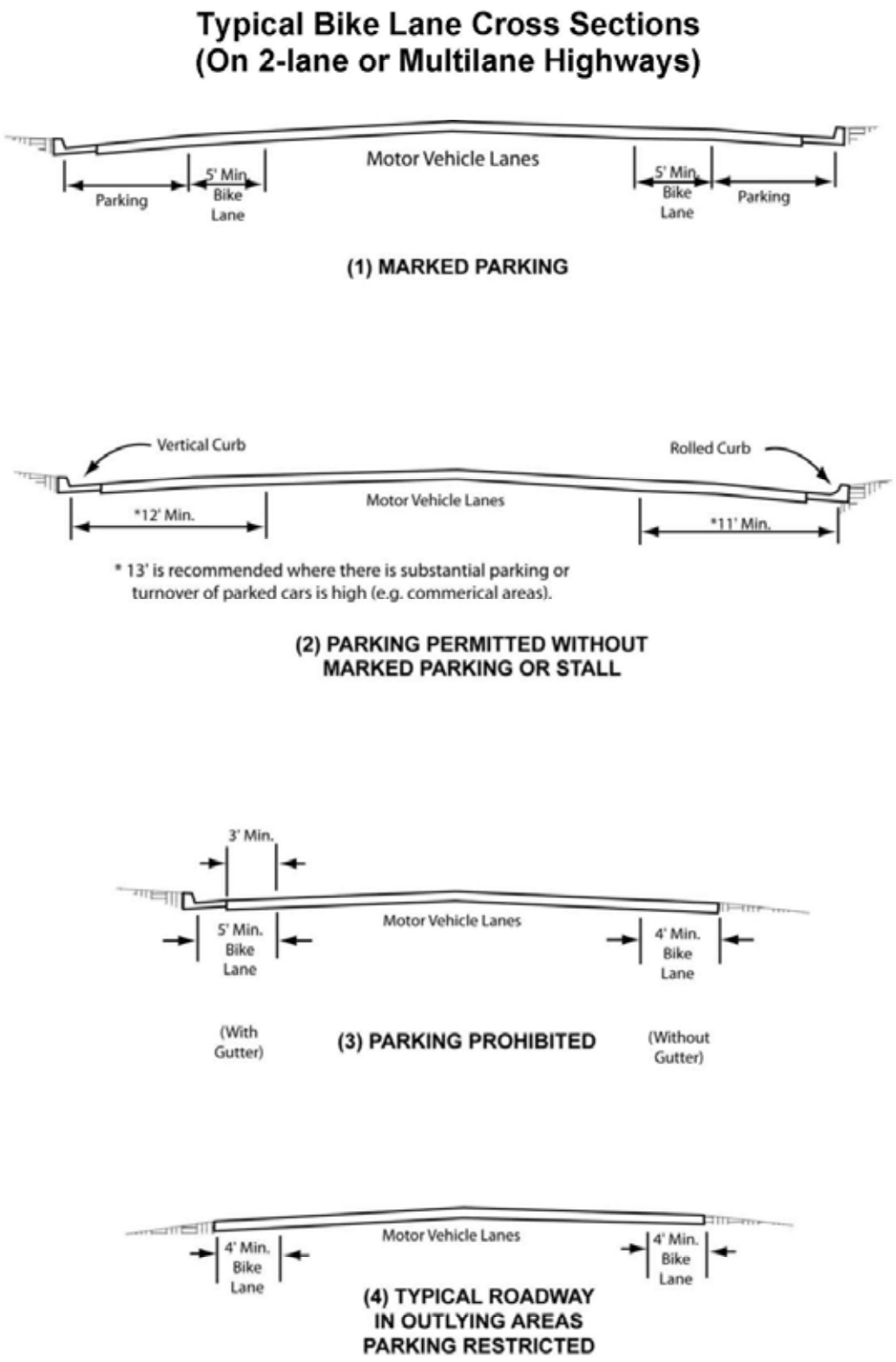


Figure 9-4: Kern County Roadway Standards, Off-Street Trail Standards

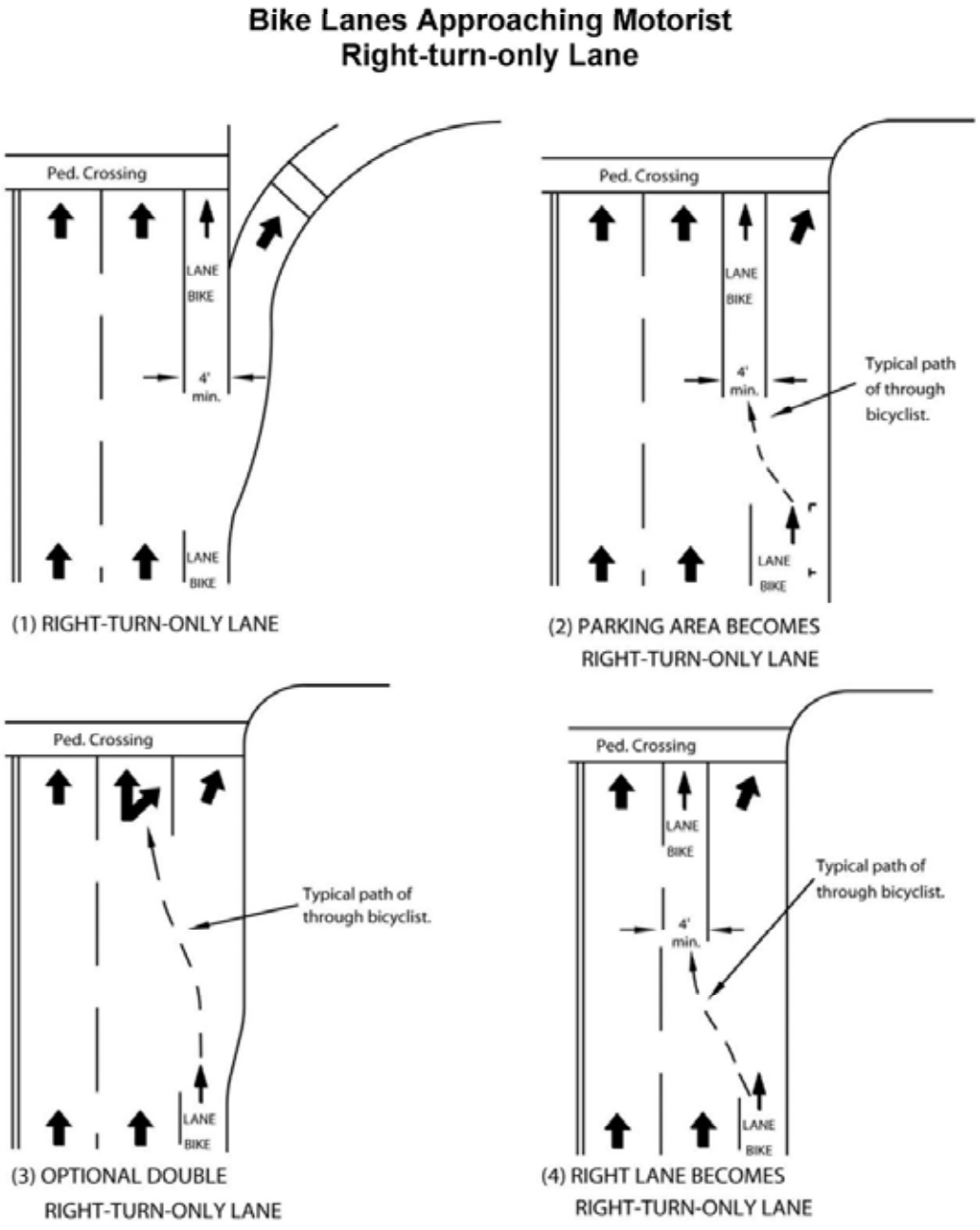
Source: Caltrans Highway Design Manual, Chapter 1000

Figure 9-5: Kern County Roadway Standards, Typical Widths for Class II Bike Lanes



Source: Caltrans Highway Design Manual, Chapter 1000

Figure 9-6: Kern County Roadway Standards, Bike Lane Transitions at Intersections



Source: Caltrans Highway Design Manual, Chapter 1000

9.6 Innovative Facilities

This section presents design guidelines for innovative complete streets treatments. The following guidelines should be assessed and implemented on a case-by-case basis depending on the existing conditions of the project site. They are organized by pedestrian facilities, bicycle treatments, transit treatments, and roadway treatments.

9.6.1 Applicability

These guidelines are recommendations and do not constitute a standard which must be followed, or suggest that the treatments are necessarily approved by Kern County. They represent the most innovative practices now being undertaken elsewhere in the United States. Guidelines may be used alongside sound traffic engineering judgment to inform the provisions for bicycling. Where there is a discrepancy with a requirement outlined in an applicable California manual, then that manual takes precedence over the guideline.

For geometric design and layout of bicycle facilities on state highways, the California Streets and Highways Code Section 890.6 specifies that the California Department of Transportation (Caltrans) "in cooperation with county and city governments, shall establish minimum safety design criteria for the planning and construction of bikeways and roadways where bicycle travel is permitted. The criteria shall include, but not be limited to, the design speed of the facility, minimum widths and clearances, grade, radius of curvature, pavement surface, actuation of automatic traffic control devices, drainage, and general safety." These criteria are contained within the California Highway Design Manual (HDM) Chapter 1000. Although the HDM applies to state highways only (not local streets), Section 891 currently requires cities, counties, and other agencies to utilize the HDM safety design criteria for bikeways or roadways where bicycle travel is permitted. The HDM "is neither intended as, nor does it establish, a legal standard...the standards, procedures and requirements...herein are for the information and guidance of the officers and employees of the Department." In other words, the HDM is not a substitute for the application of sound engineering judgment.

For signs and markings, Section 890.8 specifies that Caltrans "shall establish uniform specifications and symbols for signs, markers, and traffic control devices to designate bikeways, regulate traffic, improve safety and convenience for bicyclists, and alert pedestrians and motorists of the presence of bicyclists on bikeways and on roadways where bicycle travel is permitted." These specifications are contained within the California Manual of Uniform Traffic Control Devices (CA-MUTCD). The CA-MUTCD is applicable to all public streets, highways, pedestrian facilities and bikeways in the state, but not to private roads.

Section 18 of the CA-MUTCD states that "in cases involving Federal-aid projects for new highway or bikeway construction or reconstruction, the traffic control devices installed (temporary or permanent) shall be in conformance with the most recent edition of the National MUTCD before that highway is opened or re-opened to the public for unrestricted travel [23 CFR 655.603(d)(2) and (d)(3)]."

Some of the designs presented in this chapter are currently approved or in trial at the federal or state level. If adopted at the federal level, the Code of Federal Regulations requires that the CA-MUTCD be in substantial conformance with changes to the National MUTCD within 2 years of the effective date of the Final Rule for the changes.

Innovations could be implemented through an experimental trial, which generally requires the collection of before and after treatment data and a potentially lengthy approval process. Assembly Bill 819: Bikeways was enrolled on August 22, 2012. If signed and chartered, this legislation would establish procedures for granting exceptions to the HDM and CA-MUTCD.

9.6.2 Design Guidelines for Pedestrian Facilities

Sidewalks

Design Summary

	Curb	Planting Strip (buffer)*	Sidewalk Width
Arterials and Collectors	1 ft	6-8 ft	8 ft †
Local Streets	0-1 ft	6-8 ft	5 ft †
Bus Stops	1 ft	varies	5' x 8' area ‡
Commercial Walkways	1 ft	6-8 ft	6-10 ft
Mixed Use Center Streets	1 ft	6-8 ft	10-12 ft

* In constrained locations, the full sidewalk width should be provided, with a reduced-width planting strip/buffer.
† Note: short sidewalk segments can have narrower widths in physically-constrained areas.
‡ Required minimum by ADA
† Sidewalk patterns below 10 feet may create sight distance problems for drivers, cyclists and pedestrians at driveways.

Discussion

Recommended widths enables two pedestrians (including wheelchair users) to walk side-by-side, or to pass each other comfortably. Proposed sidewalk guidelines apply to new development and depend on available street width, motor vehicle volumes, surrounding land uses, and pedestrian activity levels. Standardizing sidewalk guidelines for different areas of the region, dependent on the above listed factors, ensure a minimum level of quality for all sidewalks. As part of a roadway reconstruction project on a street with a narrow sidewalk corridor, planners should analyze the impact of reclaiming a portion of the existing right-of-way. If this proves impractical, the feasibility of acquiring additional right-of-way should be examined. Acquisition should be considered where cost is reasonable in proportion to the overall project cost.

Guidance

- United States Access Board. (2002). Accessibility Guidelines for Buildings and Facilities.
- United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).

A well-designed sidewalk provides plenty of pedestrian space.

A landscaping buffer between the sidewalk and the street provides the pedestrian with a protected space from motor vehicle traffic.

High Visibility Crosswalks

Design Summary

- See MUTCD for pavement marking spacing.
- Mark all crosswalks at signalized intersections. At un-signalized intersections, mark crosswalks under the following conditions:
  - At a complex intersection, to orient pedestrians in finding their way across.
  - At an offset intersection, to show pedestrians the shortest route across traffic with the least exposure to vehicular traffic and traffic conflicts.
  - At an intersection with visibility constraints, to position pedestrians where they can best be seen by oncoming traffic.
- At mid-block locations, mark crosswalks where:
  - There is a demand for crossing AND
  - There are no nearby marked crosswalks.

Discussion

Marking crosswalks, especially high visibility crosswalks, signals to drivers that they should stop for pedestrians, and encourages pedestrians to cross at safer locations. Crosswalk markings also indicate to pedestrians the appropriate route across traffic, to facilitate crossing by the visually impaired and remind turning drivers of potential conflicts with pedestrians.

Use ladder pavement markings at crossings with high pedestrian use or where vulnerable pedestrians are expected, including:

- School crossings.
- Across arterial streets for pedestrian-only signals.
- At mid-block crosswalks.

Guidance

- United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).
- FHWA. (2005). Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations Final Report and Recommended Guidelines. http://www.fhwa.dot.gov/publications/research/safety/04100/

Ladder / zebra style crosswalks increase the visibility of pedestrians to drivers because the striping is in the same direction as the motorist path of travel.

Marking high visibility crosswalks at schools help children cross at safer locations.

Pedestrian Signals: Hybrid Beacons

Design Summary

Hybrid beacons are used to improve non-motorized crossings of major streets. A hybrid beacon consists of a signal-head with two red lenses over a single yellow lens on the major street, and a pedestrian signal head for the crosswalk.

Hybrid beacons may be installed without meeting traffic signal control warrants if roadway speed and volumes are excessive for comfortable pedestrian crossings.

- If installed within a signal system, signal engineers should evaluate the need for the hybrid signal to be coordinated with other signals.
- Parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the marked crosswalk to provide adequate sight distance.

A hybrid beacon consists of a signal-head with two red lenses over a single yellow lens on the major street

Discussion

Hybrid beacon signals are normally activated by push buttons, but may also be triggered by infrared, microwave or video detectors. The maximum delay for activation of the signal should be two minutes, with minimum crossing times determined by the width of the street.

Each crossing, regardless of traffic speed or volume, requires additional review by a registered engineer to identify sight lines, potential impacts on traffic progression, timing with adjacent signals, capacity, and safety.

Hybrid beacons are subject to the same maintenance needs and requirements as standard traffic signals. Signing and striping need to be maintained to help users understand any unfamiliar traffic control.

Guidance

- FHWA. (2009). Manual on Uniform Traffic Control Devices.
- NACTO. (2011). Urban Bikeway Design Guide.

Pedestrian Signals: Active Warning Beacons

Design Summary

Active warning beacons are user actuated illuminated devices designed to increase motor vehicle yielding compliance at crossings of multi lane or high volume roadways. Types of active warning beacons include conventional circular yellow flashing beacons, in-roadway warning lights, or Rectangular Rapid Flash Beacons (RRFB).

- Warning beacons shall not be used at crosswalks controlled by YIELD signs, STOP signs, or traffic signals.
- Warning beacons shall initiate operation based on pedestrian or bicyclist actuation and shall cease operation at a predetermined time after actuation or, with passive detection, after the pedestrian or bicyclist clears the crosswalk.

Discussion

Rectangular rapid flash beacons have the most increased compliance of all the warning beacon enhancement options.

A study of the effectiveness of going from a no-beacon arrangement to a two-beacon RRFB installation increased yielding from 18 percent to 81 percent. A four-beacon arrangement raised compliance to 88 percent. Additional studies over long term installations show little to no decrease in yielding behavior over time.

Guidance

- NACTO. (2011). Urban Bikeway Design Guide. FHWA. (2009).
- Manual on Uniform Traffic Control Devices. FHWA. (2008).
- MUTCD - Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons (IA-11)

Example of Rectangular Rapid Flash Beacons (RRFB)

Pedestrian Amenities

Design Summary

Amenities can make a pedestrian zone more inviting to users. Costs vary depending on the design and materials selected for each amenity. Amenities should be designed and located so as not to impede accessibility, and should be placed to create a buffer between the sidewalk and the street.

Discussion

Benches

Providing benches at key rest areas encourages people of all ages to walk by ensuring that they have a place to rest along the way. Benches can be simple (e.g., wood slates) or more ornate (e.g., stone, wrought iron, concrete).

Water Fountains

Water fountains provide water for people (and pets, in some cases), encouraging pedestrians to take a longer trip and improving user comfort.

Trash Receptacles

Litter receptacles should be placed frequently along sidewalks. Litter should be picked up regularly (at least once per week) to ensure a clean and inviting environment.

Guidance

- United States Access Board. (2002). Accessibility Guidelines for Buildings and Facilities.
- United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).

Benches, water fountains, and trash receptacles help to create a clean and comfortable pedestrian environment, thus encouraging people to walk more often.

Limit Driveways

Design Summary

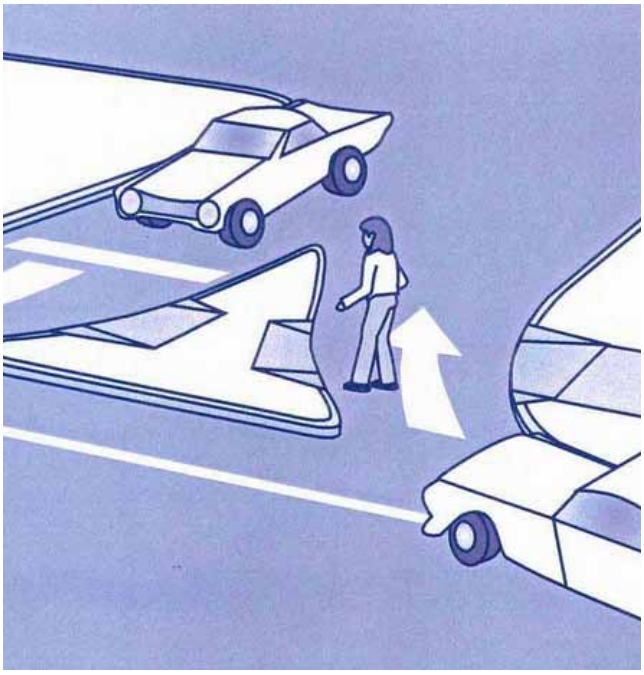
Driveways can cause conflicts between pedestrians and drivers when pedestrians cross the motor vehicle path of travel. Bicyclists riding on the sidewalk are also at risk of being involved in collisions with motor vehicles. Limiting the number of driveways pedestrians must cross and relocating them to rear parking lot entrances can improve safety for all road users.

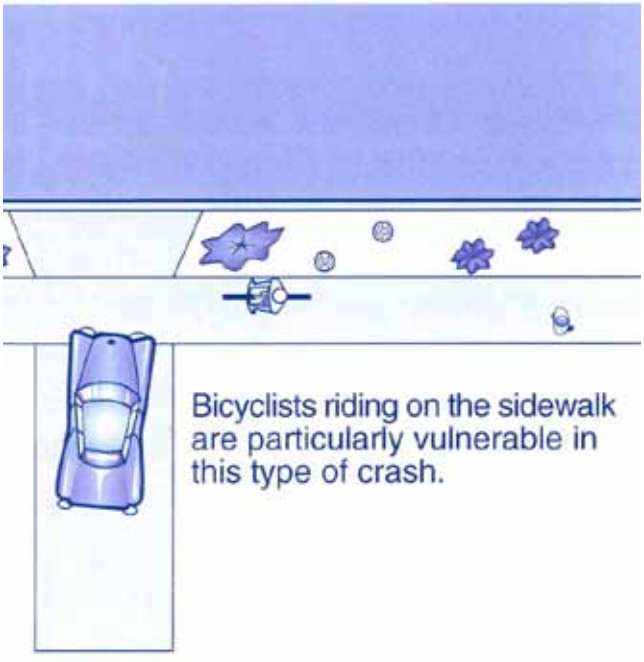
Discussion

- The maximum width of driveways across sidewalks should be 12 feet
- Driveways should not be located within four feet of any crosswalk
- There should only be one driveway per parcel of land (with some exceptions)
- There should be a minimum distance of at least 24 feet between driveways on one property

Guidance

- Davis, Calif., Municipal Code § 35.05.0. Available at: http://cityofdavis.org/cmo/citycode/printsection.cfm?chapter=35&section=05.





Both bicyclists and pedestrians are at risk of being involved in a collision when drivers enter and exit driveways across sidewalks

Reducing Cross Distance: Curb Extensions and Pedestrian Refuge Islands

Design Summary

Minimize pedestrian exposure to travel lanes by shortening the crossing distance; 50-feet or four travel lanes is generally the longest uninterrupted crossing of an unsignalized crosswalk.

Discussion

Curb Extension

Curb extensions may be constructed where there is a parking lane adjacent to the curb. They can be used as bus stop locations to improve safety for transit riders. However, if there is no parking lane, the extensions may impede bicycle travel (where no bike lane is striped). Guidelines for use include:

- Design curb extensions to transition between the extended curb and the running curb in the shortest practicable distance.
- For street sweeping, use the minimum radius for the reverse curves of 10 feet and balance the two radii to be nearly equal.
- Stop the curb extensions one foot short of the parking zone for bicycle safety.

Pedestrian Refuge Island

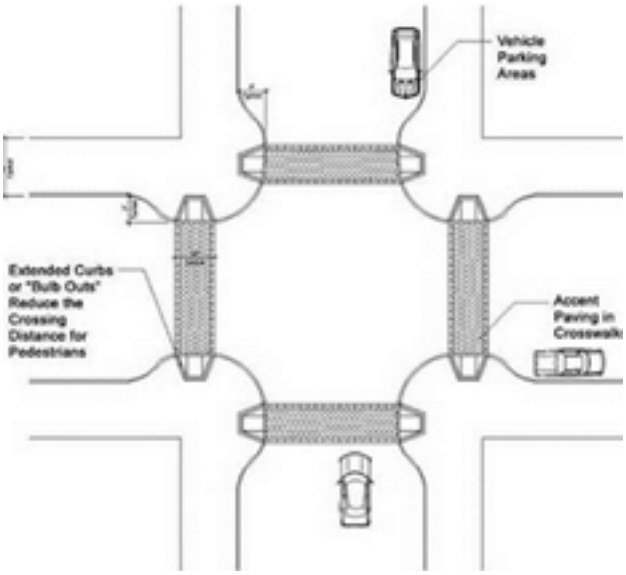
In addition to narrowing the crossing distance, pedestrian refuge islands provide a crossing refuge, allowing pedestrians to gauge safe crossing of "one direction" of traffic at a time, and slowing motor vehicle traffic. The refuge island must be accessible, preferably with an at-grade passage through the island rather than ramps and landings. Refuge islands can include median islands and triangular or "porkchop" islands.

