Caltrans Bay Area District 4

Bike Plan Update 2025

Bicycle Best Practices

Table of Contents

Framework and Overview

The Caltrans Bay Area (District 4) Best Practices presents considerations and strategies for the development of bikeways on Caltrans facilities. The Best Practices were developed to obtain consensus and feedback from the public, stakeholders and partner agencies on preferred designs, fill in gaps in existing design guidance, be a resource to staff when making comments on projects, and showcase examples of all ages and abilities facilities built on Caltrans right of way. The sections that follow serve as an inventory of bicycle design treatments on the State Highway System and provide a framework for their development. This report also serves as a quick reference for staff and planners, with references to other guidelines that can be useful in the scoping and design of Caltrans projects. The Best Practices are not, however, a substitute for a more thorough evaluation by a professional upon implementation of facility improvements.

Photos by Sergio Ruiz

Bicycle User Type

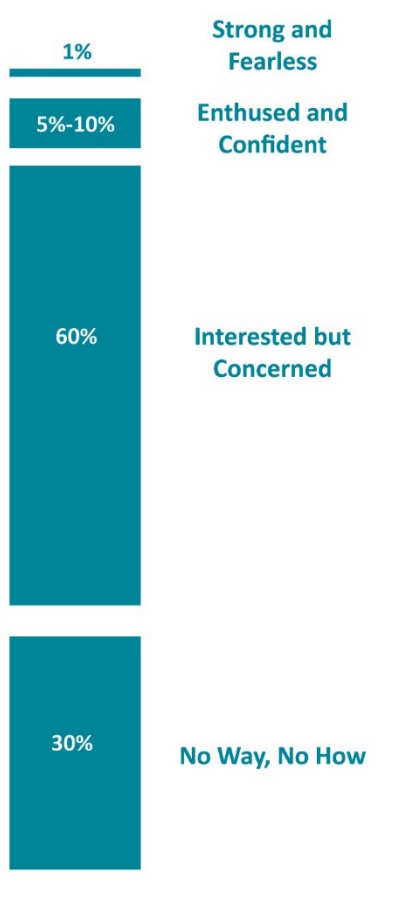
Caltrans Director's Policy 37 establishes an organizational priority to maximize biking and complete streets as a strategy to meet state climate, health and equity goals, as well as foster vibrant communities. Research has demonstrated that to attract the widest possible segment of the population, bikeways need to provide comfortable, low stress connectivity (Mekuria, Furth, Nixon, 2012). The "all ages and abilities" concept strives to serve all users-regardless of age, gender, race, or ability and inclusive of the mobility needs of children, older adults, and people with disabilities-by embodying national and international best practices related to traffic calming, speed reduction, universal design, and roadway design to increase user safety and comfort, as well as accessibility for people with disabilities. A user-type framework for understanding a potential rider's willingness to bike is illustrated in the figure below. Developed by planners in Portland, OR, and supported by research, this classification identifies four distinct types of adult bicyclists. (Notably, it does not include those who bike because they have no alternative means of transportation.)

Strong and Fearless - Characterized by bicyclists that will typically ride anywhere regardless of roadway conditions or weather. These bicyclists can ride faster than other user types, prefer direct routes and will typically choose roadway connections (even if shared with vehicles) over separated bicycle facilities such as shared-use paths.

Enthused and Confident - This user group encompasses bicyclists who are fairly comfortable riding on all types of bikeways but usually choose low traffic streets or shared-use paths when available. These bicyclists may deviate from a more direct route in favor of a preferred facility type. This group includes all kinds of bicyclists such as commuters, recreationalists, racers, and utilitarian bicyclists.

Interested but Concerned - This user type comprises the bulk of the cycling population and represents bicyclists who typically only ride a bicycle on low traffic streets or shared-use paths under favorable weather conditions. These bicyclists perceive significant barriers to their increased use of cycling, spcifically traffic and other safety issues. These people may become "Enthused and Confident" with encoraugement, education and experience.

No Way, No How - Persons in this category are not bicyclists, and perceive severe safety issues with riding in traffic. Some people in this group may eventually become more regular cyclists with time and education. A significant portion of these people will not ride a bicycle under any circumstances.



Source: Geller R. *Four Types of Cyclists*. Portland Bureau of Transportation, Portland, Ore., 2006.

Design Needs of Bicyclists

Users of bicycle facilities have become increasingly diverse over the last 10 years. Bikeway design must meet the needs of a broad set of users and vehicle types. The use of shared mobility has soared in the Bay Area. E-scooters went from nonexistent to ubiquitous in large cities and E-bike sales in the United States have increased three-fold between 2019 and 2022 (Electrek, Feb 8, 2022). This increase has come with a wide variety of new devices. For example bike facilities are now shared with pedal bikes, e-bikes, cargo bikes, e-scooters, sit-down scooters, and powered skateboards are more common throughout the Bay Area. In addition to vehicle diversity, active transportation facilities need to meet the needs of different user types. Casual cyclists have different bikeway type preferences than experienced cyclists, who may be more comfortable in higher-stress environments.

User Type	Average Speed of Travel	Dimensional Needs
 **Casual and New Cyclists**	6 to 15 mph	• Physical Width 2’6” • Minimum Operating Space 3’6” • Preferred Operating Space 5’0” • Handle Bar 3’8” • Eye Level 4’0” - 5’10” *Class 1, 2, and 3 (use, access and equipment restrictions apply to Class 3), electric tricycles, electric cargo bikes, and pedal-less e-bikes. Class 1 and 2 e-bikes are throttle-limited to 20 mph.
 **Experienced Cyclists**	12 to 25 mph	
 **E-Bike Users**	10 to 28 mph	
 **Cargo E-Bike Users**	10 to 28 mph	
 **Freight Cargo E-Bike Users**	10 to 25 mph	
 **Recumbent Cyclists**	12 to 25 mph	• Physical Width 2’9” • Minimum Operating Space 4’0” • Preferred Operating Space 5’6” • Handle Bar 2’6” • Eye Level 4’1”
 **E-Scooter Users**	Up to 20 mph	• Physical Width 2’6” • Minimum Operating Space 3’6” • Preferred Operating Space 5’0” • Handle Bar 3’8” • Eye Level 4’6” - 5’10”

Source: Adapted from Caltrans Bay Area Bike Highway Study (2022)

Bikeway Selection

Caltrans Director's Policy 37 calls for the department to build complete streets that "serve people of all ages and abilities." To provide a bikeway network that meets the needs of the Bay Area's "Interested but Concerned" residents, who typically comprise the majority of the population, bikeways must be low-stress, comfortable, and well-maintained. Caltrans facilities are often the most stressful parts of cyclists' routes. By using a metric called Level of Traffic Stress (LTS), specific facility types can be matched to the needs of people who bicycle in the Bay Area. Generally, "Interested but Concerned", users will only bicycle on LTS 1 or LTS 2 facilities. The following table is based on NACTO's "Designing for All Ages and Abilities" pamphlet but modified to Caltrans' specific roadway context. Note that shared streets and bicycle boulevards weren't included in this table as they don't apply to the Caltrans context but can be an ages and abilities facilities for local roadways. This will be used as a guide for selecting bikeway improvements. Please refer to the Contextual Guidelines for the Selection of Bicycle Facilities Memorandum.

Contextual Guidance for Selecting All Ages and Abilities				
Roadway Context				**All Ages and Abilities Bicycle Facility**
Posted Speed Limit	Target Max Motor Vehicle Volume (ADT)	Motor Vehicle Lanes	Key Operational Considerations	
Any	Any	Any	Any of the following: high curbside activity, frequent buses, motor vehicle congestion, or turning conflicts	Separated Bicycle Lane (Class IV) or Shared-Use Path (Class I)
<= 25 mph	≤ 1,500 – 3,000	Single lane each direction, or single lane one-way	Low curbside activity, or low congestion pressure	Conventional (Class II) or Buffered Bicycle Lane (Class IIB), or Separated Bicycle Lane (Class IV)
	≤ 3,000 – 6,000			Buffered (Class IIB) or Separated Bicycle Lane (Class IV)
	Greater than 6,000			Separated Bicycle Lane (Class IV)
	Any	Multiple lanes per direction		
Greater than 26 mph	≤ 6,000	Single lane each direction	Low curbside activity, or low congestion pressure	Separated Bicycle Lane (Class IV) or Reduce Speed
		Multiple lanes per direction		Separated Bicycle Lane (Class IV), or Reduce to Single Lane and Reduce Speed
	Greater than 6,000	Any	Any	Separated Bicycle Lane (Class IV) or Shared-Use Path (Class I)
Interchanges	Any	Multiple lanes per direction	High-speed merging	Separated Bicycle Lane (Class IV) or Shared-Use Path (Class I)

Context and Place Type

These best practices provide a framework for development for both interim and final project designs. While the final design is almost always a more comfortable and preferred option, many Caltrans projects are capital maintenance projects which provide an opportunity to upgrade bicycle facilities but precludes the use of certain robust features that require detailed drainage and structural work. These projects provide some limitations but can sustainably improve comfortable, convenient, and connected facilities.

Location Type	Project Type	Place Type
Corridors		
Rumble Strip Buffered Bike Lanes	Interim	Rural
Separated Bikeways	Final	All place types
Separated Bikeways – Options	Interim/ Final	All place types
Bus Boarding Island	Final	Urban/ Suburban
Road Diet	Interim / Final	Urban/ Suburban
Green Streets	Final	All place types
Pop Up Bikeway	Interim	All place types
Intersections		
Roundabout	Final	All place types
Two-way Separated Bikeway Connector	Interim/Final	Urban/ Suburban
Protected Intersection	Final	All place types
Protected Intersection - Interim Design	Interim	All place types
Multi-Use Path Intersection	Final	All place types
Interchanges		
Active Transportation Freeway on/off ramp considerations	Interim/Final	All place types
Interchange – Partial Clover Leaf	Final	All place types
Interchange – Grade Separated Crossings	Final	All place types
Interchange – Diamond	Final	All place types
Interchange – Diverging Diamond	Final	All place types
Interchange – Interim Design Option 1 On-ramp Tight Merge	Interim	All place types
Interchange – Interim Design Option 2 On-ramp Direct Path	Interim	All place types
Interchange – Interim Design Option 1 Off-ramp Tight Merge	Interim	All place types
Interchange – Interim Design Option 2 Off-ramp Direct Path	Interim	All place types
Partially Separated Floating Bike Lane – Interim Design	Interim	All place types
Raised Crosswalk at on-ramps	Final	All place types
Bicycle Parking		
Bicycle Parking at Mobility Hubs	Final	All place types

Corridors

I-580 in Marin County (Photo by Sergio Ruiz)

Rumble Strip Buffered Bike Lanes – Interim Design

Rumble strip buffered bike lanes are conventional Class II bicycle lanes paired with a designated buffer space that contains a rumble strip, separating the bike lane from adjacent motor vehicle travel lane. While this treatment does not provide vertical separation, it helps delineate separation of bicyclists and higher speed traffic. This facility wouldn't be considered an all ages and abilities facility but does provide bicyclists some separation in a constrained environment where vehicle access to the shoulder may be required. Continuous rumble strips are difficult for cyclists to traverse, so usage should adhere to the guidelines in Caltrans' Traffic Safety Bulletin 20-07 R1, which explains the use of intermittent 12-foot gaps to allow cyclists to enter or exit the bike lane.

Typical Application

- This treatment is most applicable on rural high-speed routes
- Rumble strips are an FHWA Proven Safety Countermeasure for reducing roadway departure crashes.

Example Caltrans Facilities

- I-580 in Marin County

Design Features

A Buffers should be at least 2 feet wide. If buffer area is 4 feet or wider, white chevron or diagonal markings should be used (CAMUTCD 9C-104).

B A minimum clearance (bike lane width) of 5 feet is required from the outer edge of the rumble strip to the outer edge of the paved shoulder (7 feet preferred) per Traffic Safety Bulletin 20-07 R1.

- To better accommodate the needs of bicyclists, consideration may be given to providing intermittent gaps in the rumble strip patterns, compared to a continuous pattern. (Caltrans Standard Plan A40H)
- Rumble strips should be terminated 50' in advance of intersections to allow bicyclists to safely maneuver into nearby lanes in advance of desired left turns and other potential movements.

US 101/Willow Road (SR 114) in San Mateo County

Separated Bikeway

Separated bicycle lanes are on-street bikeway facilities that are separated from vehicle traffic. Separation for protected bikeways is provided through physical barriers between the bikeway and the vehicular travel lane. These barriers can include bollards, planter strips, concrete medians, or on-street parking along with vertical delineators to prevent motorists from parking in the bikeway.

Typical Application

- Along streets on which conventional bicycle lanes would not be considered a low stress and comfortable facility, consistent with Caltrans Director's Policy 37, because of factors such as multiple lanes, high bicycle volumes, high motor traffic volumes (9,000 – 30,000 ADT), higher traffic speeds (25+ mph), high incidence of double parking, higher truck traffic (10% of total ADT) and high parking turnover

Example Caltrans Facilities

- US 101/Willow Road (State Route 114) in San Mateo County

Design Features

A Pavement markings, symbols and/or arrow markings must be placed at the beginning of the separated bikeway and at intervals along the facility based on engineering judgment to define the bike direction. (CAMUTCD 9C.04)

B 7 to 9 foot width preferred, not including gutter, in areas with high bicycle volumes or uphill sections to facilitate safe passing behavior (5 foot minimum). HDM 1003.1(1) and DIB 89-02. See DIB 94 Section 5.1.5 for minimum, preferred and practical maximum widths.

C 2' minimum buffer width for separated bikeways with no on-street parking (3 foot preferred where parking is allowed). (DIB 89-02)

- More information on separated bikeways can be found in Caltrans' DIB 89-02.

Separated Bikeway – Separation Options

Channelizers

While planters or concrete offer more permanent separation, some projects such as maintenance projects or Capital Preventative Maintenance (CAPM) projects may preclude the use of high-cost materials. In these cases, lane channelizers may be used to provide more robust protection than bollards alone. These materials have been used in high-speed Caltrans routes, such as the Bay Bridge toll plaza, and have held up in high-traffic environments and are on Caltrans' list of authorized delineation materials. Pictured channelizers is called qwick kurb. See also https://dot.ca.gov/-/media/dot-media/programs/engineering/documents/mets/signing-and-delineation-materials-a11y.pdf

Landscaping

Landscaping offers multiple benefits when used as the separation of a Class IV bikeway. These facilities provide shade, reduced urban heat island effects, improved air quality, stormwater treatment, and are also pleasant to bike along. Use landscaping along bike facilities whenever possible.

Concrete Barrier/ Concrete Curb

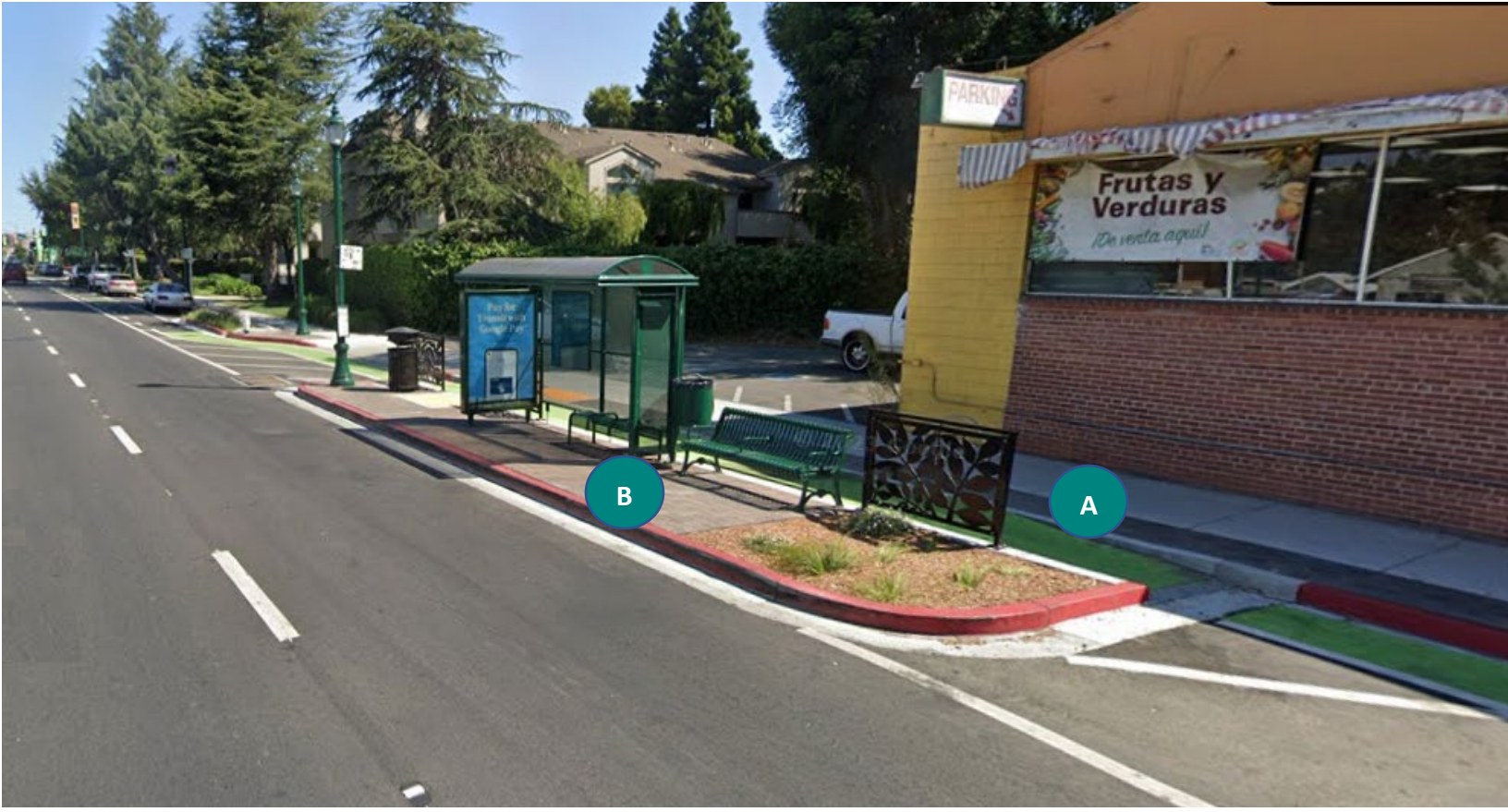
Concrete curbs or barriers provide robust separation, with taller concrete barriers providing stronger protection. This separation type may be the most appropriate treatment, particularly when landscaping is not an option. Pre-made concrete K-rails or Jersey barriers offer an easy-to-deploy option compared to poured concrete curbs.