A pedestrian refuge island should be at least six-feet wide between travel lanes and at least 20-feet long. On streets with posted speeds over 25 mph, include double centerline marking, reflectors, and "KEEP RIGHT" signs.

If a refuge island is landscaped, the landscaping should not compromise the visibility of pedestrians crossing in the crosswalk. Tree species should be selected for small diameter trunks and tree branches should be no lower than 14 feet. Shrubs and ground plantings should be no higher than one foot, six inches.

Guidance

- United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).



Curb extensions improve visibility of pedestrians and provide additional sidewalk space at street corners.

Pedestrian refuge islands break up a crossing and allow pedestrians to cross one side of a street at a time

ADA-Compliant Curb Ramps

Design Summary

- Provide a landing at the top of every curb ramp that:
  - Is at least 4' long
  - Is at least the same width as the ramp itself
  - Slopes no more than 1:50 (2.0%) in any direction
- Maximum ramp slope: 1:12 (8.3%) with a cross slope of no more than 1:50 (2.0%).
- Minimum width of a ramp: 3'

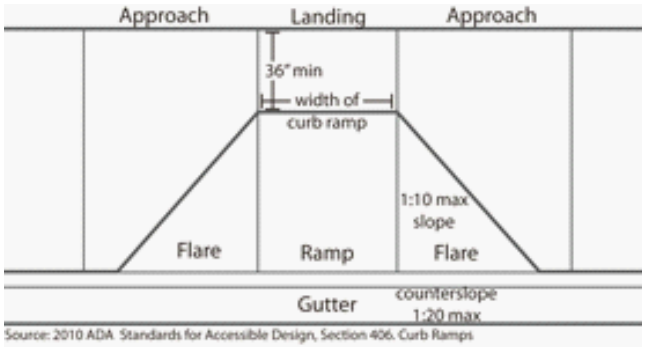
Discussion

The 2010 ADA Standards (Section 405) define a curb ramp as, "a short ramp cutting through a curb or built up to it." Curb ramps provide a transition from the street to the sidewalk at a street corner. Properly designed curb ramps ensure that the sidewalk is accessible to all types of pedestrians from the roadway. A sidewalk without a curb ramp can be useless to someone in a wheelchair, forcing them back to a driveway and out into the street for access.

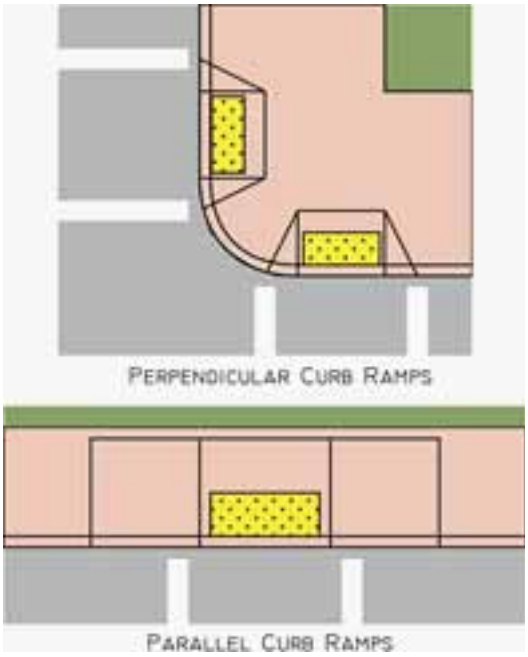
The ADA defines two types of curb ramp systems, "perpendicular ramps" and "parallel ramp," shown right. Diagonal curb ramps, which are a single ramp at a corner, are not recommended because they place the pedestrian in the middle of the intersection, rather than at the crosswalk.

Guidance

- 2010 ADA Accessibility Standards, http://www.ada.gov/regs2010/2010ADAStandards/2010ADAstandards.htm
- United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).



ADA Standards for Curb Ramps



Curb ramp options identified by the U.S. Access Board

Example of an ADA-compliant perpendicular curb ramp

ADA-Compliant Curb Ramps: Raised Tactile Devices Used as Detectable Warnings

Design Summary

- Raised tactile devices (also known as truncated domes) alert people with visual impairments to changes in the pedestrian environment and should be used at:
  - The edge of depressed corners.
  - The border of raised crosswalks and intersections.
  - The base of curb ramps.
  - The border of medians.
  - The edge of transit platforms where railroad tracks cross the sidewalk.

Discussion

Contrast between the raised tactile device and the surrounding infrastructure is important so that the change is readily evident. These devices are most effective when adjacent to smooth pavement so the difference is easily detected. The devices must provide color contrast so partially sighted people can see them.

Raised Tactile Devices Used for Wayfinding

Raised tactile devices can also be used for wayfinding along a pathway or across a road. This is particularly useful to visually impaired pedestrians in areas where the pedestrian environment is unpredictable. Complex intersections, roundabouts, wide intersections and open plazas are areas where raised tactile devices could be considered. No standards or guidelines for these devices have been adopted nationally. Raised devices with bar patterns can indicate the proper walking direction. Textured pavement that provides enough material and color contrast can be used to mark the outside of crosswalks, in addition to white paint or thermoplastic.

Guidance

- 2010 ADA Accessibility Standards, http://www.ada.gov/regs2010/2010ADAStandards/2010ADAstandards.htm
- United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).

A diagonal curb ramp with detectable warning

Pedestrian Push Buttons

Design Summary

- Locate so that someone in a wheelchair can reach the button from a level area of the sidewalk without deviating significantly from the natural line of travel into the crosswalk.
- Mark (for example, with arrows) so that it is clear which signal is affected.
- Raise buttons above or flush with their housing.
- Provide buttons that are large enough for people with visual impairments to see, minimum 2".
- The U.S. Access Board recommends the force to activate the signals should be no more than 22.2 Newtons.

Discussion

Pedestrian push buttons are used to permit the signal controller to detect pedestrians desiring to cross. They can be used at an actuated or semi-actuated traffic signal at intersections with low pedestrian volumes, and at mid-block crossings.

Accessible pedestrian signals should be installed whenever major signalized intersection upgrades are undertaken or when new signals are installed.

Signalized crossings in areas of high pedestrian use may automatically provide a pedestrian crossing phase during every signal cycle, excluding the need for pedestrian push-buttons. In high pedestrian use areas, there should be a demonstrated benefit for actuated signals before push buttons are installed. The following are some criteria for that benefit:

- The main street carries through traffic or transit, such as a major city traffic or transit street, or a district collector.
- Traffic volumes on the side street are considerably lower than on the main street.
- The pedestrian signal phase is long (for example, on a wide street) and eliminating it when there is no demand would significantly improve the level of service of the main street.

Where push buttons must be installed in high pedestrian use areas, designers should consider operating the signal with a regular pedestrian phase during off-peak hours.

Guidance

- United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).

Example standard pedestrian push button

Pedestrian push buttons can be accompanied by informational signage

Pedestrian Countdown Signals

Design Summary

When timing signals with pedestrian countdown heads:

- Assume a pedestrian walking speed of three feet per second to provide sufficient time for a pedestrian to safely cross during the signal phase (per MUTCD guidance).
- Assume slower crossing speeds at crossings where older pedestrians or pedestrians with disabilities are expected.

Discussion

Pedestrian signal indicators use a symbol to indicate when to cross at a signalized crosswalk. All traffic signals are now required to be equipped with pedestrian signal indications except where pedestrian crossing is prohibited by signage. Countdown pedestrian signals are particularly beneficial, as they indicate whether a pedestrian has time to cross the street before the signal phase ends.

Audible Pedestrian Traffic Signals

Audible pedestrian traffic signals provide crossing assistance to pedestrians with vision impairment at signalized intersections. To be considered for audible signals, the location must:

- Be suitable to the installation of audible signals (safety, noise level, and neighborhood acceptance).
- Have a need, demonstrated through a user request.

Audible signals should be activated by a pedestrian push-button with at least a one second-delay to activate the sound.

Guidance

- United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).
- Manual on Uniform Traffic Control Devices (2008)

A pedestrian countdown signal displays the time remaining for pedestrians to cross

Traffic signals should provide sufficient time for pedestrians of all ages and abilities to cross the street

9.6.3 Design Guidelines for Bicycle Facilities

Cycle Tracks

Design Summary

- Used for one-direction bicycle travel.
- Can be placed on one side of the street (bidirectional path) or both sides of the street (one-way paths)
- 7' minimum to allow passing.
- 12'minimum for two-way facility.

Discussion

A cycle track is an exclusive bicycle facility that combines the user experience of a separated path with the on-street infrastructure of a conventional bike lane. Cycle tracks can be either one-way or two-way, on one or both sides of a street, and are separated from vehicles and pedestrians by pavement markings or coloring, bollards, curbs/medians or a combination of these elements. Cycle tracks provide:

- Increased comfort for bicyclists
- Greater clarity about expected behavior
- Fewer conflicts between bicycles and parked cars as cyclists ride inside the parking lane
- Space to reduce the risk of "car dooring."

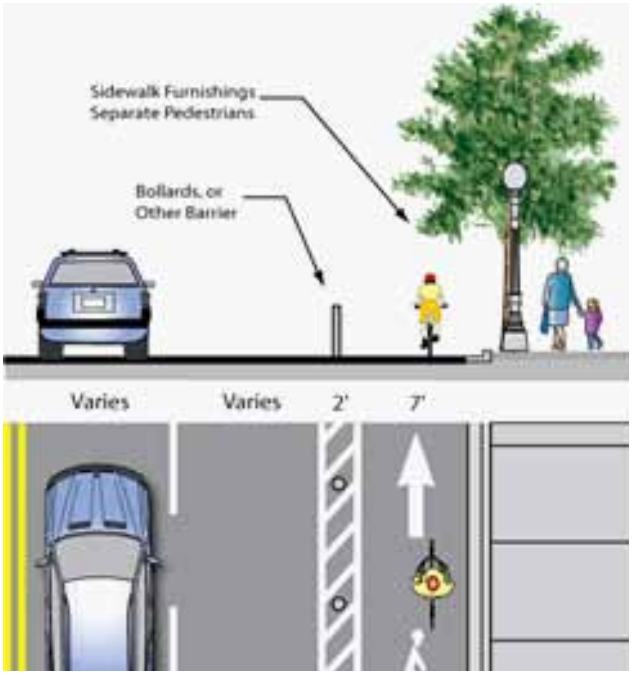
Danish research has shown that cycle tracks can increase bicycle ridership 18-20%, compared with the 5-7% increase associated with bike lanes. However, disadvantages of cycle tracks include:

- Increased vulnerability at intersections
- Regular street sweeping trucks cannot maintain the cycle track; requires smaller sweepers.
- Conflicts with pedestrians and bus passengers can occur, particularly on cycle tracks that are un-differentiated from the sidewalk or that are between the sidewalk and a transit stop.

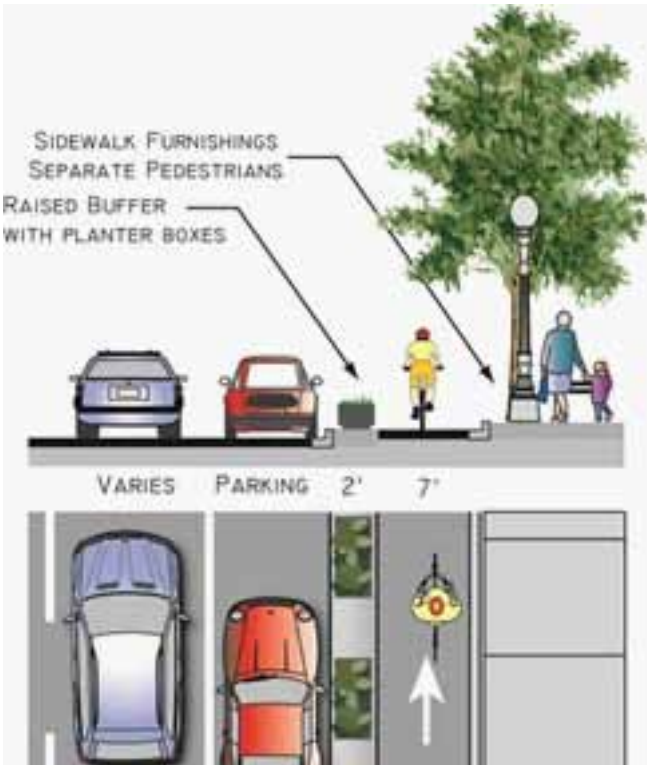
While recently implemented in the US, cycle tracks have been used in European countries for several decades. The cycle track design guidance which follows was developed using European experience applied to American situations.

Guidance

- Cycle Tracks: Lessons Learned, Alta Planning + Design (2009)
- NACTO. (2011). Urban Bikeway Design Guide.



Recommended cycle track design without parking, using striping and flexible bollard separation



Recommended design with on-street parking, using a raised buffer with planter boxes for separation

Intersection Crossing Markings

Design Summary

Bicycle pavement markings through intersections indicate the intended path of bicyclists through an intersection or across a driveway or ramp. They guide bicyclists on a safe and direct path through the intersection and provide a clear boundary between the paths of through bicyclists and either through or crossing motor vehicles in the adjacent lane.

Discussion

- See MUTCD Section 3B.08: "dotted line extensions"
- Crossing striping shall be at least six inches wide when adjacent to motor vehicle travel lanes. Dotted lines should be two-foot lines spaced two to six feet apart.
- Chevrons, shared lane markings, or colored bike lanes in conflict areas may be used to increase visibility within conflict areas or across entire intersections. Elephant's Feet markings are common in Europe and Canada.

Additional markings such as chevrons, shared lane markings, or colored bike lanes in conflict areas are strategies currently in use in the United States and Canada. Cities considering the implementation of markings through intersections should standardize future designs to avoid confusion.

Because the effectiveness of marked crossings depends entirely on their visibility, maintaining marked crossings should be a high priority.

Guidance

- FHWA. (2009). Manual on Uniform Traffic Control Devices. (3A.06)
- NACTO. (2011). Urban Bikeway Design Guide.

Crossing marking treatments from left to right: chevrons, shared lane markings, colored conflict areas, and elephant's feet

Example of dotted line extensions

Bike Boxes

Design Summary

- Bike box dimensions: 14' deep to allow for bicycle positioning.
- Use appropriate signs as recommended by the MUTCD. Signs should prohibit 'right turn on red' and indicate where the motorist must stop.

Discussion

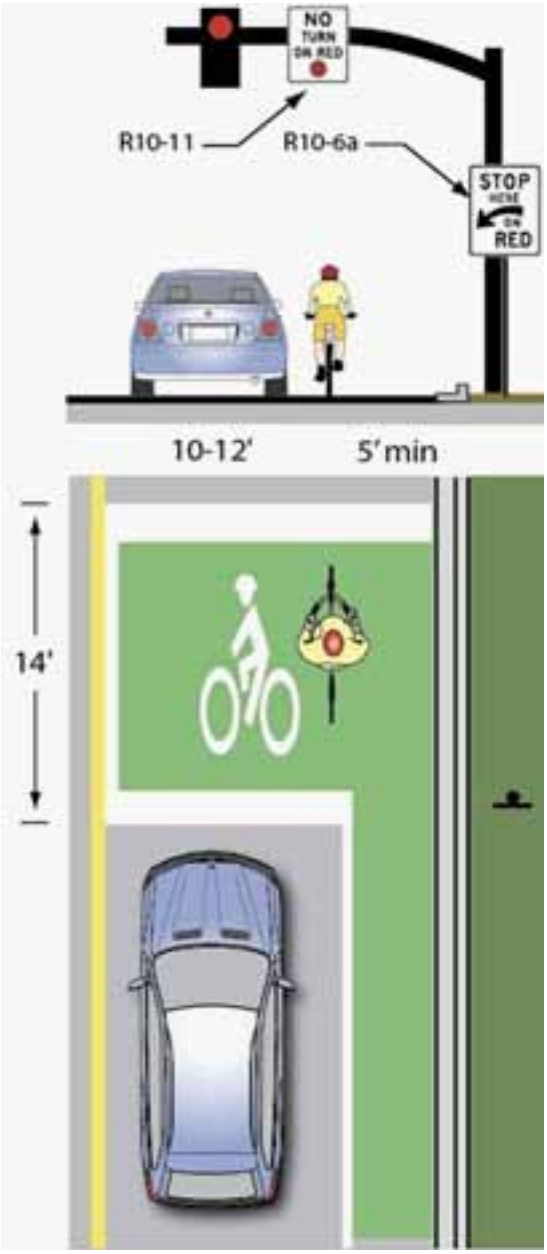
A bike box is generally a right angle extension of a bike lane at the head of a signalized intersection. The bike box allows bicyclists to move to the front of the traffic queue on a red light and proceed first when that signal turns green. Motor vehicles must stop behind the white stop line at the rear of the bike box.

Bike boxes can be combined with dashed lines through the intersection for green light situations to remind right-turning motorists to be aware of bicyclists traveling straight, similar to a colored bike lane treatment. Bike boxes can be installed with striping only or with colored treatments to increase visibility. Use of coloration substantially increases costs of maintenance over uncolored (striping, bicycle symbol, and text only) treatments.

Bike boxes should be located at signalized intersections only, and right turns on red should be prohibited. Bike boxes should be used at locations that have a large volume of cyclists, and are often utilized in central areas where traffic is usually moving slowly. Reducing right turns on red improves safety for cyclists and does not significantly impede motor vehicle travel.
On roadways with one travel lane in each direction, the bike box also facilitates left turning movements for cyclists.

Guidance

- Evaluation of Innovative Bike Box Application in Eugene, Oregon, Author: Hunter, W.W., 2000
- NACTO. (2011). Urban Bikeway Design Guide.



Recommended design of a bike box

Bike Signals

Design Summary

Bicycle signals are authorized in California under the California Vehicle Code Sections 21450, 21456.2 and 21456.3. Bicycle signals have commonly been actuated by a pedestrian push-button with supplementary signage plate. However, since 2007 AB-1581 mandated that Caltrans develop enhanced loop detectors. Caltrans conducted numerous studies which resulted in a preferred loop detector Type "D" as shown in Caltrans Standard Plan ES-5B. An additional "bike" pavement logo may also be placed over the loop detector to help bicyclists and motorcyclists properly position themselves over the detectors. Bicycle signals are used for bicycle-only movements or at bicycle path crossings of roadways. In California, minimum bicycle timing is set on a 14.7 ft/sec travel speed (10 mph).

Discussion

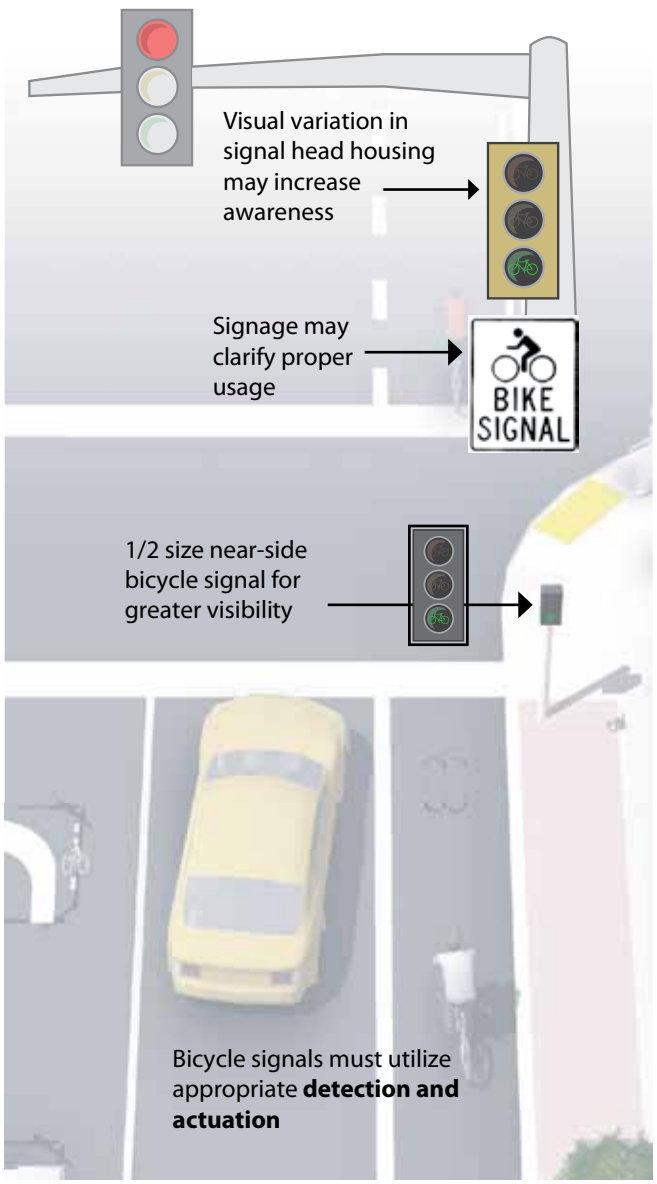
Specific locations where bicycle signals have had a demonstrated positive effect include:

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

Local municipal code should be checked or modified to clarify that at intersections with bicycle signals, bicyclists should only obey the bicycle signal heads. For improved visibility, smaller (4 inch lens) near-sided bicycle signals should be considered to supplement far-side signals.

Guidance

- CA-MUTCD Section 4C Bicycle Signal Warrant; Section 4D Bicycle Signals; Figure 4D-112(CA); Section 9B.13 Bicycle Signal Actuation Sign (R10-22); Section 9D.02 Signal Operations for Bicycles



Bicycle signal guidance

9.6.4 Transit Treatments

Transit Amenities

Design Summary

Transit users begin their trips as pedestrians or bicyclists, therefore it is important to provide bicycle and pedestrian amenities at transit stops and stations.

Discussion

Shelter

A shelter will protect transit users from sun and inclement weather while waiting for the bus or train. Shelters should be placed to not minimize accessibility,

Seating

Providing seating in the form of chairs or benches provides a place for transit users to rest. This is particularly important for those who may have trouble standing for long periods of time. Seating should be placed within shelters when provided.

Trip Information

Displaying trip information, such as time tables and fares, makes transit more convenient for riders. Information posted should be placed to not minimize accessibility and should be available in multiple languages where necessary.

Bicycle Storage

Short- and long-term bicycle parking is critical for people who combine their trips. See the bicycle parking design guidelines for more information.

Guidance

- United States Access Board. (2002). Accessibility Guidelines for Buildings and Facilities.
- United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).

Providing trip information increases convenience for transit riders

Shelters and benches at transit stops provide a protected place for users to rest and wait for the bus or train

9.6.5 Roadway Treatments

Advance Stop Bar / Yield Line

Design Summary

Separating pedestrians and motor vehicles at intersections improves safety and visibility.

Discussion

Advance stop bars and yield lines increase pedestrian comfort and safety by stopping motor vehicles well in advance of marked crosswalks, allowing drivers a better line of sight of pedestrians.