Guard Rail

When adjacent to vehicle speeds over 50 mph, robust separation that can withstand a major impact is recommended. Guard rails have been successfully used along routes with high speeds.

Movable Barrier

When adjacent to vehicle speeds over 50 mph, robust separation that can withstand a major impact is recommended. Movable barriers have been used successfully in high-speed environments to provide robust separation. This separation type can also be retrofitted on an existing bridge.



Transit Integration: Bus Boarding Island

Bus boarding islands place the bikeway behind the bus stop, which minimizes conflicts between the bicycle movement and the bus boarding/alighting operation. They also reduce the chance of a cyclist riding in a bus operator's blind spot. Bus boarding islands are dedicated waiting and boarding areas for passengers that streamline transit service and improve accessibility by enabling in-lane stops. Boarding islands eliminate bus-bike "leapfrogging" conflict at stops, in which buses merge across the bicycle travel path at stops, causing bicycles to merge into general traffic to pass the stopped bus, only to be passed again as the bus accelerates. At boarding islands, both buses and bicycles can move straight at the stop, in their own dedicated space.

Typical Application

- Along streets that have separated bikeways and transit stops

Example Caltrans Facilities

- San Pablo Ave (SR 123) in Contra Costa and Alameda County

Design Features

A The bikeway behind the floating boarding island can be at street grade or may be raised. Where the bike lane changes grade, bicycle ramps should not exceed a 1:8 slope. Delineate bike and pedestrian space using colored paint, tactile strips, or distinct paving materials to reduce conflicts.

B Boarding island stops must be fully ADA accessible and should include shelters, seating, lighting, wayfinding, and passenger information when feasible.

- More information on bus boarding islands and bus/bike conflicts can be found in Caltrans DIB 94 section 7.3

Encinal Ave (SR 61) in Alameda County

Road Diet

A road diet repurposes motor vehicle travel lanes and utilizes the space for other uses and travel modes. The most common road diet reconfiguration is the conversion of an undivided four-lane roadway to a three-lane undivided roadway made up of two through lanes and a center two-way left-turn lane (TWLTL). The reduction of lanes allows the roadway cross section to be reallocated for other uses such as bike lanes, pedestrian refuge islands and transit uses. The FHWA conducted an empirical Bayes evaluation of total crash frequency before-and-after Road Diet implementation. Results indicated a statistically significant reduction in crashes due to the Road Diet treatment with an estimated 29 percent reduction in total crashes (Transportation Research Board: Washington, DC, 2008).

Typical Application

- The FHWA advises that roadways with 20,000 ADT (average daily traffic) or less may be good candidates for a Road Diet and should be evaluated for feasibility.
- If the ADT is near the upper limits of the study volumes, further analysis may be needed to determine its operational feasibility, including peak hour volumes by direction, signal spacing, turning volumes at intersections, and other access points.
- Road Diets are an FHWA Proven Safety Countermeasure for reducing traffic collisions.

Example Caltrans Facilities

- Encinal Ave (SR 61) in Alameda County
- Broadway (SR 12) in Sonoma County

Design Features

A Road diets typically include Class II bike lanes, which are only an all ages and abilities facility if vehicle speeds are less than 26 mph. (NACTO, 2017) However, bike facilities with greater separation can also be incorporated. See Contextual Guidance table above.

B Road diets typically include two-way left turn lanes (TWLTL), which have been shown to reduce rear-end, head-on, and turning-related crashes occurring on two-lane roads (FHWA, 2008).

1st St and SR-29 in Napa County

Green Streets

Landscaped areas provide sustainability and livability benefits in a wide range of State Highway System environments. Site-appropriate trees and plants encourage bicycling, walking and transit use by improving the quality of the public space, providing shade, and reducing traveler stress-especially when sited as a buffer between auto traffic and active transportation modes. Landscaping also enhances the natural environment by improving air quality, treats storm water, reduces the urban heat islands, supports pollinators, sequesters carbon /GHGs and increases user safety through traffic calming.

Typical Application

- Any street with available space

Example Caltrans Facilities

- 1st St and SR-29 in Napa County

Design Features

- Green Stormwater Infrastructure (GSI) is often most effectively integrated into the planting/furnishing zone between the curb and pedestrian through zone, where sidewalk width allows.
- Vegetated space on pedestrian refuge islands, bikeway buffers, roundabout splitter islands, transit boarding islands, or other constructed elements that are offset from the curb can improve the streetscape and provide space for street trees.
- Biofiltration planters that provide water quality treatment and reduce runoff volumes are effective where water cannot be infiltrated into the sub-base.
- Refer to the Caltrans Landscape Architecture Design website.

East 14th Street (SR 185) in Alameda County (Photo by Sergio Ruiz)

Pop Up Bikeways

Pop up bikeways, also known as "quick builds," are temporary bikeways that can be used to test proposed designs, they can be used as public outreach to gain consensus around a preferred design. Temporary bikeways can help agencies learn more about what solutions would work and how to implement those solutions more quickly – and then, if they work, to make them permanent.

Typical Application

- Can be constructed to test an interim design of a larger long-term project.

Example Caltrans Facilities

- East 14th Street (SR 185) in Alameda County (operational in June 2023) (pictured example)
- El Camino Real (SR 82) in San Mateo County (operational in August 2023)

Design Features

- Pop up bikeways on Caltrans right of way require a permit to construct. Since all functional units need to sign off on the designs, some designs are much easier to obtain a permit on then others. Removing a travel lane would likely require a much longer process than repurposing a shoulder or parking.
- Caltrans prefers using materials included in Caltrans' list of authorized delineation materials (https://dot.ca.gov/-/media/dot-media/programs/engineering/documents/mets/signing-and-delineation-materials-a11y.pdf)

Caltrans Bay Area Bicycle Best Practices

Intersections

Photo by Sergio Ruiz

I-580 and MacArthur Blvd/ Foothill Blvd in Alameda County

Roundabout

Roundabouts can improve traffic safety, reduce air pollution, and increase operational performance at intersections. At roundabouts it is important to indicate to motorists, bicyclists and pedestrians the right-of-way rules and correct way for them to circulate, using appropriately designed signage, pavement markings, and geometric design elements.

Typical Application

- Roundabouts can be implemented in both urban and rural areas under a wide range of traffic conditions, including conventional streets and freeway ramp intersections. They can replace signals, two-way stop controls, and all-way stop controls.
- Roundabouts are an effective option for managing speed and transitioning traffic from high-speed to low-speed environments, such as freeway interchange ramp terminals, and rural intersections along high-speed roads.
- Roundabouts are a FHWA Proven Safety Countermeasure, with a 78% reduction in fatal and injury crashes. (The Highway Safety Manual, AASHTO, Washington, D.C., (2010))

Example Caltrans Facilities

- I-580 and MacArthur Blvd/ Foothill Blvd (Proposed Facility)

Design Features

A Design approaches/exits to the lowest speeds possible. 10-15 mph preferred with 25 mph maximum circulating design speed for single lane entries. (FHWA, 2000)

B Allow bicyclists to exit the roadway onto a separated bike lane (preferred option) or shared use path that circulates around the roundabout.

C Maximize yielding rate of motorists to pedestrians and bicyclists at crosswalks with traffic calming elements including small corner radii, pedestrian refuge islands, concrete medians, green conflict bike-lane striping, raised crosswalks, and reduced crossing distance.

- At crossing locations of multi-lane roundabouts or roundabouts where the exit geometry will result in faster exiting speeds by motorists (thus reducing the likelihood that they will yield to bicyclists and pedestrians), additional measures should be considered to induce yielding such as providing an actuated device such as a Rapid Flashing Beacon.

San Pablo Ave (SR 123) in Alameda County (Photo by Sergio Ruiz)

Two-Way Separated Bikeway Connector

Offset intersection can be a challenging for bicyclists who are required to briefly travel along the busier major cross street in order to continue along the lower stress crossing streets. Constructing short two way separated bike facilities can increase the connectivity of the overall network, while minimizing cost.

Typical Application

- Can be constructed to connect multiple facility types, including bicycle boulevards, bike lanes, or separated bikeways.
- Appropriate treatments depend on volume of traffic including turning volumes, traffic speeds and the type of bicyclist using the crossing.

Example Caltrans Facilities

- San Pablo Ave (SR 123) in Alameda County
- El Camino Real (SR 82) in San Mateo County

Design Features

A Grade separation and the use of physical barriers such as concrete medians, bollards, planters, etc. provide enhanced protection for bicyclists and pedestrians.

B Pavement markings provide clear delineation between pedestrian and bicyclists travel spaces. 10-foot minimum width preferred, not including gutter.

C At signalized crossings, bicyclists should be able to trigger signals and safely maneuver the crossing.

- Motorists may not expect two directional bike traffic. Extra signage may be needed, such as “no right on red” signs.
- Ensure comfortable and convenient connections at transitions.