They give drivers in the traffic inner lane time to yield to pedestrians, minimizing the risk of a multiple threat crash. Without an advance yield bar, the driver in the outer lane may yield to the pedestrian, but the vehicle in the inner lane proceeds, increasing the possibility of a vehicle-pedestrian conflict.

Pedestrians may also feel more comfortable since motor vehicles are not stopped adjacent to the crosswalk.

Advanced stop bars should be used:

- On streets with at least two travel lanes in each direction.
- Prior to a marked crosswalk
- In one or both directions of motor vehicle travel
- Recommended 30-feet in advance of the crosswalk.
- A "Yield Here for Pedestrians" sign must accompany the advance yield line.

Guidance

- United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).

Advance stop bars and yield lines alert motorists of pedestrians and provide increased visibility for persons crossing the street

Curb Radii Reduction

Design Summary

- Consider the desired pedestrian area of the corner, traffic turning movements, the turning radius of the design vehicle, the geometry of the intersection, the street classifications, and whether there is parking or a bicycle lane (or both) between the travel lane and the curb.
- Use the smallest possible curb radius for the circumstances:
  - May be three-feet where there are no turning movements.
  - Increase to five-feet where there are turning movements and there is adequate street width and a larger effective curb radius created by parking or bicycle lanes.

Discussion

Factors that govern the choice of curb radius in any given location include:

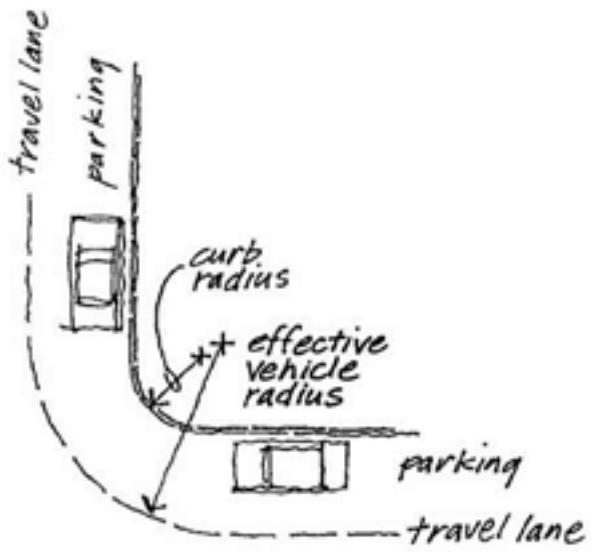
- The desired pedestrian area of the corner
- Traffic turning movements
- Turning radius of the design vehicle
- Geometry of the intersection
- Street classifications
- Whether there is parking or a bike lane (or both) between the travel lane and the curb

In general, smaller curb radii are preferred for pedestrians. A tight curb radius provides more pedestrian area at the corner, allows more flexibility in the placement of curb ramps, results in a shorter crosswalk, and requires vehicles to slow more as they turn the corner. A small curb radius is also beneficial for street sweeping.

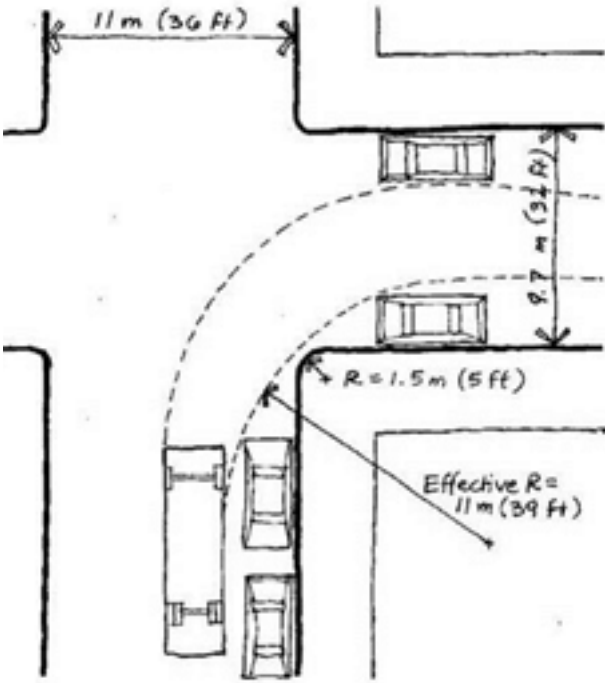
The presence of a parking or bike lane creates an 'effective radius' that allows the designer to choose a radius for the curb that is smaller than the turning radius required by the design vehicle.

Guidance

- United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG).



An "effective radius" is created by the presence of a parking lane and/or bike lane



Where there is an effective curb radius sufficient for turning vehicles, the actual curb radius may be as small as 5 feet (1.5 m)

Traffic Calming Features

Design Summary

- To reduce the speed of motor vehicles traveling on a roadway in order to enhance the safety and comfort of pedestrians and bicyclists

Discussion

Speed Humps / Speed Tables

Speed humps and speed tables reduce speeds by causing motorists to slow when approaching. Slopes should be between 1:10 and 1:25. Tapers should be no greater than 1:6 to reduce the risk of bicyclists losing their balance. The vertical lip should be no more than a 1/4" high.171

Chicanes/Chokers

Chicanes and chokers shift the driver's paths, which result in reduced speeds. Where possible, provide a bicycle route outside of the element so bicyclists have a direct path away from the pinch point.

Speed Feedback Signs

Speed feedback signs display the driver's speed on a digital display. The signs will flash when a driver is over the posted speed limit and will show a blank screen otherwise.

Neighborhood Traffic Circles or Roundabouts

These intersection designs require drivers and bicyclists to yield and merge around a circular island. This increases awareness of road users and decreases speeds. Circles, which have stop control or no control, have generally been replaced by roundabouts, which require entering vehicles to yield to circulating vehicles.

Traffic calming can deter motorists from driving on a street. Anticipate and monitor vehicle volumes on adjacent streets to determine whether traffic calming results in inappropriate volumes. Traffic calming can be implemented on a trial basis.

Guidance

- BikeSafe. (No Date). Bicycle countermeasure selection system.
- Ewing, Reid. (1999). Traffic Calming: State of the Practice.
- Ewing, Reid and Brown, Steven. (2009). U.S. Traffic Calming Manual.
- NCHRP. (2010) Roundabouts: An Informational Guide

Speed humps

Traffic circle

Chicane

On-Street Parking

Design Summary

- Improve the safety of bicyclists traveling adjacent to on-street parking by increasing visibility

Discussion

Back-In Angle Parking and Parallel Parking

In areas with high parking demand such as urban commercial areas, diagonal parking can be used to increase parking supply. Conventional "head-in" diagonal parking is not recommended in conjunction with high levels of bicycle traffic or with the provision of bike lanes as drivers backing out of conventional diagonal parking spaces have poor visibility of approaching bicyclists.

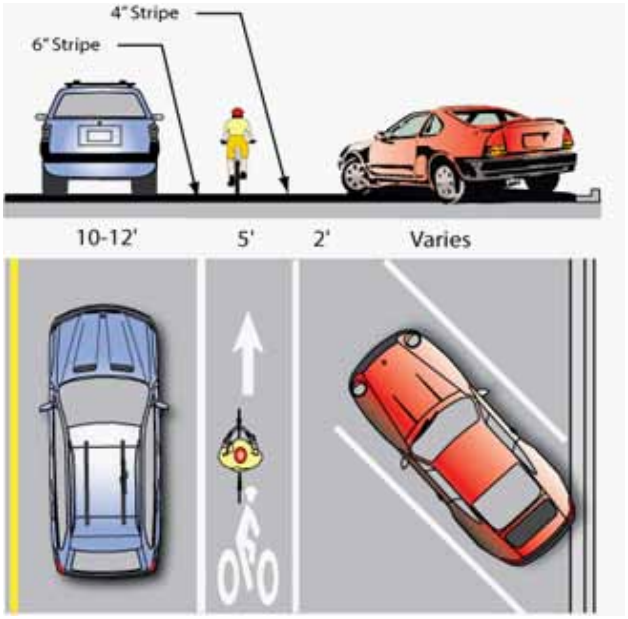
Back-in angle parking benefits include: improved sight distance between drivers and bicyclists, cargo access occurs at the curb rather than in the street, passengers (including children) are directed by open doors towards the curb, and no door conflict with bicyclists. While there may be a learning curve for some drivers, using back-in diagonal parking is typically an easier maneuver than conventional parallel parking. Spaces should be at least 9'6" wide and explanatory signage may be needed initially. Parallel parking is also preferred as it can provide sufficient space for adjacent bikeway facilities.

Parking Control

Parking restrictions improve visibility in the vicinity of the crosswalk. Prohibit parking within all intersections and crosswalks unless otherwise signed. At "T" and offset intersections, where the boundaries of the intersection may not be obvious, this prohibition should be emphasized with signage.

Guidance

- Currently slated for inclusion in the upcoming AASHTO Guide for the Development of Bicycle Facilities.
- Nelson Nygaard Consulting Associates. (2005). Back-in/ Head-out Angle Parking.



Recommended design of bike lanes next to back-in diagonal parking

Back-in diagonal parking provides increased safety for bicyclists as compared to head-in diagonal parking due to drivers' improved visibility as they exit the parking spot

Roadway Widening

Design Summary

Although opportunities to add bike lanes through roadway widening may exist in some locations, other major streets in Kern County pose physical and other constraints requiring street retrofit measures within existing curb-to-curb widths. As a result, many of the recommended measures effectively reallocate existing street width through striping modifications to accommodate dedicated bike lanes.

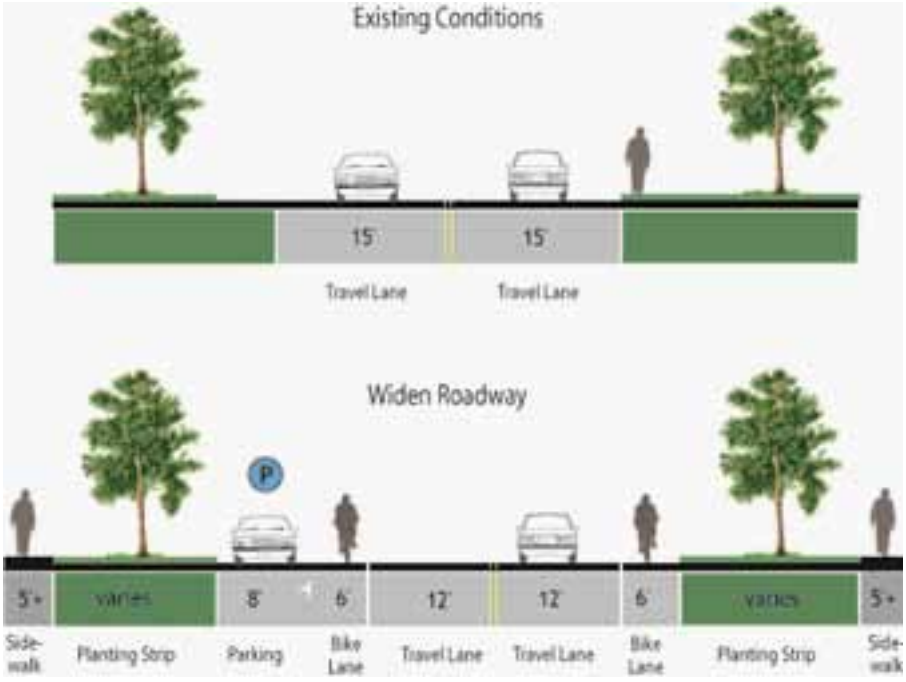
Discussion

Bike lanes could be accommodated on many streets with excess right-of-way through shoulder widening. Although street widening incurs higher expenses compared with re-striping projects, bike lanes could be added to streets currently lacking curbs, gutters and sidewalks without the high costs of major infrastructure reconstruction.

As a long-term measure, Kern County should find opportunities to add bike lanes to other major streets where they are needed. Opportunities include adding bike lanes as streets and bridges are widened for additional auto capacity or as property development necessitates street reconstruction.

Roadway widening is preferred on streets lacking curbs, gutter, and sidewalks

Guidance



Example of roadway widening to accommodate bike lanes

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A. Bicycle Facilities Design Guidelines

The design guidelines presented in this chapter are a combination of minimum standards outlined by the California Highway Design Manual's Chapter 1000, recommended standards prescribed by the American Association of State Highway and Transportation Officials (AASHTO) Guide for the Development of Bicycle Facilities, the CA MUTCD, and design recommendations developed specifically for Kern County.

The minimum standards and guidelines presented by Chapter 1000 and AASHTO provide basic information about the design of bicycle network infrastructure, such as bicycle lane dimensions, striping requirements and recommended signage and pavement markings. However, this plan also recommends that the County continually reference and supplement the design guidance in this chapter with the latest bicycle facility guidelines and best practices, including the revised AASHTO guide (when published) and the NACTO Urban Bikeway Design Guide. The NACTO guide represents the most up-to-date expertise in the field of bicycle facility design as implemented by leading agencies and municipalities throughout the United States. It is recommended that the NACTO guide serve as a prioritized reference for developing future bicycle facilities in Kern County.

The Design Guidelines are intended to provide a range of design options for bicycle treatments. The Design Guidelines provide a toolbox of ideas that may be implemented by Kern County, but is not inclusive of all treatments that may be used and does not identify treatments intended for any specific projects. The following key principles should guide the development of all future County bikeways and bicycle facilities:

- **The bicycling environment should be safe.** Bicycle routes, pathways, and crossings should be designed and built to be free of hazards and to minimize conflicts with external factors such as noise, vehicular traffic and protruding architectural elements.
- **The bicycle network should be accessible.** Bicycle routes, pathways, and crosswalks should ensure the mobility of all users by accommodating the needs of people regardless of age or ability. Bicyclists have a range of skill levels, and facilities should be designed for use by experienced cyclists at a minimum, with a goal of providing for inexperienced / recreational bicyclists (especially children and seniors) to the greatest extent possible. In areas where specific needs have been identified (e.g., near schools) the needs of appropriate types of bicyclists should be accommodated.
- **The bicycle network should connect to places people want to visit.** The bikeway network should provide continuous direct routes and convenient connections between destinations, including homes, schools, offices, commercial districts, shopping areas, recreational opportunities and transit.
- **The bicycling and trail environments should be clear and easy to use.** On-and off-road bikeways should be designed so people can easily find a direct route to a destination and delays are minimized.
- **Bicyclists should be able to enjoy a positive environment.** Good design should enhance the feel of the bicycling environment. A complete network of on-street bicycling facilities should connect seamlessly to the existing and proposed off-street pathways to complete recreational and commuting routes around the County.
- **All roadway projects and improvements should accommodate bicyclists.**
- **Bicycle improvements should be economical.** Improvements should be

designed to achieve the maximum benefit for their cost, including initial cost and maintenance cost as well as reduced reliance on more expensive modes of transportation. Where possible, improvements in the right-of-way should stimulate, reinforce, and connect with adjacent private improvements.

A.1 National, State, and Local Guidelines / Best Practices

The following is a list of references and sources utilized to develop design guidelines for Kern County. Many of these documents are available online.

A.1.1 Federal Guidelines

- American Association of State Highway and Transportation Officials. (2004). AASHTO Policy on Geometric Design of Streets and Highways. Washington, DC. www.transportation.org
- American Association of State Highway and Transportation Officials. (1999). AASHTO Guide for the Development of Bicycle Facilities. Washington, DC. www.transportation.org
- Federal Highway Administration. (2009). Manual on Uniform Traffic Control Devices (MUTCD).Washington, DC. http://mutcd.fhwa.dot.gov
- United States Access Board. (2007). Public Rights-of-Way Accessibility Guidelines (PROWAG). Washington, D.C. http://www.access-board.gov/PROWAC/alterations/guide.htm

A.1.2 State and Local Guidelines

- California Department of Transportation. (2006). Highway Design Manual (HDM), Chapter 1000: Bikeway Planning and Design. http://www.dot.ca.gov/hq/oppd/hdm/pdf/chp1000.pdf
- California Department of Transportation. (2006). Highway Design Manual (HDM), Chapter 300: Geometric Cross Section. http://www.dot.ca.gov/hq/oppd/hdm/pdf/chp0300.pdf
- California Department of Transportation. (2006). Highway Design Manual (HDM), Chapter 400: Intersections at Grade. http://www.dot.ca.gov/hq/oppd/hdm/pdf/chp0400.pdf
- California Department of Transportation. (2012). California Manual of Uniform Traffic Control Devices for Streets and Highways, Part 9: Traffic Controls for Bicycle Facilities. http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/pdf/camutcd2012/CAMUTCD2012.pdf
- California Department of Transportation. (2005). Pedestrian and Bicycle Facilities in California: A Technical Reference and Technology Transfer Synthesis for Caltrans Planners and Engineers. http://www.dot.ca.gov/hq/traffops/survey/pedestrian/TR_MAY0405.pdf

A.1.3 Best Practices Documents

- Association of Pedestrian and Bicycle Professionals (APBP). (2010). Bicycle Parking Design Guidelines, 2nd Edition.
- City of Berkeley. (2000). Bicycle Boulevard Design Tools and Guidelines. http://www.ci.berkeley.ca.us/Public_Works/Transportation/Bicycle_Boulevard_Guidelines.aspx
- City of Chicago and the Pedestrian and Bicycle Information Center (PBIC). (2002). Bike Lane Design Guide.http://www.activelivingresources.org/assets/chicagosbikelanedesignguide.pdf
- City of Portland Bureau of Transportation. (2010). Portland Bicycle Master Plan for

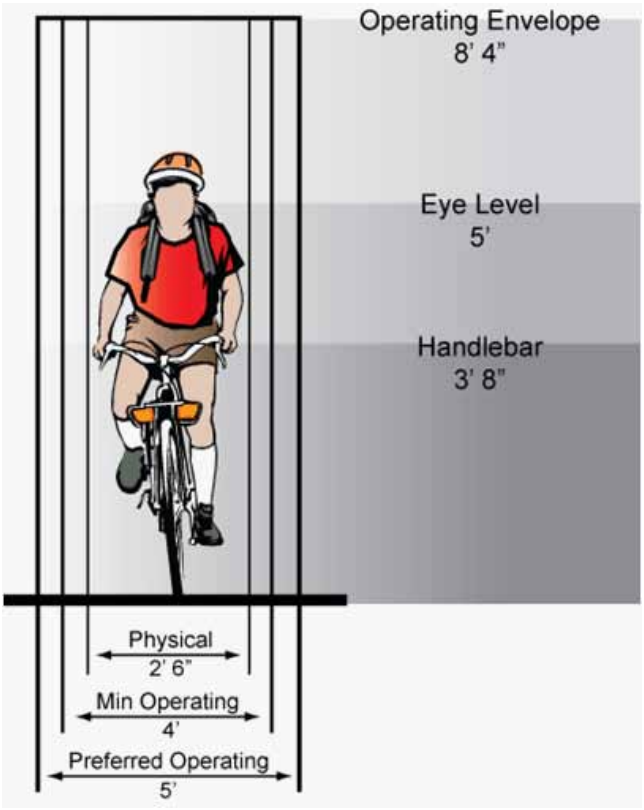
2030.http://www.portlandonline.com/transportation/index.cfm?c=44597
- Federal Highway Administration. (2005). Report HRT-04-100, Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations. http://www.tfhrc.gov/safety/pubs/04100/
- Federal Highway Administration. (2001). Designing Sidewalks and Trails for Access. http://www.fhwa.dot.gov/environment/sidewalk2/contents.htm
- Institute of Transportation Engineers Pedestrian and Bicycle Council. (2003). Innovative Bicycle Treatments.
- King, Michael, for the Pedestrian and Bicycle Information Center. (2002). Bicycle Facility Selection: A Comparison of Approaches. Highway Safety Research Center, University of North Carolina – Chapel Hill. http://www.bicyclinginfo.org/pdf/bikeguide.pdf
- National Association of City Transportation Officials, NACTO Urban Bikeway Design Guide, (2011), http://nacto.org/cities-for-cycling/design-guide/
- Oregon Department of Transportation. (1995). Oregon Bicycle and Pedestrian Plan. http://www.oregon.gov/ODOT/HWY/BIKEPED/planproc.shtml
- Rosales, Jennifer. (2006). Road Diet Handbook: Setting Trends for Livable Streets. Institute of Transportation Engineers.

All bikeways facilities are required at a minimum to meet the design guidelines outlined in the Highway Design Manual (HDM), Chapter 1000 and in the California MUTCD. When using designed treatments not approved but the CA-MUTCD and the HDM, Chapter 1000, the County must follow the protocol for testing innovative treatments specified by the state.

A.2 The Bicycle as a Design Vehicle

Similar to motor vehicles, bicyclists and their bicycles come in a variety of sizes and configurations. This variation can take the form of variety in types of vehicle (such as a conventional bicycle, a recumbent bicycle, or a tricycle), or the behavioral characteristics and comfort level of the cyclist riding the vehicle. Any bicycle facility undergoing design should consider what types of design vehicles will be using the facility and design with that set of critical dimensions in mind.

Figure A-1: Standard Bicycle Rider Dimensions



A.2.1 Physical Dimensions

The operating space and physical dimensions of a typical adult bicyclist are shown in **Figure A-1.** Clear space is required for the bicyclist to be able to operate within a facility; this is why the minimum operating

width is greater than the physical dimensions of the bicyclist. Although four feet is the minimum acceptable operating width, five feet or more is preferred.

Outside of the design dimensions of a typical bicycle, there are many commonly used pedal driven cycles and accessories that should be considered when planning and designing bicycle facilities. The most common types of bicycles are depicted in **Figure A-2.**

Table A-1 summarizes the typical dimensions for most commonly-encountered bicycle designs.

The speed that various types of bicyclists can be expected to maintain under various conditions can also have influence over the design of facilities such as shared use paths. **Table A-2** provides typical bicyclist speeds for a variety of conditions.