Protected Intersection

A protected intersection uses a collection of intersection design elements to maximize bicyclist's comfort within the intersection and promote a high rate of motorists yielding to people bicycling. Because standard intersections have many conflict points, additional protection for cyclists helps maintain an all-ages-and-abilities environment for users. The design maintains a physical separation within the intersection to define the turning paths of motor vehicles, slow vehicle turning speed, and offer a comfortable place for people bicycling to wait at a red signal.

Typical Application

- Protected intersections can be placed on streets with standard bike lanes (Class II), separated bicycle lanes (Class IV) with a buffer zone, or shared use paths (Class I).
- Protected intersection help reduce conflicts between right-turning motorists and bicycle riders by reducing turning speeds and providing a forward stop bar for bicycles.
- Protected intersections can reduce pedestrian crossing distance.

Example Caltrans Facilities

- San Pablo Ave (SR 123) and Cutting in Contra Costa County

Design Features

A Setback bicycle crossing of 16.5 feet allows for one passenger car to queue while yielding. Smaller setback distance is possible in slow speed, space constrained conditions.

B Corner safety island with a 15-20 foot corner radius slows motor vehicle speeds. Larger radius designs may be possible when paired with a deeper setback or a protected signal phase, or low mountable aprons as shown in the image above. Bicycle lanes can also be brought up to sidewalk level at the protected corner for increased visibility and reduced pedestrian crossing distance.

- See DIB 89-02 page 11 for more design guidance.

Ninth and Division St in San Francisco County

Protected Intersection - Interim Design

- While concrete is a more durable material for a protected intersection, improved safety benefits can be also achieved with a low-cost interim design using paint, bollards, and channelizers.
- An interim low-cost design still needs the key design elements of a protected intersection: the setback between the motor vehicle lane and the bikeway as well as the corner turning islands, which extend into the intersection as far as possible to tighten the corner's vehicular turn radius and reduce pedestrian crossing distances.

Example Caltrans Facilities

- I-580 and Rydin Rd in Contra Costa County
- Ninth and Division St in San Francisco County

N Mathilda Ave/ Moffett Park/ SR-237 in Santa Clara County

Shared Use Path Intersection

While shared use paths offer a comfortable biking connection, it is important to ensure that intersections are as well designed as the paths they connect with. Intersections present opportunities for vehicle/bicycle conflict and need to be mitigated. A number of design features can be used, such as median refuge islands, cross bike markings, wide directional curb ramps and no right on red blank out signs to provide a connected and comfortable facility. The design should slow vehicle turning speed, make bicyclists more visible and highlight that trail users have the right of way.

Typical Application

- Any intersection with a Class I shared use path.

Example Caltrans Facilities

- N Mathilda Ave/ Moffett Park/ SR-237 in Santa Clara County

Design Features

A Directional curb ramps allow for a more direct path of travel for cyclists

B Ramps should be the same width as the bicycle paths. (HDM 1003.1 5) Wide curb ramps are easier for cyclists to navigate and allow for a more convenient transition.

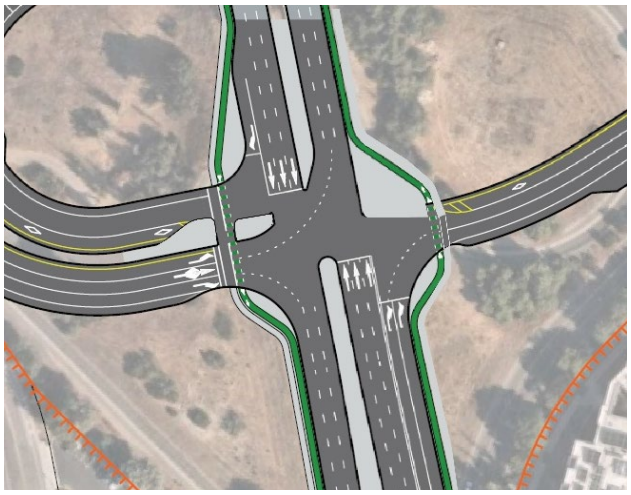
C Consider adding green cross bike markings to further provide conspicuity and highlight where conflict could potentially occur.

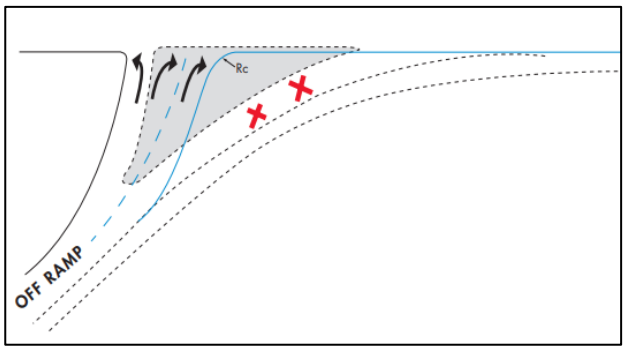
- Consider using a blank out “no right on red signs” at signalized intersection multi use path crossings.
- Consider adding bicycle detection, bicycle signal heads and bicycle signal phase at signalized intersection multi use path crossings.
- Consider adding a median refuge island, which reduces the overall crossing length

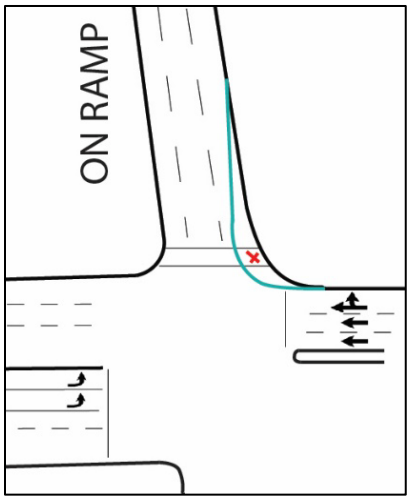
Interchanges

Active Transportation Freeway On/Off Ramp Considerations

Below is a list of freeway on/off ramp considerations for designing interchanges that are more comfortable for bicyclists and pedestrians. This section includes general design best practices at freeway ramps, examples for overall interchange project design, and near-term treatments that can make existing interchanges more comfortable for bicyclists and pedestrians and reduce potential conflicts.