Figure A-2: Various Bicycle Dimensions

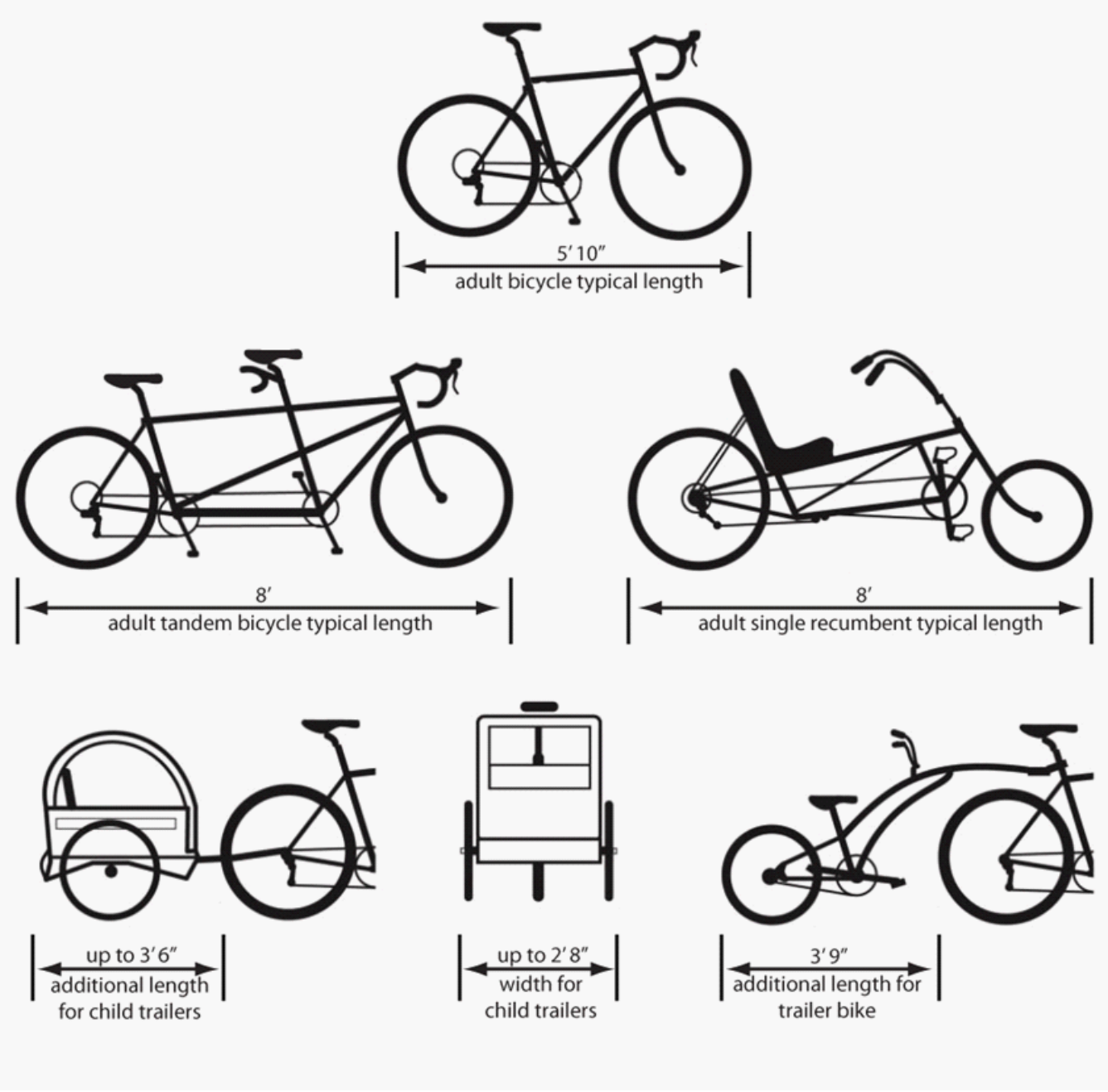


Table A-1: Bicycle as Design Vehicle – Typical Dimensions

Bicycle Type	Feature	Typical Dimensions
Upright Adult Bicyclist	Physical width	2' 6"
	Operating width (Minimum)	4'
	Operating width (Preferred)	5'
	Physical length	5' 10"
	Physical height of handlebars	3' 8"
	Operating height	8' 4"
	Eye height	5'
	Vertical clearance to obstructions (tunnel height, lighting, etc).	10'
	Approximate center of gravity	2' 9" to 3' 4"
Recumbent Bicyclist	Physical length	8'
	Eye height	3' 10"
Tandem Bicyclist	Physical length	8'
Bicyclist with child trailer	Physical length	10'
	Physical width	2' 6"

Table A-2: Design Speed Expectations

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

A.3 Design Toolbox

This section presents design guidelines for recommended facilities as part of this Plan. It is organized by:

- On-Street Facility Design Guidelines
- Off-Street Facility Design Guidelines
- Wayfinding Standards and Guidelines
- Bicycle Parking Guidelines
- Routine Maintenance of Bikeways

A.3.1 On-Street Facility Design Guidelines

On-Street Facility Design Guidelines

There are a range of different types of bicycle facilities that can be applied in various contexts, which provide varying levels of protection or separation from automobile traffic. This section summarizes best practice on-street bicycle facility design from North America and elsewhere.

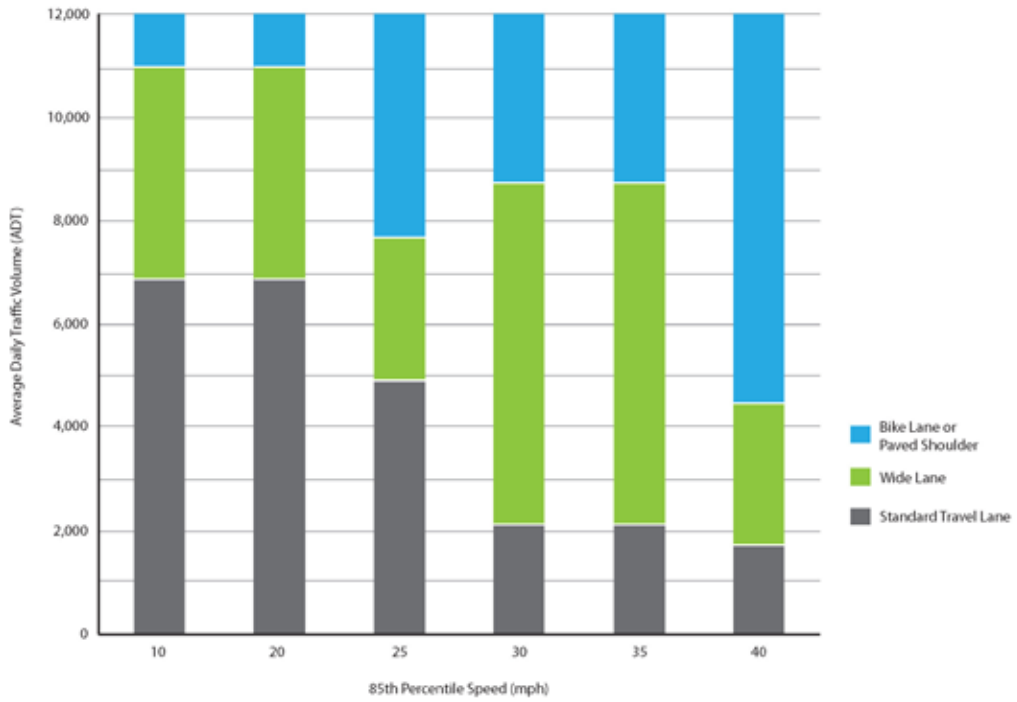
Facility Selection

There are a wide variety of techniques for selecting the type of facility for a given context. Roadway characteristics that are often used include:

- Motor vehicle speed and volume
- Presence of heavy vehicles/trucks
- Roadway width
- Demand for bicycle facilities
- User preference
- Land use/urban or rural context

There are no 'hard and fast' rules for determining the most appropriate type of facility for a particular location; engineering judgment and planning skills are critical elements of this decision.

A 2002 study combined bikeway dimension standards for ten different communities in North America. The goal of the study was to survey the varying requirements available and provide a best practices approach for providing bicycle facilities. The study included a comparison with European standards, and found that "North Americans rely much more on wide lanes for bicycle accommodation than their counterparts overseas." The table below shows the results of this analysis, which recommends use of bike lanes or shoulders, wide lanes, or normal lanes. Finally, the study shows the 'worldwide speed-volume chart,' which synthesizes findings from Europe and North America. The final chart is useful for the inclusion of separated lanes, or cycle tracks, and generally has a lower threshold for increasing separation than the North America selection table.



North American Bicycle Facility Selection Chart

(King,. Michael. (2002). Bicycle Facility Selection: A Comparison of Approaches. Pedestrian and Bicycle Information Center and Highway Safety Research Center, University of North Carolina – Chapel Hill.)

Class III - Bike Routes

Design Summary

Shared Roadway Considerations:

Use D11-1 Bike Route sign at:

- Beginning or end of bike route (with applicable M4 series sign below)
- Entrance to bike path (class I) – optional
- At major changes in direction or at intersections with other bike routes (with applicable M7 series arrow sign)
- At intervals along bike routes not to exceed ½ mile

Additional considerations:

- Locate 5 feet from the face of the guardrail, curb, or other roadside barrier
- Use D11-1 "Bike Route" sign as specified for shared roadways

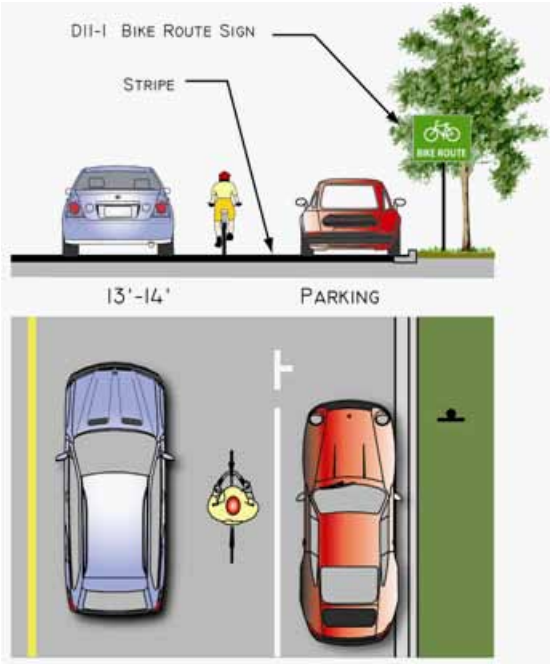
Discussion

Class III bicycle facilities – (Caltrans designation) are defined as facilities shared with motor vehicles. They are typically used on roads with low speeds and traffic volumes; however, they can be used on higher volume roads with wide outside lanes or with shoulders. Roadways appropriate as shared roadways often have a centerline stripe only, and no designated shoulders.

Bike routes are indicated exclusively by signage, which provide key connections to destinations and trails where providing additional separation is not possible.

Guidance

- From Caltrans Highway Design Manual (HDM) Chapter 1000: *"Class III bikeways (bike routes) are intended to provide continuity to the bikeway system. Bike routes are established along through routes not served by Class I or II bikeways, or to connect discontinuous segments of bikeway (normally bike lanes). Class III facilities are shared facilities, either with motor vehicles on the street, or with pedestrians on sidewalks, and in either case bicycle usage is secondary. Class III facilities are established by placing Bike Route signs along roadways."*
- 2012 California MUTCD Section 9C.04 states, "Class III Bikeways (Bike Route) are shared routes and do not require pavement markings. In some instances, a 4 in white edge stripe separating the traffic lanes from the shoulder can be helpful in providing for safer shared use. This practice is particularly applicable on rural highways and on major arterials in urban areas where there is no vehicle parking."
- AASHTO Guide for the Development of Bicycle Facilities
- Caltrans Standard Plan (2006 Edition).



Shared roadway recommended configuration

This bike route in the City of Los Angeles provides a wide outside lane adjacent to on-street parking

D11-1 "Bike Route" sign should be used along designated shared roadways

Shoulder Bikeways

Design Summary

Shoulder Bikeway Considerations:

- Widths (measured from painted edge line to edge of pavement or gutter pan):
- The shoulder should be a minimum of 4 feet and preferably, 6 feet wide
- On steep hills, additional width should be provided in the uphill direction, both for cyclists to pass each other and to allow cyclists to 'traverse' the hill by weaving slightly back and forth
- For shoulder bikeways along high-speed roadways, a buffer between the shoulder and vehicle lane using paint or bike-friendly rumble strips (see right) may be considered.

Discussion

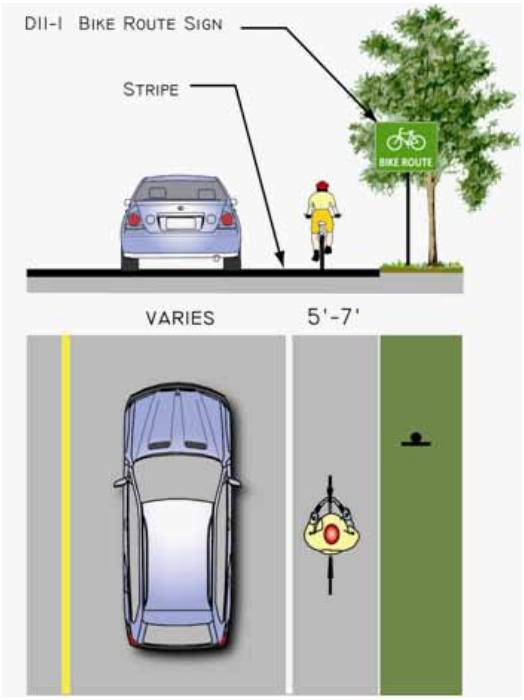
Rural roads with a large shoulder may already accommodate bicycle travel. Reclassifying these large shoulders as "shoulder bikeways" may encourage additional cyclist use. This type of facility can be developed on a rural roadway without curb and gutter. Bike routes along shoulders are appropriate and preferable to bike lanes in rural areas. The separation between the shoulder and the travel lane should be marked with an edge line, and the shoulder should be paved and maintained. A shoulder bikeway could also be used on an urban road where traffic speeds and volumes are low, although shared lane markings in addition to signage may be more appropriate in these locations.

When a roadway with a shoulder bikeway is reconstructed, widened, or overlaid, open drainage grates should be oriented with openings perpendicular to the direction of bicycle travel, so that bicycle wheels are not caught in the openings.

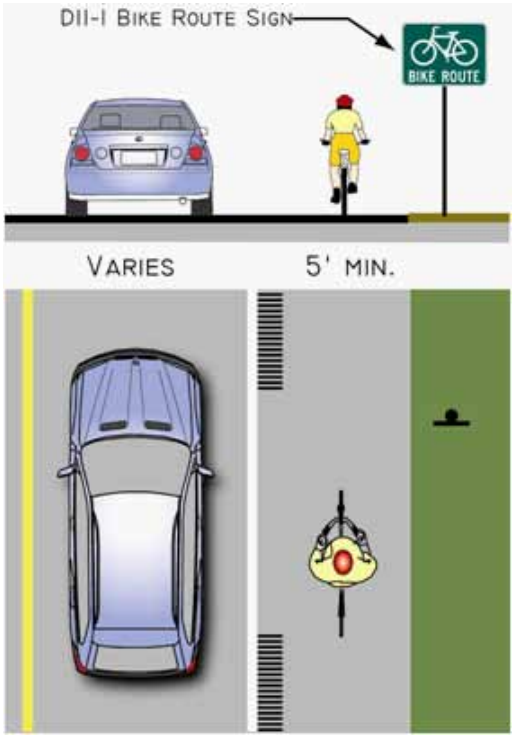
Rumble strips are placed along the sides of high-speed and rural roads, in order to alert drivers when their vehicles have left the roadway. Rumble strips can be high risk for bicyclists, as a cyclist who runs over a strip could lose control of the bicycle. Conversely, rumble strips can help bicyclists feel more comfortable, knowing that drivers will be alerted if they are near the edge of the roadway. The bikeable area should have sufficient width (5-foot minimum) to accommodate bicycle travel. Rumble strips along shoulder bikeways should also include gaps to allow bicyclists to cross the rumble strip area.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities
- 2012 California MUTCD, Chapter 9



Recommended Shoulder bikeway configuration



Shoulder bikeway with bike-friendly rumble strip

Shared Lane Markings (Sharrows)

Design Summary

- Use D11-1 "Bike Route" sign as specified for shared roadways
- Place in a linear pattern along a corridor at least 11' from face of curb (or shoulder edge) on streets with on-street parking. The longitudinal spacing of the markings may be increased or reduced as needed for roadway and traffic conditions.
- Shared lane markings should not be placed on roadways with a speed limit at or above 35 MPH (CA MUTCD)
- Marking should be placed immediately after an intersection and spaced at intervals no greater than 250 feet hereafter
- Use only on a roadway Class III Bikeway (bike route) or shared roadway (no bikeway designation) which has on-street parallel parking
- If used on a street without on-street parking that has an outside travel lane that is less than 14 feet wide, the centers of the Shared Lane Markings should be at least 4 feet from the face of the curb, or from the edge of the pavement where there is no curb.

Discussion

Shared lane marking stencils (also called "sharrows") have been introduced for use in California as an additional treatment for Class III facilities. The California MUTCD states that the shared roadway bicycle marking is intended to:

- Reduce the chance of collisions between open doors of parked vehicles and bicyclists on a roadway with on-street parallel parking
- Alert road users within a narrow traveled way of the lateral location where bicyclists ride
- Encourage safe passing of bicyclists by motorists, and reduce the incidence of wrong-way bicycling.

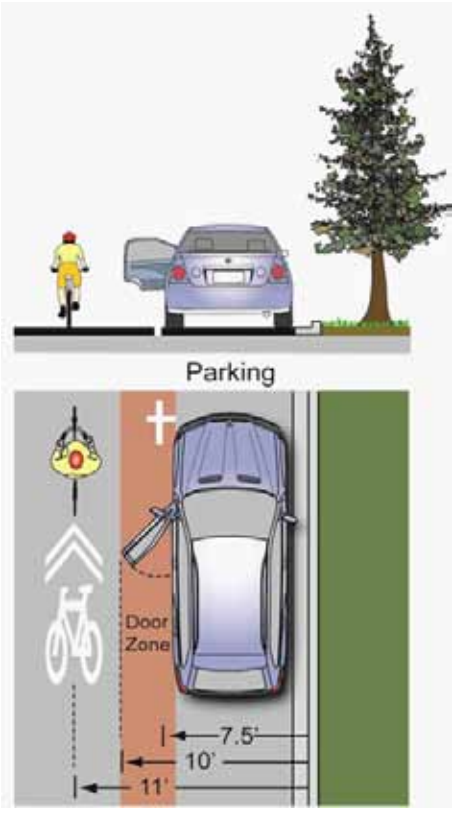
The stencil can serve a number of purposes, such as making motorists aware of bicycles potentially in their lane, showing bicyclists the direction of travel, and, with proper placement, reminding bicyclists to bike further from parked cars to prevent "dooring" collisions.

A wide outside lane can be used on roadways where bike lanes might otherwise be used, but the existing road width does not allow for restriping. The wide lane allows motor vehicles to pass bicycles while providing the recommended 3 feet of clearance.

Guidance

- Caltrans Highway Design Manual (Chapter 1000)
- Use of shared lane markings was adopted by Caltrans in 2005 as 2012 California MUTCD Section 9C.07 and Figure 9C-9
- AASHTO Guide for the Development of Bicycle Facilities
- 2012 California MUTCD Section 9C.07

Wide curb lanes can include shared lane pavement markings to increase visibility



Shared lane marking placement guidance for streets with on-street parking.

Class II Bicycle Lanes

Bike lanes or Class II bicycle facilities (Caltrans designation) are defined as a portion of the roadway that has been designated by striping, signage, and pavement markings for the preferential or exclusive use of bicyclists. Bike lanes are generally found on major arterial and collector roadways and are 5-8 feet wide. Bike lanes can be found in a large variety of configurations, and can have special characteristics including coloring and placement if beneficial. Bike lanes enable bicyclists to ride at their preferred speed without interference from prevailing traffic conditions and facilitate predictable behavior and movements between bicyclists and motorists. Bicyclists may leave the bike lane to pass other cyclists, make left turns, avoid obstacles or debris, and to avoid other conflicts with other roadway users.

Design Summary

Width varies depending on roadway configuration, see following pages for design examples. 4-8 feet is standard, measured from edge of gutter pan, although a maximum of 7 feet is recommended to prevent parking or driving in the bike lane.

Striping

- Separating vehicle lane from bike lane (typically left sideline): 6 inches
- Delineate conflict area in intersections (optional): Length of conflict area
- Separating bike lane from parking lane (if applicable): 4 inches
- Dashed white stripe when:
  - Vehicle merging area (optional): Varies
  - Approach to intersections: 100-200 feet
  - Delineate conflict area in intersections (optional): Length of conflict area

Signing: use R-81 Bike Lane Sign at:

- Beginning of bike lane
- Far side of all bike path (class I) crossings
- At approaches and at far side of all arterial crossings
- At major changes in direction
- At intervals not to exceed ½ mile

Pavement markings: the preferred pavement marking for bike lanes is the bike lane stencil with directional arrow to be used at:

- Beginning of bike lane
- Far side of all bike path (class I) crossings
- At approaches and at far side of all arterial crossings
- At major changes in direction
- At intervals not to exceed ½ mile
- At beginning and end of bike lane pockets at approach to intersection

Guidance

- Caltrans Highway Design Manual (Chapter 1000)
- 2012 California MUTCD
- AASHTO Guide for the Development of Bicycle Facilities
- Additional standards and treatments for bike lanes are provided in the following pages

Approved R-81 Sign

Approved California bike lane stencils (either is optional, as is arrow).

Class II Bikeway: Bike Lane Adjacent to On-Street Parallel Parking

Design Summary

Bike Lane Width:

- 6 feet recommended when parking stalls are marked
- 5 feet minimum in constrained locations
- 8 feet maximum (greater widths may encourage vehicle loading in bike lane)

Shared bike and parking lane width:

- 13-14 feet for a shared bike/parking lane where parking is permitted but not marked on streets without curbs
- If the parking volume is substantial or turnover is high, an additional 1-2 feet of width is desirable

Discussion

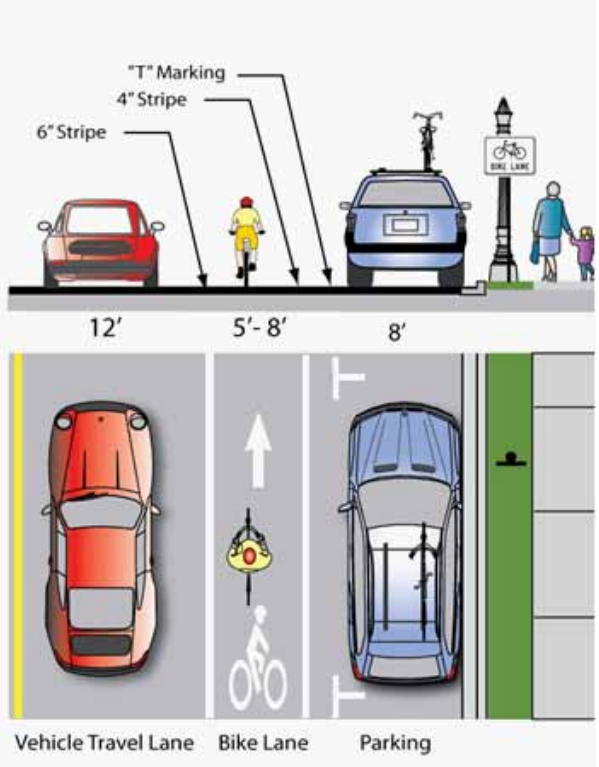
Bike lanes adjacent to on-street parallel parking are common in the U.S. and can be dangerous for bicyclists if they do not provide adequate separation from parked cars. Crashes caused by a suddenly-opened vehicle door are a common hazard for bicyclists using this type of facility. On the other hand, wide bike lanes may encourage the cyclist to ride farther to the right (door zone) to maximize distance from passing traffic. Wide bike lanes may also cause confusion with unloading vehicles in busy areas where parking is typically full.

Treatments to encourage bicyclists to ride away from the 'door zone' include:

- Provide a buffer zone (preferred design). Bicyclists traveling in the center of the bike lane will be less likely to encounter open car doors. Motorists have space to stand outside the bike lane when loading and unloading.
- Installing parking "T's" and smaller bike lane stencils placed to the left.