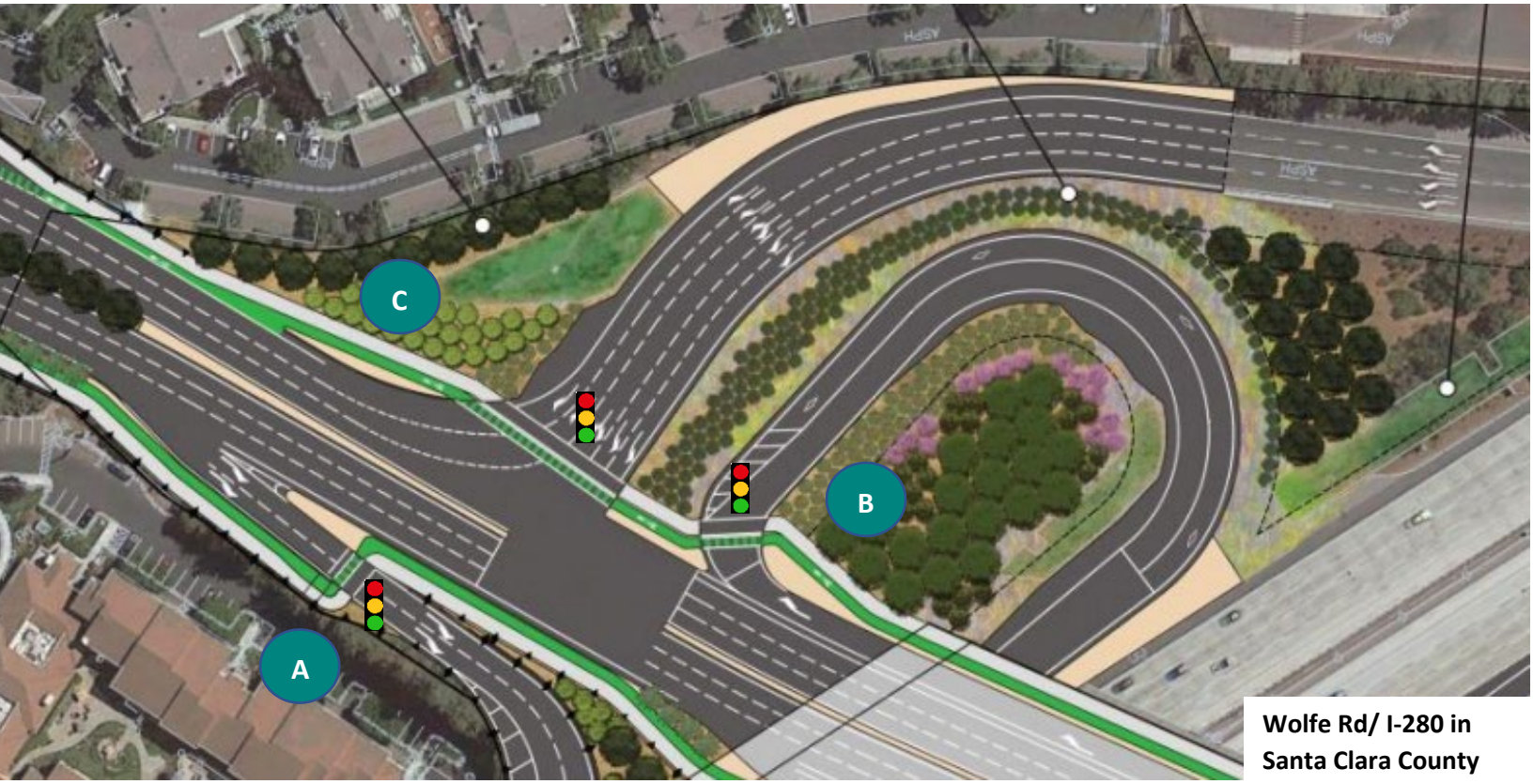






Design Features

- Class IV/Class I facility is typically preferred for interchanges because it minimizes uncontrolled conflicts and provides maximum separation.
- Square up ramps that intersect the roadway at 90 degrees minimize crossing distance for cyclists and pedestrians, slow the speed of right turning vehicles, and improve driver visibility of bicyclists.
- Maintain physical separation between bicyclists and vehicles as much as possible using permanent concrete medians or curbs.
- Long “floating” bike lanes (bike lanes between two travel lanes) are uncomfortable for most cyclists. These should be eliminated whenever possible.
- Eliminate the channelizing “pork chop” island. Pork chop islands can increase bicycle and pedestrian crossing distance as well as reduce visibility for motorists.
- Provide only as many on-ramp entry lanes as the number of lanes that feed into them during any given signal phase.
- Turning radius should be designed to be as small as possible to reduce right turning speeds and reduce crossing distances.
- Clarify the right of way. Use markings, signage, and signals to indicate throughout the interchange who has the right of way.
- Free right-turn lanes are not comfortable for most cyclists. Ideally, existing free right-turn lanes would be completely removed and should be signal controlled.
- Shorten crossing distance and separate signal phases to reduce pedestrian and cyclist exposure to potential conflicts.
- Consider eliminating right-turn-on-red, particularly when a two-way path crosses an off ramp.



Wolfe Rd/ I-280 in Santa Clara County

Interchange – Partial Clover Leaf

Crossing freeway interchanges can be uncomfortable and stressful, forcing cyclists to cross multiple streams of high-volume and high-speed traffic. A combination of bicycle infrastructure features can increase visibility and minimize conflict between motorists and active transportation users to provide a lower stress crossing.

Typical Application

- Multilane freeway interchanges

Example Caltrans Facilities

- Wolfe Road/I-280 interchange in Santa Clara County (facility under construction)

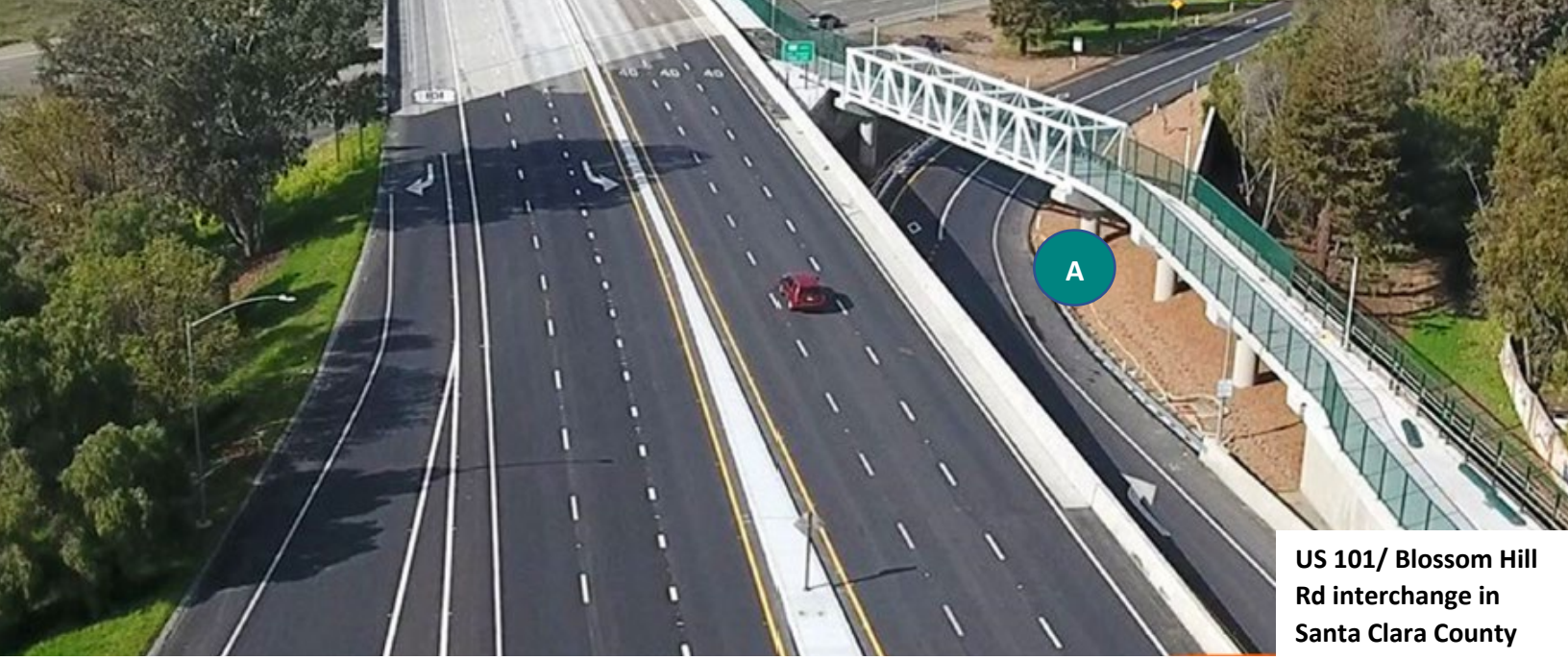
Design Features

A To achieve an all ages and abilities facility, eliminate free right turns where possible. At signalized ramp crossings, eliminate right turn on red to reduce conflicts between vehicles and cyclists.

B Meet ramps at local roads at 90-degrees where possible. Grade separation of the bike lane can improve visibility. Design the curb radii of the ramp intersection such that motorists cross the path of bicycles and pedestrians at a slow speed, preferably 15 mph. Truck aprons can be used to manage the design vehicle and still accommodate passage of trucks.

C Class IV/Class I facilities are typically preferred for interchanges, because it minimizes uncontrolled conflicts and provides maximum separation. Include landscaping, street trees and pedestrian scale lighting where possible.

- There are benefits to including both a Class IV/I and a Class II bikeway in interchange design. This design allows users who are comfortable traveling in traffic to position themselves to the left of the right turn lane, which some confident cyclists are more accustomed to.



US 101/ Blossom Hill Rd interchange in Santa Clara County

Interchange - Grade Separated Crossings

Crossing bicycle facilities through an interchange has a greater potential for conflict because of higher travel speeds and lane configurations. One solution to this is to eliminate the conflicts between motorists and bicyclists by grade separating the bicycle facility at on/off ramp crossings. This facility type should be used thoughtfully as it can increase out-of-directional travel and reduce network connectivity compared to a Class IV facility.