Guidance

- Caltrans Highway Design Manual (Chapter 1000)
- 2012 California MUTCD
- AASHTO Guide for the Development of Bicycle Facilities



Parking 'T' bike lane design

Class II Bikeway: Bike Lanes on Streets Without Parking

Design Summary

Bike lane width:

- 4 foot minimum when no curb & gutter is present, 6 foot preferred (rural road sections). Parking may be allowed on the adjacent shoulder.
- 7 feet preferred when adjacent to curb and gutter (5' more than the gutter pan width if the gutter pan is wider than 2').
- 6 feet recommended where right-of-way allows.

Maximum width:

- 7 feet Adjacent to arterials with high travel speeds (45 mph+) and widen curb lanes by 2 feet.

Discussion

Wider bike lanes are desirable in certain circumstances such as on higher speed arterials (45 mph+) where a wider bike lane can increase separation between passing vehicles and cyclists. Wide bike lanes are also appropriate in areas with high bicycle use. A bike lane width of 6-7 feet makes it possible for bicyclists to ride side-by-side or pass each other without leaving the bike lane, increasing the capacity of the lane. Appropriate signing and stenciling is important with wide bike lanes to ensure motorists do not mistake the lane for a vehicle lane or parking lane.

Guidance

- Caltrans Highway Design Manual (Chapter 1000)
- 2012 California MUTCD
- AASHTO Guide for the Development of Bicycle Facilities

Where on-street parking is not allowed adjacent to a bike lane, bicyclists do not require additional space to avoid opened car doors.

Class II Bikeway: Retrofitting Existing Streets, Roadway Widening

Design Summary

Bike lane width:

- 6 feet preferred
- 4 feet minimum (see bike lane guidance)

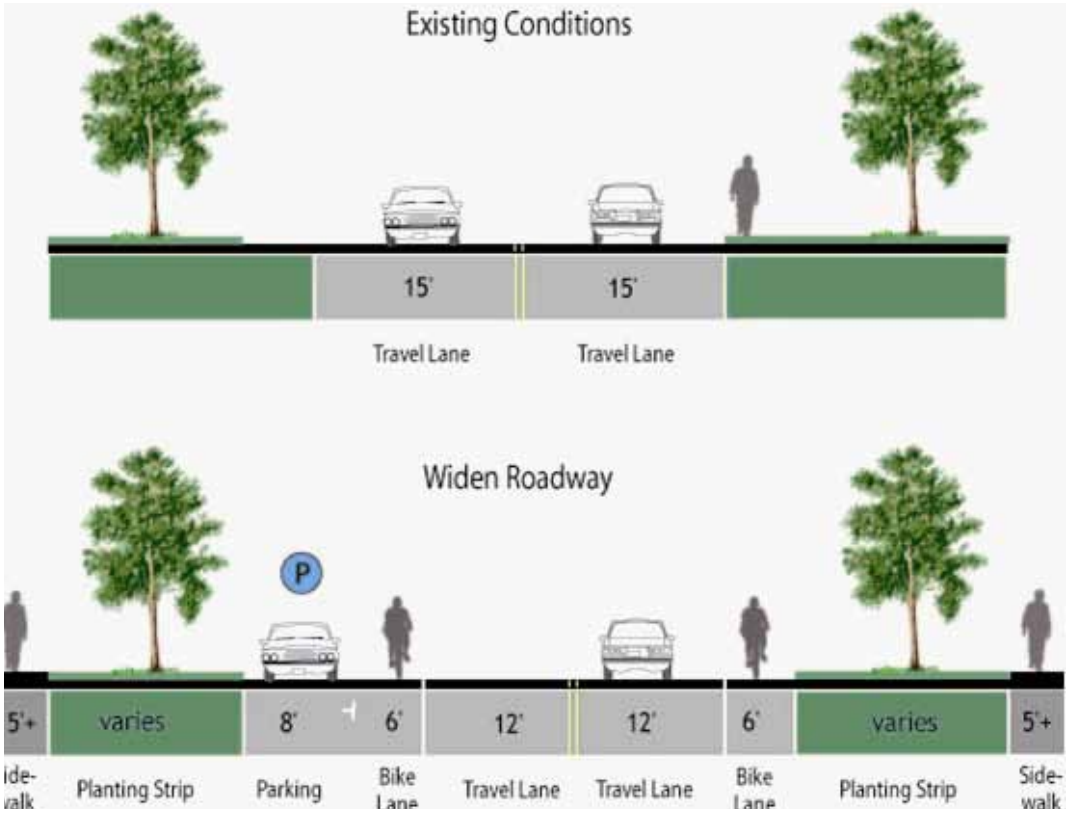
Discussion

Bike lanes could be accommodated on several streets with excess right-of-way through shoulder widening. Although street widening incurs higher expenses compared with re-striping projects, bike lanes could be added to streets currently lacking curbs, gutters and sidewalks without the high costs of major infrastructure reconstruction.

Guidance

- Caltrans Highway Design Manual (Chapter 1000)
- AASHTO Guide for the Development of Bicycle Facilities
- Rosales, Jennifer. (2006). Road Diet Handbook: Setting Trends for Livable Streets

Roadway widening is preferred on roads lacking curbs, gutters and sidewalks



Example of roadway widening to accommodate bike lanes and sidewalks

Class II Bikeway: Retrofitting Existing Streets, Lane Narrowing

Design Summary

- Vehicle lane: before 12 feet to 15 feet; after: 10 feet to 11 feet
- Bike lane width: see bike lane design guidance

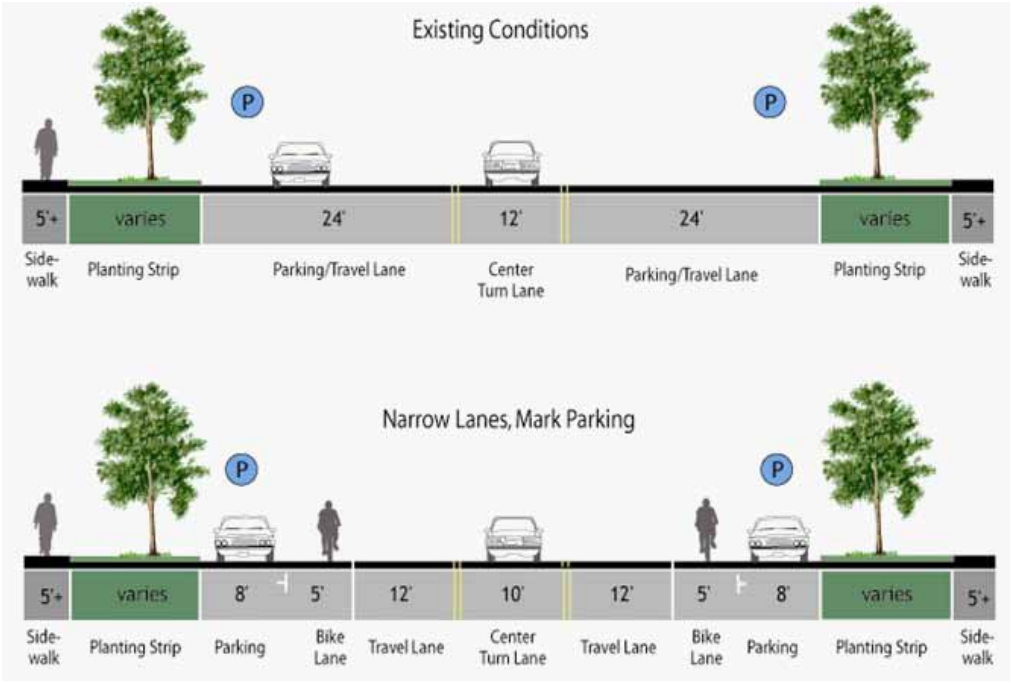
Discussion

Lane narrowing utilizes roadway space that exceeds minimum standards to create the needed space to provide bicycle lanes. Many roadways have lanes that are wider than currently established minimums contained in the AASHTO Policy on the Geometric Design of Highways and Streets and the Caltrans HCM. Most standards allow for the use of 11' and sometimes 10' travel lanes. Lane widths can be narrowed on a case by case basis to connect to bikeways in neighboring jurisdictions. Special considerations should be given to the amount of heavy vehicle traffic and horizontal curvature before the decision is made to narrow travel lanes. Center turn lanes can also be narrowed in some situations to free up pavement space for bicycle lanes.

Guidance

- Caltrans Highway Design Manual (Chapter 1000)
- AASHTO Guide for the Development of Bicycle Facilities
- Rosales, Jennifer. (2006). Road Diet Handbook: Setting Trends for Livable Streets

This street in Portland, Oregon previously had 13' lanes, which were narrowed to accommodate bike lanes without removing a lane.



Example of vehicle travel lane narrowing to accommodate bike lanes.

Class II Bikeway: Retrofitting Existing Streets, Lane Reconfiguration

Design Summary

- Vehicle lane width depends on project. No narrowing may be needed if a lane is removed.
- Bike lane width: see bike lane design guidance

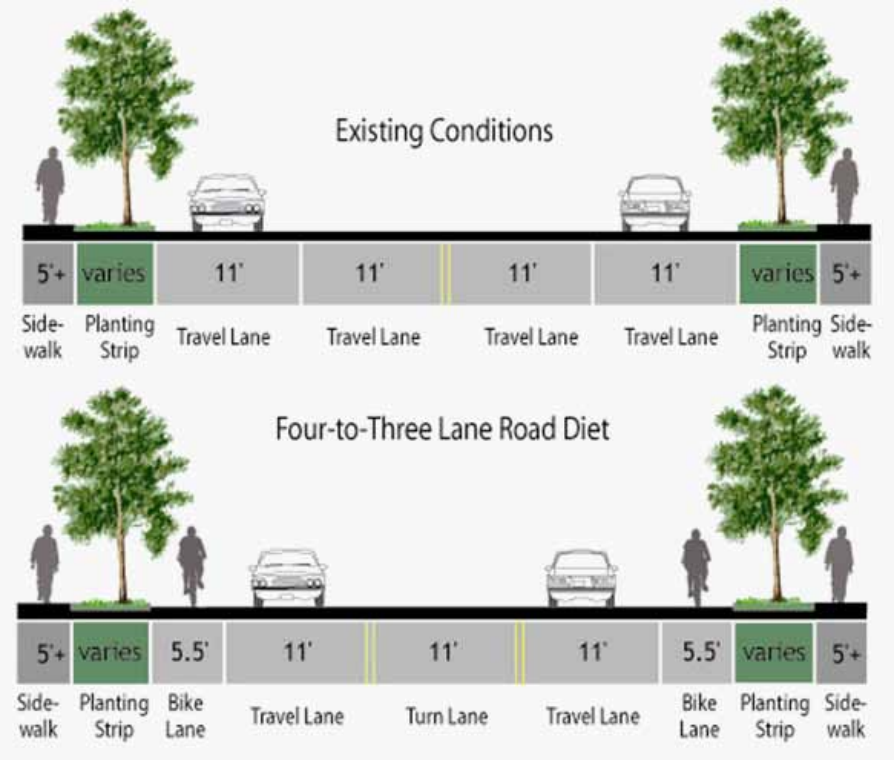
Discussion

The removal of a single travel lane, also called a "Road Diet", will generally provide sufficient space for bike lanes on both sides of a street. Streets with excess vehicle capacity provide opportunities for bike lane retrofit projects. Depending on a street's existing configuration, traffic operations, user needs, and safety concerns, various lane reduction configurations exist. For instance, a four-lane street (with two travel lanes in each direction) could be modified to include one travel lane in each direction, a center turn lane, and bike lanes. Prior to implementing this measure, a traffic analysis should identify impacts.

Guidance

- Slated for inclusion in the update to the AASHTO Guide for the Development of Bicycle Facilities
- Rosales, Jennifer. (2006). Road Diet Handbook: Setting Trends for Livable Streets

This road was re-striped to convert four vehicle travel lanes into three travel lanes with bike lanes.



Example of bikeway lane reconfiguration to accommodate bike lanes.

Class II Bikeway: Retrofitting Existing Streets, Parking Reduction

Design Summary

- Vehicle lane width depends on project. No narrowing may be needed depending on the width of the parking lane to be removed.
- Bike lane width: see bike lane design guidance

Discussion

Bike lanes could replace one or more on-street parking lanes on streets where excess parking exists and/or the importance of bike lanes outweighs parking needs. For instance, parking may be needed on only one side of a street (as shown below and at right). Eliminating or reducing on-street parking also improves sight distance for cyclists in bike lanes and for motorists on approaching side streets and driveways. Prior to reallocating on-street parking for other uses, a parking study should be performed to gauge demand and to evaluate impacts to people with disabilities. On streets where parking is at a premium and the roadway width constrains bicycle lane implementation, a Class III Bike Route can be considered.

Guidance

- Rosales, Jennifer. (2006). Road Diet Handbook: Setting Trends for Livable Streets

Some streets may not require parking on both sides.

Example of parking removal to accommodate bike lanes.

Buffered Bike Lanes

Design Summary

Bicycle Lane Width:

- 5 feet minimum. Bicycle lane should drain to street. Drainage grates should be in travel lane.

Signage & Striping:

- Bicycle lane word and/or symbol and arrow marking (CA-MUTCD Figure 9C-3) shall be used to define the bike lane and designate that portion of the street for preferential use by bicyclists)
- The buffer shall be marked with 2 solid white lines with diagonal hatching if 3 ft in width or wider.

Discussion

Provides cushion of space to mitigate friction with motor vehicles on streets with frequent or fast motor vehicle traffic. Buffered Bike lanes allow bicyclists to pass on another or avoid obstacles without encroaching into the travel lane.

These facilities increase motorist shy distance from bicyclist in the bike lane and reduce the risk of "dooring" compared to a conventional bike lane.

Buffered bike lanes require additional roadway space and maintenance

Guidance

- NACTO Urban Bikeway Design Guide (2011)
- Crow Design Manual for Bicycle Traffic - Chapter 5
- This treatment is not currently present in any U.S. State or Federal design manuals

Buffers should be at least 2 ft wide because it is impractical to mark a zone narrower than that.

Class II Bike Lane: Intersection Treatments, Bicycle Signal Actuation

Design Summary

At signalized intersections, cyclists should be able to trigger signals when cars are not present. Requiring cyclists to dismount to press a pedestrian button is inconvenient and requires the cyclist to merge in into traffic at an intersection. It is particularly important to provide bicycle actuation in a left-turn only lane where cyclists regularly make left turn movements.

Discussion

Loop Detectors

Bicycle-activated loop detectors are installed within the roadway to allow a bicycle to trigger a change in the traffic signal. This allows the cyclist to stay within the lane of travel rather than maneuvering to the side of the road to trigger a push button.

All new loop detectors installed will be capable of detecting bicycles. Identify loops that detect bicycles with the "Bicycle Detector Symbol" shown in Figure 9C-7(CA) in the CA- MUTCD.

Detection Cameras

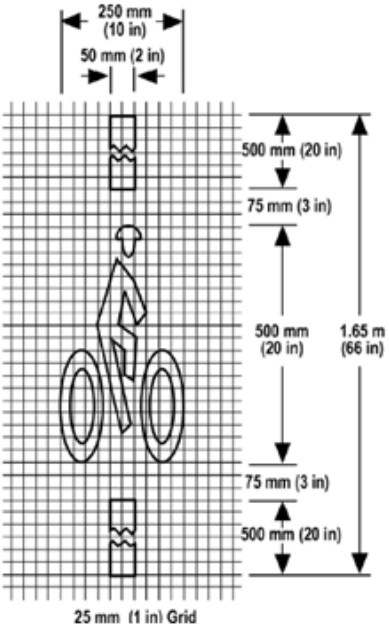
Video detection cameras can also be used to determine when a vehicle is waiting for a signal. These systems use digital image processing to detect a change in the image at the location. Cameras can detect bicycles, although cyclists should wait in the center of the lane, where an automobile would usually wait, in order to be detected. Video camera system costs range from $20,000 to $25,000 per intersection. Detection cameras are currently used for cyclists in the City of San Luis Obispo, CA, where the system has proven to detect pedestrians as well.

Remote Traffic Microwave Sensor Detection (RTMS)

RTMS is a system developed in China, which uses frequency modulated continuous wave radio signals to detect objects in the roadway. This method is marked with a time code which gives information on how far away the object is. The RTMS system is unaffected by temperature and lighting, which can affect standard detection cameras.

Guidance

- www.humantransport.org/bicycledriving/library/signals/detection.htm
- ITE Guidance for Bicycle—Sensitive Detection and Counters: http://www.ite.org/councils/Bike-Report-Ch4.pdf
- 2012 CA-MUTCD Chapter 9



Recommended loop detector marking (MUTCD-CA Supplement Figure 9C-7).

Example bicycle actuator marking.

Instructional Sign (MUTCD-CA Supplement Sign R62C).

Class II Bikeway: Intersection Treatments, Channelized Right Turn Pocket

Design Summary

- Right-turn lane width – minimum 12-foot width.
- Bike lane pocket width – minimum 4-5 feet preferred.
- Works best on streets with lower posted speeds (30 MPH or less) and with low traffic volumes (10,000 ADT or less)

Discussion

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

According to the CA MUTCD and Chapter 1000, the appropriate treatment for right-turn only lanes is to place a bike lane pocket between the right-turn lane and the right-most through lane or, where right-of-way is insufficient, to drop the bike lane entirely approaching the right-turn lane. Dropping the bike lane is not recommended, and should only be done when a bike lane pocket cannot be accommodated.

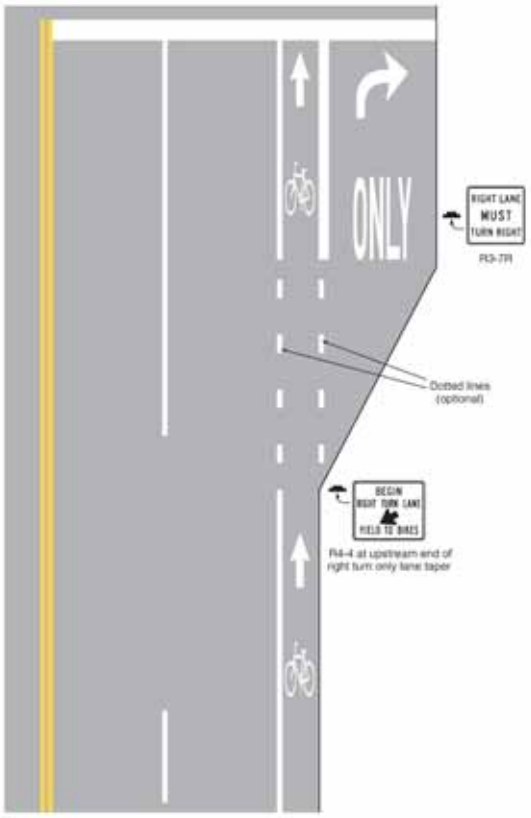
An optional through-right-turn lane next to a right-turn only lane should not be used where there is a through bicycle lane. If a capacity analysis indicates the need for an optional through-right turn lane, the bicycle lane should be discontinued at the intersection approach.

Advantages:

- Aids in correct positioning of cyclists at intersections with a dedicated right-turn lane without adequate space for a dedicated bike lane
- Encourages motorists to yield to bicyclists when using the right-turn lane
- Reduces motor vehicle speed within the right-turn lane
- Disadvantages/potential hazards:
- May not be appropriate for high-speed arterials or intersections with long right-turn lanes
- May not be appropriate for intersections with large percentages of right-turning heavy vehicles

Guidance

- Caltrans Highway Design Manual (Chapter 1000)
- California MUTCD, Section 9C.04
- AASHTO Guide for the Development of Bicycle Facilities
- This would require experimental authorization from the California Traffic Control Devices Committee (CTCDC) and FHWA.



Recommended bike/right turn lane design (MUTCD-CA Supplement Figure 9C-4).

Shared bike-right turn lanes require warning signage as well as pavement markings.

Class II Bike Lane: Intersection Treatments, Interchanges

Design Summary

Bike lane width:

- 4-foot minimum when no curb & gutter is present (rural road sections).
- 5-foot minimum when adjacent to curb and gutter (5 feet more than the gutter pan width if the gutter pan is wider than 2 feet).
- 6 feet recommended where right-of-way allows

Maximum Width:

- 8 feet adjacent to arterials with high travel speeds (45 mph+)
- Treatment for Interchange Ramp Ingress / Egress:
- Design intersections and ramps to limit the conflict areas or eliminate unnecessary uncontrolled ramp connections to urban roadways
- Follow AASHTO guidance (p. 62 and 63) on methods for delineating or not delineating a bike lane through an interchange

Discussion

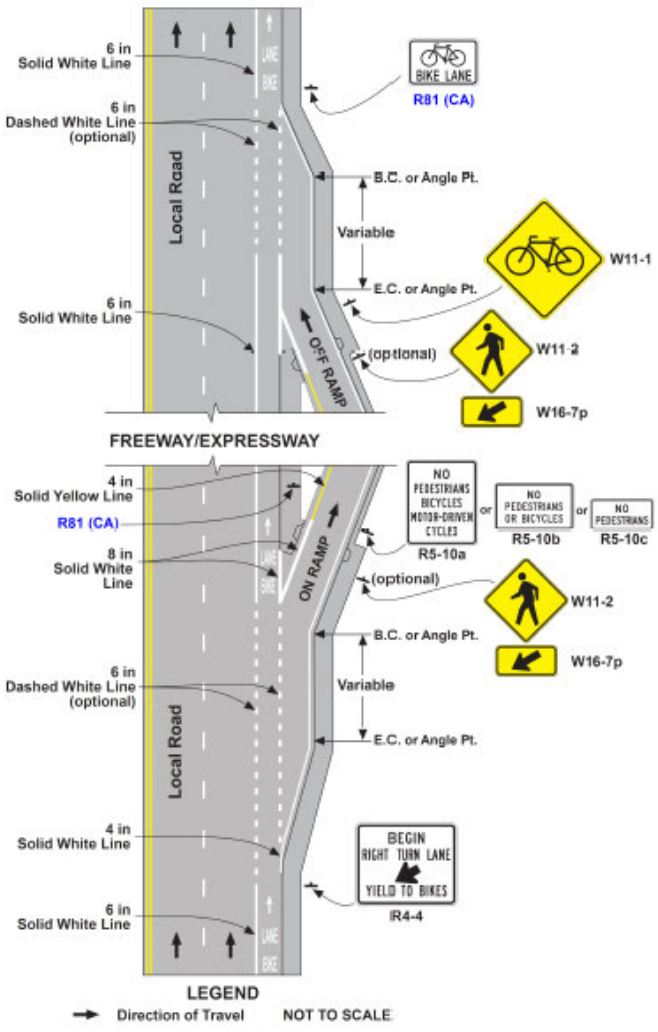
At highway interchanges, motor vehicles often make turns at higher speeds than on surface roads. Bike lanes through interchange areas should clearly warn motorists to expect bicyclists, and signage should alert bicyclists that they should not turn to enter the highway.

Figure 9C-103 (right) depicts the current guidance provided by the California MUTCD. On high traffic bicycle corridors, non-standard treatments may be desirable. Dashed bicycle lane lines with or without colored bike lanes may be applied to provide increased visibility for bicycles in the merging area.

The use of double-turn lanes should be discouraged because of the difficulties they present for pedestrians and bicyclists (see previous treatment). Existing double-turn lanes should be studied and converted to single-turn lanes, unless found to be absolutely necessary for traffic operations.

Guidance

- Caltrans Highway Design Manual (Chapter 1000)
- 2012 California MUTCD
- AASHTO Guide for the Development of Bicycle Facilities



California MUTCD Figure 9C-103 provides guidance for continuing bike lanes through interchange areas.

Colored Bike Lanes

Design Summary

Bicycle Lane Width:

5' minimum and 7' maximum

Discussion

A contrasting color for the paving of bicycle lanes can also be applied to continuous sections of roadways. These situations help to better define road space dedicated to bicyclists and make the roadway appear narrower to drivers resulting in beneficial speed reductions.

Colored bicycle lanes require additional cost to install and maintain. Techniques include:

- Paint – less durable and can be slippery when wet
- Colored asphalt – colored medium in asphalt during construction – most durable.
- Colored and textured sheets of acrylic epoxy coating.
- Thermoplastic – Expensive, durable but slippery when worn.

Guidance

- Currently this treatment has been granted interim approval per FHWA.
- National Association of City Transportation Officials (NACTO) Urban Bikeway Design Guide (2011).

Colored bike lanes are a common treatment in many European Cities and are starting to garner acceptance in US cities.

Colored Bike Lanes at Interchanges

Design Summary

Bicycle Lane Width:

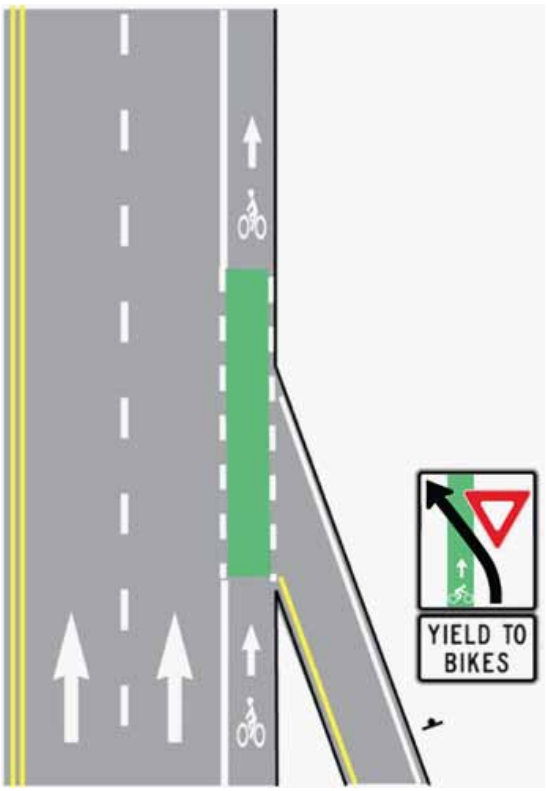
- The bicycle lane width through the interchange should be the same width as the approaching bicycle lane (minimum five feet).

Discussion

On high traffic bicycle corridors non-standard treatments may be desirable over current practices outlined in the MUTCD. Dashed bicycle lane lines with or without colored bicycle lanes may be applied to provide increased visibility for bicycles in the merging area

Guidance

- This treatment is not currently present in any State or Federal design standards
- NACTO Urban Bikeway Design Guide
- City of Chicago - Green Pavement Markings for Bicycle Lanes (Ongoing) - FHWA Experiment No. 9-77(E)
- Portland's Blue Bicycle Lanes
- http://www.portlandonline.com/shared/cfm/image.cfm?id=58842



Colored Bike Lanes in Conflict Areas

Design Summary

Bicycle Lane Width:

- The bicycle lane width through the interchange should be the same width as the approaching bicycle lane (minimum five feet).

Discussion

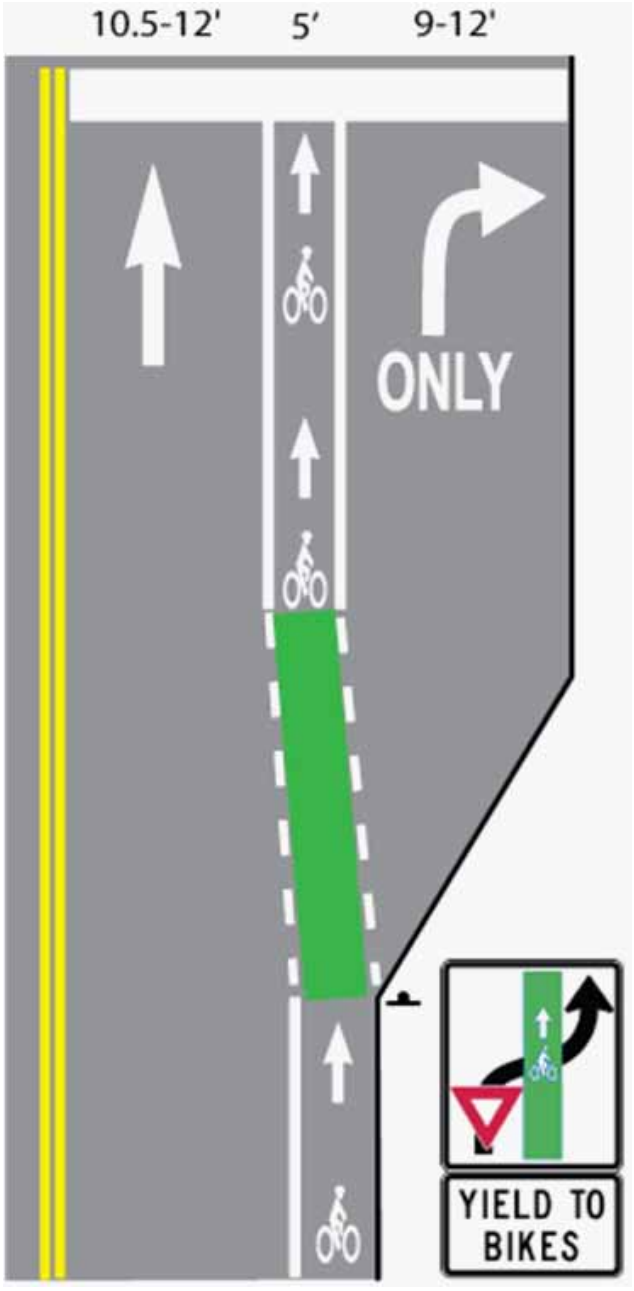
Some cities in the United States are using colored bicycle lanes to guide bicyclists through major vehicle/bicycle conflict points.

Color Considerations:

There are three colors commonly used in bicycle lanes: blue, green, and red. All help the bicycle lane stand out in merging areas. The City of Portland began using blue lanes and changed to green in April 2008. Green is the color being recommended for use.

Guidance

- This treatment is not currently present in any State or Federal design standards
- NACTO Urban Bikeway Design Guide
- City of Chicago - Green Pavement Markings for Bicycle Lanes (Ongoing) - FHWA Experiment No. 9-77(E)
- Portland's Blue Bicycle Lanes
- http://www.portlandonline.com/shared/cfm/image.cfm?id=58842



A.3.2 Off-Street Facility Design Guidelines

Off- Street Facility

A Class I facility allows for two-way, off-street bicycle and pedestrian traffic and also may be used by pedestrians, skaters, wheelchair users, and other non-motorized users. These facilities are frequently found in parks, along rivers, and in greenbelts or utility corridors where there are few conflicts with motorized vehicles. Class I facilities can also include amenities such as lighting, signage, and fencing (where appropriate). In California, design of Class I facilities is dictated by Chapter 1000 of the Highway Design Manual.

Class I facilities can provide a desirable facility particularly for novice riders, recreational trips, and cyclists of all skill levels preferring separation from traffic. Class I bikeways should generally provide new travel opportunities.

Class I facilities serve bicyclists and pedestrians and provide additional width over a standard sidewalk. Facilities may be constructed adjacent to roads, through parks, or along linear corridors such as active or abandoned railroad lines or waterways. Regardless of the type, paths constructed next to the road must have some type of vertical (e.g., curb or barrier) or horizontal (e.g., landscaped strip) buffer separating the path area from adjacent vehicle travel lanes.

Elements that enhance Class I bikeway design include:

- Providing frequent access points from the local road network; if access points are spaced too far apart, users will have to travel out of direction to enter or exit the path, which will discourage use
- Placing directional signs to direct users to and from the path
- Building to a standard high enough to allow heavy maintenance equipment to use the path without damage
- eminating the path where it is easily accessible to and from the street system, preferably at a controlled intersection or at the beginning of a dead-end street. If poorly designed, the point where the path joins the street system can put pedestrians and cyclists in a position where motor vehicle drivers do not expect them
- Identifying and addressing potential safety and security issues up front
- Whenever possible, and especially where heavy use can be expected, separate bicycle paths and pedestrian walkways should be provided to reduce conflicts
- Providing accessible parking space(s) at trailheads and access points
- Limiting the number of at-grade crossings with streets or driveways

Class I Bikeways (also referred to as "bike trails" or "paths") are often viewed as recreational facilities, but they are also important corridors for utilitarian trips.

Class I Bicycle Paths

Design Summary

Width standards:

- 8' is the minimum allowed for a two-way bikeway and is only recommended for low traffic situations
- 10' is recommended in most situations and will be adequate for moderate to heavy use
- 12' is recommended for heavy use situations with high concentrations of multiple users such as joggers, bicyclists, rollerbladers, and pedestrians
- Lateral Clearance: 2' minimum or 3' preferred shoulder on both sides (required by Caltrans' HDM, Chapter 1000)
- Overhead Clearance: 8' minimum, 10' recommended to accommodate first responders such as fire trucks or ambulance
- Minimum design speed: 25 mph. Speed bumps or other surface irregularities should never be used to slow bicycles
- Recommended maximum grade: 5%. Steeper grades can be tolerated for short distances (see guidelines following)
- Loading: AASHTO H-20. Heavy duty traffic load requirement

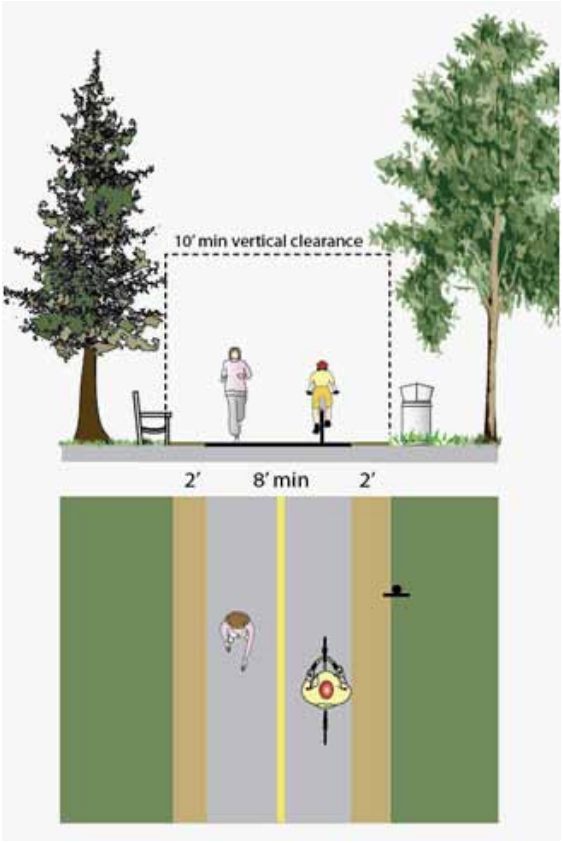
Discussion

A hard surface should be used for Class I bikeways. Concrete, while more expensive than asphalt, is the hardest of all surfaces and lasts the longest. Dyes, such as reddish pigments, can be added to concrete to increase the aesthetic value of the facility itself. When concrete is used the Class I bikeway should be designed and installed using the narrowest possible expansion joints to minimize the amount of 'bumping' cyclists experience on the facility.

Where possible, Class I bikeways should be designed according to ADA standards. Topographic, environmental, or space constraints may make meeting ADA standards difficult and sometimes prohibitive. Prohibitive impacts include harm to significant cultural or natural resources, a significant change in the intended purpose of the trail, requirements of construction methods that are against federal, state or local regulations, or presence of terrain characteristics that prevent compliance.

Guidance

- California Highway Design Manual Chapter 1000
- AASHTO Guide for the Development of Bicycle Facilities
- U.S. Access Board, Public Rights-of-Way Accessibility Guidelines (PROWAG).
- FHWA. Designing Sidewalks and Trails for Access.



Recommended Class I Bikeway design.

The Cedar Lake Regional Trail in Minneapolis, MN has sufficient width to accommodate a variety of users.

Class I Bikeway: Accessibility

Design Summary

- 3 foot minimum clear width where clear width of facility is less than 5 feet; passing space (5 foot section or wider) should be provided at least every 100 feet
- Cross slope should not exceed 5%
- Signs shall be provided indicating the length of the accessible trail segment
- Ramps should be provided at roadway crossings. Tactile warning strips and auditory crossing signals are recommended.
- FHWA recommends that when trails intersect roads, the design of trail curb ramps should, as a minimum, follow the recommendations provided in Chapter 7: Curb Ramps (FHWA Designing Sidewalks and Trails for Access; www.fhwa.dot.gov/environment/sidewalk2/sidewalks207.htm

Discussion

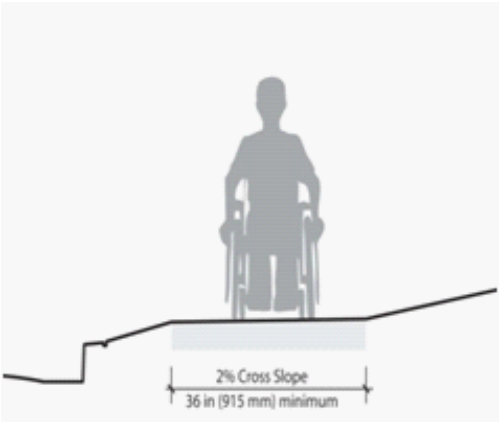
Slopes typically should not exceed 5%. However certain conditions may require the use of steeper slope. For conditions exceeding a 5% slope, the recommendations are as follows:

- Up to an 8.33% slope for a 200-feet maximum run, with landings or resting intervals at minimum of 200 feet must be provided
- Up to a 10% slope for a 30-foot maximum run, with resting intervals spaced at a 30 feet minimum
- Up to 12.5 % slope for a 10-foot maximum run, with resting intervals spaced at a 10 feet minimum

The surface shall be firm and stable. The Forest Service Accessibility Guidelines defines a firm surface as one that is not noticeably distorted or compressed by the passage of a device that simulates a person who uses a wheelchair. Where rights-of-way are available, Class I bikeways can be made more accessible by creating side paths that meander away from a roadway that exceeds a 5% slope.

Guidance

- American with Disabilities Act (ADA) for accessible trails
- See also FHWA. (2001).Designing Sidewalks and Trails for Access, Chapter 14: Shared Use Path Design, Section 14.5.1: Gradewww.fhwa.dot.gov/environment/sidewalk2/sidewalks212.htm#tra2



ADA clearance requirement.

Class I bikeways surfacing materials affects which types of users can benefit from the facility.

Managing Multiple Users

Design Summary

- Barrier separation – vegetated buffers or barriers, elevation changes, walls, fences, railings and bollards.
- Distance separation – differing surfaces.
- User behavior guidance signage.

Discussion

On trails that have high bicycle and pedestrian use, conflicts can arise between faster-moving bicyclists and slower bicyclists, as well as pedestrians and other users. As this is a common problem in more urban areas, a variety of treatments have been designed to alleviate congestion and minimize conflicts.

Centerline Striping

On trails of standards widths, striping the centerline identifies which side of the trail users should be on.

Physical Separation

Differing surfaces suitable to each user group foster visual separation and clarity of where each user group should be. When trail corridors are constrained, the approach is often to locate the two different trail surfaces side by side with no separation.

Offsetting of the pedestrian path should be provided if possible. Otherwise, physical separation should be provided in the form of a small hump or other crossable barrier.

The bicycle path should be located on whichever side of the path will result in the fewest number of anticipated pedestrian crossings. For example, the bike path should not be placed adjacent to large numbers of destinations. Site analysis of each project is required to determine expected pedestrian behavior.

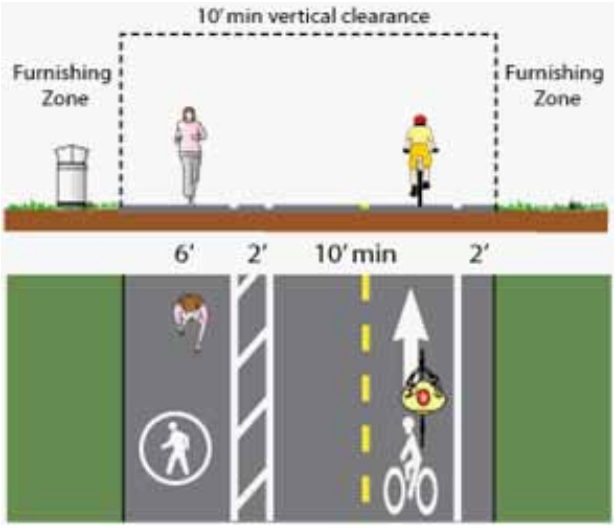
Trail Etiquette Signage

Informing trail users of acceptable trail etiquette is important when multiple user types are anticipated. Yielding the right-of-way is a courtesy and a necessary part of a safe trail experience involving multiple trail users. Trail right-of-way information should be posted at trail access points and along the trail. The message must be clear and easy to understand. Where appropriate, trail etiquette systems should instruct trail users to the yielding of bicyclists to pedestrians and equestrians and the yielding of pedestrians to equestrians.

Guidance

- 2012 California MUTCD, Part 9. Section 9C.03 contains additional information about centerline striping on a trail.

Centerline striping and directional arrows encourage trail users to provide space for other users to pass.



Recommended design for a separated shared-use path

A commonly used multi-use trail etiquette sign

Trails Along Roadways

Design Summary

- 5' minimum buffer should separate the path from the edge of the roadway, otherwise a physical barrier should be installed.

Shared use paths may be considered along roadways under the following conditions:

- The path will generally be separated from all motor vehicle traffic.
- Bicycle and pedestrian use is anticipated to be high.
- To provide continuity with an existing path through a roadway corridor.
- The path can be terminated at each end onto streets or trails with good bicycle and pedestrian facilities.
- There is adequate access to local cross-streets and other facilities along the route.
- Any needed grade separation structures do not add substantial out-of-direction travel.
- The total cost of providing the proposed path is proportionate to the need, compared to the cost of providing on-street facilities.

Trails directly adjacent to roadways can be challenging for users at roadway intersections.

Discussion

Concerns about shared use paths directly adjacent to roadways (e.g., with minimal or no separation) are:

- Half of bicycle traffic may ride against the flow of vehicle traffic, contrary to the rules of the road.
- When the path ends, bicyclists riding against traffic tend to continue to travel on the wrong side of the street, as do bicyclists who are accessing the path. Wrong-way bicycle travel is a major cause of crashes.
- At intersections, motorists crossing the path often do not notice bicyclists approaching, especially where sight distances are poor.
- Bicyclists are required to stop or yield at cross-streets and driveways, unless otherwise posted.
- Stopped vehicles on a cross-street or driveway may block the path.
- Because of the proximity of vehicle traffic to opposing bicycle traffic, barriers are often necessary to separate motorists from bicyclists. This type of improvement increases construction and maintenance costs.
- Paths directly adjacent to high-volume roadways diminish users' experience by placing them in an uncomfortable environment.

As bicyclists gain experience and realize some of the advantages of riding on the roadway, some riders stop using paths adjacent to roadways. Bicyclists may also tend to prefer the roadway as pedestrian traffic on the shared use path increases. When designing a bikeway network, the presence of a nearby or parallel path should not be used as a reason to forego adequate shoulder or bike lane width on the roadway, as the on-street bicycle facility will generally be superior to the "sidepath" for experienced bicyclists and those who are bicycling for transportation purposes. Bike lanes should be provided as an alternate (more transportation-oriented) facility whenever possible

Guidance

- Both the California Highway Design Manual Chapter 1000, and the AASHTO Guide for the Development of Bicycle Facilities recommend against the development of multi-use paths directly adjacent to roadways, without providing adequate buffers/barriers between path users and motorists.

Class I Bikeway: Roadway Crossings

While at-grade crossings create a potentially high level of conflict between Class I bikeway users and motorists, well-designed crossings have not historically posed a safety problem for path users. This is evidenced by the thousands of successful paths around the United States with at-grade crossings. In most cases, at-grade path crossings can be properly designed to a reasonable degree of safety and can meet existing traffic and safety standards.

Evaluation of crossings involves analysis of vehicular and anticipated path user traffic patterns, including

- Vehicle speeds
- Street width
- Sight distance
- Traffic volumes (average daily traffic and peak hour traffic)

Path user profile (age distribution, destinations served)

Consideration must be given for adequate warning distance based on vehicle speeds and line of sight. Visibility of any signing used to mark the crossing is absolutely critical. Catching the attention of motorists jaded to roadway signs may require additional alerting devices such as a flashing light, roadway striping or changes in pavement texture. Signing for Class I bikeway users must include a standard "STOP" sign and pavement marking, sometimes combined with other features such as a kink in the pathway to slow bicyclists.

Design Summary

At-grade Class I bikeway/roadway crossings that provide assistance for cyclists and pedestrians crossing the roadway generally will fit into one of four basic categories:

- Type 1: Marked/Unsignalized - Uncontrolled crossings include trail crossings of residential, collector, and sometimes major arterial streets or railroad tracks.
- Type 1+: Marked/Enhanced – Unsignalized intersections can provide additional visibility with flashing beacons and other treatments.
- Type 2: Route Users to Existing Signalized Intersection - Trails that emerge near existing intersections may be routed to these locations, provided that sufficient protection is provided at the existing intersection.
- Type 3: Signalized/Controlled - Trail crossings that require signals or other control measures due to traffic volumes, speeds, and trail usage.
- Type 4: Grade-separated crossings - Bridges or under-crossings provide the maximum level of safety but also generally are the most expensive and have right-of-way, maintenance, and other public safety considerations.

An offset crossing forces pedestrians to turn and face the traffic they are about to cross.

Guidance

- California Highway Design Manual Chapter 1000
- AASHTO Guide for the Development of Bicycle Facilities
- Federal Highway Administration (FHWA) Report, Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations

Class I Bikeway: Roadway Crossings (continued)

Summary of Path/Roadway At-Grade Crossing Recommendations[1]

Roadway Type		Vehicle ADT ≤ 9,00			Vehicle ADT > 9,000 to 12,000			Vehicle ADT >12,000 to 15,000			Vehicle ADT > 15,000		
	Speed Limit (mph)**												
	30	35	40	30	35	40	30	35	40	30	35	40	
2 Lanes		1	1	1/1+	1	1	1/1+		1	1+/3		1/1+	1+/3
3 Lanes			1	1/1+		1/1+	1/1	1/1+	1/1+	1+/3	1	1+	1+/3
Multi-Lane (4 +) w/ raised median***		1	1	1/1+	1	1/1+	1+/3	1/1+	1/1+	1+/3	1+/3	1+/3	1+/3
Multi-Lane (4 +) w/o raised median		1	1/1+	1+/3	1/1+	1/1+	1+/3	1+/3	1+/3	1+/3	1+/3	1+/3	1+/3

**General Notes: Crosswalks should not be installed at locations that could present an increased risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone will not make crossings safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions), as needed, to improve the safety of the crossing. These are general recommendations; good engineering judgment should be used in individual cases for deciding which treatment to use.*

For each pathway-roadway crossing, an engineering study is needed to determine the proper location. For each engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, etc. may be needed at other sites.