Typical Application

- Multilane freeway interchanges

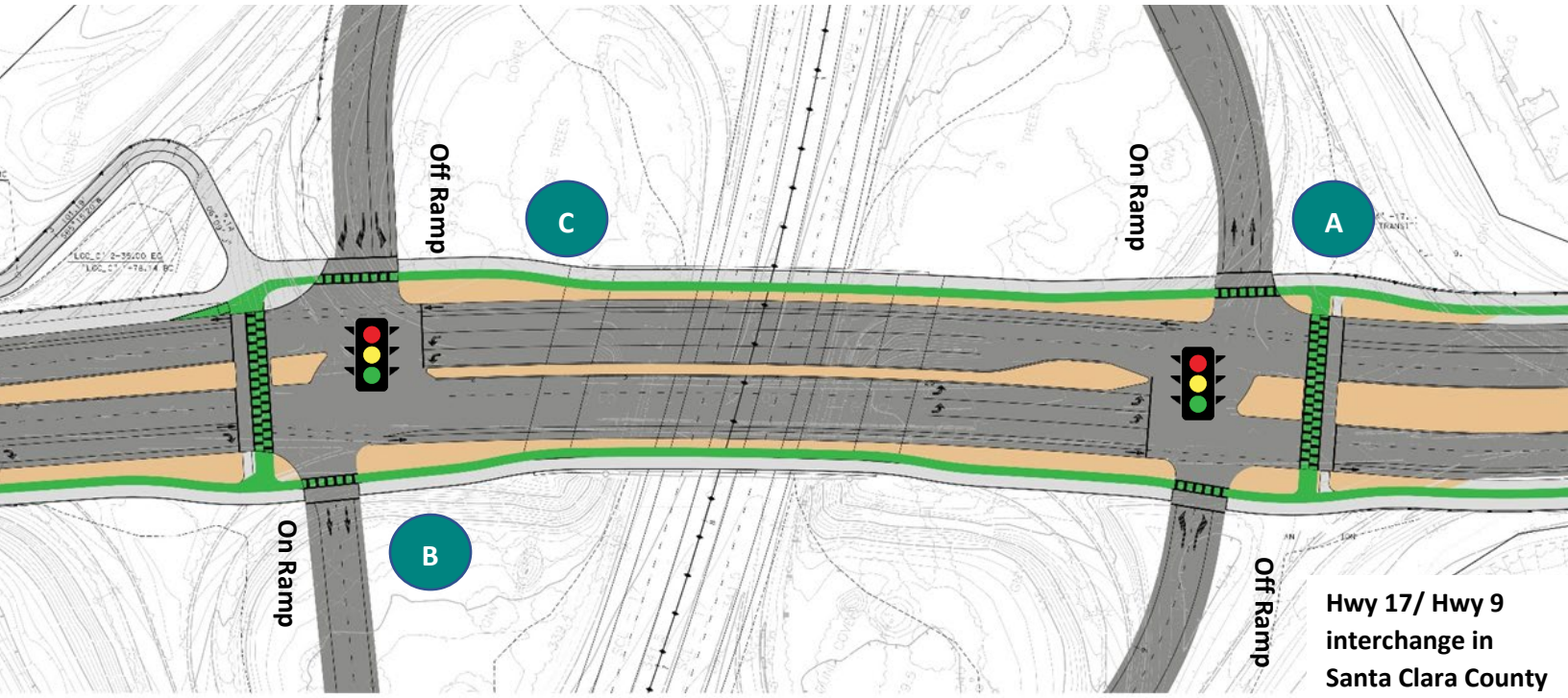
Example Caltrans Facilities

- US 101/ Blossom Hill Rd interchange in Santa Clara County
- US 101/ De La Cruz Blvd/ Trimble Rd Interchange in Santa Clara County

Design Features

A Overcrossings and undercrossing eliminate pedestrian and bicycle motor vehicle conflicts.

- Design bicycle crossings to minimize out of directional travel.
- Include pedestrian-scale lighting where possible and emphasize other crime-prevention strategies through design.
- Provide wayfinding to assure users that they can reach their destination through use of off-street facilities.
- Avoid use of landings if possible and instead maintain a flatter grade less than 5%. Landings on Class I facilities can cause undulations for cyclists.
- Consider providing redundant on-street facilities for confident cyclists who may be more accustomed to traveling adjacent to traffic.
- On long downgrades consider widening the pathway for extra clearance between bikes and pedestrian where cyclists may be traveling faster
- Encourage light, air and roadway visibility to undercrossings.



Hwy 17/ Hwy 9 interchange in Santa Clara County

Interchange – Diamond

Diamond interchanges typically contain characteristics that provide more comfortable bicycle access than alternative configurations. Diamond interchanges normally have the on-ramp/off-ramps intersect the local roadway at 90 degrees, facilitating slower turning speeds and minimizing long crossing distances. Intersections are often signal or stop controlled, which cause motorists to stop before turning, increasing the likelihood that they will see and yield to bicyclists or pedestrians.

Typical Application

- Multilane freeway interchanges

Example Caltrans Facilities

- Hwy 17/ Hwy 9 interchange (Proposed Design Option) in Santa Clara County

Design Features

A Signal-separated crossing and/or a protected intersection at the on ramp/off ramps.

B Meet ramp and local roads at 90-degrees where possible. Design the curb radii of the ramp intersection such that motorists cross the path of bicycles and pedestrians at a slow speed, preferably 15 mph.

C Class IV or Class I are typically preferred for interchanges, because it minimizes uncontrolled conflicts and provides maximum separation.

- Use contrasting pavements to clearly indicate to pedestrians the sidewalk path of travel.
- Consider using truck aprons to tighten curb radii.

Interchange – Diverging Diamond

Diverging diamond interchanges (DDI) can present challenges to bicycle connectivity. These interchanges require bicyclists to cross multiple streams of vehicle traffic, with many designs requiring four different crossings. Some designs put cyclists in between two streams of moving traffic, which is not a comfortable bicycle facility. These facilities also may not be intuitive to cyclists as they require cyclists to travel in a manner that is not typical.

Typical Application

- Multilane freeway interchanges

Example Caltrans Facilities

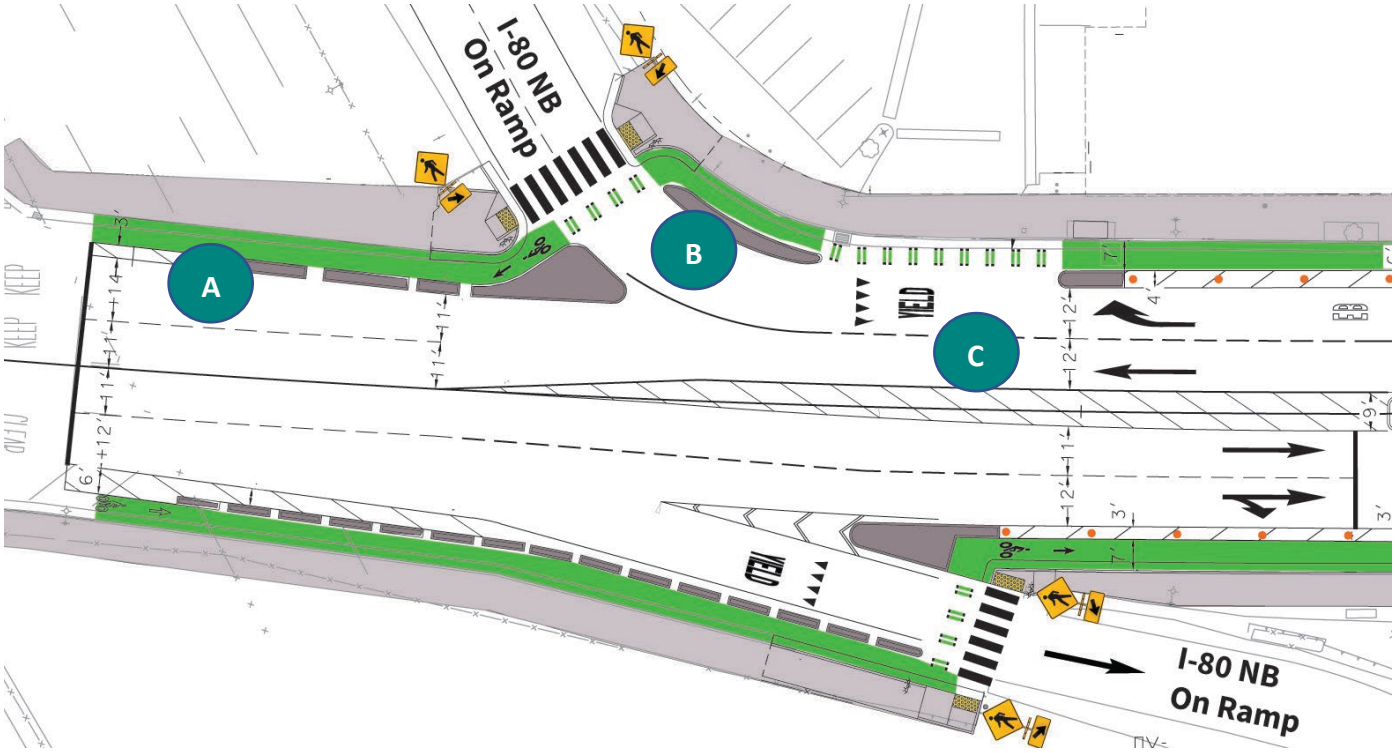
- Hwy 17/ Hwy 9 interchange (Design Option) in Santa Clara County

Design Features

A Design approaches/exits to the lowest speeds possible. 10-15 mph preferred with 25 mph maximum design speed.

B Class IV/Class I facility is typically preferred for interchanges, because it minimizes uncontrolled conflicts and provides maximum separation.

- Consider wayfinding signage and striping to guide cyclists across the interchange.
- Control all conflicting bicycle-vehicle movements where feasible and consider bicyclists/pedestrians in signal timing to reduce wait time at multiple crossings.
- See FHWA's Improving Intersections for Pedestrians and Bicyclists (2022) page 47 and 48 for more info on DDI's



Cutting Blvd/ I-80 Interchange in Contra Costa County

Interchange – Interim Design

Option 1: On-Ramp – Tight Merge

Restriping an interchange presents an opportunity to improve biking and walking facilities. While constrained situations may preclude the ability to upgrade to an all-ages and abilities facility, interim improvements, are still possible. The on-ramp tight merge, moves the conflict point of bicyclists and motor vehicles closest to where motor vehicles turn, which is where the motor vehicle's speed decreases for drivers performing a right turn. This design also avoids long "floating" bike lanes, which are not comfortable facilities. Crossing unsignalized ramps at a perpendicular angle minimizes crossing distance and exposure to crash risk.

This facility wouldn't be considered an all ages and abilities facility and would only be an interim design, until more robust bicycle improvement could be installed.