*** Where the speed limit exceeds 40 mph marked crosswalks alone should not be used at unsignalized locations.*

**** The raised median or crossing island must be at least 4 ft (1.2 m) wide and 6 ft (1.8 m) long to adequately serve as a refuge area for pedestrians in accordance with MUTCD and AASHTO guidelines. A two-way center turn lane is not considered a median. Los Angeles County prefers a 14 ft wide raised median, although a 12 ft wide median without a median nose could be used.*

1= Type 1 Crossings. Ladder-style crosswalks with appropriate signage should be used.

1/1+ = With the higher volumes and speeds, enhanced treatments should be used, including marked ladder style crosswalks, median refuge, flashing beacons, and/or in-pavement flashers. Ensure there are sufficient gaps through signal timing, as well as sight distance.

1+/3 = Carefully analyze signal warrants using a combination of Warrant 2 or 5 (depending on school presence) and EAU factoring. Make sure to project pathway usage based on future potential demand. Consider Pelican, Puffin, or Hawk signals in lieu of full signals. For those intersections not meeting warrants or where engineering judgment or cost recommends against signalization, implement Type 1 enhanced crosswalk markings with marked ladder style crosswalks, median refuge, flashing beacons, and/or in-pavement flashers. Ensure there are sufficient gaps through signal timing, as well as sight distance.

Class I Bikeway: Marked/Unsignalized Crossings

If well-designed, multi-lane crossings of higher-volume arterials of over 15,000 ADT may be unsignalized with features such as a combination of some or all of the following: excellent sight distance, sufficient crossing gaps (more than 60 per hour), median refuges, and/or active warning devices like flashing beacons or in-pavement flashers. These are referred to as "Type 1 Enhanced" (Type 1+). Such crossings would not be appropriate; however, if a significant number of schoolchildren used the path. Furthermore, both existing and potential future path usage volume should be taken into consideration.

On two-lane residential and collector roads below 15,000 ADT with average vehicle speeds of 35 MPH or less, crosswalks and warning signs ("Path Xing") should be provided to warn motorists, and stop signs and slowing techniques (bollards/geometry) should be used on the path approach. Curves in paths that orient the path user toward oncoming traffic are helpful in slowing path users and making them aware of oncoming vehicles. Care should be taken to keep vegetation and other obstacles out of the sight line for motorists and path users. Engineering judgment should be used to determine the appropriate level of traffic control and design.

On roadways with low to moderate traffic volumes (<12,000 ADT) and a need to control traffic speeds, a raised crosswalk may be the most appropriate crossing design to improve pedestrian visibility and safety. These crosswalks are raised 75 millimeters above the roadway pavement (similar to speed humps) to an elevation that matches the adjacent sidewalk. The top of the crosswalk is flat and typically made of asphalt, patterned concrete, or brick pavers. Brick or unit pavers should be discouraged because of potential problems related to pedestrians, bicycles, and ADA requirements for a continuous, smooth, vibration-free surface. Detectable warning strips are needed at the sidewalk/street boundary so that visually impaired pedestrians can identify the edge of the street.

Design Summary

A marked/unsignalized crossing (Type 1) consists of a crosswalk, signage, and often no other devices to slow or stop traffic. The approach to designing crossings at mid-block locations depends on an evaluation of vehicular traffic, line of sight, path traffic, use patterns, vehicle speed, road type and width, and other safety issues such as proximity to schools.

Maximum traffic volumes:

- Up to 15,000 ADT on two-lane roads, preferably with a median
- Up to 12,000 ADT on four-lane roads with median

Maximum travel speed:

- 35 MPH

Minimum line of sight:

- 25 MPH zone: 155 feet
- 35 MPH zone: 250 feet
- 45 MPH zone: 360 feet

Type 1 crossings include signage and pavement markings.

Guidance

- California Highway Design Manual Chapter 1000
- AASHTO Guide for the Development of Bicycle Facilities
- Federal Highway Administration (FHWA) Report, Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations

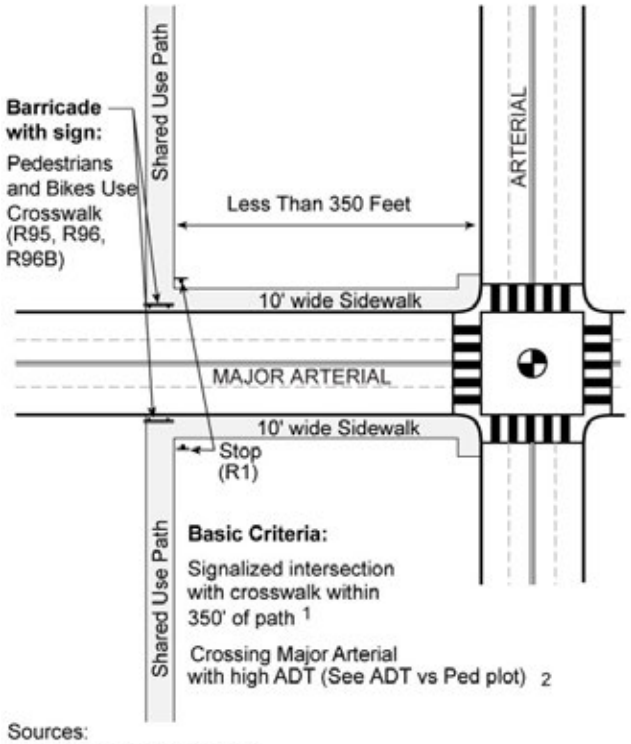
Class I Bikeway: Route Users to Existing Signalized Intersection

Design Summary

- A Class I bikeway should cross at a signalized intersection if there is a signalized intersection within 350 feet of the path and the crossroad is crossing a major arterial with a high ADT.
- Intersection Warning (W2-1 through W2-5) signs may be used on a path in advance of the intersection to indicate the presence of the crossing and the possibility of turning or entering traffic. A trail-sized stop sign (R1-1) should be placed about 5 feet before the intersection.

Discussion

Crossings within 350 feet of an existing signalized intersection with pedestrian crosswalks are typically diverted to the signalized intersection for safety purposes. For this option to be effective, barriers and signing may be needed to direct shared-use path users to the signalized crossings. In most cases, signal modifications would be made to add pedestrian detection and to comply with ADA.



Sources:
1. California MUTCD, 2006
2. Investigation of Exposure Based Accident Areas: Crosswalks, Local Street, and Arterials, Knoblauch, 1987

Recommended at-grade crossing of a major arterial at an intersection where trail is within 350' of a roadway intersection

Guidance

- Caltrans Highway Design Manual (Chapter 1000)
- 2012 California MUTCD, Part 9
- AASHTO Guide for the Development of Bicycle Facilities
- AASHTO Policy on the Geometric Design of Highways and Streets
- FHWA-RD-87-038 Investigation of Exposure-Based Pedestrian Accident Areas: Crosswalks, Sidewalks, Local Streets, and Major Arterials

Class I Bikeway: Uncontrolled Mid-Block Crossing

Design Summary

- Installed where there is a significant demand for crossing and no nearby existing crosswalks
- If yield lines are used for vehicles, they shall be placed 20–50 feet in advance of the nearest crosswalk line to indicate the point at which the yield is intended or required to be made and "Yield Here to Pedestrians" signs shall be placed adjacent to the yield line. Where traffic is not heavy, stop or yield signs for pedestrians and bicyclists may suffice.
- The Bicycle Warning (W11-1) sign alerts the road user to unexpected entries into the roadway by bicyclists, and other crossing activities that might cause conflicts

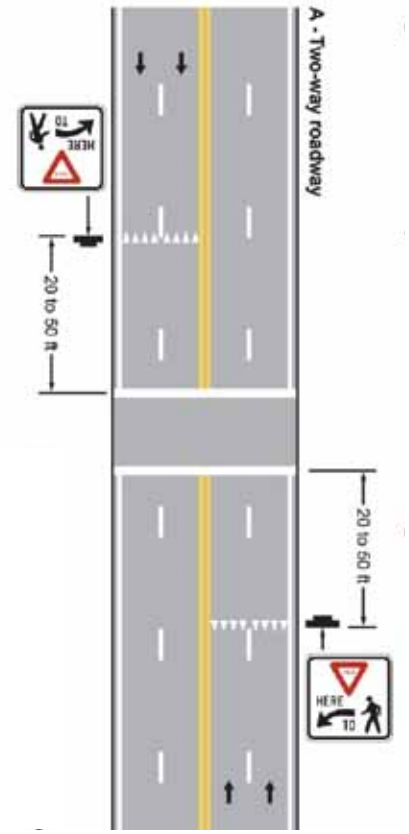
A ladder crosswalk should be used. Warning markings on the path and roadway should be installed.

Discussion

The National MUTCD requires yield lines and "Yield Here to Pedestrians" signs at all uncontrolled crossings of a multi-lane roadway. Yield lines are not required by the CA MUTCD. The National MUTCD includes a trail crossing sign, shown to the right on the next page (W11-15 and W11-15P), which may be used where both bicyclists and pedestrians might be crossing the roadway, such as at an intersection with a shared-use path.

Guidance

- California MUTCD, Part 9
- AASHTO Guide for the Development of Bicycle Facilities



Recommended design from CA-MUTCD, Figure 3B-17.

Recommended signage.

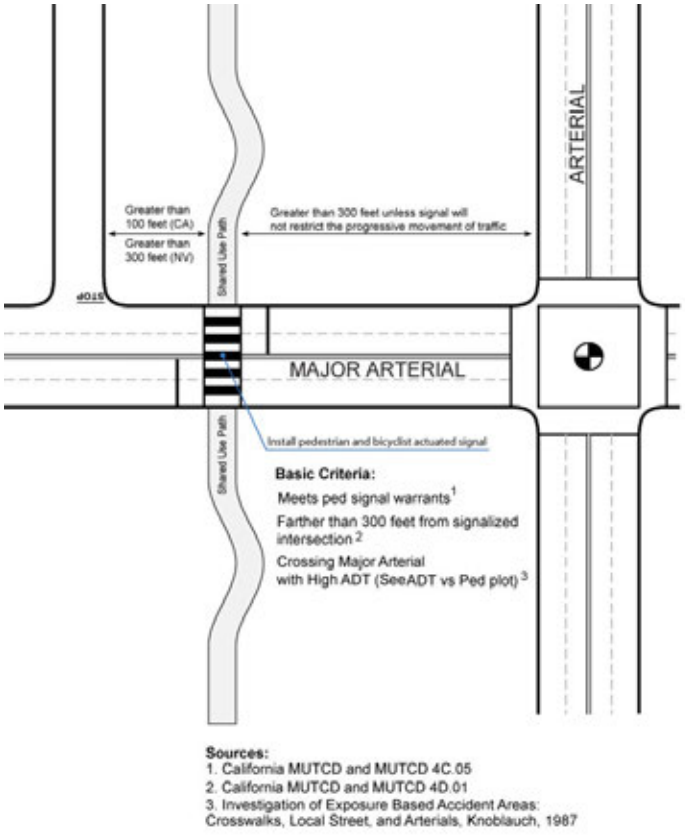
Class I Bikeway: Signalized Mid-Block Crossing

Design Summary

- Section 4C.05 in the CAMUTCD describes pedestrian volume minimum requirements (referred to as warrants) for a mid-block pedestrian-actuated signal
- Stop lines at midblock signalized locations should be placed at least 40 feet in advance of the nearest signal indication

Discussion

Warrants from the MUTCD combined with sound engineering judgment should be considered when determining the type of traffic control device to be installed at path-roadway intersections. Traffic signals for path-roadway intersections are appropriate under certain circumstances. The MUTCD lists 11 warrants for traffic signals, and although path crossings are not addressed, bicycle traffic on the path may be functionally classified as vehicular traffic and the warrants applied accordingly. Pedestrian volumes can also be used for warrants.



CA-MUTCD guidance for a signalized mid-block crossing.

Guidance

- MUTCD, Sections 4C.05 and 4D
- 2012 California MUTCD, Chapters 3 and 9 and Section 4C.05 and 4D
- AASHTO Guide for the Development of Bicycle Facilities, Chapter 2

Class I Bikeway: Grade Separated Undercrossing

Design Summary

- 14' minimum width to allow for access by maintenance vehicles if necessary
- 10' minimum overhead height (AASHTO)
- The undercrossing should have a centerline stripe even if the rest of the path does not have one

Discussion

Undercrossings should be considered when high volumes of bicycles and pedestrians are expected along a corridor and:

- Vehicle volumes/speeds are high
- The roadway is wide
- A signal is not feasible
- Crossing is needed under another grade-separated facility such as a freeway or rail line

Advantages of grade separated undercrossings include:

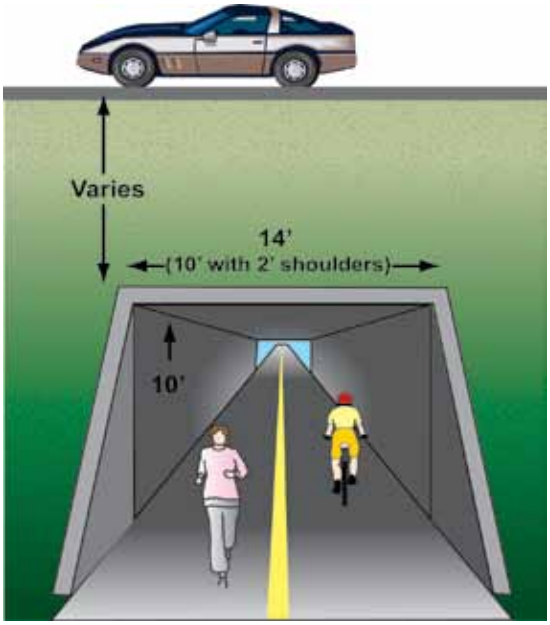
- Improves bicycle and pedestrian safety while reducing delay for all users
- Eliminates barriers to bicyclists and pedestrians
- Undercrossings require 10 feet of overhead clearance from the path surface. Undercrossings often require less ramping and elevation change for the user versus an overcrossing, particularly for railroad crossings.

Disadvantages or potential hazards include:

- If crossing is not convenient or does not serve a direct connection it may not be well utilized
- Potential issues with vandalism and maintenance
- Security may be an issue if sight lines through undercrossing and approaches are inadequate. Lighting or openings for sunlight may be desirable for longer crossings to enhance users' sense of security, especially at tunnels and underpasses under freeways and major highways. Lighting should follow Caltrans-accepted lighting design guidelines.
- High cost

Guidance

- Caltrans Highway Design Manual (Chapter 1000)
- ASHTO Guide for the Development of Bicycle Facilities



Recommended undercrossing design.

Undercrossings provide key connections and allow path users to avoid a potentially dangerous at-grade crossing of a major street.

Class I Bikeway: Grade Separated Overcrossing

Design Summary

- 12 foot minimum width
- If overcrossing has any scenic vistas additional width should be provided to allow for stopped path users
- A separate 6 foot pedestrian area may be provided in locations with high bicycle and pedestrian use
- Minimum of 17 feet of vertical clearance to the roadway below
- 10 foot headroom on overcrossing
- Clearance below will vary depending on feature being crossed
- The overcrossing should have a centerline stripe even if the rest of the path does not have one.
- Ramp slopes should be ADA-accessible: 5% (1:20) grade with landings at 400-foot intervals, or 8.33% (1:12) with landings every 30 feet

Overcrossings are frequently used over a major roadway.

Discussion

Overcrossings require a minimum of 17' of vertical clearance to the roadway below versus a minimum elevation differential of around 12' for an undercrossing. This results in potentially greater elevation differences and much longer ramps for bicycles and pedestrians to negotiate.

Overcrossings should be considered when high volumes of bicycles and pedestrians are expected along a corridor and:

- Vehicle volumes/speeds are high
- The roadway is wide
- A signal is not feasible
- Crossing is needed over a grade-separated facility such as a freeway or rail line

Advantages of grade separated overcrossings include:

- Improves bicycle and pedestrian safety while reducing delay for all users
- Eliminates barriers to bicyclists and pedestrians

Disadvantages and potential hazards include:

- If crossing is not convenient or does not serve a direct connection it may not be well utilized
- Overcrossings require at least 17 feet of clearance to the roadway below involving up to 400 feet or greater of approach ramps at each end. Long ramps can sometimes be difficult for the disabled
- Potential issues with vandalism, maintenance
- High cosst

Guidance

- Caltrans Highway Design Manual (Chapter 1000)
- AASHTO Guide for the Development of Bicycle Facilities

Class I Bike Paths: Trailheads

Design Summary

- Major trailheads should include automobile and bicycle parking, trail information (maps, user guidelines, wildlife information, etc.), garbage receptacles and restrooms
- Minor trailheads can provide a subset of these amenities
- Any trailhead improvements installed within Los Angeles County Flood Control District (LACFCD) right-of-way needs to be operated and maintained by the project sponsor

Discussion

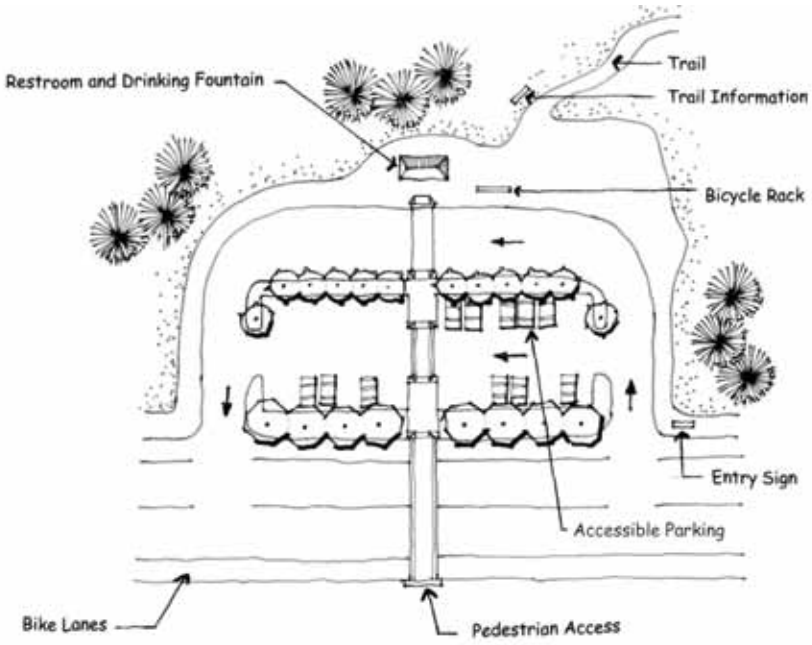
Good access to a path system is a key element for its success. Trailheads (formalized parking areas) serve the local and regional population arriving to the path system by car, transit, bicycle or other modes. Trailheads provide essential access to the shared-use path system and include amenities like parking for vehicles and bicycles, restrooms (at major trailheads), and posted maps.

Trailheads with a small parking area should additionally include bicycle parking and accessible parking.

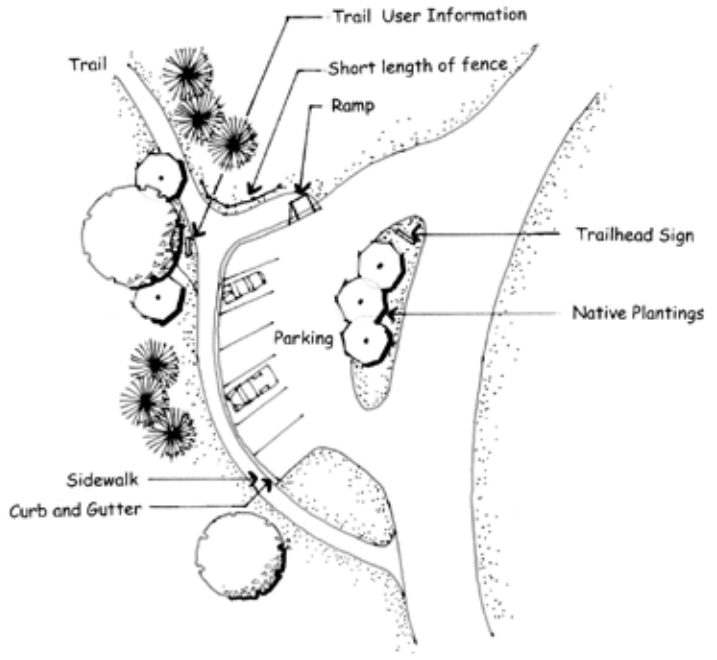
Neighborhood access should be achieved from all local streets crossing the trail. In some situations "No Parking" signs on the adjacent streets are desirable to minimize impact on the neighborhood.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities



Example major trailhead.



Example minor trailhead.

Path Amenities Guidelines

Design Summary

A variety of amenities can make a path inviting to the user. Costs vary depending on the design and materials selected for each amenity. Amenities shall be designed and located so as not to impede accessibility.

Discussion

Benches

Providing benches at key rest areas and viewpoints encourages people of all ages to use the trail by ensuring that they have a place to rest along the way. Benches can be simple (e.g., wood slates) or more ornate (e.g., stone, wrought iron, concrete).

Restrooms/Drinking Fountains

Restrooms benefit path users, especially in more remote areas where other facilities do not exist. Restrooms can be sited at trailheads along the path system. Drinking fountains should be provided at restrooms to allow trail users to rehydrate and recover.

Bicycle Racks/Parking

Bicycle racks allow recreational users to safely park their bikes if they wish to stop along the way, particularly at parks and other desirable destinations. Bicycle parking allows trail users to store their bicycles safely for a short time. Bicycle parking should be provided if a trail transitions to an unpaved pedestrian-only area.

Trash Receptacles

Trash receptacles should be placed at access points. Litter should be picked up once a week and after any special events held on the trail, except where specially designed trash cans have been installed. If maintenance funds are not available to meet trash removal needs, it is best to remove trash receptacles.

Kiosks/Wayfinding Signs

Informational kiosks with maps at trailheads and signage for key destinations can provide valuable information for trail users. See Section 6.7 Wayfinding Standards and Guidelines for additional discussion of trail signage.

Art

Local artists can be commissioned to provide art for the pathway system, creating a sense of place. Pathway art can be functional as well as aesthetic, providing places to sit and play.

Benches and rest areas encourage trail use by seniors and families with children.

Bathrooms are recommended for longer trails and in more remote areas.

Art installations can provide a sense of place for the trail.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.

Pedestrian-Scale Lighting

Design Summary

- Depending on the location, average maintained horizontal illumination levels of 5 lux to 22 lux should be considered (AASHTO).
- Where security problems exist, higher illumination levels may be considered.
- Light standards (poles) should meet the recommended horizontal and vertical clearances.

Discussion

Pedestrian-scale lighting enhances safety and enables the facility to be used year-round, particularly on winter afternoons. Lights should not have a visible source, either to the trail users or to neighboring residences, as they can blind users and pollute the night sky. Low level lighting, such as very short poles or bollards, are often problematic, due to their easy access for vandalism. In some areas, street lighting provides sufficient light for trail users. If pedestrian-scale lighting is desired, some neighborhood friendly options include:

- In-ground lighting – dim lights which indicate the extent of the path.
- Bollards – low-level lighting; can be susceptible to vandalism.
- Solar lighting – best used in situations where running power to the trail would be costly or undesirable.