Typical Application

- Freeway interchange retrofit or repaving projects

Example Caltrans Facilities

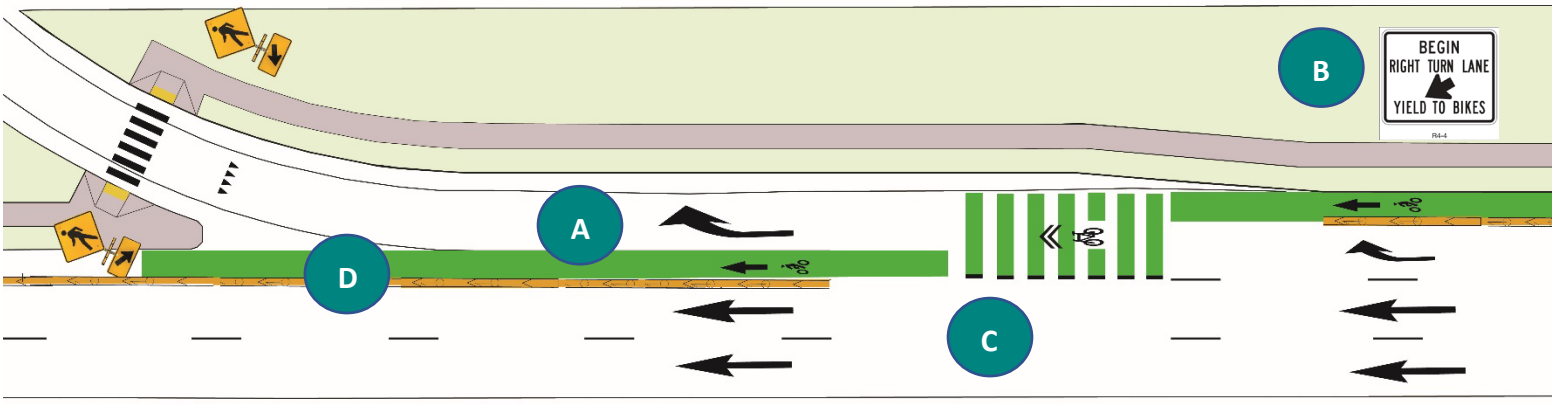
- Davis St/ I-880 Interchange in Alameda County
- Cutting Blvd / I-80 Contra Costa County

Design Features

A Class IV/Class I facility is typically preferred for interchanges, because it minimizes uncontrolled conflicts and provides maximum separation. Breaks in the buffer can be used to allow confident cyclists to merge early. Class IV through interchanges typically require a Design Standard Decision Document (DSDD) to implement.

B Provide signs and warning beacons to increase motorist awareness to the presence of bicyclists.

C Mark vehicle entrance on to ramp with green-colored conflict markings



Interchange – Interim design

Option 2: On-Ramp – Direct Path

The on-ramp direct path design option moves the conflict point of bicyclists and motor vehicles before the on-ramp, where confident cyclists would begin negotiating the merge. This treatment is similar to the striping of on-street bicycle lanes at standard intersections where dedicated right turn movements are present to avoid a right-hook collision. A benefit of this treatment is that it is a more direct route and a more expected facility, especially for strong and confident cyclists.

This facility wouldn't be considered an all ages and abilities facility and would only be an interim design, until more robust bicycle improvement could be installed.

Typical Application

- Existing freeway interchange upgrades or repaving projects

Example Caltrans Facilities

- Auto Mall Pkwy/ I-880 interchange in Alameda County
- Fremont Blvd/ I-880 interchange in Alameda County

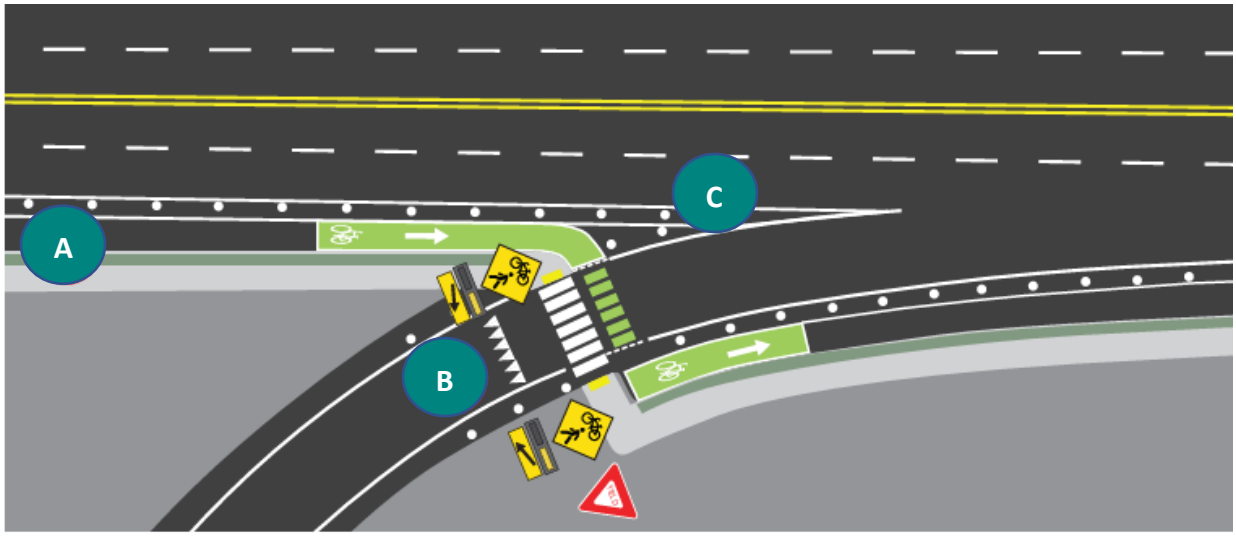
Design Features

A Limit length of the 'floating' bike lane to 150' or provide for greater separation such as a buffer or raised outer separation when the bike facility is between two lanes of traffic. Consider including a partially separated floating bike lane.

B Regulatory signs can help clarify who has the right of way.

C Mark vehicle entrance onto ramp with green-colored conflict markings. Green-colored pavement is used to enhance the conspicuity of locations where bicyclists are expected to operate and areas where bicycles and other roadway traffic might have potentially conflicting weaving crossing movements. Even if ramp includes multiple lanes, reduce ramp entry to a single vehicle lane to limit conflicts.

D Upgrade Class II bike lanes to Class IV separated bikeways where possible. Class IV through interchanges typically require a Design Standard Decision Document (DSDD) to implement.



Interchange – Interim design

Option 1: Off Ramp – Tight Merge

The off-ramp tight merge moves the path of the cyclists perpendicular to the off-ramp to minimize crossing distances. The use of green conflict markings and signage helps clarify the right of way. This option allows for as much of the bikeway to be upgraded to a Class IV as possible. The turn in the bikeway and the motor vehicle lane slows down speeds to take the turn slower.

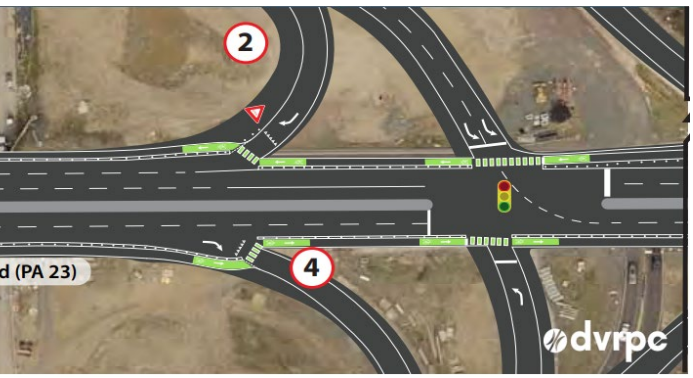
This facility wouldn't be considered an all ages and abilities facility and would only be an interim design, until more robust bicycle improvement could be installed.

Typical Application

- Freeway interchange retrofit or repaving projects

Example Caltrans Facilities

- Davis St/ I-880 Interchange in Alameda County



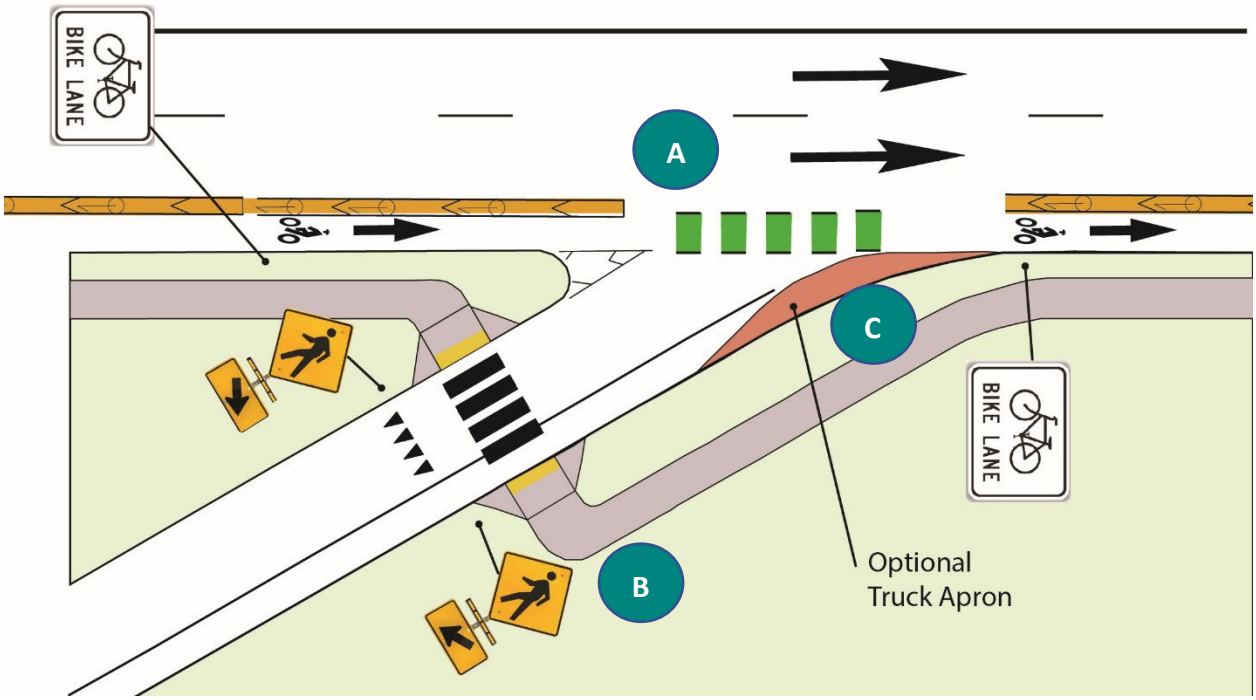
Design Features

A — Install Class IV separated bikeways where possible. Class IVs through interchanges typically require a Design Standard Decision Document (DSDD) to implement.

B — Use yield markings, and a green conflict crossing to clarify right of way at the crossing.

C — Mark vehicle crossing with green-colored conflict markings. Green-colored pavement is used to enhance the conspicuity of locations where bicyclists are expected to operate and areas where bicycles and other roadway traffic might have potentially conflicting weaving crossing movements.

- Provide signs and warning beacons to increase motorist awareness to the presence of bicyclists.
- For more info see Delaware Valley Regional Planning Commission. (2019). Guidance for Pedestrian and Bicycle Facilities at Expressway Interchanges in Southeastern Pennsylvania.



Interchange – Interim design

Option 2: Off ramp – Direct Path

The off-ramp direct path design option moves the conflict point of bicyclists closer to the roadway where motor vehicles merge with local road traffic. A benefit of this treatment is that it is a more direct route and a more expected facility, especially for strong and confident cyclists. This treatment can be supplemented with a truck turning apron to encourage motorists to take the turn slower and to reduce the crossing distance of cyclists.

This facility wouldn't be considered an all ages and abilities facility and would only be an interim design, until more robust bicycle improvement could be installed.

Typical Application

- Freeway interchange retrofit or repaving projects

Example Caltrans Facilities

- El Camino Real (SR-82)/ SR-85 interchange in Santa Clara County

Design Features

A Mark vehicle crossing with green-colored conflict markings. Green-colored pavement is used to enhance the conspicuity of locations where bicyclists are expected to operate and areas where bicycles and other roadway traffic might have potentially conflicting weaving crossing movements.

B Regulatory signs and supplemental striping can help clarify who has the right of way.

C Consider providing a truck apron along the right-side of the rightmost lane to encourage slower speeds.

Upgrade Class II bike lanes to Class IV separated bikeways where possible. Class IV through interchanges typically require a Design Standard Decision Document (DSDD) to implement.

For more info see Ohio Department of Transportation. (2024). Multimodal Accommodations at Interchanges and Alternative Intersections.

I-880 and Auto Mall Pkwy in Alameda County

Partially Separated Floating Bike Lanes – Interim Design

Partially separated floating bike lanes are Class II bike lanes that are positioned between two lanes of traffic with separation between the outside lane of traffic and the bike lane. While this wouldn't offer the same benefits of a full Class IV facility, it offers some benefits in constrained situations. The row of separation may act as a traffic calming feature that may increase the comfort of bicyclists. Using the features can be particularly effective at interchanges that often have high speeds and high volumes that can be uncomfortable facilities for bicyclists. This is an interim design to a fully separated bikeway and wouldn't be considered an all ages and abilities facility if adjacent to high-speed traffic.

Typical Application

- Any floating bike lane between a through and dedicated turn lane

Example Caltrans Facilities

- US-101 and Cochrane Rd in Santa Clara County
- I-880 and Auto Mall Pkwy in Alameda County

Design Features

A

Partially separated bike lanes can use bollards or channelizers for the separation.

- Channelizers may provide more robust separation than delineators. Qwick Kurb (see qwickkurb.com) is on Caltrans' list of authorized delineation materials. See also https://dot.ca.gov/-/media/dot-media/programs/engineering/documents/mets/signing-and-delineation-materials-a11y.pdf

US-101 and Old Redwood Hwy in Sonoma County

Raised Crosswalk at On Ramps

Raised crosswalks are ramped speed tables spanning the entire width of the roadway. The crosswalk is demarcated with paint and/or special paving materials. These crosswalks allow pedestrians to cross at grade with the sidewalk. A raised crosswalk can reduce speeds and enhance the pedestrian crossing environment. While these are primarily pedestrian facilities, they offer traffic calming benefits to cyclists and could also be used at Class I facilities.

Typical Application

- Raised crosswalks can be placed at freeway on ramp and off ramps
- Raised crosswalks can reduce pedestrian crashes by 45% (FHWA, 2018)

Example Caltrans Facilities

- US-101 and Old Redwood Hwy in Sonoma County

Design Features

A Detectable warnings (truncated domes) and curb ramps are installed at the street edge for pedestrians with impaired vision.

B The typical width for a raised crosswalk is 10 feet, which includes two 1-foot header curbs. Wider crosswalks may be appropriate at areas with higher pedestrian volumes.

Caltrans Bay Area Bicycle Best Practices

Bike Parking

Bike Parking at Mobility Hubs P-1

I-580 and Lakeshore Ave in Alameda County

Bicycle Parking at Mobility Hubs

Bike parking is an essential component to providing convenient bicycle facilities. Bicycle parking should be considered at all Caltrans locations that provide vehicle parking. Mobility hubs offer a unique opportunity to provide secure long-term parking, such as lockers. Mobility hubs are community anchors that enable travelers of all backgrounds and abilities to access multiple travel options — including shared scooters, bicycles and cars, and transit — as well as supportive amenities in a cohesive space. Offering secure bike parking at these locations is key to their success as a mobility hub. Unfortunately, Caltrans' outside vendor rules make providing secure bike lockers, such as BikeLink lockers, challenging. This can still be done by partnering with local city or other local jurisdictions.

Typical Application

- Long-term bike lockers can be located on the edges of mobility hubs, transit stations, or parking lots.
- Short-term bike parking should be placed near the entrances of major destinations, like shopping centers, schools, or parks.

Example Caltrans Facilities

- Caltrans' mobility hub beneath I-580 near Lakeshore Ave and Lake Park Ave

Design Features

A BikeLink lockers are common in the Bay Area. Most require a mobile app or membership card to unlock and pay by the hour. All long-term parking facilities should accommodate a variety of bicycle sizes and accessories.

B Standard short-term bike racks should be simple to use and visible to the building or facility entrance they serve. The best racks provide two points of contact with a bike frame, fit a standard U-lock, and accommodate a variety of bike shapes and sizes.

- Ensure all bike parking is located adjacent to sidewalks or Class I paths.
- Include pedestrian scale lighting and ensure visibility to prevent theft and ensure user safety at bicycle parking areas.

Other Best Practice Resources:

NACTO Urban Bikeway Guide, 2nd Edition

NACTO Urban Streets Design Guide

NACTO Transit Street Design Guide

Federal High Administration (FHWA) Small and Rural Multi-modal Networks Guide

AASHTO Guide for the Development of Bicycle Facilities, 4th Edition

AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities, 1st Edition

Caltrans Highway Design Manual Chapter 1000 Bicycle Transportation Design

Caltrans Class IV Bikeway Guidance Design Information Bulletin (DIB -89-02)

Caltrans Complete Streets Contextual Design Guidance Design Information Bulletin (DIB 94)

Federal Highway Administration (FHWA) Separated Bicycle Lane Planning and Design Guide

MassDOT Separated Bike Lane Planning and Design Guide

FHWA's Improving Intersections for Pedestrians and Bicyclists (2022)

References:

1. Maaza C. Mekuria, PhD, PE, PTOE Peter G. Furth, PhD Hilary Nixon, PhD. (2012) Low-Stress Bicycling and Networks Connectivity
2. Toll, Micah. (2022). US electric bicycle sales tracking toward 1 million annually, global market heading to $40B with a 'B' (Electrek, Feb 8, 2022).
3. Persaud, B., Lyon, C., Eccles, K., Lefler, N., Carter, D., and Amjadi, R. (2007) Safety Evaluation of Installing Center Two-Way Left-Turn Lanes on Two-Lane Roads. FHWA-HRT-08-042 Federal Highway Administration, Washington, DC
4. California Department of Transportation. (2022). Caltrans Class IV Bikeway Guidance (DIB -89-02).
5. Valley Transportation Authority. (2022). VTA Bicycle Technical Guidelines.
6. California Department of Transportation. (2023). Authorized Material List for Signing and Delineation Materials.
7. Washington Department of Transportation. (2015). WSDOT Design Manual M 22-01.12
8. Federal Highway Administration. (2000). FHWA. Roundabout: An Information Guide 2000.
9. Delaware Valley Regional Planning Commission. (2019). Guidance for Pedestrian and Bicycle Facilities at Expressway Interchanges in Southeastern Pennsylvania.
10. Ohio Department of Transportation. (2024). Multimodal Accommodations at Interchanges and Alternative Intersections.
11. Atlanta Regional Commission. Bike to Ride: An Idea Book of Regional Strategies for Improving Bicycling Access to Transit.
12. Alta. Corner Design for All Users. (2020).