Pedestrian-scale lighting can have screens to minimize glare. In addition, lights can be programmed to dim or turn off later in the night. A guideline for lighting a pedestrian way is illumination of between 0.5 foot-candle to 1 foot-candle.

Recommended pedestrian-scale lighting.

Guidance

- AASHTO *Guide for the Development of Bicycle Facilities*.
- Caltrans *Highway Design Manual* (Chapter 1000).

Bollards

Design Summary:

- Where removable bollards are used, the top of the mount point should be flush with the path's surface so as not to create a hazard.
- Posts should be permanently reflectorized for night time visibility and painted a bright color for improved daytime visibility.
- Striping an envelope around the post is recommended.
- When more than one post is used, an odd number of posts at 5 feet spacing is desirable.
- Recommended bollard height is 4 feet.

Discussion

Bollards are posts that can be used to block vehicle access to the path and can provide information such as mile markings, wayfinding for key destinations, or small area maps. Minimize the use of bollards to avoid creating obstacles for bicyclists. The California MUTCD explains, "Such devices should be used only where extreme problems are encountered" (Section 9C.101). Instead, design the path entry and use signage to alert drivers that motor vehicles are prohibited.

Flexible bollards and posts are designed to give way on impact and can be used instead of steel or solid posts. These bollards are typically made of plastic that is bolted to the roadway, and bend and return to their original position when hit. They are intended to deter vehicular access, but allow access for emergency vehicles and maintenance equipment.

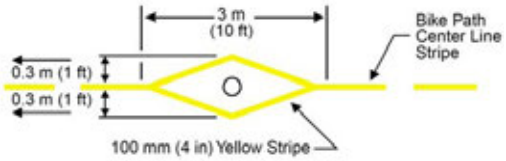
Bollards are typically installed using one of two methods: 1) The bollard is set into a concrete footing in the ground; and 2) the bollard is attached to the surface by mechanical means (mechanical anchoring or chemical anchor).

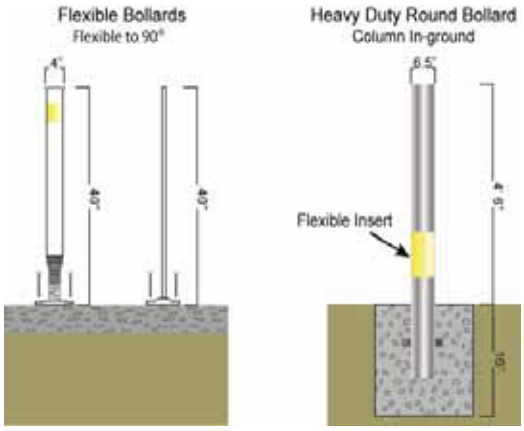
Where used, bollards should have high-visibility, reflective tape or paint. Bollards should be placed in the middle of the path, with sufficient space for path users of all abilities, using a variety of mobility devices, to pass. They can create bottlenecks with path users at intersections, and should be used with caution.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.
- Caltrans Highway Design Manual (Chapter 1000).
- 2012 California MUTCD, Part 9.

Bollards deter motorists from driving on the trail.





Recommended bollard designs.

Fencing

Design Summary:

- Height: 4.5 ft (minimum)
- Fencing provides access control, visual screening, and channeling of path users.

Discussion

Fencing is a means of enhancing safety for both trail users and neighboring residents by deterring unwanted access onto or off of the trail. However, fencing both sides of the trail right of way can result in a "tunnel" effect with the perception of being trapped, resulting in a detrimental effect on the trail user experience. Additionally, solid fencing could inhibit community surveillance of the trail and should be discouraged.

Fencing should not be a barrier to wildlife passage across the corridor. A small six inch gap between the bottom of the fence and the ground should allow smaller wildlife to pass.

Fencing that allows a balance between the need for privacy, while simultaneously allowing informal surveillance of the trail should be encouraged. If fencing is requested purely for privacy reasons, vegetative buffers should be considered.

Some factors to consider when deciding on fencing necessity and styles include:

- Cost: Fencing and other barriers, depending on the type of materials used and the length, can be costly.
- Security: Fencing between the path and adjacent land uses can protect the privacy and security of the property owners.
- Fencing height: The height and design of a fence influences whether lateral movement will be inhibited. Heavy-duty fencing such as wrought iron or other styles of fencing that are difficult to climb are often more expensive.
- Noise and dust: Trail corridors adjacent to busy roadways, freeways or rail lines may be subject to noise, dust, and vibration. Methods of reducing this impact include the addition of vegetation or baffles to fencing barriers.

Post and wire fence.

Open boundaries can be created where users may be entering the trail.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.
- Caltrans Highway Design Manual (Chapter 1000).

Landscaping

Design Summary

Safety and security concerns on a trail can be addressed through Crime Prevention Through Environmental Design (CPTED) guidelines. The four principles of CPTED are:

- Natural surveillance – maintain sight lines and visibility to deter criminal activities.
- Natural access control – use of fences, lighting, signage and landscaping to clearly define where people and vehicles are expected to be.
- Territorial reinforcement – use of physical designs such as pavement treatments, landscaping, and signage to develop a sense of proprietorship over the trail.
- Maintenance - if graffiti or vandalism occurs and is not addressed in a timely manner, it can send the message that no one is watching or that no one cares.

Plantings adjacent to the trail can be attractive, but should be managed to maintain visibility and keep the path clear.

Discussion

Whether natural or planted, vegetation can serve as both a visual and physical barrier between a roadway and a path, make the path more attractive, and provide shelter from the sun. The density and species of plants in a vegetative barrier determine how effective the barrier can be in deterring potential trespassers. A dense thicket can be, in some cases, just as effective as a fence (if not more so) in keeping trail users off restricted areas. Even tall grasses, although less effective than trees and shrubs, can discourage trail users from venturing into these areas. Planted barriers typically take a few years before they become effective barriers. Separation of the path may need to be augmented with other temporary barriers until planted trees and hedges have sufficiently matured.

All proposed trailside, trailhead and screen landscaping should consist of an approved native and drought-tolerant plant palette. A preliminary plant palette should be designed in conjunction with local botanical expertise, biological expertise, and landscape architectural consultation.

Guidance

- Trail landscaping guidelines are not discussed in great detail within the AASHTO Guide or Caltrans Highway Design Manual, Chapter 1000, but are briefly referenced as a buffer or retaining mechanism.

A.3.3 Wayfinding Standards and Guidelines

Wayfinding Standards and Guidelines

Design Summary

Types of signage include:

- Regulatory signs - indicate to bicyclists the traffic regulations which apply at a specific time or place on a bikeway.
- Warning signs - indicate upcoming changes in the roadway or path enviroment that requires caution and may require a reduction in speed.
- Guide and information signs - indicate information for route selection, locating off-road facilities, or identifying geographical features or points of interest.

Discussion

The ability to navigate through a region is enhanced by landmarks, natural features, and other visual cues. Signs placed at strategic locations can indicate to pedestrians and bicyclists their direction of travel, location of key destinations, and travel time/distance to those destinations.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.
- Caltrans Highway Design Manual (Chapter 1000).
- 2012 California MUTCD, Part 9.
- NACTO Urban Bikeway Design Guide (2011)

MUTCD Sign R5-1b and R9-3c are regulatory sign. The bicycle path exclusion sign (R44A) is specific to the CA MUTCD.

Warning signs are yellow, such as this combination of W11-15 and W11-15P from the MUTCD

Wayfinding signs are green, and include directional arrows. (MUTCD sign D1-3C).

Multi-Use Trail Signage

Design Summary

- Signage style and imagery should be consistent throughout the trail to provide the trail user with a sense of continuity, orientation, and safety.
- Do not over sign the trail. Where possible, incorporate signage into trailside vertical elements such as bollards.

Discussion

Directional Signage

Directional signage provides orientation to the trail user and emphasizes trail continuity. Street names should be called out at all trail intersections with roadways. In addition to providing a distance reference, mileage markers are attractive to users who target exercise for set distances.

Directional signing may be useful for pathway users and motorists alike. For motorists, a sign reading "Path Xing" along with a City emblem or logo helps warn drivers and promote use of the path itself. The directional signing should impart a unique theme so path users know which path they are following and where it goes. The theme can be conveyed in a variety of ways such as, engraved stone, medallions, bollards, and mile markers.

Directional signage should identify key destinations along the trail route and include schools, parks, municipal centers, connecting trails, and other points of interest.

Trail Etiquette Signage

Establishing goals and policies sets a common framework for understanding trail rules and regulations. Rights and responsibilities of trail usage should be stated at main trail access points. Once rules and regulations are established, the trail managing agency has a means of enforcement. Local ordinances may be adopted to help enforce trail policies. Penalties such as fines or community service may be imposed in response to non-compliance.

Interpretive Signage

Interpretive signage enriches the trail user experience, focuses attention on the unique attributes of the local community, and provides educational opportunities. Natural and cultural resources in trail corridors, including historic signs and photos, boat ramps, and wildlife may provide opportunities for interpretation.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.
- Caltrans Highway Design Manual (Chapter 1000).
- California MUTCD, Part 9.

Sample trail directional sign (Los Angeles County)

Pavement markings along the way indicate mileage at quarter mile intervals.

Example of signing for an on-roadway bicycle route (MUTCD-CA Figure 9B-6).

On-Street Bikeway Signage

Design Summary

Destinations for on-street bikeway signage may include:

- Other bikeways
- Commercial centers
- Parks and trails
- Public transit stations
- Civic/community destinations
- Hospitals
- Schools

Recommended uses for on-street signage include:

- Confirmation signs - confirm that a bicyclist is on a designated bikeway. Confirmation signs can include destinations and their associated distances, but not directional arrows.
- Turn signs - indicate where a bikeway turns from one street onto another street. Turn signs are located on the near-side of intersections.
- Decision signs - mark the junction of two or more bikeways. Decision signs are located on the near-side of intersections. They can include destinations and their associated directional arrows, but not distances.

Wayfinding signage concept MUTCD signs D1-3C.

Wayfinding that includes distance and time can aid bicyclists in route finding.

Discussion

Signage can provide wayfinding and enhance safety by:

- Familiarizing users with the pedestrian and bicycle network,
- Helping users identify the best routes to key destinations,
- Addressing misperceptions about time and distance,
- Helping overcome a "barrier to entry" for infrequent bicyclists or pedestrians (e.g., "interested but concerned" bicyclists).

Bicycle wayfinding signs also visually cue motorists that they are driving along a bicycle route and should use caution.

Signs are typically placed at key locations leading to and along bicycle routes, including the intersection of multiple routes. Too many road signs tend to clutter the right-of-way. It is recommended that bikeway signs be posted at a level most visible to bicyclists and pedestrians, rather than per vehicle signage standards. Additional recommended guidelines include:

- Place the closest destination to each sign in the top slot. Destinations that are further away can be placed in slots two and three. This allows the nearest destination to 'fall off' the sign and subsequent destinations to move up the sign as the bicyclist approaches.
- Use pavement markings to help reinforce routes and directional signage. Markings, such as bicycle boulevard symbols, may be used in addition to or in place of directional signs along bike routes. Pavement markings can help bicyclists navigate difficult turns and provide route reinforcement.

Guidance

- City of Oakland. (2009). Design Guidelines for Bicycle Wayfinding Signage.
- City of Portland (2002). Bicycle Network Signing Project.
- 2012 CA-MUTCD -Chapter 9

A.3.4 Bicycle Parking Guidelines

Bicycle Parking

Design Summary

- Short-term parking accommodates visitors, customers, messengers and others expected to depart within two hours. This parking requires approved standard rack(s), appropriate location and placement, and weather protection.
- Long-term parking accommodates employees, students, residents, commuters, and others expected to park more than two hours. This parking is to be provided in a secure, weather-protected manner and location.

Discussion

Minimum Rack Height	To increase visibility to pedestrians, racks should have a minimum height of 33 inches or be indicated or cordoned off by visible markers.
Signing	Where bicycle parking areas are not clearly visible to approaching cyclists, signs at least 12 inches square should direct them to the facility. The sign should include the name, phone number, and location of the person in charge of the facility, where applicable.
Lighting	A minimum of one foot-candle illumination at ground level should be provided in all high capacity bicycle parking areas.
Frequency of Racks on Streets	In popular retail areas, two or more racks should be installed on each side of each block. This does not eliminate the inclusion of requests from the public which do not fall in these areas. Areas officially designated or used as bicycle routes may warrant the consideration of more racks.
Location and Access	Access to facilities should be convenient; where access is by sidewalk or walkway, ADA-compliant curb ramps should be provided where appropriate. Parking facilities intended for employees should be located near the employee entrance, and those for customers or visitors near main public entrances. (Convenience should be balanced against the need for security if the employee entrance is not in a well traveled area). Bicycle parking should be clustered in lots not to exceed 16 spaces each. Large expanses of bicycle parking make it easier for thieves to be undetected.
Locations within Buildings	Provide bike racks within 50' of the entrance. Where a security guard is present, provide racks behind or within view of a security guard. The location should be outside the normal flow of pedestrian traffic.
Locations near Transit Stops	To prevent bicyclists from locking bikes to bus stop poles - which can create access problems for transit users, particularly those who are disabled - racks should be placed in close proximity to transit stops where there is a demand for short-term bike parking.
Locations within a Campus-Type Setting	Racks are useful in a campus-type setting at locations where the user is likely to spend less than two hours, such as classroom buildings. Racks should be located near the entrance to each building. Where racks are clustered in a single location, they should be surrounded by a fence and watched by an attendant. The attendant can often share this duty with other duties to reduce or eliminate the cost of labor being applied to bike parking duties; a cheaper alternative to an attendant may be to site the fenced bicycle compound in a highly visible location on the campus. For long-term parking needs of employees and students, attendant parking and/or bike lockers are recommended.
Retrofit Program	In established locations, such as schools, employment centers, and shopping centers, the County should conduct bicycle audits to assess bicycle parking availability and access, and add additional bicycle racks where necessary.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.
- Caltrans Highway Design Manual (Chapter 1000).
- 2012 California MUTCD, Part 9.
- Association of Pedestrian and Bicycle Professionals, Bicycle Parking Guidelines, 2nd Edition

Short-Term Bicycle Parking

Design Summary

- See dimensions below.

Discussion

Short-term bicycle parking facilities include racks which permit the locking of the bicycle frame and at least one wheel to the rack, and support the bicycle in a stable position without damage to wheels, frame or components. Short-term bicycle parking is currently provided at no charge at various locations in National City. Such facilities should continue to be free, as they provide minimal security, but encourage cycling and promote proper bicycle parking.

The majority of short-term bicycle parking is provided via a 'staple' on the sidewalk, located within the buffer zone.

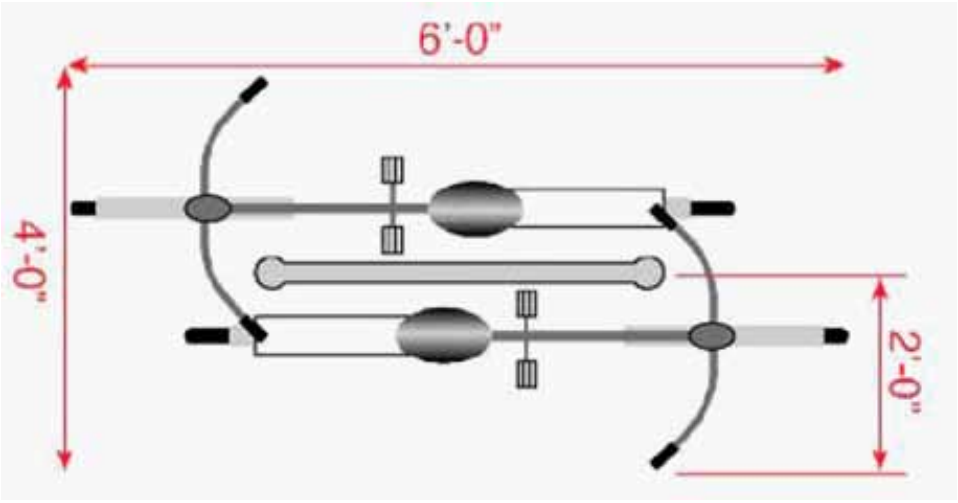
Art racks can be an attractive way of providing bicycle parking facilities. Costs can be subsidized by businesses sponsoring racks that compliment their business (e.g., a pair of glasses for an optician).

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.
- Caltrans Highway Design Manual (Chapter 1000).
- 2212 California MUTCD, Part 9.

Standard bicycle 'staple' rack.

Art racks can be an attractive way of marketing bicycle parking.



Staple rack parking configuration.

Long-Term Bicycle Parking

Design Summary

- Dimensions and configuration depends on the type of parking.

Discussion

Long-term bicycle parking facilities are intended to provide secure, long-term bicycle storage. Long-term facilities protect the entire bicycle, its components and accessories, against theft and inclement weather, including snow and wind-driven rain. Examples include lockers, check-in facilities, monitored parking, restricted access parking, and personal storage.

Long-term parking facilities are more expensive to provide than short-term facilities, but are also significantly more secure. Although many bicycle commuters would be willing to pay a nominal fee to guarantee the safety of their bicycle, long-term bicycle parking should be free wherever automobile parking is free. Potential locations for long-term bicycle parking include transit stations, large employers and institutions where people use their bikes for commuting, and not consistently throughout the day.

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.
- Caltrans Highway Design Manual (Chapter 1000).
- 2012 California MUTCD, Part 9.

Bike lockers at a transit station.

A.3.5 Routine Maintenance of Bike Facilities

Guidelines for regularly maintaining bicycle facilities

Sweeping

Bicyclists often avoid shoulders and bike lanes filled with gravel, broken glass and other debris; they will ride in the roadway to avoid these hazards, causing conflicts with motorists. Debris from the roadway should not be swept onto sidewalks (pedestrians need a clean walking surface), nor should debris be swept from the sidewalk onto the roadway. A regularly scheduled inspection and maintenance program helps ensure that roadway debris is regularly picked up or swept.

Action items involving sweeping activities include:

- Establish a seasonal sweeping schedule that prioritizes roadways with major bicycle routes.
- Sweep walkways and bikeways whenever there is an accumulation of debris on the facility.
- In curbed sections, sweepers should pick up debris; on open shoulders, debris can be swept onto gravel shoulders.
- Pave gravel driveway approaches to minimize loose gravel on paved roadway shoulders.
- Provide extra sweeping in the fall where leaves accumulate.

Roadway Surface

Bicycles are more sensitive to subtle changes in roadway surface than motor vehicles. Some paving materials are smoother than others, and compaction/uneven settling can affect the surface after trenches and construction holes are filled. Uneven settlement after trenching can affect the roadway surface nearest the curb where bicycles travel. Sometimes compaction is not achieved to a satisfactory level, and an uneven pavement surface can result due to settling over the course of days or weeks. When resurfacing streets, the county should use the smallest chip size and ensure that the surface is as smooth as possible to improve safety and comfort for bicyclists.

Recommended action items involving maintaining the roadway surface include:

- On all bikeways, use the smallest possible chip for chip sealing bike lanes and shoulders
- Use sealants with the same color as the pavement. This avoids sealing cracks in concrete segments with asphalt
- During chip seal maintenance projects, if the pavement condition of the bike lane is satisfactory, it may be appropriate to chip seal the travel lanes only
- Ensure that on new roadway construction, the finished surface on bikeways does not vary more than ¼ inch
- Maintain a smooth surface on all bikeways that is free of potholes
- Maintain pavement so ridge build-up does not occur at the gutter-to-pavement transition or adjacent to railway crossings
- Inspect the pavement two to four months after trenching construction activities are completed to ensure that excessive settlement has not occurred
- Remove existing markings before reapplying new markings
- When applying thermoplastic stencils for signalizing bikeways, ensure that maximum thickness is 90 millimeters.

Gutter-to-Pavement Transition

On streets with concrete curbs and gutters, 10-20 inches of the curbside area is typically devoted to the gutter pan, where water collects and drains into catch basins. On many streets, the bikeway is situated near the transition between the gutter pan and the pavement edge. It is at this location that water can erode the transition, creating potholes and a rough surface for travel.

The pavement on many streets is not flush with the gutter, creating a vertical transition between these segments. This area can buckle over time, creating a hazardous environment for bicyclists. Since it is the most likely place for bicyclists to ride, this issue is significant for bike travel.

Action items related to maintaining a smooth gutter-to-pavement transition include:

- Ensure that gutter-to-pavement transitions have no more than a 1/4 inch vertical transition
- Examine pavement transitions during every roadway project for new construction, maintenance activities, and construction project activities that occur in streets

Guidelines for regularly maintaining bicycle facilities (Continued)

Drainage Grates

Drainage grates are typically located in the gutter area near the curb of a roadway. Drainage grates typically have slots through which water drains into the municipal wastewater system. Many grates are designed with linear parallel bars spread wide enough for a tire to get caught so that if a bicycle were to ride over them, the front tire would get caught and fall through the slot. This would cause the cyclist to tumble over the handlebars and sustain potentially serious injuries. The County should consider the following:

- Continue to require all new drainage grates be bicycle-friendly, including grates that have horizontal slats on them so that bicycle tires and assistive devices do not fall through the vertical slats
- Create a program to inventory all existing drainage grates and replace hazardous grates as necessary – temporary modifications such as installing rebar horizontally across the grate is no alternative to replacement

Pavement Overlays

Pavement overlays represent good opportunities to improve conditions for cyclists if it is done carefully. A ridge should not be left in the area where cyclists ride (this occurs where an overlay extends part-way into a shoulder bikeway or bike lane). Overlay projects offer opportunities to widen a roadway, or to re-stripe a roadway with bike lanes. Action items related to pavement overlays include:

- Extend the overlay over the entire roadway surface to avoid leaving an abrupt edge
- If there is adequate shoulder or bike lane width, it may be appropriate to stop at the shoulder or bike lane stripe, provided no abrupt ridge remains
- Ensure that inlet grates, manhole, and valve covers are within ¼ inch of the pavement surface and are made or treated with slip resistant materials
- Pave gravel driveways to property line to prevent gravel from spilling onto shoulders or bike lanes

Signage

Signage is crucial for safe and comfortable use of the bicycle and pedestrian network. Such signage is vulnerable to vandalism or wear, and requires regular maintenance and replacement as needed. The County should consider:

- Check regulatory and wayfinding signage along bikeways for signs of vandalism, graffiti, or normal wear
- Replace signage along the bikeway network as-needed
- Perform a regularly-scheduled check on the status of signage with follow-up as necessary
- Create a Maintenance Management Plan (see below)

Landscaping

Bikeways can become inaccessible due to overgrown vegetation. All landscaping needs to be designed and maintained to ensure compatibility with the use of the bikeways. After a flood or major storm, bikeways should be checked along with other roads, and fallen trees or other debris should be removed promptly. Landscaping maintenance action items include:

- Ensure that shoulder plants do not hang into or impede passage along bikeways
- After major damage incidents, remove fallen trees or other debris from bikeways as quickly as possible.

Guidance

- Caltrans Highway Design Manual (Chapter 1000)
- 2012 California MUTCD